1955

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Technical Bulletin No. 15 May 1955

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## Acknowledgements

These investigations were supported in part by grants-in-aid from the Abbott Laboratories, the Lederle Laboratories Division of American Cyanamid Company, and Chas. Pfizer and Company, Inc.

Supplies for this work were furnished as follows: crystalline Procaine Penicillin, Streptomycin mixture, vitamin $B_{12}$, riboflavin, niacin, and calcium pantothenate by Merck and Company; chlortetracycline (Aureomycin HC1) and tetracycline by Lederle Laboratories Division of American Cyanamid Company; arsanilic acid (Pro-Gen) by Abbott Laboratories; oxytetracycine (Terramycin), Antibiotic Feed Supplement P-2.4 (Diamine Penicillin), and the commercial fermentation product (Vigofac) by Chas. Pfizer and Company, Incorporated; D-L methionine by Dow Chemical Company; and protomone by Cerophyl Laboratories, Inc.

# Reproductive Performance of Chickens as Influenced by Antibiotics in the Diet

C. W. Carlson, R. A. Wilcox, Wm. Kohlmeyer, and D. G. Jones[1]

## Introduction

Many workers have reported on the failure of antibiotic supplementation to improve the performance of hens already in high egg production. Berg et al. (2) found Terramycin and Aureomycin[2] to be without effect on the performance of S. C. W. Leghorn pullets. Pullets fed either the basal plant protein mash-grain type diet or a diet containing up to 3 percent fish meal with or without antibiotics laid at a rate of 60 to 70 percent for the entire length of the various experiments.

Criteria used in their studies were rate of lay, gain in body weight, feed consumption, mortality, egg weight, egg quality, and hatchability of fertile eggs. Other workers reporting similar results included Lillie and Bird (14) with Aureomycin and R. I. Red pullets; Petersen and Lampman (16) with penicillin, streptomycin, or Terramycin and S. C. W. Leghorn pullets; Sunde, et al (20) with Aureomycin and S. C. W. Leghorn pullets; Johnson (12) with penicillin and New Hampshire pullets; and Carpenter et al. (9) with Aureomycin and Buff Rock pullets.

On the other hand, reports have appeared which indicated that under the reported conditions the antibiotics have favorably affected the performances of laying pullets. Reid et al. (17) reported that Aureomycin improved egg production with or without vitamin $B_{12}$ on a plant protein type diet containing 18 percent protein. Elam et al. (10) found penicillin improved the rate of egg production of crossbred pullets receiving a purified diet and injections of vitamin $B_{12}$.

Carlson et al. (8) reported that penicillin and streptomycin improved the performance of New Hampshire and White Plymouth Rock pullets with respect to egg production, feed efficiency, and hatchability of fertile eggs.[3] Kennard and Chamberlin (13) report-

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[2]Registered trademarks for oxytetracycline and chlortetracycline, respectively.

[3]A summation of part of the data submitted in this report has previously been published (8), (6), and (4).

ed that birds which received antibiotic supplements laid 10 percent more eggs with 11 percent less feed required per dozen eggs than those which received the same diet without antibiotics.

A later report from the Ohio Station by Yacowitz et al. (22) did not show any beneficial effects upon egg production with the use of Aureomycin and penicillin. They did report a beneficial effect of antibiotics in the diet of the dam upon progeny growth which confirmed earlier work by Bentley and Hershberger (1), Slinger et al. (18), and Carlson et al. (5).

A more recent report by Lillie and Sizemore (15) showed that a vitamin $B_{12}$ antibiotic feed supplement definitely improved egg production of the low producers but not that of the high producers. The results to be presented are a summation of 4 years of study on this problem involving heavy and light breed chickens on various feeding systems and with various antibiotics. In one instance arsanilic acid was also used.

## Procedure

The experiments were designed to make it possible to determine effects of supplementation with antibiotics as well as to compare various feeding systems. The diets used in these trials are shown in table 1. It will be noted that diets 205 and 206 were 20 percent protein mashes fed with free access to cereal grains, that diets 207 and 211 were 26 percent protein mashes fed with free access to cereal grains, and that diets 208, 209, and 210 were used as all-mash diets.

The total number of birds used in the series of experiments was 2300 laying hens and 7000 of their progeny.

As indicated in table 2, New Hampshire, White Plymouth Rock, Barred Plymouth Rock, S. C. W. Leghorn, or Experimental Hybrid pullets were used in these experiments. They were debeaked at housing time and were equally distributed by physical selection and according to source into prospective control and treated groups.

One exception in this regard concerns trial 6 of experiment 2 where the first choice birds were placed in the control group and those of second choice and showing 23 percent incidence of ocular leucosis were placed in the group to be treated. In all but two trials, 60 pullets were used per pen, with 5 males of similar stock.

In trial 5 of experiment 3 only 30 pullets per pen were used, and in trial 6 of the same experiment 70 pullets per pen were used. The pullets used in experiment 1 had been grown to housing time on typical starter and grower diets without antibiotics, whereas those for experiments 2 and 3 had received penicillin at a level of 2 grams per ton of diet during the growing period.

**Table 1. Composition of Breeder Diets Used**

| Ingredients | 205* % | 206* % | 207* % | 208† % | 209† % | 210† % | 211* % |
|---|---|---|---|---|---|---|---|
| Ground yellow corn | 20 | 31.5 | 10 | 66 | 72 | 64 | 10 |
| Wheat bran | 18 | 10 | 15 | 5 | 5 | 5 | 15 |
| Wheat standard middlings | 18 | 10 | 15 | 5 | 5 | 5 | 15 |
| Ground oats | 18 | 10 | 3 | 5 | 5 | 5 | 3 |
| Alfalfa meal (17%) | 4 | 4 | 6 | 2 | 2 | 2 | 6 |
| Meat scraps | 14 | 10 | 15 | 5 | 1 | 5 | 15 |
| Soybean meal (41%) | 7 | 10 | 15 | 5 | ---- | ---- | ---- |
| Soybean meal (44%) | ------- | ------- | ---- | ---- | 2 | 7 | 15 |
| Fish meal (60%) | ------- | 4 | 6 | 2 | 2 | 2 | 6 |
| Dried buttermilk | ------- | 4 | 6 | 2 | 2 | 2 | 6 |
| A & D oil (750-300D) | .5 | 1.5 | 1.5 | .5 | .5 | .5 | 1.5 |
| Steamed bone meal | ------- | 4 | 6 | 2 | 3 | 2 | 6 |
| Salt mix‡ | .5 | 1 | 1.5 | .5 | .5 | .5 | 1.5 |
| Riboflavin mg./lb. | 1.5 | 1.5 | 1.5 | .6 | 1.7 | 1.7 | 4.4 |
| Niacin, mg./lb. | ------- | ------- | ------- | 10 | 10 | 10 | 30 |
| Ca pantothenate, mg./lb. | ------- | ------- | ------- | ------- | 3 | 3 | 9 |
| Vitamin $B_{12}$, mcg./lb. | ------- | ------- | ------- | ------- | 2 | 2 | 3 |
| Calculated % protein | 20 | 20 | 26 | 15 | 12 | 16 | 26 |

*Fed with access to corn, oats, oyster shell, granite grit, and water.
†Fed as all-mash with access to oyster shell, granite grit, and water.
‡Iodized salt containing 2½ percent manganese sulfate.

**Table 2. Plan of Experiments**

| Exp. No. | Trial No. | Diet Number | Breed | Supplement Added Gm. per Ton of Mash | |
|---|---|---|---|---|---|
| 1 | 1 | 205 | New Hampshire | Procaine Penicillin | 24* |
| | | | | Streptomycin | 60† |
| | 2 | 205 | New Hampshire | Procaine Penicillin | 4* |
| | | | | Streptomycin | 60† |
| | 3 | 205 | White Plymouth Rock | Procaine Penicillin | 4* |
| | | | | Streptomycin | 60† |
| | 4 | 205 + Vit. $B_{12}$‡ | White Plymouth Rock | Procaine Penicillin | 4* |
| | | | | Streptomycin | 60† |
| 2 | 1 | 205 | White Plymouth Rock | Procaine Penicillin | 4* |
| | 2 | 206 | White Plymouth Rock | Procaine Penicillin | 4* |
| | 3 | 207 | White Plymouth Rock | Procaine Penicillin | 6* |
| | 4 | 207 | New Hampshire | Procaine Penicillin | 6* |
| | 5 | 208 | New Hampshire | Procaine Penicillin | 2* |
| | 6 | 205 | Barred Plymouth Rock | Chlortetracycline | 200†§ |
| 3 | 1a | 209 | White Plymouth Rock | Arsanilic Acid | 120† |
| | 1b | 209 | White Plymouth Rock | Procaine Penicillin | 4* |
| | 2‖ | 210 | White Plymouth Rock | Procaine Penicillin | 4* |
| | 3 | 211 | New Hampshire | Chlortetracycline | 150† |
| | 4 | 211 | New Hampshire | Chlortetracycline | 300† |
| | 5 | 211 | Exp. Hybrids | Oxytetracycline | 300† |
| | 6 | 211 | Single Comb White Leghorn | Tetracycline | 300† |

*Considered as "low level" in the discussion and presentation of results.
†Considered as "high level" in the discussion and presentation of results.
‡4 mcg. per lb. of mash.
§Dropped to 100 grams midway in the experiment.
‖Replicated.

After housing, the pullets of experiments 1 and 2 were fed the 20 percent protein laying mash-grain diet No. 205 shown in table 1 for at least a 2-month pre-treatment period. In the pre-treatment period of experiment 3, diet No. 208, slightly modified, was used for trials 1 and 2, and diet No. 207, slightly modified, was used for 3, 4, 5, and 6.

The experiments were conducted during the years as follows: trial 1 of experiment 1 in 1950-51, trials 2, 3, 4 of experiment 1 in 1951-52, experiment 2 in 1952-53, and experiment 3 in 1953-54. Treatments were begun and the changeover to the various diets made on December 1 of the various years with the exception that trial 1 of experiment 1 was initiated on November 15, and trial 6 of experiment 3 was initiated January 1.

In trials 2, 3, and 4 of experiment 1 a Newcastle Disease outbreak occurred in December. Because of these differences in initiation dates and the disease outbreak, all feed efficiency data presented for the treatment periods represent that obtained after January 1.

All trials were conducted in 12 foot by 20 foot pens under one roof and in similar locations with access from a central alleyway with the exception that trial 6 of experiment 3 was conducted in a divided 16 foot by 32 foot rammed-earth laying house. Fresh straw litter was provided at the start of the pre-treatment period with removal and replenishment undertaken only as the need arose. Electric lights were used to obtain a minimum of 13 hours of light daily.

Eggs were saved for at least three hatches at intervals of approximately 4 weeks during the treatment periods. A minimum of 200 fertile eggs per pen was thus obtained over the entire period. Infertile eggs were removed by candling after 7 days of incubation and were checked for possible error by breaking them and observing the germ spot. The progeny obtained were placed on various diets and grown out to 4 weeks of age or longer. At the time of setting eggs for incubation in February, three eggs from each hen were weighed to obtain the average weight of eggs produced on the various treatments.

Interior egg quality as measured by Haugh units (11) was obtained on eggs saved from each hen in production in June for experiment 2 and in both February and June for experiment 3. For experiment 2, two eggs were broken out from each hen for Haugh unit determinations and only those data where the agreement between the two eggs was within 8 Haugh units were used in calculating the averages reported. The accuracy gained by that procedure was of little magnitude and therefore only one egg per hen was broken out in experiment 3.

Averaging the values obtained from a number of hens seemed to provide an accurate index of the pen Haugh unit value. Brant et al. (3) showed that two eggs from the same hen agreed within 8 Haugh units 93 percent of the time.

Feed consumption tabulations and individual body weight measurements were made periodically throughout the trial periods.

# Results and Discussion

### Egg Production

Data obtained for percent egg production are shown in table 3. As indicated in the table, egg production during the pre-treatment period for the various groups was rather uniform in all trials, however, there were some exceptions. In spite of the care taken to provide uniformity, these data point up the frequency of encountering nonuniformity in similar groups of birds. By having the pre-treatment data however, each group of birds within each trial can be used to serve as its own control. The relative performance figures represented the production performance during the entire treatment period as a percent of that during the pre-treatment period.

Pre-treatment egg production should represent typical production of the group before treatment to make these calculations valid. For example in trials 3 and 4 of experiment 3, where pre-treatment production was between 21 and 30 percent, the relative performance figures were of reverse order to those of the treatment period. Many of the pullets in these trials were not yet in production in the pre-treatment period, and so their performance would not have been rated.

Further consideration should be given to the pre-treatment data of trial 6, experiment 2. Here the control group was producing at 50 percent while the prospective treated group, that had showed evidence of ocular leucosis, was producting at 42 percent. Following initiation of treatment however, the control group went into a production slump which was a common occurrence in January and February, whereas the treated group maintained production at about the same level.

Concerning the treatment period, as a whole, it is noteworthy that greater advantages for the antibiotic treated pens were indicated for January and February than for the entire experimental period ending June 30. Many earlier advantages were to some extent lost by a failure of the treated groups to perform as well as the control groups in the last 3 months of the treatment period. Nevertheless, considering the final averages for each part of each trial as an individual statistic, the differences between the average of the respective "low level" and "high level" (see table 2) control groups and average of the corresponding treated groups as shown in table 4 were found to be highly significant by an analysis of variance.

The final differences, thus real, justify further consideration of their earlier complement. However, no completely satisfactory explanation can be given for the relatively greater differences shown early in the experimental period.

The outbreak of Newcastle Disease encountered in experiment 1 undoubtedly placed a stress upon the birds that would have been most evident in January, however in trial 3 of experiment 1, one ex-

**Table 3. Egg Production of Hens Fed Diets With and Without Antibiotics***

| | | | Egg Production Cumulative Through Month Listed (Hen Day) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-treatment Period | Treatment Period† | | | | | |
| Exp. | Trial | Group | Oct. & Nov. % | Feb. % | March % | April % | May % | June % | Relative Performance‡ |
| 1 | 1 | Control | 39.4 | 38.0 | 39.5 | 38.8 | 38.7 | 38.3 | 97.2 |
| | | Penicillin | 39.2 | 47.1 | 46.2 | 43.8 | 42.1 | 39.0 | 99.5 |
| | | Streptomycin | 41.8 | 45.4 | 45.2 | 43.6 | 42.1 | 40.7 | 97.4 |
| | 2 | Control | 54.1 | 37.8 | 40.0 | 41.9 | 43.7 | 43.1 | 79.7 |
| | | Penicillin | 47.5 | 44.9 | 46.9 | 46.3 | 45.9 | 45.5 | 95.8 |
| | | Streptomycin | 54.0 | 45.1 | 49.1 | 48.6 | 50.0 | 49.3 | 91.3 |
| | 3 | Control | 68.3 | 45.6 | 43.1 | 39.3 | 37.3 | 35.4 | 51.8 |
| | | Penicillin | 64.6 | 40.1 | 40.0 | 36.1 | 36.7 | 35.2 | 54.5 |
| | | Streptomycin | 66.7 | 40.4 | 40.3 | 41.5 | 40.3 | 38.7 | 58.0 |
| | 4 | Control | 58.8 | 32.4 | 34.5 | 35.8 | 36.1 | 34.9 | 59.4 |
| | | Penicillin | 57.3 | 43.5 | 42.3 | 42.1 | 41.3 | 39.1 | 68.2 |
| | | Streptomycin | 61.4 | 46.5 | 46.8 | 46.7 | 45.1 | 41.8 | 68.1 |
| 2 | 1 | Control | 59.9 | 38.5 | 38.7 | 37.5 | 37.2 | 36.3 | 60.6 |
| | | Penicillin | 61.3 | 49.8 | 46.2 | 44.5 | 42.3 | 40.6 | 66.2 |
| | 2 | Control | 60.9 | 39.1 | 41.3 | 39.5 | 40.2 | 40.0 | 65.7 |
| | | Penicillin | 52.4 | 45.3 | 46.5 | 46.4 | 44.1 | 43.1 | 82.3 |
| | 3 | Control | 63.8 | 48.9 | 46.0 | 44.0 | 41.7 | 40.9 | 64.1 |
| | | Penicillin | 59.5 | 54.8 | 51.0 | 47.7 | 45.9 | 44.7 | 75.1 |
| | 4 | Control | 51.1 | 43.1 | 46.0 | 45.6 | 43.3 | 42.0 | 82.2 |
| | | Penicillin | 51.4 | 45.8 | 47.6 | 47.9 | 47.7 | 47.1 | 91.6 |
| | 5 | Control | 56.2 | 45.2 | 45.8 | 46.8 | 48.2 | 49.1 | 87.4 |
| | | Penicillin | 58.2 | 48.4 | 51.4 | 52.0 | 50.9 | 49.4 | 84.9 |
| | 6 | Control | 49.6 | 37.3 | 36.6 | 36.0 | 35.4 | 34.9 | 70.4 |
| | | Chlortetracycline | 41.9 | 40.8 | 42.8 | 42.5 | 40.9 | 39.3 | 93.8 |
| 3 | 1 | Control | 53.5 | 49.4 | 50.3 | 50.1 | 49.5 | 48.2 | 90.1 |
| | | Arsanilic Acid | 49.8 | 59.2 | 57.4 | 56.6 | 54.4 | 52.4 | 105.2 |
| | | Penicillin | 47.3 | 51.0 | 53.9 | 53.6 | 52.0 | 50.4 | 106.6 |
| | 2a | Control | 45.9 | 53.3 | 52.5 | 53.4 | 52.9 | 51.9 | 113.1 |
| | | Penicillin | 48.0 | 62.0 | 60.5 | 59.6 | 57.9 | 55.7 | 116.0 |
| | 2b | Control | 48.2 | 56.5 | 56.3 | 55.7 | 54.2 | 52.4 | 108.7 |
| | | Penicillin | 39.7 | 49.6 | 50.3 | 50.9 | 51.2 | 50.6 | 127.5 |
| | Av. | Control—2a and 2b | 47.1 | 54.9 | 54.4 | 54.6 | 53.6 | 52.2 | 110.8 |
| | Av. | Penicillin—2a and 2b | 43.9 | 55.9 | 55.5 | 55.4 | 54.6 | 53.2 | 121.2 |
| | 3 | Control | 24.5 | 37.6 | 40.7 | 41.5 | 41.9 | 41.7 | 170.2 |
| | | Chlortetracycline | 29.7 | 44.4 | 46.0 | 46.4 | 46.1 | 45.1 | 151.9 |
| | 4 | Control | 21.3 | 41.0 | 43.1 | 43.0 | 42.9 | 42.9 | 201.4 |
| | | Chlortetracycline | 24.5 | 46.0 | 46.2 | 44.1 | 44.2 | 43.3 | 176.7 |
| | 5 | Control | 39.2 | 66.8 | 66.7 | 66.9 | 66.3 | 65.0 | 165.8 |
| | | Oxytetracycline | 34.7 | 76.1 | 75.0 | 73.8 | 72.4 | 70.6 | 203.5 |
| | 6 | Control | 30.0§ | 52.1 | 54.4 | 54.2 | 53.7 | 51.8 | 172.7 |
| | | Tetracycline | 33.6§ | 63.9 | 66.3 | 67.7 | 66.7 | 65.0 | 193.5 |

*See table 2 for levels of antibiotics used.

†Starting January 1 and through end of month listed for experiments 1 and 2; December 1 for experiment 3.

‡Performance during entire treatment period as percent of that during pre-treatment period.

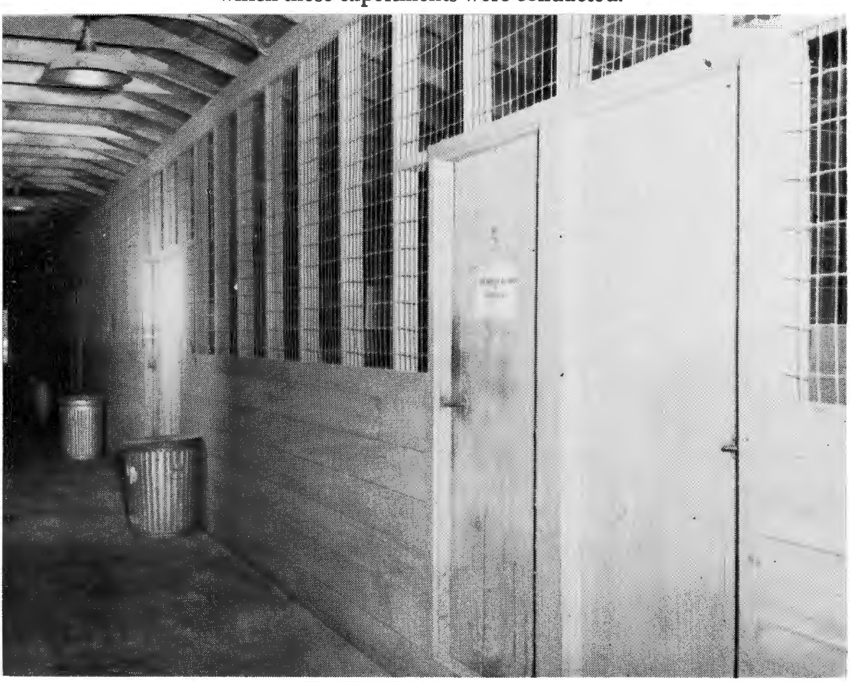
§December production averages, treatment period began January 1.

ception to this general trend was noted. The beneficial effect in this trial was not evidenced until late in the period and then only for the streptomycin-treated group and not the penicillin-treated group. In general, the dietary energy requirement would be greater in January and February because of the colder weather and consequently lower temperature within the laying house.

Recent evidence from this station with growing turkeys (7) indicates that greater responses to antibiotics are evidenced on diets of relatively low available energy content than on so-called "high energy diets." It may well be then, that when the requirements for energy are more critical or when infectious organisms are more virulent, the antibiotics may have more of a beneficial effect upon laying hens as in the majority of the trials here reported.

Considering the data given for relative performance, it is striking that in all instances except trial 1, experiment 1; trial 5, experiment 2; and trials 2a, 3, and 4 of experiment 3, the antibiotic-treated groups showed a higher relative performance than is indicated by the data on percent egg production for the treatment period. For the most part, performance data obtained during the pre-treatment period accentu-

**Figure 1. Center alleyway and east half of laying house pens in which these experiments were conducted.**



ated the differences in results obtained during the treatment period.

The effects of dietary variations other than antibiotic supplementation and response to antibiotics should be considered. The relative performance figures when considered concurrently with the treatment period figure under June in table 3 indicate that some improvement in the control diets was made in the course of this work. Not to be disregarded however, is that successive generations of stock selected for egg production were used in the successive experiments, and therefore some improvement in performance was no doubt due to selection. Disease incidence and other environment influences may have also had an effect. Nevertheless, consideration of probable dietary improvements is in order.

Diet No. 205 used for experiment 1 and in trials 1 and 6 of experiment 2 appeared inferior to the improved 20 percent protein mash and grain diet No. 206 used in trial 2 of experiment 2. The 26 percent protein mash and grain diet No. 207 as used in trial 3 of experiment 2 did not appear to promote any better egg production than diet No. 206 when used with the White Plymouth Rocks. However, diet No. 207 when used with the New Hampshires in trial 4, experiment 2, appeared somewhat inferior to the all-mash high energy diet No. 208, used in trial 5. Diet No. 210, which was essentially diet No. 208, modified to contain a higher protein level and more riboflavin, calcium pantothenate, and vitamin $B_{12}$ used in trials 2a and 2b, experiment 3, appeared to greatly improve the performance of the White Plymouth Rocks. The all-mash diet No. 209 used in trial 1, experiment 3 supported rather exceptional egg production, considering its low protein content of 12 per cent. Modifications of diet No. 207 in producing diet No. 211 did not appear to improve its performance as used in trials 3 and 4, experiment 3. The Experimental Hybrids were able to produce well on diet No. 211 however.

It would not appear that the changes made in the mash-grain types of diets had a great effect on the responses obtained from penicillin. In experiment 1 the supplementation of diet No. 205 with vitamin $B_{12}$ apparently allowed for a response to penicillin, comparing trial 4 with trial 3. However, in experiment 3 when all-mash diets of adequate vitamin $B_{12}$ and protein content were used, the responses from penicillin were small. The relative performace figures show a good response in trial 2b, but only a slight response in trial 2a.

When the 12 percent protein all-mash diet was used, however, the relative performance figures show a good response from both arsanilic acid and penicillin. These latter results indicate that penicillin and arsanilic acid may enhance the utilization of protein for laying hens, as has been reported for penicillin and Aureomycin for chicks by Thayer and Heller (21). These results do not show a sparing effect on the protein requirements, although the results may point in that direction. Further work is needed to clarify this point, but the results indicate the feasibility of producing eggs quite economically on low protein diet composed of essentially of cereal grains and very small additions of recognized sources of unidentified factors supplemented with ample amounts of minerals, vitamins, and arsanilic acid or an antibiotic.

The antibiotic responses on the free-choice diets were not correlated with percentage protein intake, however. Calculations based on relative mash and grain intake and compositions indicated that the percentage protein of the consumed diets varied from approximately 13 percent in trial 3 of experiment 1 to 16 percent in trial 3 of experiment 2

In trial 3 of experiment 1 there was no effect of penicillin on egg production, whereas in trial 3 of experiment 2 there appeared to be an effect. There were too many variables other than protein composition to make a valid comparison. Nevertheless, it is evident that the effect of the antibiotics on the free choice diets cannot be explained on the basis of enhanced protein utilization. Further work is in progress to clarify this problem. Enhanced energy utilization coupled with enhanced utilization of protein not excluding other nutrients, are all possible modes of action.

The figures in table 4 show that larger responses to antibiotics were obtained with the "high levels" than with the "low levels" of antibiotics. Although the averaged responses in either case were not great, use of the antibiotics would appear desirable. Whether to use a "low level" of an antibiotic or a "high level" should not be determined from these data, however. The actual disease level encountered as in part evidenced by rate of lay would probably be the determining factor. A breakdown of the data from trial 1, experiment 1 showed that the better egg producers were not being affected by the antibiotics; only the poorer producers were enabled to lay more eggs. This is in agreement with the results reported by Lillie and Sizemore (15).

## Mortality

Any effect mortality may have had on the results would be ruled out of the data shown in table 5.

**Table 4. Summary of Egg Production of Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| Experiment | No. of Trials | Hen Day Production Control % | Low Level % | High Level % |
|---|---|---|---|---|
| 1 | 4 | 37.9 | 39.7 | 42.6 |
| 2 | 5 | 41.7 | 44.9 | ........ |
| 2 | 1 | 34.9 | ... | 39.3 |
| 3 | 3 | 50.9 | 52.3 | 52.4* |
| 3 | 4 | 47.9 | ..... | 53.3 |
| **Average all Low Levels** | **12** | **42.7** | **45.0†** | ...... |
| **Average all High Levels** | **9** | **43.6** | | **48.2†** |

*Arsanilic acid, one trial, not included in the averages.
†The increase over that of the control groups was found to be highly significant.

**Table 5. Average Number of Trap-nested Eggs Laid Per Survivor From Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| Exp. | Trial | No. Days Trap Nested | Control | Low Level | High Level |
|---|---|---|---|---|---|
| 1 | 1 | 151 | 52 (33)* | 48 (41) | 51 (34) |
| | 2 | 145 | 56 (31) | 62 (26) | 64 (30) |
| | 3 | 145 | 46 (42) | 48 (39) | 51 (39) |
| | 4 | 145 | 53 (37) | 54 (33) | 54 (36) |
| | **Av.** | | **52** | **53** | **55** |
| 2 | 1 | 140 | 51 (45) | 62† (40) | ---- ---- |
| | 2 | 140 | 58 (45) | 62 (41) | ---- ---- |
| | 3 | 140 | 59 (39) | 67 (42) | ---- ---- |
| | 4 | 140 | 59 (28) | 68† (38) | ---- ---- |
| | 5 | 140 | 70 (39) | 69 (38) | ---- ---- |
| | 6 | 140 | 53 (37) | ---- -- | 57 (23) |
| | **Av. of 1, 2, 3** | | **56** | **63‡** | --- |
| | **Av. of 4, 5** | | **64** | **68** | ---- |
| 3 | 1 | 95 | 46 (20) | 46 (20) | 49 (16)§ |
| | 2a | 95 | 50 (15) | 51 (14) | ---- ---- |
| | 2b | 95 | 49 (16) | 47 (12) | - - ---- |
| | 3 | 95 | 40 ( 7) | ---- - -- | 41 ( 9) |
| | 4 | 95 | 40 ( 6) | ---- - - | 37 ( 7) |
| | 5 | 95 | 59 ( 8) | ---- ---- | 64 ( 8) |
| | 6 | 80 | 46 ( 6) | | 56‡ ( 9) |

*Numbers in parenthesis indicate production during pre-experimental periods.
†Significantly greater at the 5% point than the corresponding control.
‡Significantly greater at the 1% point that the corresponding control.
§Arsanilic acid.

Statistical analyses were conducted on the egg production data of surviving hens from which this summary was obtained, and these analyses showed that three trials exhibited significant differences. These were trials 1 and 4 of experiment 2 and trial 6 of experiment 3. Greater numbers of individuals in other trials may have shown a higher level of significance, as is indicated when trials 1, 2, and 3 of experiment 2 were consolidated and thus showed a highly significant difference in favor of the antibiotic group. Total mortality or type of mortality was not greatly affected by antibiotic feeding as shown in tables 6 and 7. There were some differences in mortality that would appear to be of real magnitude—trial 4, experiment 1, trial 6, experiment 2, and trial 6, experiment 3—where more birds from the respective control groups died. However there are other trials showing a reverse order with more birds dying from the treated groups, particularly the first four trials of experiment 2.

**Table 6. Mortality of Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| Exp. | Trial | Mortality Control % | Low Level % | High Level % |
|---|---|---|---|---|
| 1 | 1 | 22 | 16 | 20 |
| | 2 | 20 | 29 | 26 |
| | 3 | 24 | 23 | 33 |
| | 4 | 44 | 32 | 19 |
| 2 | 1 | 19 | 33 | ---- |
| | 2 | 18 | 36 | ---- |
| | 3 | 24 | 38 | --- |
| | 4 | 25 | 34 | - - |
| | 5 | 43 | 29 | -- |
| | 6 | 64 | - -- | 43 |
| 3 | 1 | 16 | 14 | 21* |
| | 2 | 26 | 20 | - - |
| | 3 | 16 | ---- | 17 |
| | 4 | 34 | ---- | 36 |
| | 5 | 17 | ---- | 21 |
| | 6 | 36 | | 14 |

*Arsanilic acid.

**Table 7. Distribution of Types of Mortality—Experiment 3**
(Not including Arsanilic acid part of trial 1 or any of trial 6.)

| Cause* | Control % | Low Level Antibiotics % | High Level Antibiotics % |
|---|---|---|---|
| Leucosis | 1.3 | 1.6 | ---- |
| Chronic Respiratory Disease | 1.0 | 1.8 | 1.4 |
| Fowl Cholera | 2.9 | 1.2 | 3.6 |
| Hemorrhage | 1.6 | .6 | ------ |
| Visceral Gout | 1.6 | ---- | 2.2 |
| Miscellaneous | 1.6 | 1.2 | 5.0 |
| No Diagnosis | 12.9 | 12.9 | 11.5 |
| **Total** | **22.9** | **18.1** | **23.7** |

*Post mortems were conducted by Dr. T. A. Dorsey of the Veterinary Department.

## Weight Maintenance

Body weight maintenance was not appreciably affected by the antibiotics except in trial 6, experiment 3, as shown in table 8. The controls in that instance were definitely losing weight and only averaged 3.7 pounds in June, whereas the treated group averaged 4.4 pounds at the same time. This difference, coupled with the egg production and mortality differences, indicates that the control birds in this trial were affected by one or more pathological conditions. Symptoms of a respiratory disease in this group were evident during the course of the trial. Chronic Respiratory Disease was suspected as being prevalent though diagnosis did not reveal this.

**Table 8. Body Weight Index of Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| | | June Weight as a Percent of January Weight | | |
|---|---|---|---|---|
| Exp. | Trial | Control | Low Level | High Level |
| 1 | 1 | 106 | 111 | 108 |
| | 2 | 98 | 97 | 99 |
| | 3 | 94 | 100 | 97 |
| | 4 | 94 | 96 | 93 |
| 2 | 1 | 99 | 98 | ----- |
| | 2 | 101 | 98 | ------ |
| | 3 | 96 | 93 | ------ |
| | 4 | 100 | 97 | ------ |
| | 5 | 100 | 99 | ------ |
| | 6 | 101 | ---- | 104 |
| 3 | 1 | 99 | 99 | 100* |
| | 2 | 103 | 102 | ------ |
| | 3 | 103 | ------ | 103 |
| | 4 | 103 | ------ | 99 |
| | 5 | 106 | ------ | 105 |
| | 6 | 82 | --- | 104 |

*Arsanilic acid.

**Table 9. Pounds of Feed Consumed Per Dozen Eggs Produced By Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| Exp. | Trial | Control Lbs. | Low Level Lbs. | High Level Lbs |
|---|---|---|---|---|
| 1 | 1 | 10.4 | 10.1 | 9.7 |
| | 2 | 8.3 | 8.4 | 7.3 |
| | 3 | 9.7 | 9.3 | 9.0 |
| | 4 | 10.1 | 8.5 | 7.4 |
| 2 | 1 | 11.6 | 10.3 | ------ |
| | 2 | 10.4 | 9.5 | ------ |
| | 3 | 10.1 | 9.4 | ----- |
| | 4 | 9.5 | 8.5 | ----- |
| | 5 | 8.1 | 7.3 | ------ |
| | 6 | 11.0 | --- | 10.4 |
| 3 | 1 | 7.1 | 7.2 | 6.6* |
| | 2 | 6.5 | 6.9 | ------ |
| | 3 | 7.6 | ------ | 8.0 |
| | 4 | 8.5 | ------ | 7.2 |
| | 5 | 6.3 | ------ | 5.9 |
| | 6 | 5.0 | - | 4.5 |

*Arsanilic acid.

## Feed Efficiency

Results on the efficiency of feed utilization for egg production, shown in table 9, demonstrated greater efficiency where higher production was obtained. Such would be expected, and these figures for most part only corroborate the previous data. One general observation would be that as the diets were improved, egg production and subsequent feed efficiency also improved.

The feed efficiency obtained in trial 6, experiment 3 was worthy of note, particularly that from the antibiotic group—4.5 pounds of feed per dozen eggs—especially since relative feed intake was greater in that group also. Examination of feed consumption data, not shown, indicates that the low level antibiotic supplemetation had little effect upon feed intake. It may have reduced feed consumption, particularly mash intake of the free-choice diets.

Further evidence that the antibiotics had an effect in part by improving the utilization of energy was that in the free-choice trials of experiment 2 (all but trial 5 which was all-mash) the antibiotic groups all ate less mash and corn and more oats than the control groups. In experiment 1, the antibiotic-fed groups in general ate less mash, but grain was fed as a mixture and relative oats and corn consumption could not be determined. It would appear that the birds were able to utilize oats to a greater extent in the presence of an antibiotic. The groups receiving "high levels" of antibiotics showed an increased feed consumption in general, although in some cases it appeared to be more of an initial stimulation effect that wore off in time.

## Egg Weight and Quality

Some effects of antibiotics upon egg weight and quality are shown in table 10. It appeared, on the basis of the results of experiment 1, that the hens receiving antibiotics produced slightly smaller eggs. However, that effect was not noted in experiments 2 and 3 where the average weights varied both ways. There does not appear to be any great effect upon interior egg quality as shown by the Haugh unit values, however, the control groups did show higher values in most instances.

Of note also is the decline in interior egg quality observed between most of the February and June observations. This is in agreement with previous reports. Less

**Table 10. Weight and Quality of Eggs Produced by Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| | | Average Weight—February | | | Average Haugh Units—June | | |
|---|---|---|---|---|---|---|---|
| Exp. | Trial | Control gm. | Low Level gm. | High Level gm. | Control | Low Level | High Level |
| 1 | 1 | 59.1 | 59.6 | 57.7 | ------------ | ------------ | ------------ |
| | 2 | 56.1 | 55.4 | 54.8 | ------------ | ------------ | ------------ |
| | 3 | 60.4 | 59.6 | 59.3 | ------------ | ------------ | ------------ |
| | 4 | 61.0 | 60.0 | 60.6 | ------------ | ------------ | ------------ |
| 2 | 1 | 65.3 | 66.3 | ------ | 81 | 78 | ------------ |
| | 2 | 67.1 | 66.2 | ------ | 80 | 79 | ------------ |
| | 3 | 66.6 | 63.6 | ------ | 80 | 77 | ------------ |
| | 4 | 57.0 | 57.7 | ------ | 76 | 76 | ------------ |
| | 5 | 56.9 | 59.1 | ------ | 74 | 72 | ------------ |
| | 6 | 58.8 | ------ | 57.7 | 73 | ------------ | 72 |
| 3 | 1 | 64.2 | 64.9 | 65.1* | 75 (76)† | 77 (80) | 76 (77)* |
| | 2 | 63.9 | 64.2 | ------ | 72 (76) | 71 (78) | ------------ |
| | 3 | 57.5 | ------ | 58.4 | 74 (77) | ------------ | 71 (73) |
| | 4 | 58.1 | ------ | 58.4 | 77 (80) | ------------ | 73 (76) |
| | 5 | 56.6 | ------ | 54.9 | 66 (78) | ------------ | 59 (76) |
| | 6 | 59.6 | ------ | 59.7 | 71 (75) | ------------ | 70 (71) |

*Arsanilic acid.
†Numbers in parenthesis refer to the Haugh Unit value determined in February.

**Table 11. Hatchability of Fertile Eggs from Hens Fed Diets Without and With Low and High Levels of Antibiotics**

| Exp. | Trial | Control % | Low Level % | High Level % |
|---|---|---|---|---|
| 1 | 1 | 80.6 | 85.1 | 90.5 |
| | 2 | 88.2 | 86.7 | 86.9 |
| | 3 | 66.8 | 73.3 | 73.6 |
| | 4 | 62.4 | 67.1 | 73.0 |
| 2 | 1 | 80.5 | 80.2 | ...... |
| | 2 | 76.0 | 81.7 | ..... |
| | 3 | 77.3 | 77.2 | ..... |
| | 4 | 83.9 | 86.2 | ..... |
| | 5 | 85.6 | 84.6 | ..... |
| | 6 | 74.7 | ..... | 70.7 |
| 3 | 1 | 70.6 | 80.8 | 77.7* |
| | 2 | 67.7 | 71.7 | ...... |
| | 3 | 83.4 | ...... | 87.6 |
| | 4 | 87.7 | ...... | 85.0 |
| | 5 | 78.7 | ...... | 74.3 |
| | 6 | 76.5 | ...... | 82.3 |

*Arsanilic acid.

decline was observed on the 12 percent protein diet (trial 1, experiment 3) than on the regular 16 percent protein diet (trial 2, experiment 3). It would not appear therfore that a low protein diet is necessarily detrimental to interior egg quality, as some have presumed.

**Table 12. Growth Index of March Hatched Progeny From Antibiotic-Fed Hens as Compared to That of Control Hens**
Experiment 1
(16-53 chicks/lot)

| Trial | Antibiotic in Maternal Diet | Four Week Comparative Growth*: Chick Basal Diet† % | Four Week Comparative Growth*: Chick Basal Diet + 5 mg. Procaine Penicillin/lb. % |
|---|---|---|---|
| 1 | Penicillin | 97 | 99 |
| | Streptomycin | 99 | 101 |
| 2 | Penicillin | 109 | 103 |
| | Streptomycin | 101 | 101 |
| 3 | Penicillin | 88 | 91 |
| | Streptomycin | 84 | 107 |
| 4 | Penicillin | 92 | 96 |
| | Streptomycin | 93 | 88 |
| **Av.** | **Penicillin** | **97** | **97** |
| **Av.** | **Streptomycin** | **94** | **99** |

*Growth is expressed as $\frac{\text{Average Weight of Treated group}}{\text{Average Weight of Control Group}}$.

†The basal diet used for the progeny consisted of, in percent, ground yellow corn 40, wheat bran 5, wheat standard middlings 5, ground oats 17, alfalfa meal 3, meat scraps 10, soybean meal 14, dried buttermilk 5, fish oil (300D-750A) ½, salt mix ½, and vitamin $B_{12}$ 0.6 mcg./lb. The chicks were grown in batteries.

## Hatchability

Hatchability was not consistently affected by the antibiotics used, as is shown in table 11. In some trials

**Table 13. Growth Index of June Hatched Progeny from Antibiotic-Fed Hens as Compared to That of Control Hens**
Experiment 1
(9-17 chicks/lot)

| Trial | Antibiotic in Maternal Diet | Four Week Comparative Growth*: Chick Basal Diet† % | 1 mg. Penicillin/lb. % | Penicillin + 0.1% Methionine % | Penicillin + 5% Fish Meal % | Penicillin + Fish Meal + Methionine % |
|---|---|---|---|---|---|---|
| 2 | Penicillin | 88 | 102 | 96 | 95 | 95 |
| | Streptomycin | 108 | 105 | 103 | 110 | 100 |
| 3 | Penicillin | 98 | 96 | 86 | 90 | 98 |
| | Streptomycin | 107 | 88 | 89 | 90 | 96 |
| 4 | Penicillin | 84 | 80 | 77 | 84 | 90 |
| | Streptomycin | 90 | 89 | 88 | 93 | 97 |
| **Av.** | **Penicillin** | **90** | **93** | **86** | **90** | **94** |
| **Av.** | **Streptomycin** | **102** | **94** | **93** | **98** | **98** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.

†The chicks were fed the diet described in table 12 and were grown in batteries.

**Table 14. Growth Index of January Hatched Progeny From Antibiotic-Fed Hens Compared to That of Control Hens**
Experiment 2
(7-22 chicks/lot)

| | | Four Week Comparative Growth* | | | |
|---|---|---|---|---|---|
| Trial | Antibiotic in Maternal Diet | Chick Basal Diet† % | 2 mg. Penicillin % | Penicillin+ 5% Fish Meal % | Penicillin+ Fish Meal+ 0.1% Methionine % |
| 1 | Penicillin | 97 | 97 | 101 | 96 |
| 2 | Penicillin | 98 | 105 | 95 | 115 |
| 3 | Penicillin | 110 | 103 | 107 | 113 |
| 4 | Penicillin | 113 | 94 | 90 | 98 |
| 5‡ | Penicillin | ( 92) | (109) | (101) | (102) |
| 6‡ | Chlortetracycline | ( 98) | ( 92) | (117) | (100) |
| **Av.** | | **104** | **100** | **98** | **106** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.

†The basal diet contained, in percent, ground yellow corn 40, ground oats 13, wheat bran 5, wheat standard middlings 5, alfalfa meal 3, soybean meal 30, steamed bonemeal 3, fish oil ½, salt mix ½, limestone 1/5, riboflavin .7 mg./lb., and vitamin $B_{12}$ 3 mcg./lb.

‡Less than 7 chicks per lot, not figured in averages.

**Table 15. Growth Index of March Hatched Female Progeny From Antibiotic-Fed Hens Compared to That of Control Hens**
Experiment 2
(29-63 chicks/lot)

| Trial | Antibiotic in Maternal Diet | Four Week Comparative Growth* |
|---|---|---|
| 1 | Penicillin | 95 |
| 2 | Penicillin | 94 |
| 3 | Penicillin | 103 |
| 4 | Penicillin | 102 |
| 5 | Penicillin | 96 |
| **Av.** | | **98** |

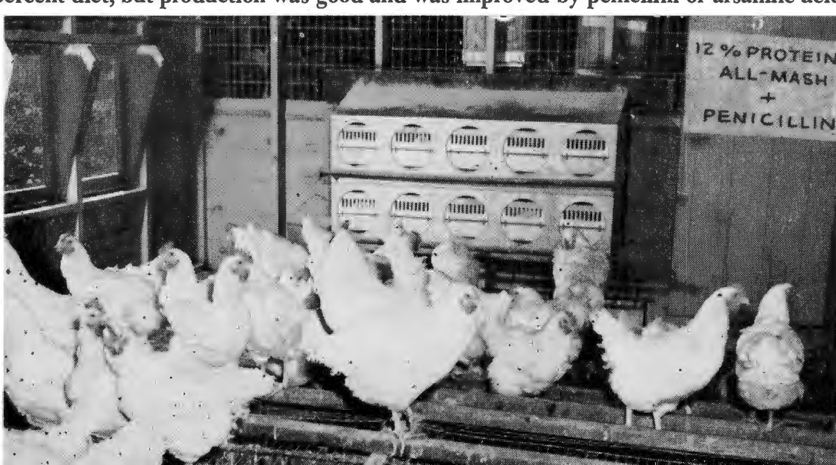
*Diet described in table 12 with the addition of 2 mg. Diamine Penicillin per pound of diet. The chicks were grown on litter and growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.

there appeared to be a marked improvement—trials 1, 3, and 4, experiment 1 and trials 1 and 6, experiment 3—however in the other trials there was little difference between the control and treated groups. In no case was there any lowered effect greater than normal variation.

## Progeny Growth

Progeny growth rate differences to 4 weeks of age also were not consistent. From an over-all consideration of the data in tables 12 through 20, it would appear that the antibi-

**Figure 2. Interior view of a laying pen. Feather picking was encountered on this 12 percent diet, but production was good and was improved by penicillin or arsanilic acid.**



otics in the breeder diet were without any great effect upon progeny growth. Actual 4-week weights are not given, but growth was expressed as an index of the relative growth of progeny from control and antibiotic-fed hens. There did appear to be a growth retardation effect in trials 3 and 4 of experiment 1, as shown in tables 12 and 13, which is similar to that reported by Slinger et al. (19). However when the chick diet was supplemented with penicillin, fish meal, and methionine, the retardation effect was less (table 13). Growth trials for the subsequent experiments did not consistently substantiate this earlier observation (tables 14, 15, 17, 18, and 19).

**Table 16. Growth Index of March Hatched Male Progeny From Antibiotic-Fed Hens Compared to That of Control Hens**
Experiment 2
(6-15 chicks/lot)

| | | Four Week Comparative Growth* | | | | |
|---|---|---|---|---|---|---|
| Trial | Antibiotic in Maternal Diet | Chick Basal Diet† % | Chlor-tetracycline‡ % | Vit. $B_{12}$§ % | Vitamin $B_{12}$+ Chlortetracycline % | Vitamin $B_{12}$+ Penicillin‖ % |
| 1 | Penicillin | 127 | 89 | 86 | 97 | 105 |
| 2 | Penicillin | 99 | 91 | 94 | 106 | 107 |
| 3 | Penicillin | 107 | 110 | 112 | 83 | 99 |
| 4 | Penicillin | 111 | 100 | 90 | 128 | 100 |
| 5 | Penicillin | 89 | 89 | 111 | 93 | 88 |
| 6 | Chlortetracycline | 93 | 104 | 104 | 87 | 84 |
| **Av.** | | **104** | **97** | **100** | **99** | **97** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.

†The basal diet consisted of, in percent, ground yellow corn 60, soybean meal 33.5, steamed bonemeal 3, alfalfa meal 2, limestone ½, fish oil ½, salt mix ½, and in mg./lb., riboflavin 1.5, niacin 5, calcium pantothenate 3.
‡5 mg./lb.
§10 mcg./lb.
‖1 mg./lb.

**Table 17. Growth Index of June Hatched Progeny From Antibiotic-Fed Hens Compared to That of Control Hens**
Experiment 2
(9-35 chicks/lot)

| | | Four Week Comparative Growth* | | |
|---|---|---|---|---|
| Trial | Antibiotic in Maternal Diet | Chick Basal Diet† % | 2 mg. Procaine Penicillin/lb. % | Penicillin+ Animal Protein‡ % |
| 1 | Penicillin | 109 | 102 | 104 |
| 2 | Penicillin | 93 | 104 | 92 |
| 3 | Penicillin | 86 | 103 | 99 |
| 4 | Penicillin | 108 | 103 | 113 |
| 5 | Penicillin | 107 | 102 | 98 |
| 6 | Chlortetracycline | 113 | 111 | 86 |
| **Av.** | | **103** | **104** | **99** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.

†Corn-soybean type diet, the same as that given in table 16, with 10 mcg. vitamin $B_{12}$ added per lb. of diet.
‡1% fish meal and 1% dried buttermilk.

In general, when the chick diet was supplemented with the various growth promotants, the growth responses between progeny of control and antibiotic-fed hens were more uniform. Table 16 shows the results obtained by using a chick diet low in vitamin $B_{12}$. Although the trials 1, 3, and 4 of experiment 2 appeared to show evidence of a greater carry-over of vitamin $B_{12}$ activity through the egg the over-all results were not consistent.

Since the diets used in the growth trials reported in tables 12 and 13 were lower in riboflavin content than those used later, it was decided to determine what effect a diet very low in riboflavin would have upon the growth index. The results

**Table 18. Growth Index of February Hatched Progeny From Hens Fed Supplemented Diets Compared to That of Control Hens**
Experiment 3
(16-33 chicks/lot)

| | | Four Week Comparative Growth* | | |
|---|---|---|---|---|
| Trial | Supplement in Maternal Diet | Chick Basal Diet† % | Penicillin+ Oxytetracycline‡ % | Antibiotics+ Fermentation Product§ % |
| 1 | Penicillin | 109 | 91 | 104 |
| | Arsanilic acid | 109 | 92 | 107 |
| 2‖ | Penicillin | 87 | 93 | 97 |
| 3 & 4‖ | Chlortetracycline | 100 | 102 | 97 |
| 5 | Oxytetracycline | 103 | 98 | 92 |
| **Av.** | | **99** | **96** | **99** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.
†The basal diet was similar to the corn-soybean type diet given in table 16, except that 1½ percent animal fat replaced a like amount of soybean meal, which in this instance was a 50 percent protein soybean meal instead of the regular 44 percent protein solvent type product, and 10 mcg. of vitamin $B_{12}$ was added per pound.
‡2 mg. of Procaine Penicillin and 5 mg. of oxytetracycline per pound of diet.
§Penicillin and oxytetracycline as above, plus ½ percent of a commercial fermentation product.
‖In the averages the data for these trials were given double value because they represented the averages of two pens.

**Table 19. Growth Index of March Hatched Progeny From Hens Fed Supplemented Diets Compared to That of Control Hens**
Experiment 3
(14-36 chicks/lot)

| | | Four Week Comparative Growth* | | |
|---|---|---|---|---|
| Trial | Supplement in Maternal Diet | Chick Basal Diet† % | Penicillin+ Oxytetracycline‡ % | Antibiotics+ Fermentation Product§ % |
| 1 | Penicillin | 96 | 97 | 106 |
| | Arsanilic acid | 96 | 99 | 111 |
| 2 | Penicillin | 99 | 98 | 99 |
| 3 & 4 | Chlortetracycline | 96 | 101 | 96 |
| 5 | Oxytetracycline | ------ | ------ | 90 |
| 6 | Tetracycline | 102 | 99 | 105 |
| **Av.** | | **98** | **99** | **100** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.
†Basal diet same as that given in table 18.
‡6 mg. Procaine Penicillin and 15 mg. oxytetracycline per pound of diet.
§Antibiotics as above plus 1½ percent of the commercial fermentation product.

**Table 20. Growth Index of May Hatched Progeny From Hens Fed Supplemented Diets Compared to That of Control Hens**
Experiment 3
(9-22 chicks/lot)

| Trial | Supplement in Maternal Diet | Four Week Comparative Growth* No added Riboflavin† % | Chick Basal Diet† % | 2% Fish Meal % | 0.03% Protamone % | Protamone+ Fish Meal % |
|---|---|---|---|---|---|---|
| 1 | Penicillin | 103 | 102 | 106 | 99 | 98 |
| | Arsanilic acid | 108 | 113 | 113 | 105 | 96 |
| 2 | Penicillin | 107 | 95 | 96 | 102 | 92 |
| 3 & 4 | Chlortetracycline | 105 | 107 | 104 | 104 | 107 |
| 5 | Oxytetracycline | 98 | 126 | 102 | 97 | 102 |
| 6 | Tetracycline | 106 | 99 | 98 | 90 | 92 |
| **Av.** | | **105** | **106** | **102** | **100** | **98** |

*Growth is expressed as $\frac{\text{Average Weight of Treated Group}}{\text{Average Weight of Control Group}}$.

†The basal diet was that given in table 18; the 1.5 mg. of riboflavin per pound was left out of the first diet, but added to all others.

obtained with these growth trials are given in table 20.

Protomone was also used to provide a stress factor, in an attempt to determine whether stress may have caused the earlier differences. As shown in table 20, however, neither of these conditions allowed for the expression of a growth retardation effect on the part of antibiotics in the maternal diet. In fact, there is some evidence of a beneficial effect of antibiotics upon growth of progeny on either the basal diet or diet deficient in riboflavin, thus confirming previous observations here with turkeys (5) and at the Ohio Station (1, 22) with chickens.

## Summary

In a series of experiments to study the effects of antibiotics upon reproductive performance in the chicken, 2300 laying hens were used, with various diets and kinds and levels of antibiotics. Data were obtained on egg production, feed consumption, body weight, mortality, egg quality, hatchability of fertile eggs, and growth of nearly 7000 progeny.

Egg production was in general improved by antibiotic supplementation, particularly when the hens were fed a free-choice diet of mash and grain. Some data are presented and other conditions discussed which indicate the effect may have been due in part to an enhanced utilization of protein and energy. However, the exact mode of action cannot be ascertained from the results here reported. Although "high levels" of antibiotics caused a greater increased rate of production, it is apparent that the economy of their use will depend upon the level of disease conditions prevalent in a particular flock. One trial indicated that arsanilic acid could be used with value on a low protein diet.

Where egg production was improved, feed efficiency was likewise improved. Body weight maintenance, mortality, egg quality, and hatchability of fertile eggs were not consistently affected by the antibiotics. Progeny growth appeared to be somewhat retarded in a few instances, although as a whole, where improved chick starter diets were used there were no consistent effects. There were several instances in which it appeared that progeny growth was improved by antibiotics in the breeder diet.