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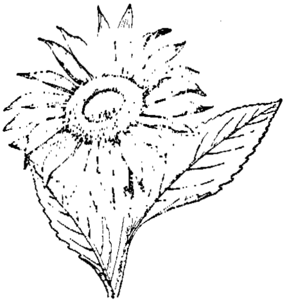
AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE

MANHATTAN, KANSAS

TURKEY PRODUCTION IN KANSAS



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SUMMARY

1. Turkeys are grown on 10 percent of Kansas farms, located principally in the central part of the state. Few growers employ artificial hatching and brooding.

2. Pullet breeders produce larger families than do hen breeders. Egg production and hatchability decrease with age. Vigorous, well-matured, "plump," straight-keeled individuals should be selected for breeding purposes. There appears to be little evidence that it is necessary to introduce new blood every few years to maintain vigor.

3. The average Kansas breeding female will reach sexual maturity in March and will produce 40 eggs during the hatching season. The use of morning lights starting December 1 will advance the onset of egg production two months. Under these conditions the average female will lay 68 eggs. The stimulation of early production may reduce the hatching power of the egg. Confining the breeding stock appears to have no deleterious effect on fertility or hatchability if the known dietary requirements are cared for.

4. Breeding turkeys have a high vitamin A (green feed) requirement. The number of eggs laid and the color and texture of the egg shell are affected by the level of this vitamin in the ration.

5. Continuous incubation in the gravity ventilated incubator appears to give best hatching results. Turkey eggs should sustain by evaporation and metabolism a loss in the original weight ranging from 11 to 13 percent at the conclusion of the 24th day of incubation. Of the eggs viable on the 24th day, those having the greatest relative loss in weight gave the poorest hatchability. Eggs of medium size appear to hatch better than larger or smaller eggs.

6. A temperature of 100° F. for the first week of incubation and an increase of 1° for each succeeding week gave the best hatching results in the particular gravity ventilated machine used.

7. For the period that intervenes between laying and setting, hatching eggs should be held at a temperature of approximately 54° F. for optimum results.

8. Mortality is increased and growth retarded when stemmy material is used on the brooder house floor or when included in the diet of young poults as green feed.

9. Kansas poults may be brooder "weaned" at the expiration of four to six weeks.

10. The young turkey is more sensitive to feed deficiencies than the chick. Experiments indicate that the vitamin D requirement of the poult is thrice, and the vitamin A requirement twice that of the chick.

11. It requires from 3.26 to 3.54 pounds of feed to produce a pound of Bronze turkey up to 24 weeks of age.

12. Turkeys that are to be killed for market should be in good health, well fleshed, reasonably well covered with fat, and fairly free from short pinfeathers.

13. There appears to be little difference in the price paid for turkeys sold in November, December, or January. Western fresh-killed turkeys are quoted higher on the New York market in the months of August and September than for the remaining months. Storage holdings reach their peak in February or March. The average holding on March 1 for the period 1923 to 1935 was slightly more than 14,000,000 pounds. The average holding on November 1 for the period 1923 to 1934 was slightly more than 4,000,000 pounds.

TABLE OF CONTENTS

TURKEY PRODUCTION IN KANSAS[1]

H. M. SCOTT

INTRODUCTION

ADAPTABILITY OF KANSAS TO TURKEY RAISING

Conditions for growing turkeys in Kansas are extremely favorable. There is an abundance of home-grown feed, climatic conditions are favorable, several large consuming centers are close to the state, extensive ranges are available, and the enterprise fits in very well with the general type of farming in the state.

THE TREND OF THE INDUSTRY IN KANSAS

Although conditions are favorable for turkey production in Kansas, the industry has followed a downward trend from 1890 to 1920, as is true for the United States total shown in figure 1. The only

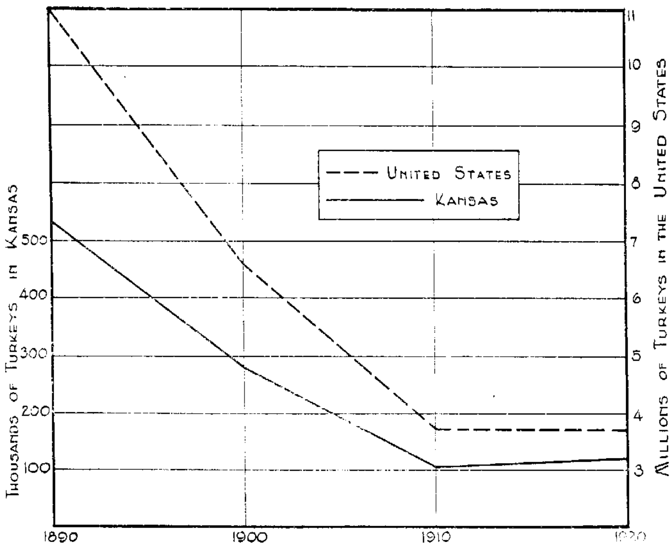


FIG. 1.—Graphs showing the relation of the number of turkeys on Kansas farms to the total number on farms in the United States.

source of information on this point is the census figures which show the number of turkeys on farms at the time the data were collected. Since the figures were taken shortly after the first of each census year, they can hardly represent more than the late-maturing stock and the actual number of turkeys retained for breeding purposes.

1. Contribution No. 93 from the Department of Poultry Husbandry.

The 1930 census report indicated that turkeys were grown on 9.27 percent of Kansas farms. A total of 319,480 turkeys valued at $797,403 were grown in Kansas for the year 1929 as compared with a United States total of 16,794,485. Since the 1930 census figures are not comparable with the earlier figures, a comparison of the industry in Kansas with that of the entire United States can Be made only on a percentage basis. This has been done in figure 2, where the Kansas figures have been plotted as percentages of the

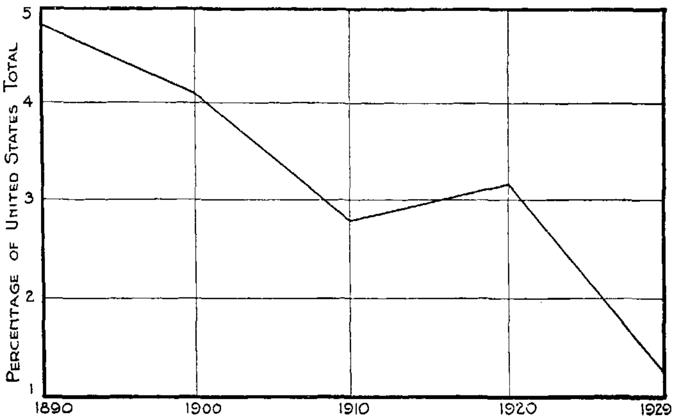


FIG. 2.—Graphs showing the number of turkeys in Kansas expressed as percentages of the United States total.

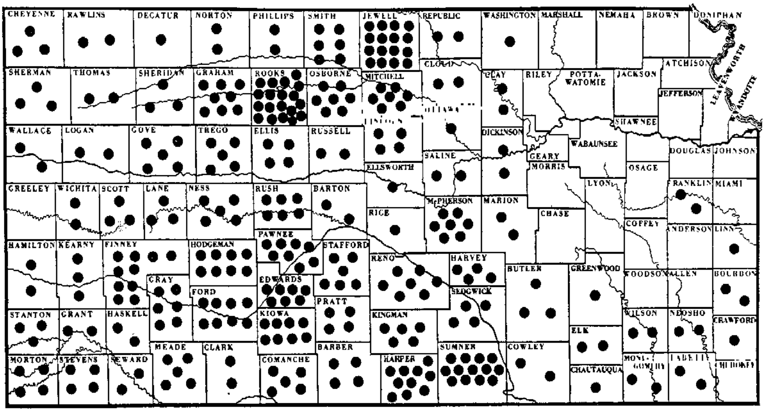
United States total. In 1890, 4.8 percent of the total turkeys on farms in the United States were on Kansas farms. In 1929 Kansas produced 1.3 percent of the United States total.

The growing of turkeys is confined almost exclusively to the western three fourths of the state and in particular to the wheat-belt region running north and south through the central part of the state. This central region consists of the second, fifth, and eighth crop-reporting districts of Kansas. Each dot, in the upper map of figure 3 represents 1,000 turkeys raised in 1929 as reported by counties in the 1930 census. More recent data, are given in the lower map of this figure where each dot represents 500 turkeys on Kansas farms January 1, 1935.

It is a well-known fact that the turkey industry in the United States has staged a remarkable recovery between the years 1920 and 1930. This has been due primarily to improved production methods and in particular to the control of disease. No doubt the pioneer work of Rettger and Kirkpatrick[2] exerted a profound influence on the recovery of the industry. Credit must be given these investigators for demonstrating that turkeys could be reared

2. Rettger LeoF., and Kirkpatrick, Wm. F. An epidemiological study of blackhead in turkeys. Storrs Agr. Expt. Sta. Bul. 148:287-313. 1027.

in confinement. Their first work on this point was done in 1917. By a yard rotation system, they were able to control blackhead.



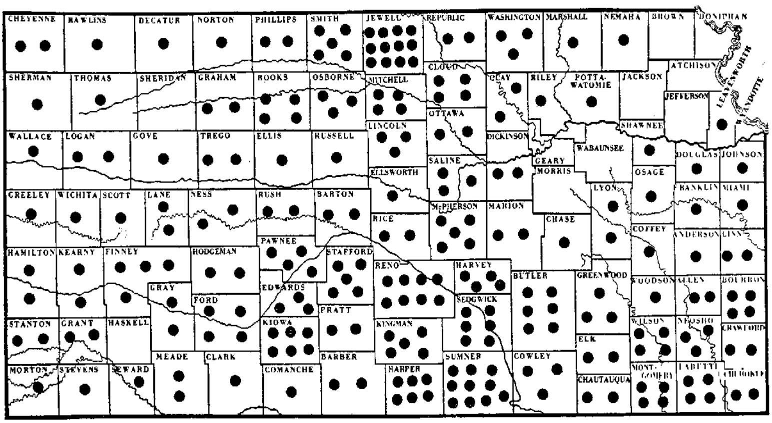


FIG. 3.—*Upper*—Map of Kansas showing the distribution of turkeys raised in 1929. Each dot represents 1,000 turkeys. *Lower*—Turkeys on Kansas farms January 1, 1935. Each dot represents 500 turkeys. (Source of data: United States census reports.)

PRACTICES USED BY KANSAS GROWERS

In 1928 a survey was conducted to determine the practices of Kansas growers. The result of this survey served as a basis for outlining the type of investigations to be undertaken by this station. Questionnaires were sent to turkey growers in all parts of the state. Fifty-four replies were received. The average number of breeding females in these flocks was found to be 15, with a range of 3 to 125. Fifty-seven percent were keeping the Bronze breed, 20 percent the Bourbon Red, 15 percent the White Holland, and 7 percent the

Narrangansett. A sunmmary of the incubation practices used by the growers is presented in Table I. Slightly less than 25 percent of the growers were making use of the incubator, while 57.8 percent were using the turkey hen or chicken and turkey hens for incubating

TABLE I.—METHODS OF INCUBATION EMPLOYED BY KANSAS TURKEY GROWERS IN 1928

METHOD.	Growers.		Percentage hatchability of total eggs set.
	Number.	Percentage.	
Artificial	6	13.3	66.8
Turkey hen	8	17.8	78.1
Chicken hen	8	17.8	71.6
Chicken and turkey hen	18	40.0	71.6
Artificial and natural	5	11.1	64.4
Total and average	45	100.0	68.8

purposes. It is interesting to note that where the growers report the use of an incubator alone or where they have used a combination of artificial and natural means, the resulting percentage hatches are below those obtained where natural incubation alone is used. More than 81 percent of the growers were using natural means of brooding with either chicken or turkey hens or both. (Table 11.)

TABLE II.—METHODS OF BROODING USED BY KANSAS TURKEY GROWERS IN 1928

METHOD.	Growers.		Average percentage mortality to three months.
	Number.	Percentage.	
Artificial	6	13.9	28.3
Natural	35	81.4	42.9
Combined	2	4.7	10.0
Total and average	43	100.0	39.5

The growers using brooder stoves reported an average mortality of 28.3 percent at three months of age as compared with 42.9 percent mortality where natural brooding methods alone were used. Slightly more than 53 percent of the growers permitted turkeys and chickens to range over the same ground. Young turkeys were given free range by 85 percent of the growers. The growers reported such a variety of feeds fed that it was impossible to tabulate the data. In addition to the common grains, they report the feeding of eggs, rolled oats, cottage cheese, panaceas, pepper, grasshoppers, etc. In some instances the turkeys received no feed other than what could be obtained on range.

In summarizing the results of the 1928 survey, it can be said that a very small percentage of the growers were using the better practices known at that time. Field observations would indicate that a greater percentage of the growers are now using improved production methods than in 1928. The larger growers, those maintaining breeding flocks of 100 or more females, for the most part use artificial methods of hatching and brooding exclusively.

GENERAL PLAN OF EXPERIMENTAL TURKEY PRODUCTION AT THIS STATION

Turkey investigational work was first started at this station in 1927 with the purchase of 200 Bronze Turkey eggs. Since that date a breeding flock of 20 to 45 females has been maintained each year. The plan has been to take off from three to five hatches throughout the breeding season of each year. In each year one group of eggs was set so as to hatch on May 23. Data on growth and feed consumption presented in this publication were obtained from turkeys hatched on this date. The Bronze variety of turkey was used throughout the period of investigation dating from 1927 to 1933. The Narragansett breed was used in the experimental work of 1933-'35. More recent work (1936-'37) has been conducted with the Bronze breed.

It is the purpose of this publication to present the results of the experimental work carried out at this station for the years mentioned. In addition, the author has attempted to review and analyze the research work of others, and where possible to make comparisons of the results obtained by them.

The researches undertaken at this station have not been confined to any particular phase of turkey production. Definite projects have been outlined to cover such phases as the selection and management of breeding stock, incubation, brooding, growth, nutrition, and marketing. In many instances it will be possible to offer nothing more than a description of the practices used.

SELECTION OF BREEDING STOCK

In selecting breeding stock, emphasis has been placed on those characters that influence market qualities. Standard qualifications have been given due consideration, but market qualities have not been sacrificed for their attainment. The American Standard of Perfection[3] gives a detailed description of the Bronze as well as other breeds of turkeys.

In choosing individuals for the breeding pens vigorous appearing males and females showing strong sex characteristics have been selected before any of the flock has been marketed. The attitude has been that the best of this year's crop is not too good for reproducing next year's flock. In addition to external characters of vigor, every effort has been made to select those individuals that show depth,

3. The American Standard of Perfection, pp. 1-487. Revised. The American Poultry Association. 1930.

length, and width of body, rapid growth, and early maturity. The latter point has been determined largely by the degree of "pinniness" and the distribution of fat over the body. The amount of pin feathers and the finish of the carcass with reference to the distribution of fat varies widely among turkeys of the same age raised under identical conditions. Rangy, stilty-appearing individuals have been discarded irrespective of their weight at 24 weeks. No birds with visible deformities, notably crooked breasts, have gone into the breeding pens. A discussion of the incidence of crooked breast will be given later.

Pullets selected for breeders have averaged from 12 to 14 pounds at 24 weeks of age, while cockerels have weighed from 20 to 22 pounds. These weights are considerably above the average for the Bronze strain bred at this station, but are below the weights given for this breed in the American Standard of Perfection. Judging from the growth data obtained at this station and those of other stations, the weights of 16 and 25 pounds required for the pullet and cockerel of this breed are far above the actual weights recorded at the time the birds are selected for breeding purposes or sold on the market.

AGE OF BREEDING FEMALES

Experiments conducted at the Kansas station would indicate that pullets are more desirable than older females for breeding purposes.

During the breeding seasons of 1931 and 1932 the station's breeding flock was divided into pens of pullets and yearling hens mated to cockerels. Both groups of females were hatched on May 23 of each year and the pullets were daughters of the yearling hens. The males were alternated weekly between the pens to reduce differences to a minimum. Data were obtained as to the percentage and distribution of egg production, egg size, hatchability, and the growth and livability of the offspring of the two groups of females.

The two groups were confined to small pens, practically devoid of vegetation. No shelter other than shade was provided, the birds having been in the open throughout the winter months and the breeding season.

In 1931 the first hen egg was produced March 19 as compared with March 23 for the first pullet egg. This was reversed in 1932 with pullets reaching maturity on March 28 and the hens April 1. In either case the number of days intervening between the dates of first egg laid by the two groups was slight. From this it can be concluded that under the conditions of this experiment there is little difference between the time pullets and yearling hens will enter production.

From March 21 to July 31, 1931, the percentage egg production of the pullets calculated on a hen-day basis was 39.58 ± 0.73 percent[a] as compared with 36.71 ± 0.68 percent[a] for the hens over the same period. The difference of 2.87 ± 0.99 percent is not significant. The following year the percentage production between the dates of March 28 to June 24 for the pullets was 50.59 ± 0.89 percent[a] and for the hens 43.18 ±0.81 percent[a] or a significant difference of 7.41 ± 1.20 percent. These figures are based on a total of 1.513 pullet eggs and 1,535 hen eggs. While it would appear that the percentage production for both ages was greater in 1932 than 1931, this is not actually the case in view of the fact that the first year's data covered a longer period of production, during the latter part of which the production wasvery low.

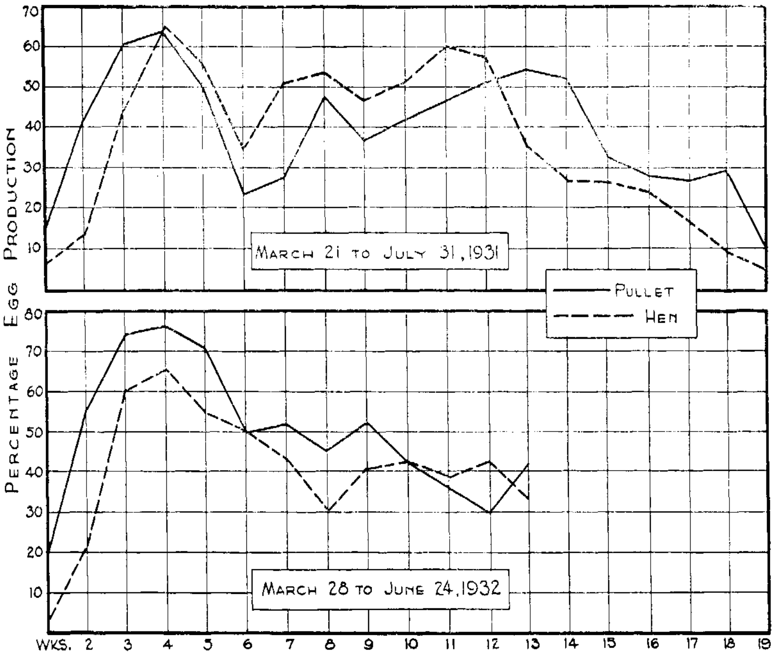


FIG. 4.—Graphs showing a comparison of the percentage egg production of pullet and hen turkeys.

The distribution of the production of the two groups as well as the number of eggs produced is of interest. The production was divided into intervals of seven days for the periods indicated in figure 4. The resulting curves show that the pullets produce a greater percentage of the more desirable early eggs than do the hens. This was

a. The probable error was determined by the formula:

$$.6745 \frac{\sqrt{Pq}}{N}$$

where p represents the percentage production, q equals (100-p) and n the total number of hen days. When this formula has been used, it will be indicated with the symbol "a."

Otherwise the formula $.6745 \frac{\gamma}{\sqrt{N}}$ has been applied.

particularly true for the year 1932. In both years the two ages reached their maximum production during the fourth week. It is remarkable that turkeys can reach such high production in so short a period.

Figure 5 illustrates clearly that the mean egg size of the hen is greater than that of the pullet when measured at the same period of

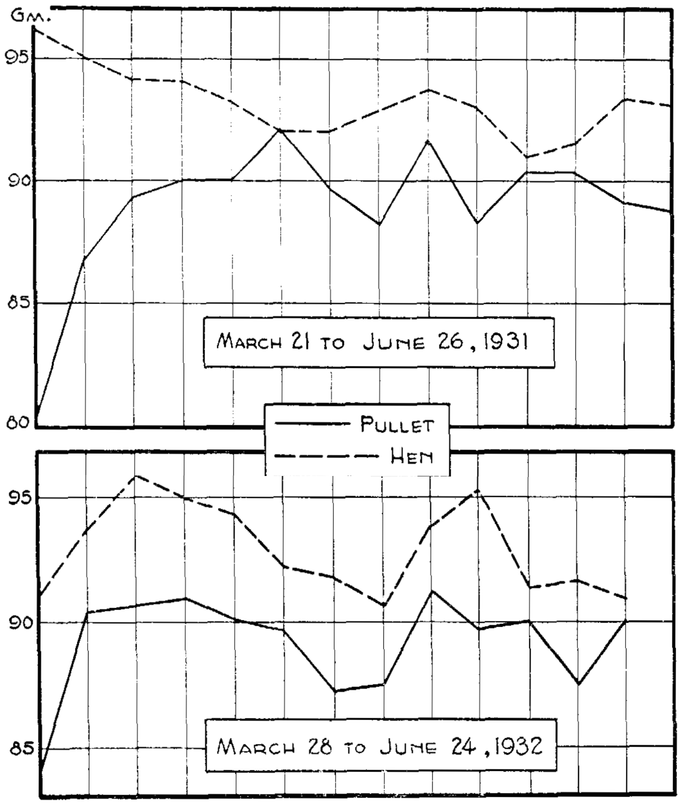


FIG. 5.—Graphs showing a comparison of pullet and hen egg weights.

the breeding season. The pullets reached their maximum egg size during the sixth week in 1931 and the ninth week in 1932. There is a tendency on the part of the hens to lay their heaviest eggs during the first three weeks of production. The mean weight of 1,285 pullet eggs produced in the two breeding seasons was found to be 89.45 grams as compared with 93.21 grams for 1,352 hen eggs. This is a difference of 3.76 grams per egg.

When the two curves, percentage production and mean egg weight, are plotted on coordinate paper, as in figure 6, it is observed that periods of high production are usually accompanied by large egg size. Particularly is this true for the hens. A study of egg size in relation to its position in the clutch or cycle of the turkey would be of interest. In the case of the chicken, the first egg of each clutch is usually the heaviest. Each successive egg is smaller than its predecessor. As the length of the laying period progresses, the difference in weight between the first and last egg of each clutch becomes

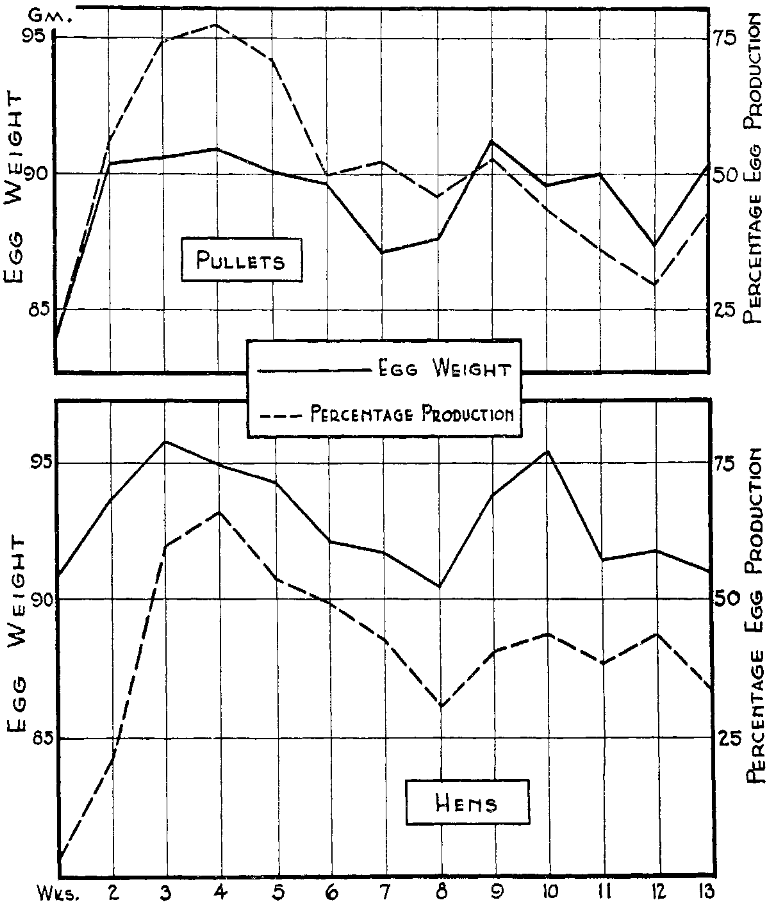


FIG. 6.—Graphs showing the relation of egg weight to percentage egg production from March 28 to June 24, 1932

progressively less. Unpublished data accumulated by Warren and Scott indicate that clutch position exerts the same influence on the size of the turkey egg as it does in the chicken.

The results of the test on fertility and hatchability are presented in Table III. These figures represent the total number of eggs set from the two lots for the two breeding seasons. Little difference was observed in the ability of the two ages to lay fertile eggs. The percentage hatch for the pullet eggs was found to be 73.1 ± 1.16 percent[a] as contrasted with 55.1 ± 1.82 percent[a] for the hen eggs. The difference of 18 percent is considered highly significant since its probable error is only ± 2.15 percent.

TABLE III.—COMPARATIVE HATCHING POWER OF PULLET AND HEN EGGS

	Number set.	Number infertile.	Percentage infertile.	Number of embryos dying.	Percentage of embryos dying.	Number of poults hatched.	Percentage of fertile eggs hatched.
Pullet...	703	51	7.2	175	26.8	477	73.1 ± 1.16(a)
Hen....	800	55	6.8	334	44.8	411	55.1 ± 1.82(a)

TABLE IV.—THE GROWTH OF FEMALE PROGENY FROM PULLET AND HEN TURKEYS

AGE.	Lot 23 (hen breeders).		Lot 24 (pullet breeders).		Difference and P. E. of difference in grams.
	No.	Mean wt. in grams.	No.	Mean wt. in grams.	
1 day.....	19	65.3 ± 0.57	33	60.08 ± 0.58	— 5.22 ± 0.81
4 wks.....	20	250.0 ± 5.99	33	296.80 ± 6.19	+ 46.80 ± 8.61
8 wks.....	20	690.0 ± 13.82	31	776.80 ± 14.59	+ 86.80 ± 20.08
12 wks.....	19	1,732.0 ± 23.44	35	1,915.00 ± 28.41	+183.00 ± 36.79
16 wks.....	20	3,109.9 ± 43.59	32	3,364.10 ± 40.56	+254.20 ± 59.02
20 wks.....	19	4,240.4 ± 40.86	32	4,426.50 ± 36.22	+186.10 ± 54.48
24 wks.....	20	5,107.5 ± 36.32	33	5,438.90 ± 54.48	+331.40 ± 65.48

TABLE V.—THE GROWTH OF MALE PROGENY FROM PULLET AND HEN TURKEYS

AGE.	Lot 23 (hen breeders).		Lot 24 (pullet breeders).		Difference and P. E. of difference in grams.
	No.	Mean wt. in grams.	No.	Mean wt. in grams.	
1 day.....	35	64.4 ± 0.51	47	62.07 ± 0.61	— 2.33 ± 0.79
4 wks.....	37	289.9 ± 4.51	47	342.80 ± 6.51	+ 52.90 ± 7.92
8 wks.....	35	821.4 ± 13.99	46	938.70 ± 14.15	+117.30 ± 19.33
12 wks.....	35	2,205.0 ± 28.03	47	2,470.00 ± 28.19	+265.00 ± 39.75
16 wks.....	35	4,090.5 ± 43.59	47	4,440.10 ± 44.04	+349.60 ± 61.74
20 wks.....	34	5,915.6 ± 59.02	47	6,514.9 ± 49.94	+599.30 ± 77.18
24 wks.....	33	7,836.0 ± 63.56	47	8,585.10 ± 77.18	+749.10 ± 99.08

Asmundson and Lloyd[4] found that hatchability declines after the second laying year, but that fertility is unaffected by age.

Some observations were made at the Nebraska station[5] relative

4. Asmundson, V. S., and Lloyd, W. E. Effect of age on reproduction of the turkey hen. Poult. Sci. **14**:259-166. 1935.

5. Anon. Turkey production. *In* Neb. Agr. Expt. Sta. Ann. Rpt., p. 39. 1930.

to the hatchability of eggs laid by hens of varying ages, but the results were not conclusive.

The growth of female and male offspring during 1932 from pullet and hen turkeys is presented in Tables IV and V. Since it has been pointed out that the average hen egg is larger than the pullet egg, it would be expected that this difference would be reflected in the size of the poults at hatching. The weight of the female offspring of the hen breeders at hatching was significantly greater than the weight of the female pullet offspring. This difference was also true for the male offspring produced by the two ages of breeders. The difference was not great enough, however, to be significant. It is observed that what differences may have existed at time of initial weighing were reversed at the four-week period and remained reversed consistently for both sexes for each successive interval up to 24 weeks of age. In each case the difference was found to be more than 3.5 times its probable error. Apparently the pullet offspring were able to overcome the early handicap of a lesser weight under the conditions of this experiment.

The Purdue stations reports that poults hatched from yearling hen breeders are heavier at time of hatching than poults hatched from pullets, but that the average weight of either sex is about the same at 16 and 24 weeks of age irrespective of whether the progeny were hatched from eggs laid by yearling or by pullet breeders.

Data relative to mortality were obtained in 1932 only. Of 206 hen offspring hatched, 20.39 ± 1.89 percent[a] died up to 24 weeks as compared with 17.29 ± 1.56 percent[a] of the 266 pullet offspring hatched. This is a difference of 3.10 ± 2.45 percent and is not significant.

From a commercial standpoint it can be concluded from the results of this experiment, with the criteria used, that pullet turkeys are superior to hen turkeys as breeders. The pullets laid at a higher rate than did the hens. Furthermore, the young females produced a greater percentage of the more desirable early eggs than did the hens; the hatching power of the pullet eggs surpassed that of the hens and the viability of the pullet offspring was as good as, if not superior to, that of the hen offspring. These factors influenced the size of the family produced. In egg size and weight of poult at hatching, the hens were found to be superior to the pullets, but these differences can be disregarded since the growth of both the male and female offspring from pullets was more satisfactory than that recorded for the hen offspring. In cases where a grower desires to distribute the blood of an exceptionally good specimen through the remainder of the flock, he would be justified in keeping the individual as a breeder for several years.

AGE OF BREEDING MALES

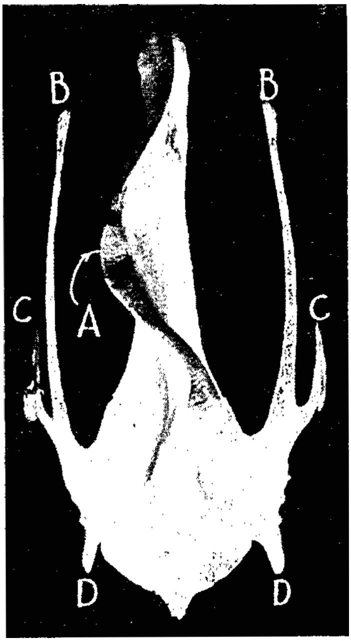
No attempt has been made by this station to determine the best age of breeding males. Cockerels have been used almost exclusively for it has been our experience that the older males because of in-

6. Anon. In Purdue Univ. Agr. Expt. Sta. 46th Ann. Rpt., p 42. 1933.

creased weight may impair the breeding efficiency of the females by inflicting injuries during the act of mating.

DEFORMED BREAST BONES

This deformity is characterized by a twisting or bending of the keel bone (metasternum) to either side of the median plane. (Fig. 7.) The direction of the twist in the fowl may be to the left or to the right, Warren.[1]



Courtesy Nevada Agr. Expt. Sta.

FIG. 7.--Ventral view of a deformed breast bone. (A) Keel of metasternum. (B) Lateral process of sternum. (C) Oblique process of sternum. (D) Costal process.

The incidence of crooked breast bones varies widely with different flocks. According to Niemann[8] as high as 40 percent of the individuals in a flock may be afflicted, in which case the grower suffers a great financial loss. However, after conducting an exhaustive study of the condition in Nevada, Niemann concluded that the loss amounted to less than 1 percent of the total sales value. This does

7. Warren, D. C. The inheritance of standard characteristics of poultry. *In* Sixth Bien. Rpt. of the Director, Kan. Agr. Expt. Sta., pp. 72-73. 1932.
8. Niemann, K. W. Crooked breasts in turkeys. Univ. of Nev. Agr. Expt. Sta. Bul. 122:1-22. 1931.

not detract from the statement that individual growers may experience heavy financial losses from this disfiguration.

Various theories have been propounded as to the causative factor or factors. Niemann in his studies could come to no definite conclusion other than that "it seemed almost certain that there might be several factors and combinations of factors which could help to cause this deformity."

Investigations relative to the cause of this deformity in birds have been conducted along four principal lines; namely, the influence of nutrition, the influence of width of roost and time of roosting, and the influence of heredity.

Kohn[9] in a series of experiments covering a period of six years concluded that a deficient diet was responsible for the deformity in turkeys. He emphasized the importance of green feed as an antifactor. Kohn also observed that diets lacking calcium, phosphorus, and the antirachitic factor, vitamin D, produced the deformity.

The addition of various mineral supplements to a standard chick ration has been found by Halpin and Holmes[10] to increase the percentage of crooked breast bones when fed to chickens. These workers have demonstrated that the lack of vitamin D may also be a contributing factor and that pullets reared to maturity free from the deformity may develop crooked breasts during the course of the laying year.

Payne and Hughesll have shown that growing chicks irradiated daily, developed breast bones that were straight and evenly ossified as compared with the twisted and poorly ossified keels of a non-irradiated group.

The California Agricultural Experiment Station[12] reports an experiment on the relation of calcium and phosphorus intake to crooked breast bones of turkeys. No details are given, however. It is well known that the skeletal tissue of the newly-hatched poult is comparatively soft and elastic. There is little question but that the failure to include the minimum level of the essential bone forming substances in the diet will assist the deformity to appear. Kohn's results on green feed are unexplainable. Experiments conducted at this station pertaining to the vitamin A requirements of turkeys have not indicated that vitamin A is associated with this deformity.

Nutrition, however, does not explain the cases that develop even though all known essential dietary factors are included in the ration. Marsden[13] observed 51 percent of the turkeys roosting on two-inch

9. Kohn, F. J. *In* Univ. of Wyo. 35th, 36th, 37th, 38th, 39th, and 40th Ann. Rpts. of the Agr. Expt. Sta. 1924-'25 to 1929-'30.

10. Halpin, J. G., and Holmes, C. E. Crooked breast bones of poultry believed due to vitamin lack. *In* Ann. Rpt. Wisc. Agr. Expt. Sta. Bul. 410:73-74. 1930.

11. Payne, L. F., and Hughes, J. S. The effect of inadequate rations on the production and hatchability of eggs. Kan. Agr. Expt. Sta. Tech. Bul. 34:1-64. 1933.

12. Anon. *In* Rpt. of the Agr. Expt. Sta. and the Col. of Agr. of the Univ. of Calif., p. 94. 1932.

13. Marsden, S. J. Progress report of turkey investigations at the United States range livestock Expt. Sta. U. S. D. A. Mimeograph leaflet pp. 1-28. 1931.

perches developed decidedly crooked keels. No significant differences were observed between groups roosting on four, five, and six-inch material, the range being from 3.6 to 11.8 percent. He concluded that four-inch roosts are desirable for turkeys. The data of Marsden would indicate that sex may be a factor worthy of consideration, as 9.8 percent of 264 males developed decidedly crooked breast. bones as contrasted with 2.9 percent of the 278 females. Statistically the difference, 6.9 1.38 percent[a] is significant.

It is possible that the extreme variation in weight existing between sexes of turkeys is partially responsible for the difference in degree of expression noted by Marsden. It has been demonstrated in various animal forms that the bones of the female ossify more rapidly than do the bones of the opposite sex and, if applicable to turkeys, might also have been a factor in the difference observed by Marsden.

Platt,[14, 15] working with young chickens, has conducted a number of experiments that point clearly to the interrelationship of diet and roosting conditions. He found that a ration adequate in the antirachitic factor did not prevent the deformity when roosts were used, but did prevent its appearance when no roosts were used. On a ration lacking the antirachitic factor, the birds developed crooked keels even though no roosts were used.

In none of the experiments mentioned so far have the investigators taken into consideration the influence that heredity might have exerted on the results obtained.

Warren[7] of the Kansas station has been breeding crooked and straight keel Leghorns for a number of years. Of 627 offspring matured from the crooked keel matings in 1931, 69.9 percent possessed crooked keel bones. The straight keel offspring were practically free from the deformity although they were reared under identical conditions given the crooked keel offspring. Warren states, "Since during several years selection it has not been possible to obtain a mating which would produce 100 percent crooked keel offspring, it seems probable that a large number of genetic factors are responsible for this character, or that some genetically 'crooked' birds do not show the deformity."

For the past five years the percentage of crooked keel turkeys reared to maturity at this station has been so small that it is insignificant. No roosts have been used the first four weeks of the brooding period; from the fifth to the tenth week 1½-inch roosts have been employed and 2-inch roosts for the remainder of the growing period. Only straight keel turkeys have been used in the breeding pens, but in the light of Warren's work, it is doubtful whether much progress can be made in this direction without pedigree breeding. Previous to the aforementioned time, the incidence of crooked breast bones was quite high in the station's flock of tur-

14. Platt, C. S. Early roosting as a cause of crooked keels in S. C. White Leghorn cockerels. Poult. Sci. **11**:362. 1932.

15. Platt, C. S. Crooked keels in relation to width of perch. Program, Abstracts and Notes of Papers presented at the 25th Ann. Meeting of Poult. Sci. Assoc., p. 94. 1933.

keys. Starting in 1931 the method of brooding was changed so that the poults did not have access to roosts until the fifth week, whereas in former years they were encouraged to roost from the outset.

The tendency towards the deformity appears to be inherited, and requires for its maximum expression such factors as faulty nutrition, roosts, and poor management. The work at this station is being continued as to the mode of inheritance and the interrelationship of heredity, nutrition, and roosts.

MATING PRACTICES AND MANAGEMENT OF BREEDING FLOCK

INTRODUCING NEW BLOOD

It is a common practice among the turkey growers of this state to exchange breeding males with distantly located growers. The necessity of doing this is questionable. Knandel and Hunter[16] report that "After four years of investigation on problems of adult turkey management, the conclusion was reached that under commercial conditions, it is not necessary to introduce new blood into the breeding pens each year in order to obtain satisfactory hatchability and livability of poults." Asmundson[17] states that brother-sister matings have no deleterious effect on hatchability or growth.

HYBRIDIZATION

Apparently no benefits are derived from crossing two breeds of turkeys when growth is the criterion used. The Nebraska station18 reports that the crosses, Bronze ♀ X White Holland ♂ and Bronze ♀ X Bourbon Red ♂ resulted in no stimulation in growth rate.

INJURIES INFLICTED THROUGH MATING ACT

In mating the skin and musculature is often torn on the back of the female by the sharp claws of the male. The result is a loss in production and fertility, and in some cases death ensues. As stated previously, the use of young males in preference to the older and heavier individuals will do much to prevent such injury. Clipping the ends of the toe nails and filing has been resorted to by some. The practice followed by this station has been to cut off the entire horny claw on each of the four toes. Tin snips or wire cutters have been used to good advantage. The blood flows quite freely for a few seconds but soon ceases without medication. Such an operation should be performed in December in order to permit healing before the mating season. Occasionally it is necessary to clip the toe nails a second time while the mating season is in progress. The use of a heavy muslin saddle covering the back and sides of females has been suggested by Albright.[19]

16. Knandel, H. C., and Hunter, J. E. *In* Penna. Agr. Expt. Sta. 45th Ann. Rpt. Bul. **279**:17. 1932.

17. Asmundson, V. S. The turkey as an experimental animal. American Naturalist **68**:466-467. 1934.

18. Anon. *In* 44th Ann. Rpt. of the Agr. Expt. Sta. of Neb., p. 39. 1931.

19. Albright, W. P. Solving Oklahoma farm problems. *In* Rpt. of Okla. A. & M. College Agr. Expt. Sta., pp. 101-103, 107-108. 1930-'32.

FERTILITY

Ordinarily infertility is not a great problem for the turkey grower. Occasionally sterility is encountered, but it is the exception rather than the rule. The fertility has averaged 92 percent over a period of five years at this station. Breeding males should be placed with the females several months in advance of the time that egg production is expected. Under such a plan, the first eggs produced will be fertile. Mating usually takes place from two to three weeks in advance of egg production. From 12 to 15 females should be mated to one young male. If older males are used, the number of females should be reduced to 10. Some growers prefer to divide the breeders into a number of breeding pens. With this plan, the males are usually alternated at weekly intervals between the various pens.

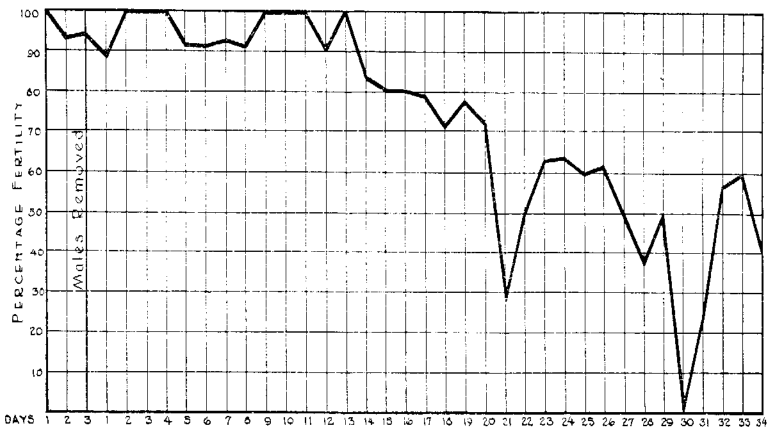


FIG. 8.—Graphs showing the decline in fertility following the removal of the males from the breeding flock.

The main objective in following this plan is to overcome preferential mating. Other growers use the flock method of mating. Both systems have been used at this station with apparently equal success.

Growers frequently state that a single mating will fertilize an entire clutch* of eggs and that following a period of broodiness, a second mating must occur to insure fertility. The work reported by Albright[19] would tend to discredit this theory. He has shown that on the first day following the removal of the male from a flock of 15 females that fertility was 66.66 percent, 33.33 percent on the 19th day, and that fertility gradually declined until no fertile eggs were produced after the 32d day. It is reasonable to suppose that a single mating will fertilize several clutches of eggs provided the clutches are small and the time elapsing between clutches is of short duration. Conversely, if a clutch extends over a long period, it is

* As used here, clutch refers to the number of eggs laid before the onset of a broody period.

just as reasonable to assume that a single mating will not fertilize all eggs in the clutch.

Near the end of the 1935 breeding season 34 females and three males were selected from the Kansas station's breeding flock to study the decline in fertility following the removal of the males. This group was placed in an ordinary poultry house May 23 and the males removed the evening of May 25. All eggs gathered between May 23 and June 28 were incubated and examined for development. The rate at which fertility declined following the removal of the males is illustrated in figure 8.

It is observed that for each of the three days preceding the removal of the males that the fertility of the eggs ranged from 90 to 100 percent and that for the first 13 days following their removal, no decline in fertility occurred. From the 14th day to the 20th day the curve flattened to range from 71 to 83 percent,. After this time fertility declined rapidly. No fertile eggs were laid on the 30th day, but it is interesting to note that 40 percent of the eggs that were laid on the 34th day after the removal of the males were fertile. It was necessary to terminate the experiment on the 34th day although, no doubt, some fertile eggs would have been laid after this date.

From these data it would appear that the decline in fertility of turkey eggs is not so rapid following the removal of the male as is the fertility of the chicken egg after the removal of the male chicken.

In this experiment the average number of eggs produced that could be incubated was slightly more than 10 eggs for each day. The shell texture of eggs produced at this period of the breeding season was poor and many eggs were broken and could not be incubated. Broodiness, with the accompanying decline in rate of production, was unquestionably a disturbing factor. To what extent the time of the year may have influenced the results is not known.

STIMIULATING EGG PRODUCTION

The hatching season for turkeys under Kansas farm conditions covers a period of 12 to 15 weeks. One can expect to obtain an average production of 35 to 45 eggs from each breeding female in the flock. The percentage distribution has been given previously in graphical form. In Table VI the data are given in terms of eggs per female. These figures were obtained from a flock of 17 pullets. A total of approximately 45 eggs was produced by each individual for the 15-week period. This figure is similar to that reported by Mussehl[20] under Nebraska conditions.

On Kansas farms the breeding flocks start to lay some time between the first week of March and the first week of April. Several instances have been called to the attention of the author where flocks have started to lay early in February, but they are exceptional cases. There is no doubt but what flocks can be stimulated to lay earlier. Turkeys will respond to favorable conditions in much the same manner that chickens do. In 1930 the Nebraska station[5] re

20. Mussehl, F. E. Turkey production. Neb. Agr. Expt. Sta. Bul. 280:1-16. 1933.

TABLE VI.—WEEKLY DISTRIBUTION OF PULLET EGG PRODUCTION FROM MARCH 1 TO JULY 3, 1931

WEEK.	Eggs per female.	WEEK.	Eggs per female.
1st	0.938	10th	2.933
2d	2.938	11th	3.267
3d	4.313	12th	3.600
4th	4.625	13th	3.867
5th	3.500	14th	3.667
6th	1.635	15th	2.336
7th	1.933		
8th	3.333	Total	45.500
9th	2.600		

ported that artificial illumination used February 1 in advance of the natural laying season caused the lighted group to lay approximately one month earlier than the control group receiving no lights. In 1933 Albright and Thompson[21] reported an experiment where turkeys were stimulated to lay as early as December 26 by the use of morning lights starting December 1. They do not, however, report the use of a control group and so the period in advance of the normal laying season cannot be given. The United States Range Livestock Experiment Station[22] found that artificial illumination advanced the laying season approximately three weeks. In 1932 the entire breeding flock of the Kansas station was housed on December 1. Morning lights starting at 4:30 a.m. were used throughout the breeding season. The first egg was produced on January 15. No controls were used. In previous years where the ,flock has remained in the open, March 4 had been the date of earliest egg production.

It was thought that both housing and lighting may have contributed to the increased activity of the sexual organs in advance of the normal laying season. To investigate this problem the 1934 breeding flock of approximately 30 Narragansett turkeys hatched May 6, 1933, was divided into three groups on December 1, 1933. One group was placed in one half of a 14'x 28' laying house and remained confined throughout the winter and breeding season. This lot received morning light from one 60-watt incandescent bulb with no reflector, daily, from 4:30 a.m. to daylight, from December 1, 1933, to February 1, 1934. From February 1 the light ration was decreased 15 minutes weekly until April 1, when it was permanently discontinued. A second lot was managed in an identical manner

21. Albright, W. P., and Thompson, R. B. Securing early turkey eggs by stimulated egg production. Poult. Sci. 12:124-128. 1933.
22. Anon. U. S. D. A. Ext. Poultry Husbandman. Serial No. 3, pp. 12-13. 1933.

except for morning lights. This group served as inside controls. A third group remained on the open range throughout the winter and breeding season to serve as the outside controls. The experiment terminated May 25, 1934. All groups received the same laying ration.

The first egg was laid on January 3, 1934, by a pullet receiving the increased light ration, 34 days after the light had been added. This female was 242 days of age. Four of the inside control pullets laid on March 9 at 307 days of age, while one of the outside control pullets laid one day later. From these data it is concluded that housing in itself had no effect on age at sexual maturity, but that increasing the length of the day alone is responsible for this change from the normal egg-laying season.

The percentage production by weekly periods for the duration of the experiment is given in Table VII. The average production of

TABLE VII.—THE EFFECT OF MORNING LIGHTS ON EGG PRODUCTION

	Lights, lot 341.			Inside controls, lot 342.			Outside controls, lot 343.		
	Week.	No. of eggs.	Percentage production.	Week.	No. of eggs.	Percentage production.	Week.	No. of eggs.	Percentage production.
....	1	5	6.0	......	......	....	......	......	....
....	2	11	13.1	......	......	....	......	......	....
....	3	32	38.1	......	......	....	......	......	....
....	4	51	60.7	......	......	....	......	......	....
....	5	68	81.0	......	......	....	......	......	....
....	6	54	64.3	......	......	....	......	......	....
....	7	27	32.1	......	......	....	......	......	....
....	8	21	25.0	......	......	....	......	......	....
....	9	29	34.5	......	......	....	......	......	....
....	10	30	35.7	1	5	7.1	1	1	1.9
....	11	36	42.9	2	13	18.6	2	9	14.3
....	12	54	64.3	3	21	30.0	3	24	38.1
....	13	61	72.6	4	32	45.7	4	46	73.0
....	14	40	47.6	5	39	55.7	5	49	77.8
....	15	31	36.9	6	37	52.9	6	42	66.7
....	16	49	58.3	7	38	54.3	7	23	36.5
....	17	43	51.2	8	37	52.9	8	34	58.6
....	18	50	59.5	9	35	50.0	9	27	48.2
....	19	56	66.7	10	26	37.1	10	26	52.0
....	20	31	36.9	11	36	51.4	11	27	55.1
....	21	47	55.9	12	45	64.3	12	28	57.1
Totals.....	......	826	....	......	364	....	......	336	....
Eggs per female	......	68.8	....	......	36.4	....	......	40.1	....
Percentage production..	......	......	46.8	......	......	43.3	......	......	47.7

desirable hatching eggs per female was 68.6, 36.4, and 40.1 for the lighted, inside controls, and outside controls, respectively, while the percentage production was 46.8, 43.3, and 47.7 percent. It is significant that the increased light ration did not, stimulate rate of production but rather increased the length of time over which hatching eggs could be obtained. All groups reached their greatest production during the fifth week of their respective laying periods. (Fig. 9.)

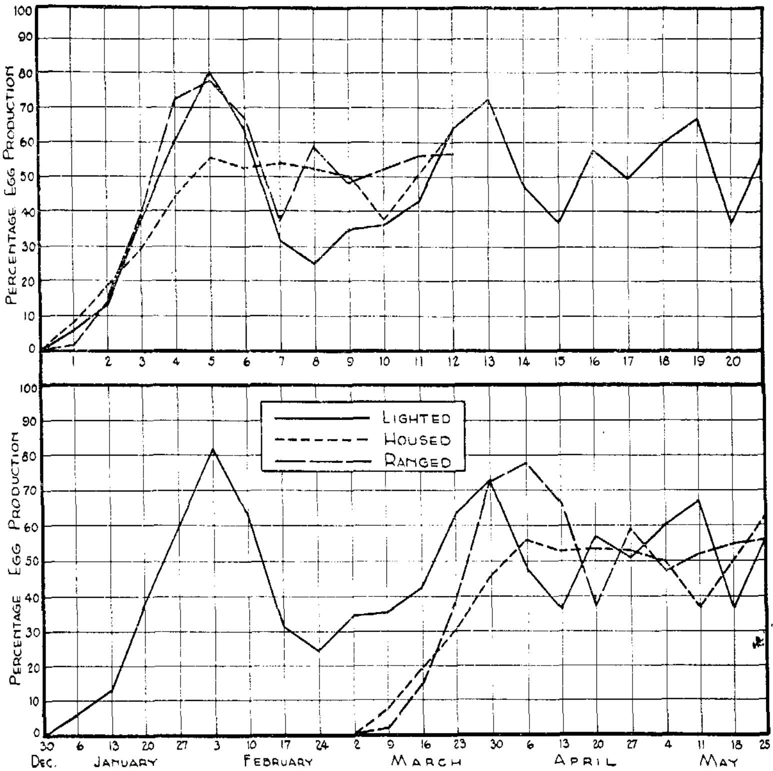


FIG. 9.—Graphs showing the effect of morning lights and management on the distribution of egg production. In the upper graph the data points have been plotted at equivalent periods.

During the course of the experiment, the eggs from the three groups were set every two weeks to determine whether confinement and the stimulation of early egg production would affect the fertility of the eggs and the viability of the embryo. The comparisons are presented in Table VIII.

The fertility of the eggs laid by the range group (outside controls) was exceptionally poor because of the failure of the male to mate with the females. This was not discovered until March 30. By introducing a new male the fertility improved to 90 percent by the middle of April. Fertility in the two housed groups was exceptionally good and is comparable to the fertility obtained in former years when the breeders were given restricted range.

TABLE VIII.—THE EFFECT OF ARTIFICIAL ILLUMINATION AND CONFINEMENT OF BREEDING TURKEYS ON FERTILITY AND HATCHABILITY

Lot.	Eggs set.			Percentage hatchability of fertile eggs.	Probable error of difference.	
	Total.	Fertile.	Percentage fertile.		Inside controls.	Outside controls.
Lights (341)......	739	707	95.7	56.4 ± 1.26	13.7 ± 2.11	8.9 ± 2.59
Inside controls (342)	361	328	90.9	70.1 ± 1.70	....	....
Outside controls (343)....	327	128	39.1	65.3 ± 2.27	4.8 ± 2.83	....

Hatchability was poorest in the group receiving morning lights. The difference between this group and the inside controls, 13.7 ± 2.11 percent, is highly significant. The difference in hatchability between the group receiving morning lights and the outside controls was 8.9 ± 2.59 percent. From these data it would appear that confining breeding turkeys does not reduce the viability of the eggs produced, but that stimulating early egg production by means of increasing the light ration appreciably decreases the viability of the embryo.

BREEDING FOR EGG PRODUCTION

In reproduction, the turkey resembles birds in the wild state. Egg laying is confined largely to the more favorable spring months. Breeding turkeys for egg production has only recently been inaugurated. Pedigree breeding has not been attempted at this station. It is interesting to note, however, that the California station,[23] through pedigree breeding, has succeeded in increasing the average egg production from 35 eggs in 1926 to 65 eggs in 1931. The period of production is not given. By pedigree breeding it is possible that the future breeding female will lay intensely over a long period of time. A number of cases are reported in the literature where exceptional females have demonstrated this ability. Irwin[24] in 1912, reported that a turkey hen laid 200 eggs. McFarlane, Lloyd, and Merrill [25] succeeded in obtaining a year's record of 170 eggs. More recently the Oklahoma Agricultural Experiment Station [26] observed a hen in the Agricultural Experiment Station flock that produced 205 eggs in her first laying year.

23. Anon. *In* Rpt. of the Agr. Expt. Sta. and of the Col. of Agr. of the Univ. of Calif., p. 21. 1933.

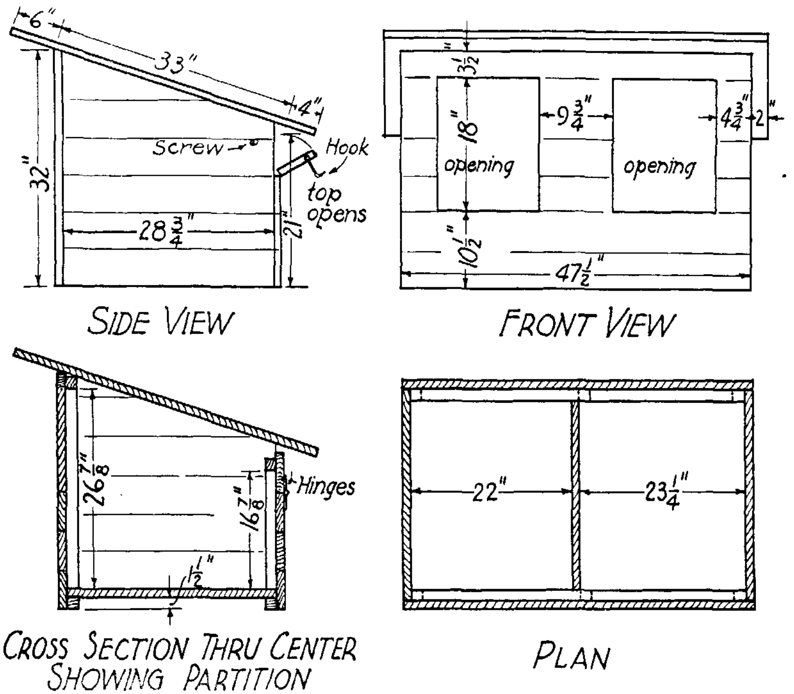
24. Irwin, W. N. The turkey as an egg producer. Am. Breeders Magazine 3:204-208. 1912.

25. McFarlane, N. L., Lloyd, W. E., and Merrill, Grant. Turkey raising in California. Calif. Ext. Circ. 58:1-64. 1931.

26. Anon. The U. S. Egg and Poultry Magazine 39:13-15. 1933.

YARDING THE BREEDERS

Unless early egg production is desired, the breeding flocks require little protection during the winter months under Kansas conditions. With the exception of the years 1933 and 1934 when the breeders were housed, the station's flock has ranged over a wooded tract of several acres from December 1 to February 15. No shelter was provided other than that afforded by natural means. They were permitted to roost in the open throughout the coldest months. No



detrimental effects were observed from such a practice. For a number of years the breeding flock was allowed to remain in this wooded tract during the egg-laying season. This plan was soon discontinued, however, for the reason that many eggs were destroyed by predatory animals and adverse weather. Under such a plan it was impossible to keep the breeders from laying in secluded nests. Thereafter the breeding flock was divided into pens of approximately 15 females each and confined to yards 50 by 50 feet. Egg production and hatchability was entirely satisfactory under this plan of close confinement. These results are not in accord with those of Berry,[27] who is of the opinion that satisfactory hatching eggs cannot be obtained without giving the breeders a minimum yarding space of one half acre.

27. Berry, L. N. Turkey raising under conditions of semiconfinement. New Mexico Agr. Sta. Bul 208 15

Feed hoppers, waterers, low roosting poles, and nests were placed in each pen. Barrels may be used for nests. A more permanent type of nest is illustrated in figure 10. Two such structures making four nests will do for each unit of 15 females. The nests are placed face to face with a narrow runway between to give ample seclusion. Covering the floors of the nests with 2 inches of sand and adding straw will reduce the number of cracked and broken eggs to a minimum.

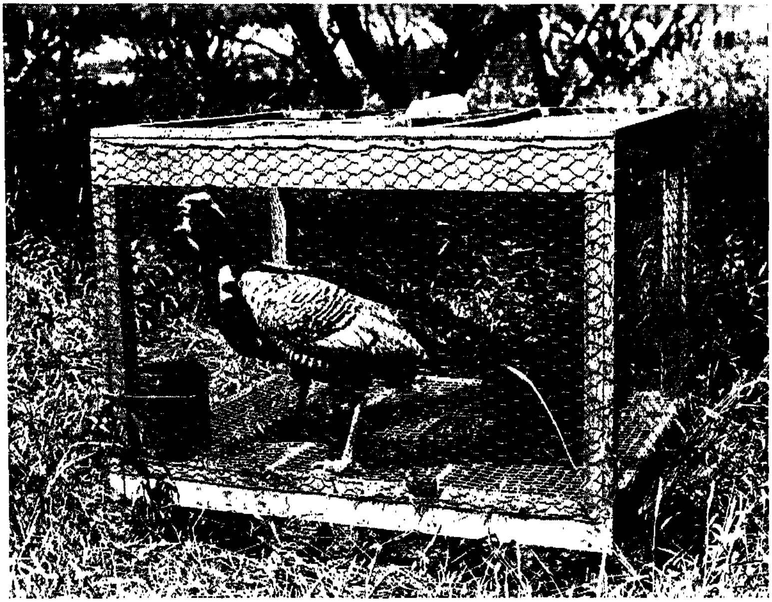


FIG. 10.—Equipment for the breeding flock.

(*Left*) Working drawings of a durable type of nest for brooding turkeys.

An inexpensive broody coop. One such coop will serve a unit of 15 females. This coop is 4 feet long, 3 feet wide, and 3 feet high. The floor, made of 1-inch-mesh hail screen, is 8 inches off the ground. Sides and top are made of 1-inch-mesh chicken wire.

BROODINESS

The relatively short egg-laying season of the turkey hen is marked by frequent periods of broodiness. It is desirable to make these rest periods of short duration. Her value as an egg producer will be influenced by the length of time she is permitted to remain broody. Immediate precaution should be taken to interrupt the broody instinct, for as the length of the broody period advances the more difficult it becomes to restore the laying condition. For these reasons the nests should be observed each evening to detect those individuals that display the first indication of broodiness. If placed in a broody coop at once, these females will soon be restored to laying condition. It is very difficult to break up a hen that has remained on the nest for as long as three nights. The type of broody coop illustrated in figure 10 will under normal conditions care for a unit of 15 breeding females, since not more than three or four individuals of this unit will become broody at the same time.

FEEDING THE BREEDING STOCK*

In many cases with the selection of the breeding stock in the fall, no attempt is made to feed a satisfactory ration until egg laying actually starts in the spring. Thus under average farm conditions the breeders are forced to range for the greater part of their feed from December until March. When this procedure is followed, it is not possible to obtain early egg production, and moreover, the failure to feed an adequate diet during the winter months is reflected in the number and hatchability of the eggs produced as well as in the general health of the flock during the egg-laying season. The following laying ration has given satisfactory results at this station:

Scratch grain

	Pounds
Whole yellow corn	200
Wheat	200

Mash

	Pounds
Ground yellow corn	100
Groundwheat	100
Ground oats	100
Meat and bone scrap	75
Alfalfa-leaf meal	25

Mash and oyster shell are made available at all times in open hoppers, while grain feeding for the most part has been restricted to evenings only. In an effort to maintain body weight, a more liberal quantity of scratch grain is fed as the egg-laying season progresses. Observations made at this station show that the average male will, during the course of the breeding season, lose approximately 18 percent of his body weight, while the loss for the female will approximate 15 percent.

Since succulent green feed is very limited during the winter months at this latitude, an experiment was planned for the purpose of observing the effects of the lack of vitamin A on breeding turkeys. On January 10, 20 well-matured Bronze females were divided into two

TABLE IX.—DIETS USED TO DETERMINE THE EFFECT OF VITAMIN A DEFICIENCY ON BREEDING TURKEYS

DIET.	Adequate vitamin A, parts per 100.	Low vitamin A, parts per 100.
Ground white corn	65	65
Wheat bran	15	15
Meat and bone scrap	10	10
Alfalfa-leaf meal	10	0
Synthetic alfalfa meal (*a*)	0	10

(*a*) Composed of ground dry sweet clover stems with enough bone meal and meat scrap added so as to have the synthetic mixture contain the same percentage of protein, fiber, and ash as the alfalfa-leaf meal.

* The author is indebted to Dr. J. S. Hughes of the Department of Chemistry for his assistance and coöperation in all nutrition studies reported herein.

lots and confined to a laboratory building. The diets used are presented in Table IX.

Leghorn hens placed on the experimental diet January 10 developed deficiency symptoms as early as the latter part of February. This would indicate that the ration containing synthetic alfalfa meal was exceptionally low in vitamin A. No symptoms were observed in the experimental turkeys until May 2. The last experimental chicken died at about the time the first deficiency symptoms were observed in the experimental turkeys. Since the chickens were laying when placed on the experiment, January 10, while the turkeys did not start to lay until March, it is reasonable to assume that vitamin storage was more rapidly depleted from the bodies of the

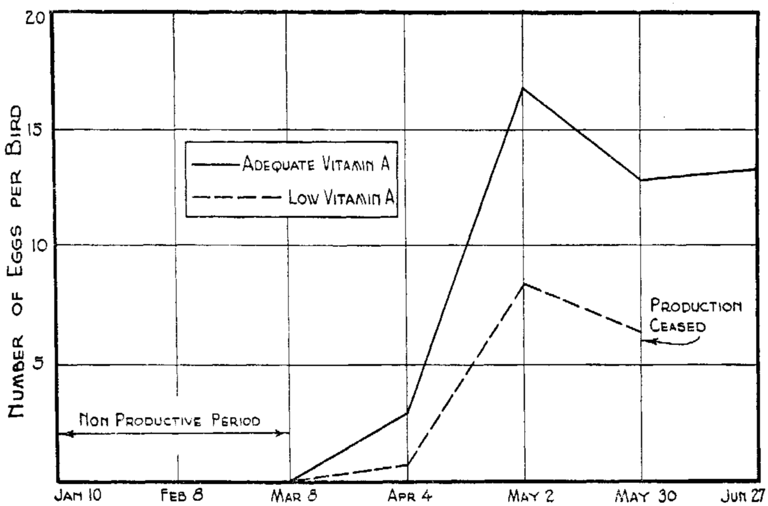


FIG. 11.—Graphs showing the effect on egg production of feeding a low vitamin A ration to breeding turkeys.

chickens than from the turkeys because the chickens were in laying condition.

The extent to which egg production was impaired by the feeding of a vitamin A low ration is shown in figure 11. The data points represent the average number of eggs produced per individual for each four-week period. The production of the control group was very satisfactory. The two curves exhibit comparable tendencies although the data points for the experimental group are considerably below the corresponding data points of the control turkeys at each interval. While the two pens mere mated and the males alternated weekly between the two groups with the view of comparing hatchability, so few eggs were produced by the experimental group that the comparison could not be made.

The experimental turkeys ceased to lay after May 21. It is interesting to note that blood analyses of the individuals in this group made 14 days after the last egg was produced showed a calcium level typical of birds in production. The range of calcium for these individuals was from 23 to 33 mg. per 100 c. c of plasma. Following the blood analysis, a celiotomy performed on each of the six surviving individuals revealed fully developed ova in their ovaries although no eggs had been produced in the previous two weeks and no eggs were obtained up to June 27 when the experiment mas terminated. The data suggest that ovulation may be conditioned by the level of vitamin A present in the diet.

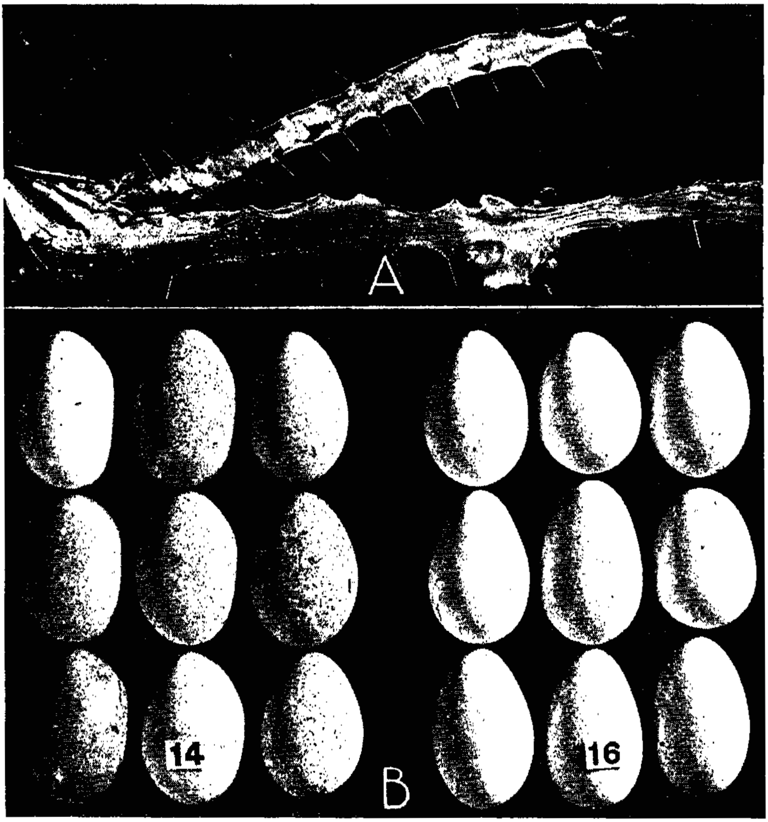


FIG. 12.—Symptoms of vitamin A deficiency.

(A) The appearance of the esophagus and trachea of a turkey receiving a diet deficient in vitamin A. Note the pustules in the anterior esophagus as well as that part of the esophagus extending caudalward from the ingluvies (crop). The white, cheesy-like exudate in the trachea was characteristic of each turkey in the advanced stages of hypovitaminosis.

(B) Eggs from two lots of turkeys, showing the influence of vitamin A on shell color and texture. The females producing the heavily spotted eggs shown on the left (lot 14) received vitamin A, while the eggs from lot 16 were produced on a low vitamin A diet.

It has been repeatedly stated that shell color in birds cannot be altered by diet. The egg of the Bronze turkey is marked by numerous brown spots. These spots seem to be confined largely to the outer surface of the shell since washing and rubbing will remove many. Our observation as well as that of Cline [28] has been that these spots become reduced in number as the egg-laying season progresses. An occasional white-shelled egg may be produced irrespective of the season. The eggs produced by the experimental turkeys during the latter part of April were extremely thin-shelled and light in color. Eggs from the control group were normal in every respect. The contrast is illustrated in figure 12B. The result of this experiment would indicate that vitamin A as well as vitamin D may influence the quality of the egg shell although the former is not usually associated with calcium metabolism. In the fowl it is well known that the lack of vitamin A results in an atrophy of the mucous membrane epithelium of the respiratory tract and the upper alimentary tract. (Fig. 12A.) Since the epithelium is concerned with secretion, it is possible that the lack of this vitamin may seriously impair the function of the glands in the oviducal tube. Oviducts have been preserved for future histological studies.

INCUBATION

COMMERCIAL HATCHING

The majority of the turkeys hatched annually in the United States have been and probably still are incubated by natural means. Artificial methods are, however, becoming more popular. The reports of the Bureau of Agricultural Economics, United States Department of Agriculture, indicate clearly the increasing tendency to hatch turkey eggs in incubators. According to the market news service of this bureau, as reported from the various geographic sections of the United States, the number of turkey eggs set by commercial hatcheries in 1931 surpassed by 13.9 percent the number set in 1930. An increase of 41.71 percent was reported for 1933 over 1932, an increase of 23.48 percent for 1934 over 1933, and an increase of 38.49 percent for 1935 over 1934. The increase in the number of salable poults hatched follows the same trend. That the incubator compares favorably with the turkey hen in hatching ability has been previously illustrated in Table I.

In the work of this station, the incubator has been used exclusively with very satisfactory results. One of the strongest arguments in favor of artificial incubation is that this method is the first pillar of support in the rigid program of sanitation so essential for success with turkeys. There is always the possibility of disease whenever the young poult is brought in contact with the parent stock or even the surroundings frequented by adult stock. Turkey hens should not be permitted to remain broody for any length of time. From a purely economic standpoint, the individual turkey egg is too valuable to allow the female to act in the capacity of an

28. Cline, L. E. Turkey production. Orange Judd Pub. Co. 436 pp. 1933.

incubator. Unless precautionary measures are taken, it is reasonable to expect that as artificial methods of hatching become more universally used, pullorum disease may become more of a major problem than it is at this time. The Rhode Island Agricultural Experiment Station [29] as early as 1927 reported an outbreak of the disease in young turkeys. Since that date, numerous outbreaks have been reported in the literature. The breeding flock at this station has been tested on two occasions with negative results. The majority of the turkey breeding flocks in this state are in all probability free from the disease. The gronwer should ever be alert to keep them disease free by incubating turkey eggs in separate compartments from chirken eggs. The plan of brooding should incorporate the same feature.

THE GENERAL PROBLEM OF INCUBATION

The transformation of the raw products of the egg such as yolk, egg white, minerals, vitamins, and water into an embryo is a highly complex physico-chemical process. Thus the developing turkey embryo is dependent upon the food stuffs laid down in the egg by the mother hen. The water content of the developing egg can be conserved by maintaining a relatively high humidity in the incubator, but cannot be replenished. If the breeding stock has been properly fed and the eggs handled in the best manner possible from time of laying to time of setting, the results from there on rest, solely with the operator and the incubator in providing the correct temperature, moisture, and ventilation.

The question arises, What are the correct conditions for artificial hatching of turkey eggs? A vast amount of research work has been done with the egg of the domestic fowl. Information on this point, as it concerns the turkey egg, is very meager. Generally it has been assumed that the requirements for the turkey embryo are the same as those for the chicken embryo. The validity of this assumption must be questioned for the time being. The question is an open one until further researches have been undertaken, since the investigations made to date both support and refute the aforementioned theory. Mussehl[30] points out that chicken eggs can be hatched under turkey hens and turkey eggs under chicken hens and, therefore, the requirements are in general the same for the two birds. From the field come complaints to the effect that poor hatches are obtained with turkey eggs where they are incubated in machines through which the air is forced rapidly and in machines where the air is agitated.

There is some experimental evidence that these types of machines, when operated as recommended for chicken eggs, do not give best hatching results with eggs other than those of the domestic chicken. Thus Callenbach, Murphy, and Hiller [31] report that the hatching

29. Anon. *In* 39th Ann. Rpt. of the Rhode Island Agr. Expt. Sta., p. 46. 1927.
30. Mussehl, F. E. Hatching turkey eggs. Univ. of Neb. Bul. **269**:1-7. 1932.
31. Callenbach, E. W., Murphy, R. R., and Hiller, C. A. The artificial propagation of ring-necked pheasants. Poult. Sci. **11**:150-157. 1932.

power of pheasant eggs in the still-air machine was greater by 18.2 percent than that obtained by hatching in a cabinet, agitated-air machine. They report that conditions in the agitated-air machine seem to be very satisfactory for the first 20 days. By starting eggs in the cabinet machine and then transferring them to a still-air machine late in the incubation period, it was found that this combination method of incubation proved to be superior by 39.5 percent over continuous incubation in the cabinet machine and 21.3 percent better than continuous incubation in the still-air machine. These results may be interpreted to mean that the agitated-air machine provides an ideal environment for the incubation of pheasant eggs up to a short period before pipping, but that hatching itself is best accomplished in a still-air machine. These workers suggest that the differences obtained may be due to (1) lack of ventilation in the agitated-air machine when the pheasant chick pips the shell, and (2) the drying of the shell membranes due to the movements of the air, notwithstanding that the air present in the agitated-air machine contained more moisture than the air of the still-air machine.

Additional evidence that air movements are a factor to be considered is provided in the work of Mussehl and Ackerson.[32] They found that when turkey eggs were incubated in a cabinet machine for the first 24 days and then divided into three groups on the 25th day with each group hatching in a different machine, that marked differences in hatchability were obtained. In group one, incubation was continued in a small cabinet machine operated at a temperature of 100° F. and a relative humidity near 71 percent. In group two, hatching was carried out in a second small cabinet machine operated at a temperature of 100° F. and a relative humidity of 52 percent. The third group was placed in a sectional machine, commonly referred to as a still-air machine that employs the gravity system of ventilation. This machine was operated at a temperature ranging from 103 to 104° F. Moisture was provided by a water pan. Two tests were carried out to completion, the results of which are shown in Table X.

TABLE X.—RESULTS OF AIR MOVEMENTS IN INCUBATION

Beginning 25th day

	Test.	
	1.	2.
Percent hatchability (strong poults):		
Group 1	56.1	49.7
Group 2	54.5	59.4
Group 3	64.2	70.8

32. Mussehl, F. E., and Ackerson, C. W. Some observations on humidity and weight loss in the incubation of turkey eggs. Neb. Agr. Expt. Sta. Res. Bul. **74**:1-11. 1934.

It is of interest here to note that the still-air machine gave the best results and that the results are much like those obtained by Callenbach and his co-workers working with the pheasant. If the proposal made by the latter group of workers to the effect that the shell membranes dry rapidly in the cabinet machine and thus adversely affect hatchability, is tenable, then it is difficult to explain why the hatchability of group 1 was not superior to that of group 2. The relative humidity for group 1 was 71 percent, while for group 2 it was 52 percent. It has been our experience with turkey eggs that the still-air machine has given better hatching results than the old model forced-draft machines or agitated-air machines, although no critical experiments have been carried out.

The incubation period for both the pheasant and the turkey is longer than that of the chicken and this fact may or may not be pertinent to the question.

While it may be true that, in general, the incubation requirements for the chicken and the turkey are identical, it must be admitted that the environment provided in the cabinet type of machine during the later stages of incubation is not particularly well adapted to the hatching of turkey eggs. This does not condemn the cabinet machine for hatching turkey eggs. The new model machines are greatly improved and it may be possible to provide conditions in these machines that will give good results during the late phases of turkey-egg incubation. The data of Callenbach and co-workers on pheasants shows definitely that early embryonic mortality is greater in the still-air machine than in the agitated-air machine. It would seem, therefore, that the ideal situation for hatching turkey eggs would be to provide conditions as they are found in the agitated-air machine for the first 24 days of incubation and conditions as found in the gravity machine for the remainder of the incubation period.

HUMIDITY AND VENTILATION STUDIES

The rate at which eggs lose weight while undergoing incubation is so closely associated with the volume of air that passes through the machine and over the eggs that the two factors are herein discussed simultaneously.

It is generally accepted that a relative humidity of approximately 60 percent gives the optimum amount of moisture for the incubating hen egg. The carbon-dioxide tolerance of the developing chicken embryo is quite high. The work of Lamson and Edmond [33] and Lamson and Kirkpatrick [34] would indicate that hatchability is not seriously impaired until the medium of air contains more than 150 parts of CO_2 in 10,000 parts of air. They report that "In the usual commercial incubation, the amount of carbon dioxide usually increases to 30 to 50 parts in 10,000." Atmospheric air contains from 2.5-4.0 parts of carbon dioxide in 10,000 parts of air.

33. Lamson, G. H., J., and Edmond, H. D. Carbon dioxide in incubation. Storrs Agr. Expt. Sta. Bul. 76:219-258. 1914.

34. Lamson, G. H., Jr., and Kirkpatrick, Wm. F. Factors in incubation. Storrs Agr. Expt. Sta. Bul. 95:311-350. 1918.

The Idaho Agricultural Experiment Station investigators[35] working with the forced-draft type of incubator, found that best results were obtained with turkey eggs when the wet bulb thermometer registered 2° F. higher prior to hatching and from 4° to 5° F. higher during pipping than the wet bulb reading maintained for chicken eggs. For chicken eggs they propose wet bulb readings of 79° to 81° F. (40 to 45 percent relative humidity) prior to hatching and 85° to 88° F. (54 to 63 percent relative humidity) during the time that the eggs are actually hatching. This same station[36] suggests that enough moisture should be given so as to cause turkey eggs to lose in weight, by evaporation 0.6 percent daily or from 13½ to 14½ percent by the 24th day. The percentage loss in weight up to 24 days for turkey eggs should approximate the same percentage loss as found in chicken eggs at 18 days of incubation, according to the Idaho Agricultural Experiment Station.[37]

Muessehl[30] has studied the loss in weight of turkey eggs where natural means of incubation are employed. Eggs incubated by chicken hens lost 12.15 percent of their original weight and hatched 89 percent, while eggs incubated in a sectional type of incubator lost 13.77 percent and hatched 67 percent. That individual eggs vary markedly in the rate at which they lose weight (9.01 to 26.29 percent) when incubated in a cabinet machine has been demonstrated by the Nebraska station.[38] Mussehl also reports that there appears to be no correlation between weight lost and the vitality of the poult where growth is the measurement of vigor.[30, 39]

During the breeding season of 1935 a study was undertaken at this station to investigate the rate at which turkey eggs lose weight while undergoing incubation in a forced-draft machine. The incubator was operated at a temperature of 100° F. and a wet bulb reading of 86° F. for the first 24 days. The eggs were laid by a flock of 44 Narragansett turkeys between the dates of March 9 and May 8. The flock had been confined to a poultry house December 1, 1934, and remained confined without yards until the conclusion of the experiment. Only the 911 fertile eggs that survived the 24th day of incubation are included in the data. This number represents 85.53 percent of the total fertile eggs incubated. Each egg was weighed individually at time of setting and again on the evening of the 24th day. Following this the eggs were placed in pedigree sacks and transferred to a separate hatcher operated at a temperature of 101° F. and a wet bulb reading of 90° F.

In summarizing the data, four arbitrary classes were selected. The range in weight. for each group and the respective mean are given in Table XI. It was found that the smaller eggs (mean size 77.20 grams) on a relative basis lost more weight than did the larger eggs in the three remaining groups. The difference was highly

35. Anon. Univ. of Idaho Agr. Expt. Sta. Bul. 192:1-49. 1932.
36. Anon. *In* Univ. of Idaho Ann. Rpt. Bul. 197:49. 1933.
37. Anon. Univ. of Idaho Agr. Expt. Sta. Bul. 179:1-47. 1931.
38. Anon. *In* 46th Ann. Rpt. of the Agr. Expt. Sta. of Neb., p. 33. 1933.
39. Anon. *In* 45th Ann. Rpt. of the Agr. Expt. Sta. of Neb., p. 37. 1932.

TABLE XI.—THE EFFECT OF EGG SIZE ON THE RELATIVE LOSS IN WEIGHT OF INCUBATING TURKEY EGGS

Egg weight in grams.		No. of eggs.	Percentage loss in weight.				Percentage hatchability.	Probable error of the difference.		
			Mean.	Probable error of the difference.						
Range.	Mean.			88.7	86.6—88.6	80.5—84.5		88.7	84.6—88.6	80.5—84.5
88.7 and above........	91.57	128	11.84 ± .109	....	....	....	64.84 ± 2.85	....	....	....
84.6—88.6...........	86.47	219	11.58 ± .067	0.26 ± .128	....	....	74.21 ± 1.99	9.58 ± 3.47	....	....
80.5—84.5...........	82.31	268	11.90 ± .063	.06 ± .126	0.32 ± .092	....	70.89 ± 1.87	6.05 ± 3.41	2.53 ± 2.73	....
80.4 and less..........	77.20	296	12.48 ± .078	.64 ± .134	.90 ± .033	0.58 ± .032	67.23 ± 1.84	2.49 ± 3.39	7.19 ± 2.71	3.66 ± 2.62
Totals.............	....	911	....	....	....	....	....	....	....	....

TABLE XII.—THE EFFECT OF RELATIVE LOSS IN WEIGHT ON THE HATCHING POWER OF EGGS VIABLE ON THE 24TH DAY

Percentage loss in weight.		Number of eggs.	Mean egg weight (*gm.*).	Percentage hatchability.	Probable error of the difference.		
Range.	Mean.				12.5 and above.	11.4—12.4	10.3—11.3
12.5 and above	14.19	296	81.33	62.84 ± 1.89	....	....	....
11.4—12.4	11.88	231	83.73	73.16 ± 1.97	10.32 ± 2.73	....	....
10.3—11.3	10.84	239	84.23	74.47 ± 1.97	11.63 ± 2.73	1.31 ± 2.78	....
1 .2 and less	9.60	145	83.44	69.65 ± 2.58	6.81 ± 3.20	3.51 ± 3.25	4.82 ± 3.25
Total	....	911	....	....	....	....	....

significant in each case. However, no significant differences could be demonstrated between the three larger classes, although the mean difference in weight between two of the classes was 9.3 grams. The differences in hatchability were not found to be significant.

To test whether the relative loss in weight bears any relationship to hatchability, the data included in Table XII have been grouped according to the percentage loss in weight rather than egg size. Table XII gives the range in loss and the mean for each group. It is observed that the eggs having a mean percentage loss in weight of 14.19 percent, gave the poorest hatchability. The hatchability of the eggs in this group was significantly less than the hatchability for the groups having a mean percentage loss of 11.88 and 10.84 percent, respectively.

The data presented in Table XIII give more detailed information concerning the rate at which turkey eggs lose weight while under-

TABLE XIII.—THE LOSS IN WEIGHT OF 144 TURKEY EGGS INCUBATED IN A FORCED DRAFT MACHINE

DAY.	Mean egg weight (grams).	Loss in weight between each interval.	
		Grams.	Percentage
Initial	84.24		
3d	83.04	1.20	1.42
6th	81.77	1.27	1.53
9th	80.30	1.47	1.80
12th	79.47	.83	1.03
15th	78.62	.85	1.06
18th	77.28	1.34	1.72
21st	76.67	.61	0.78
24th	74.99	1.68	2.19
Total loss		9.25	11.53

going incubation. The 144 eggs included in this table were individually weighed at three-day intervals up to and including the 24th day. These eggs represent a fraction of the eggs considered in Tables XI and XII.

Goff[40] reports that, umbilical infection, probably omphalitis, occurred in a group of poults that had been hatched in a compartment where the humidity was low.

In general the results of the investigations made to date would indicate that turkey eggs should sustain, by evaporation and metabolism, a loss in the original weight of approximately 11 to 13 percent.

40. Goff, O. E. Faulty incubation causes turkey losses. Solving Oklahoma farm problems. *In* Rpt. of Okla. A. & M. College Agr. Expt. Sta., pp. 103-104. 1930-'32.

COOLING EGGS

There appears to be no advantage in cooling chicken eggs where the incubator is well ventilated. (Lamson and Kirkpatrick.)[34] Not all small incubators are well ventilated, however, and cooling must be resorted to in order that the eggs may be oxygenated. The oxygen requirement of the embryo increases rapidly as the incubation period advances. The failure to supply this element in proportion to the needs of the embryo is a contributing factor to "dead in shell." In small farm incubators where fully formed embryos are found dead in the shell, cooling the eggs will in a measure compensate for what the ventilating system fails to accomplish. It should be emphasized that cooling in itself is of doubtful value and again that poor ventilation is by no means the only factor that is responsible for "dead in shell." If cooling is necessary, it should start near the tenth day. The duration of the oxygenating process should be about five minutes morning and evening. As the incubation period advances, the period of exposure may be increased to 10 or 15 minutes.

EGG SIZE AND HATCHABILITY

In addition to the 911 eggs included in Table XI, 154 eggs that failed to survive the 24th day of incubation and 65 fertile eggs that were not weighed on the last day of incubation were arranged in four weight groups. (Table XIV.) The data on the 1,130 eggs are presented in Table XIV where it is observed that eggs of medium size hatched better than did the larger or smaller eggs. The only significant difference, however, was between the two mean egg-size groups of 86.39 grams and 77.17 grams.

TEMPERATURE STUDIES

In 1930 the temperature requirement of the turkey egg was investigated when incubated in a sectional type of machine at this station. Two trials were completed in which 320 Bronze turkey eggs and a like number of Single Comb White Leghorn eggs were involved. The eggs for each trial were divided into four lots. In lot 1 the turkey eggs were incubated at 98° F.; lot 2, 99° F; lot 3, 100° F; and lot 4 at 101° F. for the first week of incubation. The temperature was raised one degree insofar as was possible in each lot for each succeeding week. Thus, during the fourth week, lot 1 was incubated at 101° F. while lot 4 was incubated at 104° F. The chicken eggs were set at the beginning of the second week in the same compartments with the turkey eggs. It was necessary to construct a wire device that would place the top of the chicken eggs on a level with the top of the turkey eggs. The thermometer rested on a level with the top of the eggs. The results are presented in Table XV.

In both trials the turkey eggs incubated at 100° F. the first week and increased to 103°F. the fourth week gave the best hatching results. The chicken eggs hatched well in the higher temperatures of

TABLE XIV.—THE RELATION OF EGG SIZE TO THE HATCHABILITY OF TURKEY EGGS

Egg weight in grams.		Number of eggs.	Percentage hatchability.	Probable error of the difference.		
Range.	Mean.			12.5 and above.	84.6—88.6	80.5—84.5
88.7 and above	92.21	147	59.86 ± 2.73	....	....	....
84.6—88.6	86.38	254	67.72 ± 1.98	7.86 ± 3.37	....	....
80.5—84.5	82.86	337	62.81 ± 1.78	2.95 ± 3.26	4.91 ± 2.66	....
80.4 and less	77.17	392	54.84 ± 1.70	5.02 ± 3.22	12.88 ± 2.61	7.97 ± 2.46
Total	....	1,130	....	....	....	....

TABLE XV.—THE EFFECT OF VARIATIONS IN TEMPERATURE ON HATCHABILITY

TRIAL.	Percentage of fertile eggs hatched.							
	Lot 1.		Lot 2.		Lot 3.		Lot 4.	
	Turkey.	Chicken.	Turkey.	Chicken.	Turkey.	Chicken.	Turkey.	Chicken.
1	71.4	61.3	69.4	56.2	81.6	75.7	75.0	82.4
2	64.9	37.5	61.5	64.9	78.4	69.2	58.3	68.8

lots 3 and 4. The lower temperatures appear to be more harmful to the chicken embryo than to the turkey embryo. The poults of lot 3 started to pip the shell late the 25th day and were through hatching late the 27th day. Hatching was later at the lower temperatures, but only slightly earlier at the higher temperature. The incidence of "spraddle legs" was greatest in lot 4 poults and to a lesser degree in lots 1 and 2. Romanoff[41] reports that the number of crippled poults hatched becomes progressively greater as the temperature falls below what is considered optimum and that no abnormalities resulted from temperatures higher than normal. The experiments conducted at the Kansas station indicate that abnormal temperature is a predisposing factor and in particular high temperature, while Romanoff's data suggest that only low temperature results in "sprawled legs." A possible explanation for this apparent difference may lie in the fact that so few of the eggs hatched that were subjected to high temperature in the experiment conducted by Romanoff. This deformity has not been observed in chickens at this station. Many poults afflicted with this disorder can gain full control of their limbs if placed in an open chick box, the floor of which is covered with excelsior padding. The recommendation of this agricultural experiment station favors incubating turkey eggs in a still-air incubator at 100°F. for the first week with an increase of 1 degree for each succeeding week of incubation.

Martin and Insko,[42] working with a much larger group of eggs and, therefore, more conclusive, found that 103.4° F. during the last week of incubation resulted in a high embryonic mortality. This work was conducted in a sectional incubator (Jamesway). Their results are shown in Table XVI. These results are in accord with the findings of this station.

In a second experiment Martin and Insko,43 after observing that the temperature of the naturally incubated embryo was consistently higher than that of the artificially incubated embryo for the first 12 days of the incubation period, reversed the usual procedure and sub-

41. Romanoff, A. L. Influence of incubation temperature on the hatchability of eggs, postnatal growth, and survival of turkeys. Jour. Agr. Sci. **25**:318-325. 1935.

42. Martin, J. Holmes, and Insko, W. M., Jr. The effect of temperature and position in the incubation of turkey eggs. Poultry Sci. **14**:152-155. 1935.

43. Martin, J. Holmes, and Insko, W. M., Jr. Turkey embryo temperature experiments. Abstracts of papers presented at the 27th Annual Meeting of Poultry Science Association, 1935.

jected the eggs to the higher temperature the first week of incubation. In two of three instances the eggs incubated at 103-102.5-101.5-100.5° F. for each of the respective weeks, hatched equally as well as those incubated with the temperatures reversed.

Romanoff[4]I incubated a group of turkey eggs for the first 20 days in a forced-draft, incubator operated at 37.5° C. (99.5° F.). These eggs were then separated into 12 lots of approximately 46 eggs each and incubated at temperatures ranging from 30.5-41.6° C. (86.9-106.7° F.). Best, hatching results were obtained at temperatures of 36 to 38° C. (96.8-100.4° F.).

TABLE XVI.—THE EFFECT OF VARIATIONS IN TEMPERATURE ON HATCHABILITY

Martin and Insko

Lot.	Temperature in degrees F. for each week of incubation.				Percentage hatchability.
	1.	2.	3.	4.	
1	100.5	101.4	102.6	103.0	77.40
2	101.0	101.9	102.9	103.4	68.70
3	101.3	102.0	102.7	103.1	75.90
4	100.9	101.1	101.3	101.4	70.47

Further studies on temperature have been reported by Barton.[44] Duplicate hatching periods were reported for temperatures ranging from 100° F. to 105° F. He found that hatchability and vigor of the poults was best when eggs were incubated at 101° F. and 102° F. Bice[45] concluded after conducting several trials in a still-air machine that a temperature of 101° F. for the first 10 days, 101.5° F. for the eleventh to the eighteenth day, and 102° F. for the remainder of the incubation period gave the best results under Hawaiian conditions. The Wyoming Agricultural Experiment Station[46] recommends operating the incubator from ½ to 1 degree lower than for chicken eggs if the bulb of the thermometer remains in the position advocated for chicken eggs. If the thermometer is placed level with the top of the turkey egg, according to the Wyoming station, then the incubator should be operated at the temperature recommended for the chicken egg. The result of the work at this station (Table XV) would indicate that turkey eggs hatch better when incubated for the first week at a temperature below that which is usually recommended for the first week of incubation for chicken eggs.

44. Barton, O. A. Temperature studies in the artificial incubation of turkey eggs. No. Dak. Agr. Expt. Sta. Bul. **256**:1-62. 1932.

45. Bice, C. M. Turkey management in Hawaii. Hawaii Agr. Expt. Sta. Circ. **10**:1-18, 1935.

46. Anon. *In* 40th Ann. Rpt. of the Univ. of Wyo. Agr. Expt. Sta., p. 16. 1929-30.

TURNING EGGS

It is advisable to turn eggs at least two times during each 24-hour period. This is usually done morning and evening. More frequent turning may be of some benefit. Turning should start on the first day and be discontinued the evening of the 24th day. The change in position brought about by turning seems to be necessary for the normal development of the embryo. In any event, there is less danger of the embryo adhering to the inner shell membrane during the early period of its development when turning is regularly performed.

Martin and Insko[42] have studied hatching position and its effect on hatchability. Eight trays of turkey eggs were hatched large end up in a Smith incubator. A like number of trays were candled on the 25th day and the remaining eggs allowed to hatch in the horizontal position. The percentage hatchability for the vertically hatched eggs was 79.2 percent and for the horizontally hatched eggs 77.9 percent. They call attention to the fact that it was necessary to remove poults and egg shells frequently from the vertically hatched eggs to prevent losses, and concluded that it is not advisable to hatch turkey eggs in full trays with the eggs in this position. They also conducted an experiment in the Smith machine where the number of eggs remaining after candling was reduced by half in part of the trays. They concluded that the additional ventilation and room provided by reducing the number of eggs per tray was of no benefit in the Smith machine. The eggs (95 to 100 per tray) incubated on their sides hatched 78.2 percent, while eggs limited to half this number per tray hatched 79.1 percent.

HOLDING EGGS

It is well known that hatching results are conditioned by the care that eggs receive in the time that intervenes between laying and setting. It is generally recognized that eggs should be set within seven to ten days following laying for the best hatching results.

In some instances it is necessary for the grower to hold eggs beyond the ten-day period. This is particularly true where one maintains a small breeding flock and at the same time employs artificial means of hatching and rearing. The early eggs in particular are held until a sufficient number have been saved to make an economical hatching or brooding unit. A study of the length of time that eggs could be held without deteriorating in hatching power and the conditions under which they should be held seemed advisable. Experiments on these points were conducted in the years 1929, 1930, and 1931.

All eggs used in these experiments were collected daily between the dates of March 4 and April 7 and held under various conditions in an ordinary egg case. Tilting the case from side to side or end to end each day of the holding period was practiced.

The results of the 1929 experiment, as shown in Table XVII would indicate that the hatching power of the egg is greatly reduced when held longer than 13 days at a temperature range of 60° F. to 75° F. These eggs were held in a basement where the temperature of the surrounding air was influenced by an incubator.

In the 1930 experiment, the eggs were held in the basement of a house where the temperature varied from 55° F. to 60° F. The figures in Table XVIII would indicate that under certain conditions, turkey eggs may be held for rather long periods without materially reducing hatchability. Physiological activity takes place at 68° F. At temperatures slightly above this point, the embryo develops at a subnormal rate. The 1929 and 1930 experiments may be interpreted to indicate that turkey eggs must be held well below 68° F. if the viability of the embryo is to be conserved over prolonged holding periods.

TABLE XVII.—THE EFFECT ON HATCHABILITY OF HOLDING TURKEY EGGS FROM 1 TO 34 DAYS BEFORE SETTING AT TEMPERATURES RANGING FROM 60 TO 75° F.

1929

NUMBER OF DAYS HELD.	Number of fertile eggs set.	Percentage of embryos dying.		Percentage hatchability.
		1- to 25-day period.	26- to 28-day period.	
1 to 6	64	15.63	12.50	71.87
7 to 13	79	10.13	16.45	73.42
14 to 20	83	34.94	20.48	44.58
21 to 27	85	76.47	9.41	14.12
28 to 34	48	85.42	8.33	6.25

TABLE XVIII.—THE EFFECT ON HATCHABILITY OF HOLDING TURKEY EGGS FROM 1 TO 34 DAYS BEFORE SETTING AT TEMPERATURES RANGING FROM 55 TO 60° F.

1930

NUMBER OF DAYS HELD.	Number of fertile eggs set.	Percentage of embryos dying.		Percentage hatchability.
		1- to 25-day period.	26- to 28-day period.	
1 to 6	93	3.23	7.53	89.25
7 to 13	68	4.41	5.88	89.71
14 to 20	46	4.35	10.87	84.78
21 to 27	25	12.00	4.00	84.00
28 to 34	7	14.29	0	85.71

In 1931 use was made of the chill rooms of a local packing establishment where temperature and humidity could be controlled.

Bronze turkey and White Leghorn chicken eggs mere held in two rooms with average temperatures of 36.3° F. and 54.2° F., respectively, from 0 to 34 days before setting. The essential facts are presented in Tables XIX and XX.

TABLE XIX.—THE EFFECT ON HATCHABILITY OF HOLDING TURKEY EGGS FROM 1 TO 34 DAYS BEFORE SETTING

1931

NUMBER OF DAYS HELD.	Number of fertile eggs set.		Percentage of embryos dying.				Percentage hatchability.	
			1 to 25 days.		26 to 28 days.			
	L. 26.	L. 28.	L. 26.	L. 28.	L. 26.	L. 28.	L. 26.	L. 28.
1 to 6	32	31	18.75	16.13	15.62	12.90	65.63	70.97
7 to 13	42	41	33.33	12.50	14.29	22.50	52.38	65.00
14 to 20	66	63	66.07	7.93	7.14	17.46	26.79	74.60
21 to 27	52	52	94.12	17.33	0	15.38	5.88	67.31
28 to 34	37	36	100.00	25.00	0	13.89	0	61.11

	Lot 26	*Lot 28*
Mean temperature	36.3° ± 0.2° F.	54.2° ± 0.26° F.
Mean wet bulb reading................	35.3° ± .2° F.	52.5° ± .25° F.

TABLE XX.—THE EFFECT ON HATCHABILITY OF HOLDING CHICKEN EGGS FROM 1 TO 34 DAYS BEFORE SETTING

1931

NUMBER OF DAYS HELD.	Number of fertile eggs set.		Percentage of embryos dying.				Percentage hatchability.	
			1 to 18 days.		19 to 21 days.			
	L. 27.	L. 29.	L. 27.	L. 29.	L. 27.	L. 29.	L. 27.	L. 29.
1 to 6	60	62	23.33	19.35	13.33	11.29	63.33	69.35
7 to 13	57	66	89.47	21.21	5.26	12.12	5.26	66.66
14 to 20	76	78	100.00	16.67	0	15.38	0	67.95
21 to 27	79	79	100.00	35.44	0	20.25	0	44.30
28 to 34	71	78	100.00	47.44	0	20.51	0	32.05

	Lot 27	*Lot 29*
Mean temperature	36.3° ± 0.2° F.	54.2° ± 0.26° F.
Mean wet bulb reading................	35.3° ± .2° F.	52.5° ± .25° F.

Eggs of the turkey and the chicken deteriorate rapidly in hatching power when held longer than six days at a temperature of 36.3° F. The fact that eggs will withstand this low temperature continuously for a period of six days probably means that poor hatching results cannot be attributed to the chilling of eggs for a short period following laying. As in the 1930 experiment, the older turkey eggs hatched remarkably well when held at, 54.2° F. The hatchability of the older chicken eggs is much better than that. recorded in the literature for eggs of the same age.

It should not be inferred from these experiments that the optimum holding temperature lies between 54° and 68° F. They merely emphasize the importance of holding the eggs below 68° F. They do show that 36.3° F. is harmful and that the optimum temperature lies somewhere between this point and 68° F. Nor should the experiments be interpreted to mean that the holding of eggs should be encouraged. On the contrary, turkey eggs should be set as soon after laying as is practicable.

TESTING EGGS

Where the breeding flock has been mated by pens it is advisable to test, the eggs as early as possible for fertility. This will enable the grower to replace males that are not giving satisfactory results. With some experience it is possible to determine fertility accurately as early as the fifth day of incubation. For one with less experience, the tenth day is recommended.

EMBRYOSIC MORTALITY

Insko and Martin[47] have investigated the distribution of embryonic mortality for the turkey. When the mortality for any one day was expressed as a percentage of the total mortality for the full incubation period, their data show two critical periods. The first of these two high mortality periods centers near the fourth day of incubation and the second on the 25th day.

ARTIFICIAL BROODING

Good chick brooding practices are applicable to the poult. The poult seems to do well in the colony or permanent type of brooder house or in the battery. The young turkey is more inclined to crowd into the corners of the brooder house than is the chick. Losses from piling and crowding are greatly reduced in the battery equipment.

Various systems of brooding employing a variety of equipment have been used at this station. Regardless of the system or equipment used, the general plan has been to brood in close confinement up off the ground for the first four or six weeks. This method has the advantage of allowing quick movement of the poults into shelter in case of sudden rain storms. It also affords protection from predatory animals. Its greatest advantage, however, is that of sanitation since the poults do not come in contact with soil that may be contaminated with coccidia, the blackhead organism, and kindred organisms until after they have developed some degree of resistance.

47. Insko, W. M., Jr., and Martin, J. Holmes. Mortality of the turkey embryo. Poult. Sci. 14:361-364. 1935

The 12'x 14' Celotex brooder house with the sanitary runway shown in figure 13 mill accommodate 200 poults up to six weeks of age. From three to four groups of turkeys may use this item of equipment in a single growing season. When brooder weaned, the turkeys are moved onto the growing range. In Kansas, turkeys hatched the middle of May or later can do without artificial heat at the termination of the fourth week. Poults hatched the middle of April will require six weeks of heat and earlier hatched poults eight weeks of heat.

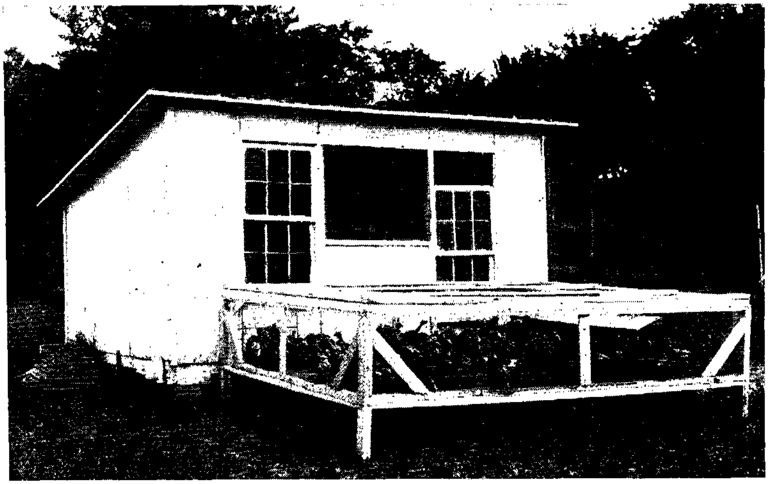


FIG. 13.—A colony brooder house with the sanitary runway in place.

The brooder house and all accessory equipment should be thoroughly cleaned and disinfected well in advance of the time that the poults are to be placed in the house. The floor of the house should be covered with coarse sand or gravel which is changed once every two weeks. The use of stemmy, fibrous material, such as straw on the floor, is to be discouraged. This also applies to the feeding of coarse, stemmy green feed. In either case, there is a tendency for the poult to ingest large amounts of such materials with the result that the muscular stomach and duodenum become impacted. Heavy mortality may occur and growth be retarded when the functional activity of the digestive tract is disturbed by the ingestion of such materials. Figure 14A shows the intestines and muscular stomach of a 12-day poult that had died from ingestion of fibrous material. The duodenum is greatly distended. Figure 14B shows the quantity of material lodged in the intestine and stomach. To measure the ill effect of the ingestion of stemmy, fibrous materials, four groups of 25 poults each were fed an all-mash turkey ration. Lot 1 was brooded on hardware cloth and received no fibrous material. Lot

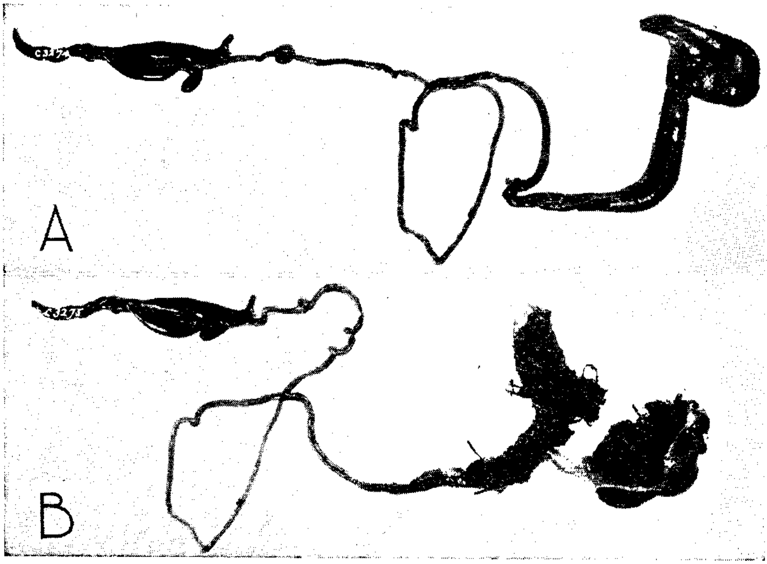


FIG. 14.—Views of the digestive tract of a 12-day-old poult showing the danger associated with the ingestion of stemmy materials. (A) The digestive tract showing the impacted duodenum. (B) The digestive tract of the same poult showing the quantity and nature of the fibrous material lodged in the duodenum and muscular stomach.

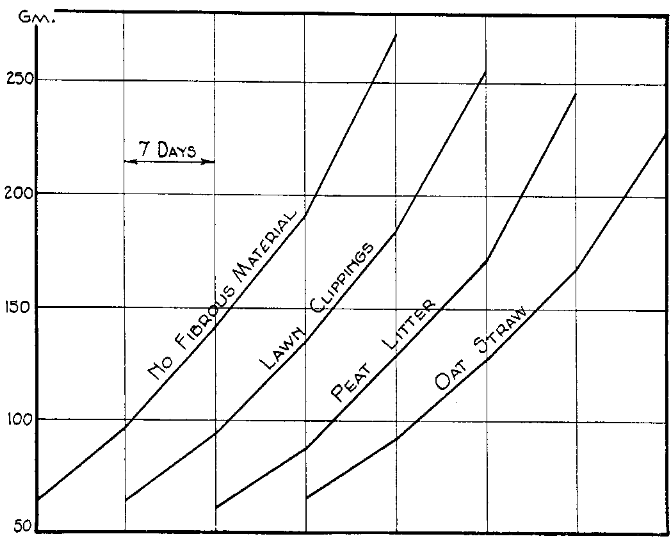


FIG. 15.—Graphs illustrating the effect on growth of ingesting stemmy, fibrous material.

2 was also brooded on hardware cloth and received a small quantity of bluegrass lawn clippings daily. Lot 3 was brooded on peat litter and lot 4 on oat straw. The percentage mortality for the four lots was 8.33, 4.17, 12.0, and 24.0, respectively, for the four-week period.

FIG. 16.—Battery equipment, the use of which will overcome much of the danger that accompanies the vice of piling.

No mortality could be attributed to impaction in lots 1 or 2. The effect on growth is illustrated in figure 15. At the conclusion of the fourth week the poults of lot 1 averaged 273.2 grams; lot 2, 256.7; lot 3, 247.7; and lot 4, 230.0. While there were no mortalities from impaction in lot 2, an examination of the muscular stomachs of five poults at the conclusion of the experiment revealed a clogging of this organ which no doubt interfered with normal digestion and assimilation.

BROODING TEMPERATURES

For the first week a temperature of 90 to 95° F. is desirable. This may be reduced approximately 5 degrees for each succeeding week until the poults are brooder weaned. Oil-burning brooders of the air-blast type, coal-burning brooders, and electrical brooders have given excellent results.

BATTERY BROODING

Turkeys may be brooded satisfactorily through the fourth week in the battery brooder. A typical battery scene is shown in figure 16. In choosing a battery one should ascertain that ample head room is provided. This should be at least 10 inches and preferably 12 inches. The sides should be adjustable so as to permit the older poults to feed from the troughs suspended on the exterior. The vertical wires should be spaced at least 1 3/8 inches apart. Each poult reared to four weeks in a battery will require approximately one third square foot of floor space.

The standard battery equipment comes equipped with one-half inch hail-screen floors. The poult, principally because of its sluggish action for the first few days following hatching, quite frequently pinions its hock joint in the half-inch meshes. For this reason it is desirable to cover the floor of the battery with cloth for the first few days, after which there is little danger of crippling the poult in the larger meshes. This difficulty may also be overcome by equipping a part of the battery with temporary floors made of one-fourth inch mesh hail screen.

RANGE MANAGEMENT

RANGE PRACTICES

The larger turkey growers of this state brood in close confinement for the first six weeks and then range the flocks over extensive areas until the turkeys are mature. In some instances the roosting equipment is moved with the birds. The flock is fed and they go to roost wherever they happen to be at the end of the day. The flocks range during the cooler part of the day and rest in whatever shade is available during the middle of the day. In other instances the flocks are returned at nightfall to a centralized feeding yard and to the permanent roosting quarters. Typical scenes about the farm of a large grower are given in figure 17.

Where the turkeys forage over such large areas, the danger of losses from disease is minimized. This is particularly true where the turkeys are moved from one location to another each day of the growing period. Feed costs are also reduced on these extensive ranges since most of them are well inhabited by insect life. The value of the feed that turkeys obtain by foraging is generally overestimated. The successful large scale grower is a liberal feeder and does not depend upon the feed that can be gleaned from the fields.

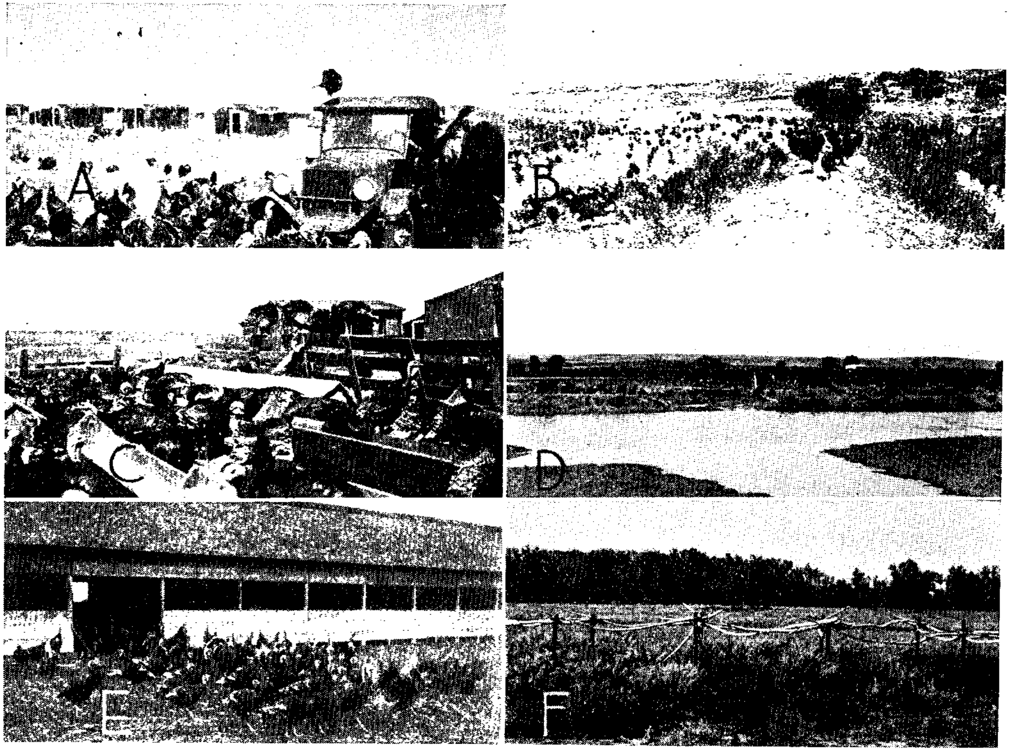


Fig. 17.—Typical scenes on a large turkey farm in Kansas. (A) A critical inspection. (B) the grasshopper brigade. (C) Home at nightfall to a full dinner pail. (D) On the banks of an irrigation ditch. (E) A permanent type of roosting shed. (F) Inexpensive roosting equipment.

On the general farm where turkeys are grown in smaller units and where natural means of incubation and brooding are used, there is little if any attempt to segregate the turkeys from other farm birds. Under these conditions, with the turkeys frequenting the same buildings and grounds as do the chickens, mortality from disease is usually high.

As has been pointed out earlier in the discussion, the pioneer work of the Storrs Agricultural Experiment Station demonstrated conclusively that clean ranges and the rotation of ranges would do much to reduce losses from disease, and, in particular, blackhead.

The importance of clean ranges cannot be overemphasized. The small grower who raises from 200 to 500 turkeys annually will do well to select each year as a growing range a plot of ground over which neither chickens or turkeys have ranged for several years. A unit of this size will more than justify the expense of fencing. An alfalfa range is desirable, though not necessary, as native grasses, clover, and sudan grass prove to be excellent forage crops. A clean stubble field would be far superior to a contaminated alfalfa pasture. Green feed can be cut and fed to the turkeys if necessary.

In the rotation system, the range is subdivided into two, three, or four lots, with the brooder house or roosting quarters so situated as to make it possible to drive the turkeys from one range to another. With the four-range rotation system the flock is allowed to range on one division for approximately one week and is then moved to the second range for a like period. This alternation of ranges is continued through the growing period so that each one is occupied for but one week out of four. This station has not used the rotation system described here.

Three growing ranges of approximately four acres each are used to grow several thousand chicks and 500 turkeys each year. The chickens and turkeys do not occupy the same ranges during any one year. The chicks are grown on the same range for three consecutive years, are then removed to a second range and the ground that they have vacated is cropped to corn, wheat, or oats and followed by alfalfa. Following this two or three years of rest, turkeys occupy the range for three consecutive years. The plan is not ideal, but is workable under the existing conditions.

RANGE SHELTERS AND ROOSTING QUARTERS

When brooder weaned at four to six weeks of age the poults are removed from the brooder house or battery and placed on range in an inexpensive shelter as shown in figure 18. Several such shelters are located on different parts of the range. This overcomes to some extent the disadvantages associated with having to grow poults of different ages on the same range.

A small wire fence encircles the shelter for several days or until the poults have learned to move freely in and out of the roosting quarters.

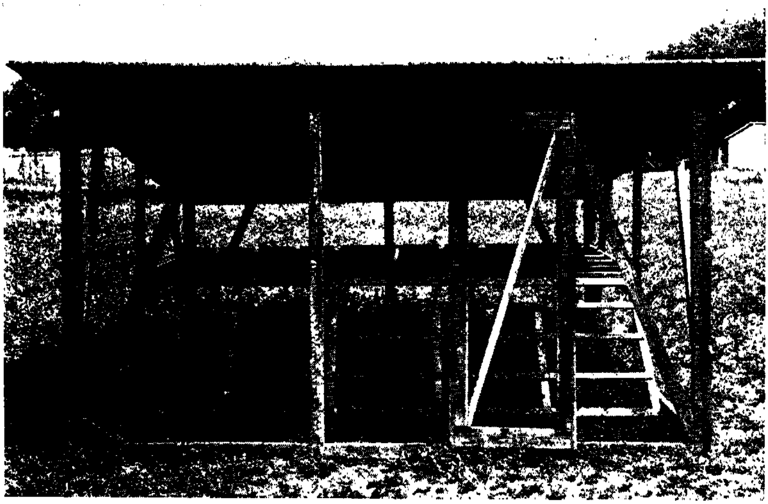


FIG. 18.—A 10- by 12-foot range shelter used from the time the poults are brooder weaned until they are roosting in the open.

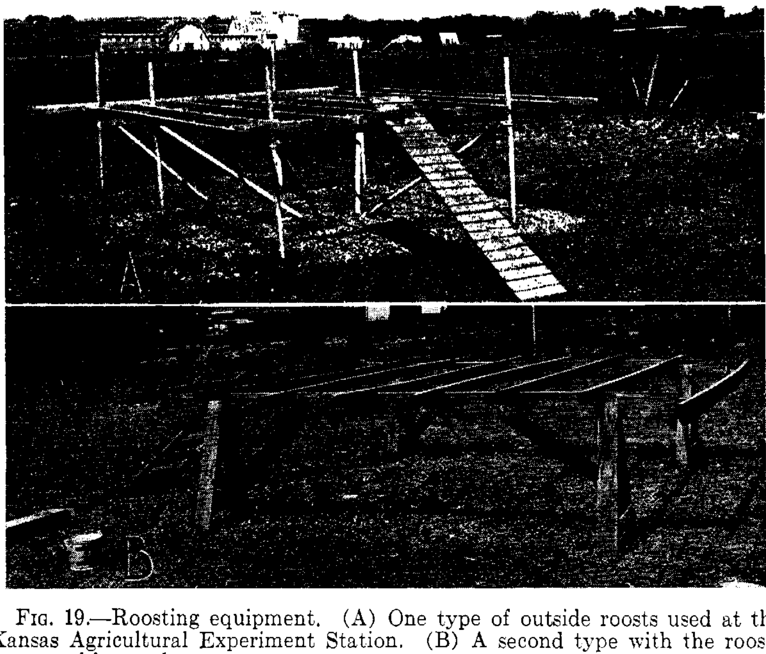


FIG. 19.—Roosting equipment. (A) One type of outside roosts used at the Kansas Agricultural Experiment Station. (B) A second type with the roosts supported by sawhorses.

Five 1" x 2" roosts run the full length of the 10' x 12' shelter. One-inch mesh wire prevents the poults from falling to the ground and from coming in contact with the droppings. A sloping runway is hinged to the front roost and the poult is forced to roost from the start. One-inch mesh wire covers the studding. The roof is built in two sections and easily removed when it is desirable to move the framework of the shelter to a new position.

This shelter will accommodate 200 poults for as long as overhead shelter is required in this state. It is necessary to protect poults

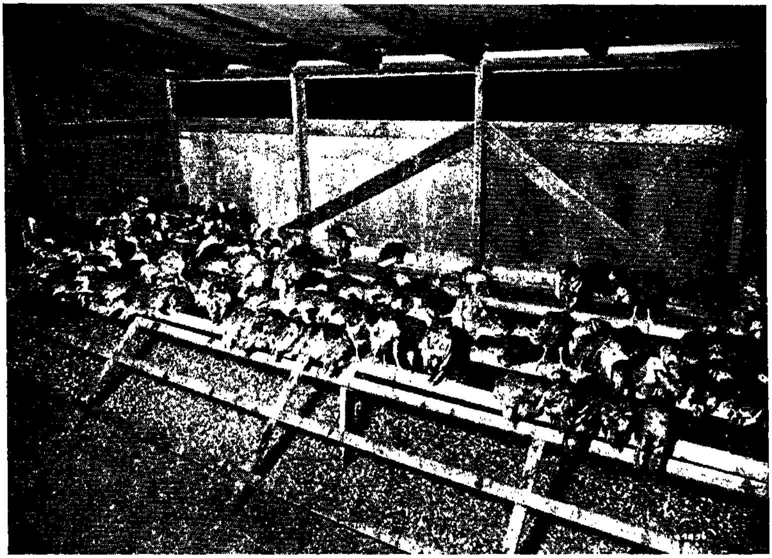


FIG. 20.—The "force roost" constructed in the interior of a brooder house. Note sand on floor and the screening off of the droppings. The approach may be raised vertically.

from drenching rain storms and in some parts of the state from hail storms until they are 10 to 12 weeks of age.

Outside roosting accommodations are constructed and located a short distance from the shelter as illustrated in figure 19. The young turkey is not encouraged to use the outside roost. The larger and more venturesome individuals will start to use the outside equipment when approximately nine weeks of age. Eventually the entire flock will be making use of the outside roost and at that time a runway may be provided.

Where the brooder house is used to give the protection that is necessary in the period that intervenes between brooder weaning and outside roosting, perches should be constructed in the house. The view given in figure 20 is the interior of the house shown in figure 13. No difficulty is encountered in teaching the poults to use the "force roost" shown. For the first few evenings a broom is used to sweep the poults onto the roosts and the runway is placed in a vertical position to keep them on the perches at night. A little patience at this point will do much to offset the danger of piling in later stages of the growing operations.

CAPACITY OF RANGES

The number of turkeys that can be grown to maturity successfully on a unit, of range with the semiconfinement system is variable. As previously stated, the practice at this station has been to grow approximately 500 turkeys on a single range of 4 acres. This is unquestionably overstocking the range and particularly so where one does not want the turkeys to destroy a stand of alfalfa. With 50 turkeys to the acre, the alfalfa plant can survive and certainly there is less danger of losses from disease. In a season of normal rainfall as many as 75 turkeys may range over an acre of alfalfa without the destruction of the alfalfa plants.

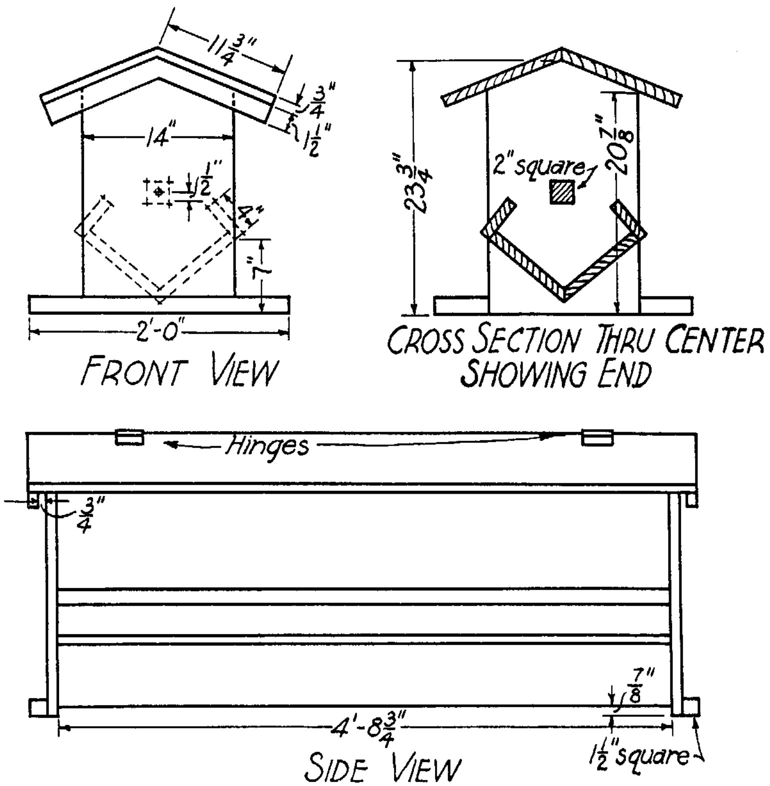


FIG. 21.—Working drawings of a satisfactory feed hopper for the turkey range.

FEEDING EQUIPMENT

The type of feed hopper shown in figure 21 has proved to be very satisfactory for poults six weeks of age or older. With this type of hopper, very little feed is wasted. It gives the turkey adequate head room and at the same time will protect the feed from rain. Three such hoppers should be provided for each unit of 100 turkeys. The half bushel pails shown in figure 22 have been used for water containers. When the turkeys are young, a hail screen platform is

FIG. 22.—Feed hoppers, water containers, and turkeys protected from the rays of the midday sun.

placed in the center of each water container to eliminate accidental drowning.

During the hot summer months all feeding equipment should be placed in the shade in order that the turkeys may feed throughout the day. The turkeys shown in figure 22 were hatched March 10. The photograph was taken June 22 toward the middle of the day. To insure good growth, it is essential that the flock be encouraged to feed even though the days are excessively warm. These turkeys made such an excellent growth that they were marketed the first week in September. They were as free from pinfeathers at 24 weeks of age as were later-hatched turkeys that were slaughtered after cool weather had set in.

Feeding equipment should be moved frequently throughout the growing period.

The range scene shown in figure 23 illustrates a type of roosting equipment that serves several purposes. It is equipped with a droppings board which in turn provides shade and an ideal location for feed and water devices. Much of the fecal material that would ordinarily reach the ground is collected and moved from the vicinity of the turkeys. A casual examination of the droppings boards as the birds are watered in the morning will tell if any individuals are voiding the sulphur-colored droppings so characteristic of blackhead.

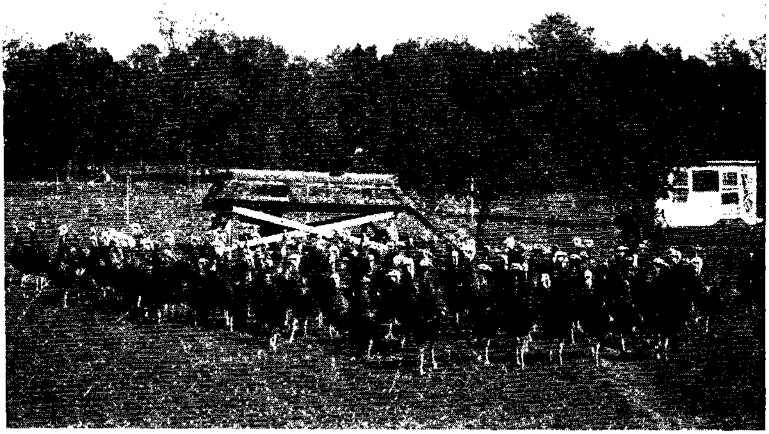


FIG. 23.—Semiconfined turkeys on range at the Kansas Agricultural Experiment Station. Note the dual-purpose outside roost.

FEEDING

TIME OF FIRST FEEDING

When compared with the chick, the poult is much slower in learning to eat. This is quite variable, however, as no difficulty is encountered with some groups while with others the learning process is much slower. For this reason it is not necessary nor is it desirable to withhold feed for a given number of hours following hatching. This station follows the practice of placing feed before the poults at the completion of the hatch.

FEEDING PRACTICES AND RATIONS

Regardless of the method of brooding used, starting mash is placed on the ordinary cupped egg flat for the first few days after the poults are taken from the incubator. The feed hoppers are also filled with mash. The mash hopper illustrated in figure 24 is used where the brooding operations are performed in the brooder house. One such hopper should be allotted to each 50 poults. These hoppers are used for the first six weeks. Thereafter the range hopper illustrated in figure 21 is used. Tvice daily one hard boiled egg for each 50 poults is crushed and spread over the surface of the mash. The egg is readily consumed by the young turkeys and no doubt the bright color does much to encourage some of the backward individuals to start eating. Egg feeding is discontinued after the third day and thereafter the mash is consumed from the hoppers. Water should be placed before the poults from the start. Liquid milk, sweet or sour, may be used to advantage, if available. Coarse sand may be used for grit if desired although observations would indicate that there is no particular evidence for or against the feeding of grit to young turkeys.

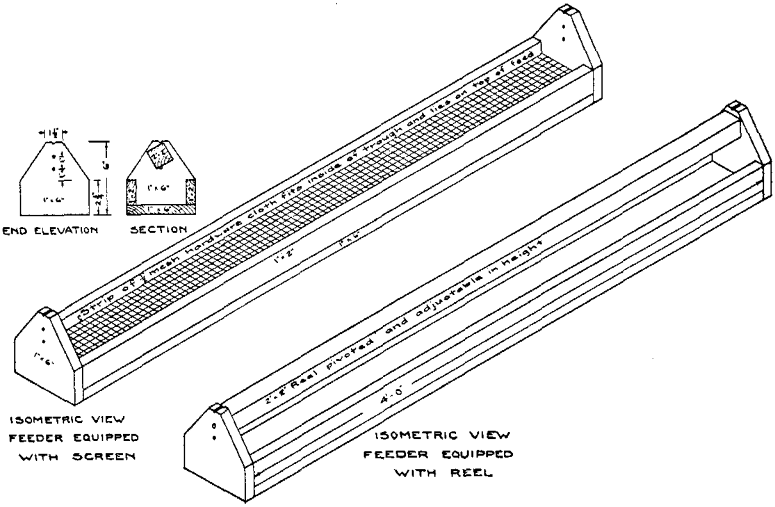


FIG. 24.—Working drawings of a type of mash hopper used for the first six weeks of the brooding period.

Two mash formulas have been used at this station during the period 1929-'37. Number one was used from 1929 to 1936 and number two in 1937. These formulas, both of which have given satisfactory results, are as follows:

	No. 1	*No. 2*
Yellow corn, ground	20	20
Wheat, ground	20	20
Oats, ground	15	20
Wheat bran	15	11
Alfalfa leaf meal	5	10
*Meat and bone scraps	15	7.5
Dried milk	10	..
*Fish meal	..	7.5
Calcium carbonate	..	2
Salt	..	1
Fish-liver oil	2	1
†Total	102	100

* The meat meal and fish meal used in ration No. 2 tested 58 and 72.75 percent protein, respectively.

† Since 1930 the Kansas station has followed the practice of adding 4 pounds of tobacco powder to each 96 pounds of the mash mixture. This is done when the poults first come in contact with the soil at 4 to 6 weeks of age. Tobacco powder is added to assist in controlling infestations of the cecum worm. It is known that the eggs of this worm are capable of harboring the organism responsible for blackhead.

This mash is kept before the birds continuously throughout the starting and growing period. No scratch grain is fed until after the twelfth week. Oyster shell is fed in open hoppers for the first time when the poults are brooder weaned or when placed on range. The scratch grain mixture, usually three parts of shelled corn to one part of wheat, is before the birds at all times after the twelfth week.

If green feed is abundant on the range, the alfalfa-leaf meal may be omitted from the mash formula when the poults are six to eight weeks of age. This also applies to the cod-liver oil when the flock is on range.

Analysis of the mash formula submitted shows the following composition:

	No. 1 Percent	No. 2 Percent
Calcium	1.85	1.87
Phosphorus	1.28	.85
Moisture	8.90	7.72
Protein	20.94	21.19
Fat	7.04	5.01
Fiber	4.57	6.34
Ash	8.62	8.85
Nitrogen-free extract	60.64	50.84

NUTRITION STUDIES

METABOLISM EXPERIMENTS

Only in recent years has an attempt been made to study the nutritive requirements of the turkey. Being a domestic bird, the assumption prevails that the needs of the turkey are not unlike those of the chicken. In general this is true, but field observations, as well as the more recent experimental work, would indicate that the nutritive requirement of the turkey is not identical with that of the chicken.

As a step toward the formulation of definite feeding standards for turkeys, Mitchell and Kelley[48] have studied the daily food requirement, heat production, and the water used and excreted by Bronze turkeys of various ages. The continuation of such studies on basal metabolism will eventually make turkey feeding standards possible.

VITAMIN STUDIES

As early as 1925 the Nebraska Agricultural Experiment Station[49] reported that the poult was more sensitive to feed deficiencies than was the growing chick. This appears to be true particularly with regards to the vitamins. The advent of confinement brooding has as never before, emphasized the point that the young turkey is exceedingly sensitive to vitamin deficiencies. Scott, Hughes, and Loy[50] studied the effect of the lack of vitamin D on the growing poult. They found that young turkeys developed characteristic signs of

48. Mitchell, H. H., and Kelley, M. A. R. Estimated data on the energy, gaseous, and water metabolism of poultry for use in planning the ventilation of poultry houses. Jour. of Agr. Res. **47**:735-748. 1933.

49. Anon. *In* Neb. Agr. Expt. Sta. 38th Ann. Rpt., p. 31. 1925.

50. Scott, H. M., Hughes, J. S., and Loy, H. W. Rickets in young turkeys. Poult. Sci. **11**:177-180. 1932.

rickets within 18 days when placed on a ration low in vitamin D. The recent study of Baird and Greene,[51] comparing the vitamin D requirements of chicks, turkeys, and pheasants, shows conclusively that the poult has a greater requirement than the chick. The minimum requirement for the growing turkey was found to be 60-70 and for the chick 18 units (U.S.P.) per hundred grams of feed.

In addition to these vitamin D experiments, a number of investigations have been made on the vitamin A requirements of turkeys. The effect of feeding a low vitamin A diet to breeding stock has been discussed elsewhere in this bulletin. A similar experiment on grow-

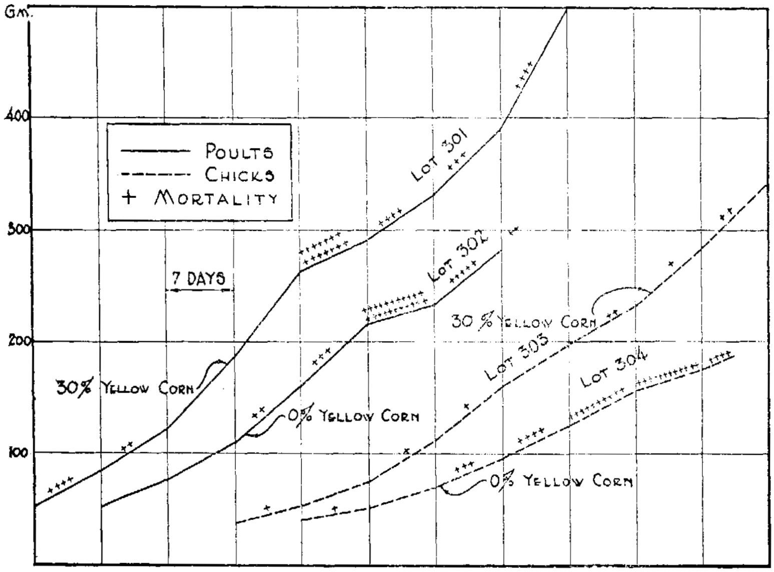


FIG 25.—Graphs showing the effect of a vitamin A low ration on the growth and mortality of poults and chicks.

ing turkeys was conducted in 1930. Two lots each of day-old turkeys and Leghorn chicks (34 in each lot) were used in the experiment. The basal ration low in vitamin A was as follows: White cornmeal 30 parts, ground wheat 25 parts, wheat bran 20 parts, and meat and bone scrap 25 parts. As a source of vitamin A, the control groups (lot 301, poults, and lot 303, chicks) received 30 parts of yellow cornmeal which replaced an equal quantity of white cornmeal in the ration. All groups were irradiated 30 minutes or longer daily.

Recent advances made in the field of poultry nutrition would indicate that the basal diet was in all probability low in vitamin G (flalvin) and the growth data must be interpreted with this in mind.

51. Baird, F. D., and Greene, D. J. The comparative vitamin D requirements of growing chicks, turkeys, and pheasants. Poult. Sci. 14:70-82. 1935.

While the level of this vitamin was probably too low to permit the most satisfactory growth, it was great enough to prevent the appearance of the symtoms associated with dermatitis.

Marked symptoms of A-avitaminosis were observed in both groups of turkeys by the 20th day. No deficiency symptoms were observed in lot 303, chicks, during the course of the experiment. Lot 304, chicks, receiving no yellow corn, developed typical symptoms on the 24th day. Mortality was greatest in the two groups of turkeys during the fifth week as was also true for lot 304, chicks.

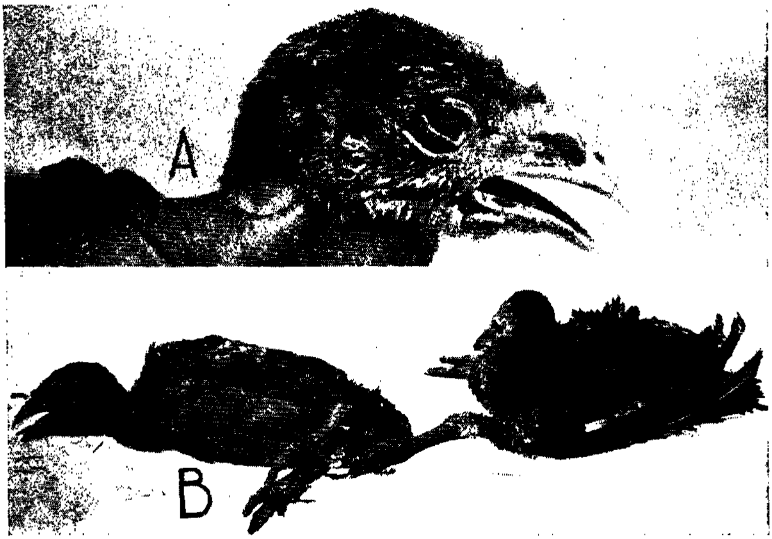


FIG. 26.—Typical symptoms of vitamin A deficiency. (A) The nictitating membrane virtually covers the eye proper. Sinusitis (swelled head) is not present, probably for the reason that the experimental animals were brooded in hail-screen compartments. (B) A-hypovitaminosis poults showing typical nerve disorders.

Three of lot 301, poults, survived the eighth week, while 100 percent mortality occurred in lot 302, poults, by the 42d day. This survival period for turkeys is in agreement with the work of Hinshaw and Lloyd.[52] None of the lot 304, chicks, survived the 46th day. Figure 25 shows that while 30 percent yellow corn as a source of vitamin A gave satisfactory growth for the chicks of lot 303, it was not sufficient for lot 301, turkeys, nor would this amount protect these turkeys from A-avitaminosis.

In general the symptoms reported by Hinshaw and Lloyd for vitamin A deficiency in poults were comparable to those noted in lots 301 and 302. The birds became listless and moved about with

52. Hinshaw, W. R., and Lloyd, W. E. Vitamin A deficiency in turkeys. Hilgardia 8:281-304. 1934.

an unsteady gait. Only occasionally were pustules observed on the hard palate. It was seldom that urates were deposited in the kidneys, and while the ureters were frequently distended, this was never so pronounced as in chicks. One noticeable feature of this dietary disorder was the failure of the nictitating membrane to contract. This is well illustrated in figure 26, where the eye is largely concealed by this membrane.

A symptom not described by Hinshaw and Lloyd, but typical of most of the poults in the advanced stages of A-avitaminosis, was

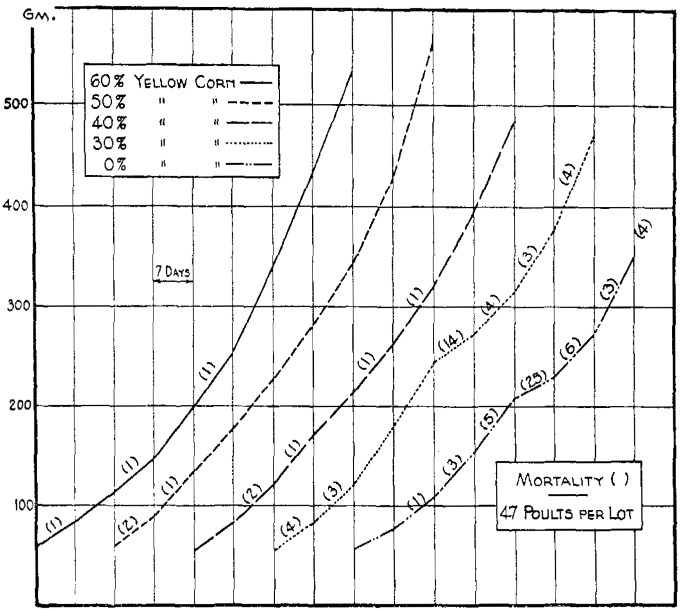


FIG. 27.—Graphs showing growth of young turkeys receiving different levels of yellow corn as a source of vitamin A.

that of frequent spasms. (Fig. 26B.) None of the chicks reacted in this manner. In addition to this, hemorrhagic enteritis was a common lesion associated with this dietary deficiency of turkeys. Careful autopsies were made of all birds that died. All cases were uncomplicated with coccidiosis or other parasites. Of the 65 poults in lots 301 and 302 that died during the course of the experiment, 36, or 55 percent, showed the lesion of acute hemorrhagic enteritis, while none of the chicks exhibited this lesion in the acute form.

From the above experiment it was apparent that the growing turkey requires a higher level of vitamin A in the ration than does the chick. A second experiment was undertaken to determine the level of yellow corn necessary to promote satisfactory growth where yellow corn is the only source of vitamin A. Five lots of 47 poults each received 60, 50, 40, 30, and 0 percent yellow corn, respectively.

Three lots of 54 chicks each received 50, 30, and 0 percent yellow corn, respectively. The basal ration consisted of ground white corn 60 parts, ground wheat 10 parts, wheat bran 10 parts, and meat and bone scrap 20 parts. As in the previous experiment, additions of yellow corn to the basal ration replaced a like amount of white corn. The lots were irradiated daily to take care of the rachitic factor. The growth curves for the eight-week period are presented in figures 27 and 28. With the particular sample of yellow corn used and as

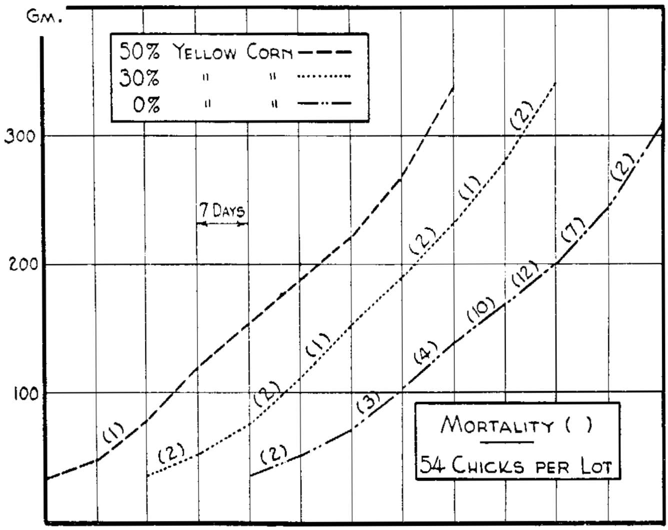


FIG. 28.—Graphs showing growth of Leghorn chicks receiving different levels of yellow corn as a source of vitamin A.

the only source of vitamin A, the data suggest that between 50 and 60 percent of the ration should consist of yellow corn to meet the vitamin A requirement of turkeys, while 30 percent or less meets this requirement for chicks. It may be concluded that the vitamin A requirement of the growing turkey is approximately twice that of the chick. Hinshaw and Lloyd,[62] using dehydrated alfalfa-leaf meal as a source of vitamin A, concluded that additions to the basal ration of 8 percent of this product was required by turkeys up to 30 weeks of age, while chickens receiving 4 percent exhibited no deficiency symptoms.

The danger associated with the feeding of coarse, stemmy green feed as a source of vitamin A has been fully discussed. Among some growers the opinion prevails that the poult must receive succulent green feed early in life to develop normally. Experiments conducted at this station would indicate that the feeding of succulent green feed does not improve a ration that contains approximately 5 percent alfalfa-leaf meal, 1 percent cod-liver oil, and 20 percent yellow corn. Four lots of 24 poults each received the following basal ration: Ground yellow corn 20 parts, ground wheat 20 parts, ground oats 15 parts, wheat bran 15 parts, meat scrap 15 parts, dried milk 10 parts, and cod-liver oil 1 part. Table XXI gives the additions made to this basal diet:

TABLE XXI.—ADDITIONS MADE TO BASAL RATION

Ration.	Lot.			
	311.	312.	313.	314.
Basal	100	95	90	95
Additions:				
Alfalfa-leaf meal	....	5	10	....
Freshly-cut alfalfa	....	....	....	(a) 5

(a) Fed daily on a basis equivalent to the dry weight of 5 percent alfalfa-leaf meal.

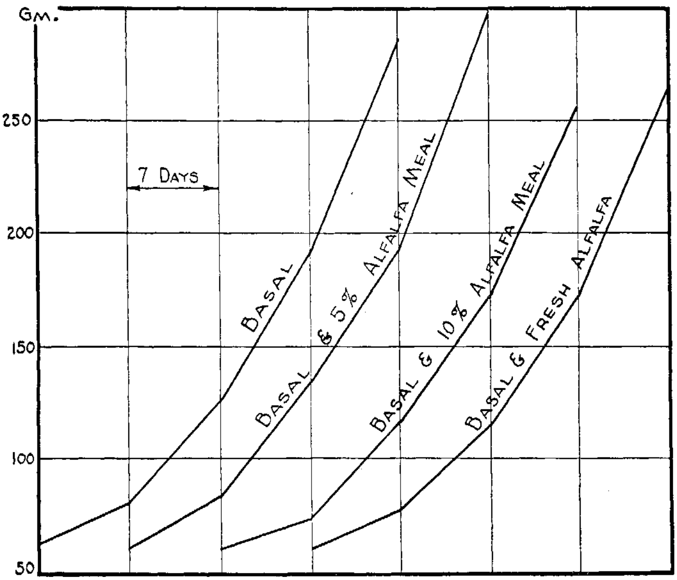


FIG. 29.—Graphs showing the growth of young turkeys receiving alfalfa-leaf meal fed at levels of 5 and 10 percent and freshly-cut alfalfa.

Mortality among the four groups was negligible as all but three poults survived the fourth week. The data on growth appear in figure 29. The growth of lot 312 receiving 5 percent alfalfa-leaf meal was better than that of the other groups. There is some indication that 10 percent alfalfa-leaf meal retards growth. It can be concluded that fresh alfalfa-leaf meal fed at a 5 percent level will give just as good growth as will the feeding of the fresh alfalfa plant, and certainly there is less danger of losses from impaction that result from the feeding of stemmy green feed. Hinshaw and Lloyd[52] observed excessive mortality (enteritis) in a pen of young turkeys receiving green alfalfa. We have found no evidence that the feeding of tender, green alfalfa before the second week is in any way harmful to the poult.

Guilbert and Hinshaw[53] concluded from their studies on the possibility of using antimony trichloride as a diagnostic aid in hypovitaminosis, that there was a greater storage of vitamin A in the livers of Leghorn chickens than in Bronze turkeys of comparable ages and feeding histories.

The work of Kohn on vitamin A in relation to skeletal deformities has been discussed under the heading of crooked keels.

Heuser[54] has recently reported on the vitamin G requirement of turkeys. Using a basal ration which was quite low in this vitamin, Heuser found that additions of 2 to 4 percent liver meal were necessary to promote good growth for the first four weeks. The basal ration with an addition of 3 percent liver meal would be equivalent to the vitamin G present in 16 percent of dried skimmilk.

Lepkovsky and Julces[54a] have pointed out that an acute dermatitis appears in poults deprived of vitamin G (flavin), whereas in chicks the filtratefactor is the antidermatitis vitamin.

PROTEIN STUDIES

Recent studies would indicate that the protein requirement of the turkey is high although Kohn[9] intimates that a ration containing 11 percent animal protein mill give growth comparable to a 20 percent animal protein level.

The Purdue station[55] reports that a ration containing from 20 to 25 percent meat scrap and in addition from 8 to 10 percent dried milk gave increased growth over smaller amounts of these protein supplements. This same station[56] reports satisfactory growth on a ration that contained from 20 to 30 percent soybean oil meal. In addition to this product the above ration contained 10 percent meat scrap and 5 percent milk plus certain grain products.

When the calcium and phosphorus losses were compensated, Hunter, Marble, and Knandel[57] found that satisfactory growth could be secured by substituting soybean oil meal or corn gluten meal for as much as two thirds of the animal protein concentrates in the wash ration fed from 13 weeks to maturity. In a starter ration

53. Guilbert, H. R., and Hinshaw, W. R. Vitamin A storage in the livers of turkeys and chickens. Jour. of Nutrition 8:45-56. 1934.

54. Heuser, G. F. A preliminary report on the vitamin requirement of turkeys. Poult. Sci. 14:376-378. 1935 .

54a. Lepkovsky, S., and Jukes, T. H. The response of rats, chicks, and turkey poults to crystalline vitamin G (flavin). Jour. of Nutrition 12:515-526, 1936.

55. Anon. *In* Purdue Univ. Agr. Expt. Sta. 44th Ann. Rpt., p. 47. 1931.

56. Anon. *In* Purdue Univ. Agr. Expt. Sta. 46th Ann. Rpt., p. 42. 1933.

57. Hunter, J. E., Marble, D. R., and Knandel, H. C. Vegetable protein in turkey rations. Penn. Agr. Expt. Sta. Bul. 321:1-13. 1935.

containing 12 percent dried skim milk, 11 percent meat scrap, and 11 percent fish meal, they report good growth by substituting soybean oil meal or corn gluten meal for 50 percent of the dried milk and 50 percent of either the meat meal or the fish meal. Bonemeal and limestone were used to adjust the calcium and phosphorus levels when the vegetable proteins were substituted for the animal proteins.

The California station[58] fed rations containing various levels of protein in an attempt to determine the amount of protein required by turkeys reared in confinement. It was concluded that turkeys required a higher level of protein than did chicks. They also report irregularity in growth on the higher protein levels, with some turkeys making a remarkable growth while others were retarded.

Moore[59] fed protein levels of approximately 21, 25, 17, and 28 percent to four lots of turkeys. At 22 weeks their average weights were: 11.03, 11.29, 10.32, and 11.51 pounds, respectively. Not only did the low protein diet give the poorest growth, but, the turkeys in this group were found to be poorly finished when dressed for market. Since the various lots were hatched at different periods during the breeding season and the numbers were small, the differences observed may not be significant.

MINERAL STUDIES

Mussehl and Ackerson[60] have studied the calcium and phosphorus requirements of growing turkeys. To a basal ration containing 0.84 percent calcium and 0.81 percent phosphorus, additions of 2 and 4 percent calcium carbonate were made. While the addition of 4 percent calcium carbonate improved growth, the difference was not statistically significant. In a second experiment it was demonstrated that additions of calcium carbonate to a basal ration low in the rachitogenic factor exerts a sparing action on the small amount of the vitamin present. These workers also found that additions of calcium sulphate to increase the calcium level of the ration gave better growth than additions of calcium chloride and suggest that the acid-base ratio of the ration may be as important as the calcium level or the calcium-phosphorus ratio of the ration. In another series of experiments, it was found that raising both the calcium and phosphorus level of the ration by additions of tricalcium phosphate neither improved the growth rate nor inhibited growth.

FIBER STUDIES

Goff[61] fed six lots of turkeys levels of fiber ranging from 3.01 to 10.28 percent of the total ration and reported that the average weight of the turkeys increased in direct proportion to the fiber level

58. Anon. *In* Rpt. of the Agr. Expt. Sta. of the Univ. of Calif., p. 91. 1931.

59. Moore, J. M. Feeding different amounts of protein to growing turkeys. The Quarterly Bulletin. Mich. Agr. Expt. Sta. 14:148-152. 1932.

60. Mussehl, F. E., and Ackerson, C. W. Calcium and phosphorus requirements of growing turkeys. Poult. Sci. 14:147-151. 1935.

61. Goff, Ollia E. Turkeys use more fiber in their feed. Rpt. of Okla. A. & M. Col. Agr. Expt. Sta., pp. 98-101. 1930-'32.

and that the feather quality likewise improved. It is common for the large juvenile wing feathers of the turkey in both the Bronze and Narragansett breeds to show various degrees of white. When the juvenile feathers molt, the adult feathers replacing them are of normal color. Goff found that fewer white feathers occurred on the higher levels of fiber. In his experiment alfalfa-stem meal was used to increase the fiber content of the ration. The six rations used by Goff varied in ash content as well as in protein and it is possible that these variations may have influenced the results.

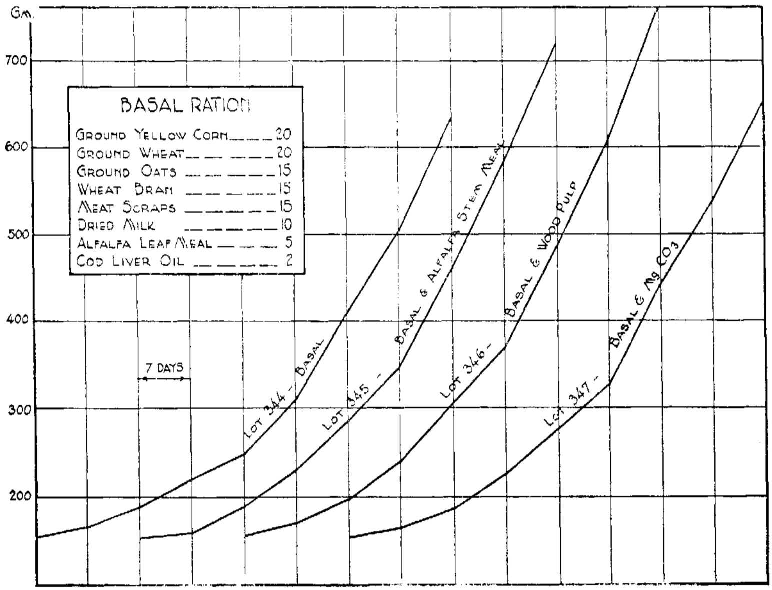


FIG. 30.—Graphs showing the effect of fiber on the growth of Narragansett turkeys.

Inasmuch as the mash ration (formula one) used at this station contains only 4.57 percent fiber, an experiment was conducted in 1934 to determine whether increasing the fiber content would improve growth and lessen the incidence of white juvenile feathers. For this study, four lots of 25 Narragansett turkeys each were used.

The basal ration used was identical to mash (formula one). Alfalfa-stem meal and wood pulp were used to increase the fiber level. To the control ration (344) enough meat scrap, bone-meal, and starch were added to give this ration the same protein and ash analysis as ration 345 where 10 pounds of alfalfa-stem meal had been added. Enough wood pulp, having a low ash content, was added to ration 346 to give this ration the same fiber content as ration 345. The ash content of rations 345 and 344 was on the same level while the ash of 346 was lower than either ration 345 or 344.

To ration 347, 3 percent magnesium carbonate was added and the protein level regulated to that of the other rations. In a feeding trial with Rhode Island Red chicks, it was observed that additions of magnesium carbonate seemed to improve feather quality and it was thought that this might also influence feather quality in turkeys.

The data on growth are presented in figure 30, where it is observed that the additions of either stem meal or wood pulp improved growth during the eight weeks of the experiment. It would appear that neither the increase in ash nor any of the accessory nutrients that were added with the alfalfa-stem meal influenced the results, since the ration containing wood pulp gave satisfactory results. Little, if any, difference could be detected in feather quality among lots 344, 345, and 346. Ration 347, containing 3 percent magnesium carbonate, gave the poorest feather quality. Unfortunately, chemical analyses of the four rations were destroyed in a fire. Rations 345 and 346 contained approximately 8 percent fiber.

GROWTH AND FEED CONSUMPTION

Data regarding the growth of the Bronze turkey mere secured in the years 1928, 1930, 1932, and 1933. The turkeys were hatched on May 23 of each year. With the exception of the year 1928, the management and feeding were the same. The 1928, 1930, and 1932 data are presented in Tables XXII, XXIII, and XXIV. There is some variation in growth from year to year as would be expected, but in general the shape of the cumulative growth curves is the same. (Fig. 31.) The data show that it requires from 3.26 pounds to 3.54 pounds of feed to produce a pound of turkey at 24 weeks of age. Particularly noticeable is the increased number of pounds of feed required to produce a pound of gain during the latter part of

TABLE XXII.—GROWTH, FEED CONSUMPTION, AND POUNDS OF FEED REQUIRED PER POUND OF GAIN

For 132 Bronze turkeys, 1928

AGE.	Mean weight in lbs.			Feed consumed per bird in lbs. (a).			Lbs. of feed consumed per lb. of gain.
	Males.	Females.	Average.	Mash.	Grain.	Total.	
1 day......	0.12	0.11	0.115	....	....	....	....
4 weeks....	.73	.69	.710	0.92	....	0.92	1.55
8 weeks....	2.53	2.27	2.400	3.89	....	3.89	2.30
12 weeks....	5.16	4.41	4.790	6.60	....	6.60	2.76
16 weeks....	8.75	6.82	7.790	9.55	1.04	10.59	3.53
20 weeks....	13.33	9.08	11.210	6.47	3.64	10.11	2.96
24 weeks....	16.80	10.90	13.850	4.03	9.97	14.00	5.30
Totals....	....	....	....	31.46	14.65	46.11	3.33

(a) No shell recorded.

the growing period. From the standpoint of costs, it is doubtful whether the grower is justified in feeding the turkey beyond six months. While during the latter part of the growing period the absolute gains in weight are large, relatively they are smaller than the earlier gains and are produced at a much higher feed cost.

In 1933, 130 Narragansett and 69 Bronze turkeys were placed under identical conditions to study their respective growth rates. These data are given in Table XXV.

TABLE XXIII.—GROWTH, FEED CONSUMPTION, AND POUNDS OF FEED REQUIRED PER POUND OF GAIN

For 198 Bronze turkeys, 1930

AGE.	Mean weight in lbs.			Feed consumed per bird, in lbs.				Lbs. of feed consumed per lb. of gain.
	Males.	Females.	Average.	Mash.	Grain.	Shell.	Total.	
1 day	0.126	0.123	0.124	....	....	....	....	....
4 weeks	.617	.558	.588	1.22	....	0.014	1.234	2.65
8 weeks	2.340	1.940	2.158	3.92	....	.026	3.946	2.51
12 weeks	4.670	3.780	4.302	6.94	....	.023	6.963	3.24
16 weeks	9.530	6.490	7.514	7.91	1.47	.014	9.394	2.92
20 weeks	12.060	8.720	10.660	8.58	3.33	.141	12.051	3.83
24 weeks	16.110	10.720	14.060	8.32	7.52	.372	16.212	4.76
Totals.	....	....	....	36.89	12.32	0.590	49.800	3.54

TABLE XXIV.—GROWTH, FEED CONSUMPTION, AND POUNDS OF FEED REQUIRED PER POUND OF GAIN

For 174 Bronze turkeys, 1932

AGE.	Mean weight in lbs.			Feed consumed per bird, in lbs.					Lbs. of feed consumed per lb. of gain.
	Males.	Females.	Average.	Mash.	Grain.	Shell.	Condensed milk.	Total.	
1 day	0.14	0.13	0.135	......	....	....	....	....	....
4 weeks	.69	.61	.650	1.65	....	....	0.294	1.944	3.78
8 weeks	1.95	1.62	1.790	3.37	....	....	....	3.370	2.96
12 weeks	5.16	4.05	4.610	6.69	....	0.003	....	6.693	2.37
16 weeks	9.32	7.00	8.160	6.38	0.26	.133	....	6.773	1.91
20 weeks	13.54	9.37	11.460	6.14	6.60	.325	....	13.065	3.96
24 weeks	17.94	11.42	14.680	2.67	11.89	.106	1.408	16.074	4.99
Totals.	....	....	....	26.90	18.75	0.567	1.702	47.919	3.26

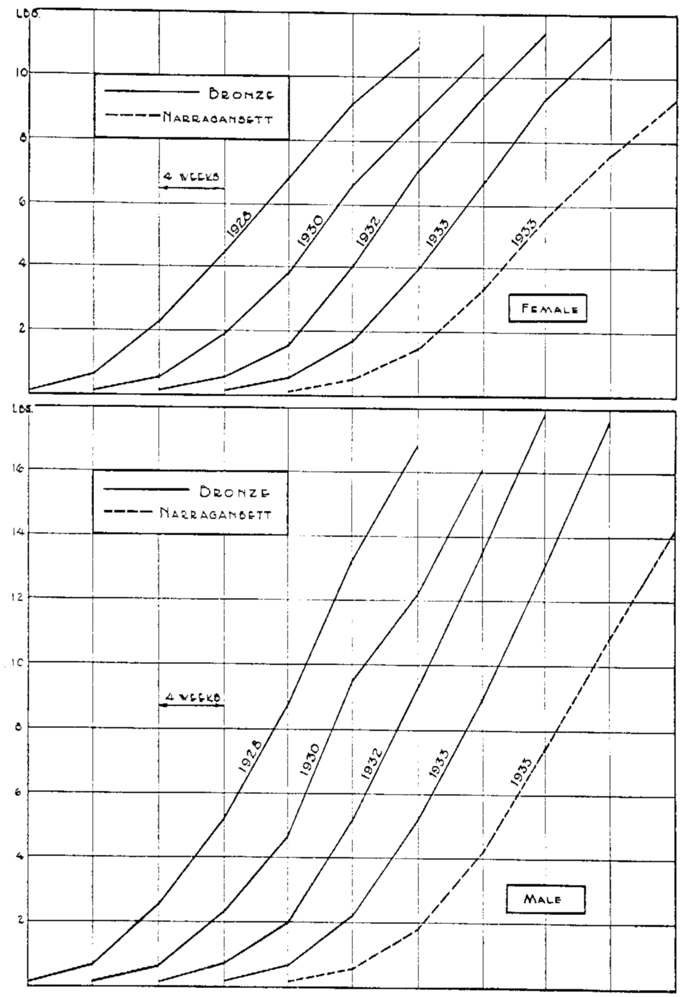


FIG. 31.—Graphs showing the cumulative growth of male and female turkeys.

The growth of Bourbon Red turkeys has been studied by the Purdue Agricultural Experiment Station,[62]. Brooks[63] reports that the male turkey utilizes feed more efficiently than the female during later stages of growth.

The growth of the Bronze and the White Holland breeds have been reported by Funk,[64] and feed consumption and costs by

62. Anon. Feed consumption and growth rate of turkeys. *In* Purdue Univ. Agr. Expt. Sta. 43d Ann. Rpt., pp. 62-63. 1930.

63. Brooks, F. D. Influence of sex on utilization of feed in turkeys. Poult. Sci. 12:299-304. 1933.

64. Funk, E. M. Rate of growth in Bronze and White Holland turkeys. Poult. Sci. 9:343-355. 1930.

Funk and Margolf.[65] Marsden,[13] Marsden, and Lee,[66] Thompson, Schnetzler, and Albright,[67] and Musseh1[20] have reported on the growth and feed consumption of the Bronze breed. Hogan, Hunter, and Kempster[68] report on the growth of the Narragansett breed.

TABLE XXV.—A COMPARISON OF THE GROWTH OF BRONZE AND NARRAGANSETT TURKEYS

Mean weight in pounds, 1933

AGE.	Bronze. Males.	Bronze. Females.	Narragansett. Males.	Narragansett. Females.
1 day	0.12	0.12	0.12	0.12
4 weeks	.66	.56	.56	.50
8 weeks	2.21	1.73	1.80	1.50
12 weeks	5.23	3.97	4.31	3.41
16 weeks	9.04	6.67	7.46	5.63
20 weeks	13.16	9.33	10.94	7.62
24 weeks	17.58	11.35	14.30	9.25

TABLE XXVI.—GROWTH OF DIFFERENT BREEDS OF TURKEYS

BREED.	Number. Female.	Number. Male.	Mean weight in lbs. at 24 weeks of age. Female.	Mean weight in lbs. at 24 weeks of age. Male.
Bourbon Red (note 62)	69	61	8.67	12.32
White Holland (note 64)	28	39	10.74	16.42
Narragansett (Kansas)	62	41	9.25	14.30
Bronze (Kansas)	174	223	10.86	16.70
Bronze (note 66)	172	161	11.48	17.96
Bronze (note 67)	36	37	9.95	15.17
Bronze (note 20)	55	43	9.60	15.50
Bronze (note 64)	21	18	12.46	19.01

In Table XXVI the growth data reported from various experiment stations have been summarized for different breeds of turkeys. This table gives some indication as to what weight might be expected for a given breed of turkeys at 24 weeks of age.

65. Funk, E. M., and Margolf, P. H. Feed consumption and costs in raising turkeys. Penn. State College Bul. 250:1-11. 1930.

66. Marsden, Stanley J., and Lee, Alfred R. Turkey raising. U. S. D. A. Farmers' Bul. 1409:1-38. 1933.

67. Thompson, R. B., Schnetzler, E. E., and Albright, W. P. Growing turkeys in confinement. Okla. A. & M. Agr. Expt. Sta. Bul. 202:1-13. 1932.

68. Hogan, A. G., Hunter, J. E., and Kempster, H. L. Acceleration of growth rates by dietary modification. Jour. Biol. Chem. 77:431-436. 1928.

MARKETING

FINISHING

Attempts to fatten turkeys in close confinement have proved futile. In 1928 three groups of 10 males each, 24 weeks of age, were used in a fattening experiment. Lots 281 and 282 were confined to 10' x 12' houses. Lot 283 was continued on the range. Lot 281 received whole corn *ad libitum,* lot 282 a buttermilk moistened mash three times daily, and lot 283 was continued on the standard growing mash and scratch grain. At the conclusion of a two-week fattening period, lot 281 showed a loss of 2.63 percent in weight, lot 282 a gain of 3.92 percent, and lot 283 a gain of 5.62 percent. The confined groups were extremely nervous and had little desire to eat.

In 1929 two lots of 10 males each, 24 weeks of age, were used in the fattening work. Both lots mere allowed to range. Lot 291 received the buttermilk moistened mash fed to lot 282 in the 1928 experiment. Lot 292 was continued on the standard growing ration. At the conclusion of the second week lot 291 had made a gain of 1.82 pounds per bird representing a gain of 12.34 percent in weight. Lot 292 gained 0.92 pound per bird or an increase of 6.2 percent. The feed cost per pound of gain for the two-meek period mas 25.7 cents for lot 291 and 25.1 cents for lot, 292.

In 1930 two lots of approximately 75 turkeys each were fattened from October 29 to November 12, neither lot being confined. Lot 3011 was continued on the growing rations. Lot 3012 was fed the buttermilk moistened mash three times each day. Water was given to lot 3011 and liquid buttermilk to lot 3012 as the only drink. The data pertaining to the increase in weight are submitted in Table XXVII and the cost of feed per pound of gain in Table XXVIII. As was true in the 1929 experiment, the buttermilk moistened mash fed group made the better gains. These gains were more expensive than the gains made by the lot which had been continued on the customary growing ration.

These studies show that turkeys will not make satisfactory gains when removed from the range and confined for a two-week fattening period. While the feeding of mashes moistened with buttermilk may result in slightly better gains than those given by the customary growing ration, the increased feed costs of the gains and the labor involved make it rather doubtful whether the average producer can make such a practice pay. The milk fattening improves the quality of the flesh and if a premium is paid for this quality, the grower may be justified in milk fattening.

For the past few years the station's turkeys have been finished very satisfactorily by feeding for a period of three or four weeks, in addition to the growing ration, three pounds of condensed buttermilk daily to each 100 turkeys. The paste is fed on the top of the mash and grain mixtures. For the first few davs onlv a small quan-

* Mash formula: Corn meal, 300 lbs.; oat groat meal, 200 lbs.; shorts, 100 lbs.; meat scrap, 25 lbs.; alfalfa-leaf meal, 25 lbs.

tity is fed and the amount gradually increased until the 100 turkeys are consuming the full three pounds.

TABLE XXVII.—GAINS IN WEIGHT OF TURKEYS USED IN THE 1930 FATTENING EXPERIMENT

Lot.	Ration.	Sex.	Number of birds.	Mean weight in pounds.		Mean gain.	
				Original.	Final.	Pounds.	Percentage.
3011	Standard mash and grain mixture.....	M. F.	45 31	17.29 11.15	18.84 12.04	1.55 .87	8.93 7.81
	Total and mean,	....	76	14.79	16.06	1.27	8.58
3012	Milk-moistened mash.	M. F.	44 31	17.09 11.11	19.04 12.02	1.95 .91	11.44 8.13
	Total and mean.	....	75	14.75	16.14	1.39	10.31

TABLE XXVIII.—FEED CONSUMPTION AND COST OF GAINS ON 1930 FATTENING EXPERIMENT

Lot.	Ration.	Feed consumed.				Cost of feed per pound of gain.
		Mash, lbs.	Grain, lbs.	Milk, gals.	Value.*	
3011	Standard mash and grain mixture,	143.0	571.0	....	$13.21	13.7c.
3012	Milk moistened mash...........	657.0	....	125	16.03	14.6

* Growing mash .... 2.65 per cwt.
Fattening mash .... 2.15 per cwt.
Grain mixture .... 1.65 per cwt.
Milk .... .02 per gal.

KILLING

Turkeys that are to be killed for market should be in good health, well fleshed, reasonably well covered with fat, and fairly free from short pinfeathers. When age and feeding history are identical, the females are in much better market condition than are the males. It has not been possible with the strain of the Bronze or the Narragansett breed, as kept at this station, to produce turkeys at 24 weeks of age that were entirely free of pinfeathers or that were well covered with fat. Experience with the station flock has been that a growing period of 28 to 30 weeks is required for all feathers to lose their "greenness" and that it is not until this time has elapsed that the feather tracts are well underlaid with fat. As has been pointed out, the cost of producing these gains beyond the 24th week is high and, moreover, many males, if held until 28 to 30 weeks of age, will have developed certain secondary sexual characteristics (spurs) to a point where they are no longer classified by some buyers as young toms. One can expect to have a large percentage of the flock reasonably well finished at 24 weeks. Turkeys should not be offered to the markets in poor flesh as they are hard to dispose of and react unfavorably on the market quotations. Such birds should be held over and marketed at a later date.

All feed should be withheld from the turkeys after the evening feeding if they are to be killed the following morning. They may have access to water.

If the flock to be marketed is large, a corral should be constructed that will accommodate several hundred birds. It is advisable to have adjacent to the large corral one or more small enclosures, separated by gates. From 15 to 20 turkeys are separated from the flock inside the large corral and maneuvered into one of the smaller enclosures.

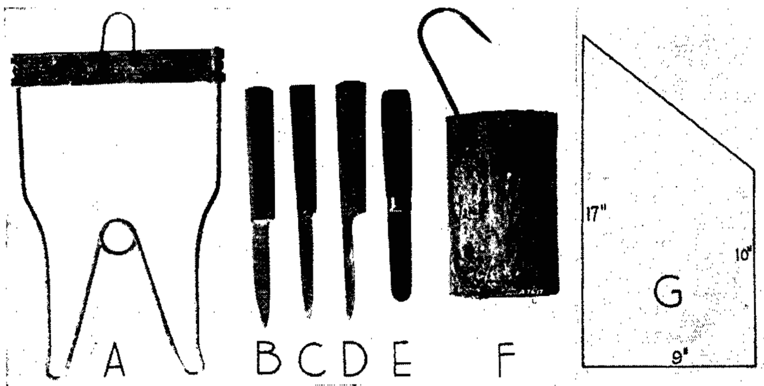


FIG. 32.—Articles of equipment used in killing and dressing and diagram of head wrap: (A) Shackle, (B), (C), and (D) killing knives, (E) pinning knife, (F) weighted blood cup, and (G) diagram of head wrap.

Fewer bruises and scratches will result where this method is employed. The turkey, when removed from the small enclosure, should be picked up by both wings and placed in whatever coops are available to await slaughter. The catching hook frequently discolors the flesh above the hock joint and causes the bird to fall on the breast. As a result, a bruise mark may cause what would otherwise have been a number one carcass to fall into a lower grade,

It is imperative that the bird be well bled and dressed if it is to bring the top price. For this operation the following articles of equipment should be available: A shackle for suspending the bird (fig. 32A); a satisfactory killing knife (fig. 32B, C, or D); a pinning knife (fig. 32E); and a weighted blood cup (fig. 32F.)

To bleed a bird properly, the two jugular veins extending on the sides of the neck and crossing over on the ventral surface and uniting where the neck and head converge (fig. 33A), and the two carotid arteries (fig. 33B) should be severed. Both the inside and

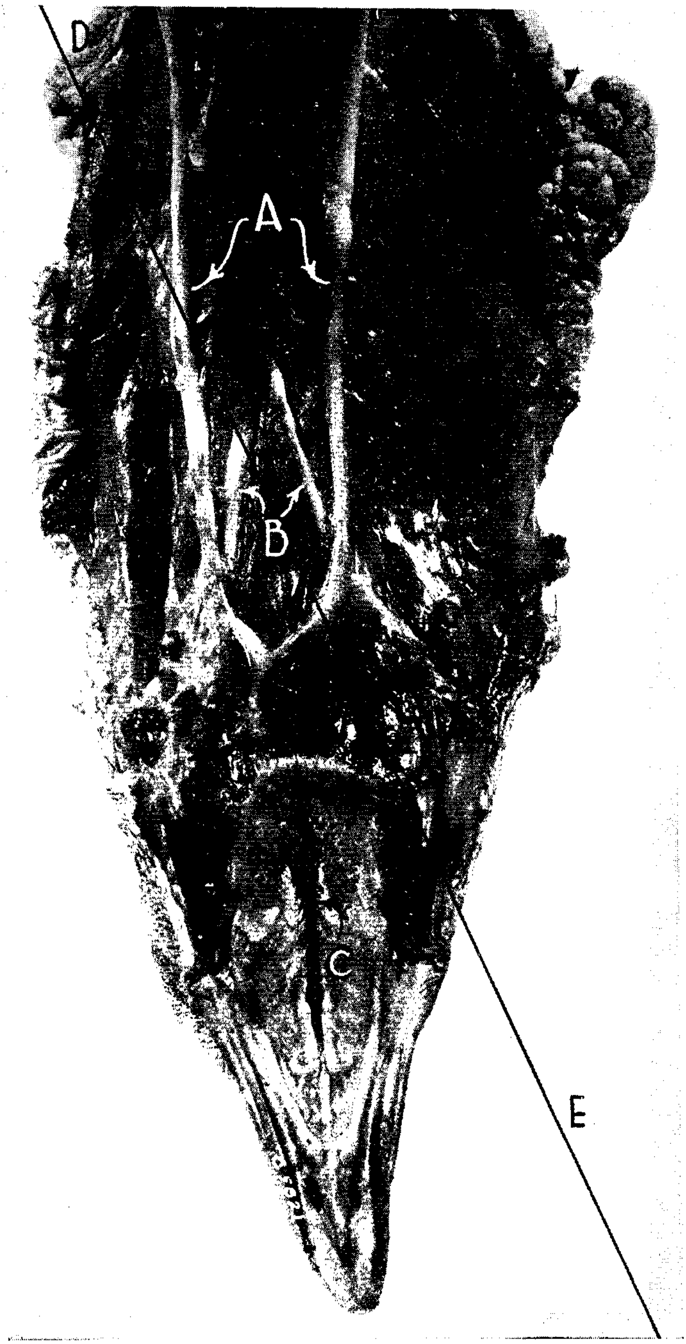


FIG. 33.—The vascular system in the neck of an injected specimen. (A) Jugular veins. (B) Carotid arteries. (C) Posterior nares. Line D-E, direction of cut.

outside cuts are used commercially. If the outside cut is used, the throat should be slashed just back of the head. With the inside cut the knife is inserted into the mouth and down the esophagus. (Fig. 34A.) The cutting edge of the knife is directed toward the vertebral column. The cut is macle at an angle on the D-E line of figure 33.

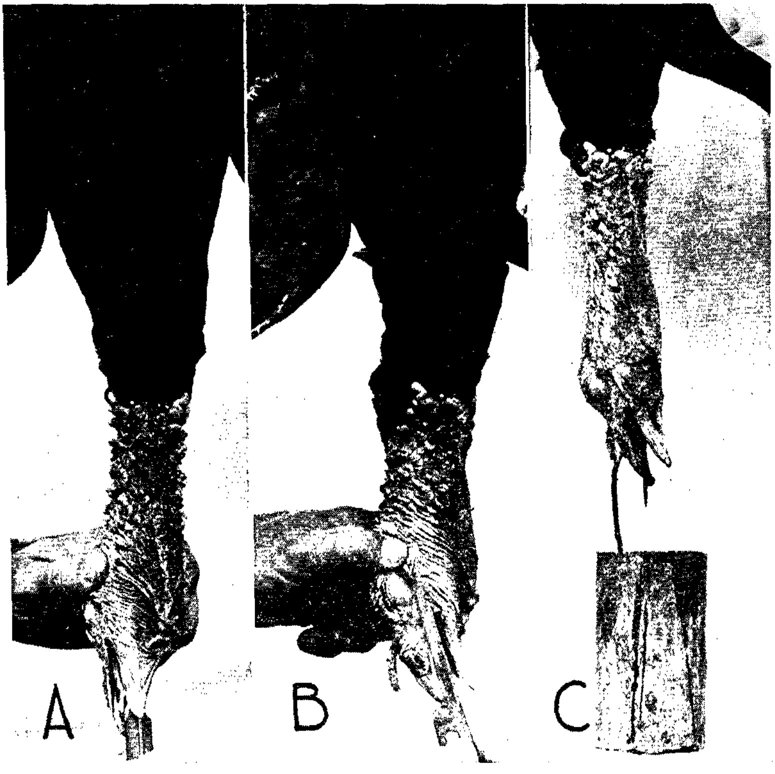
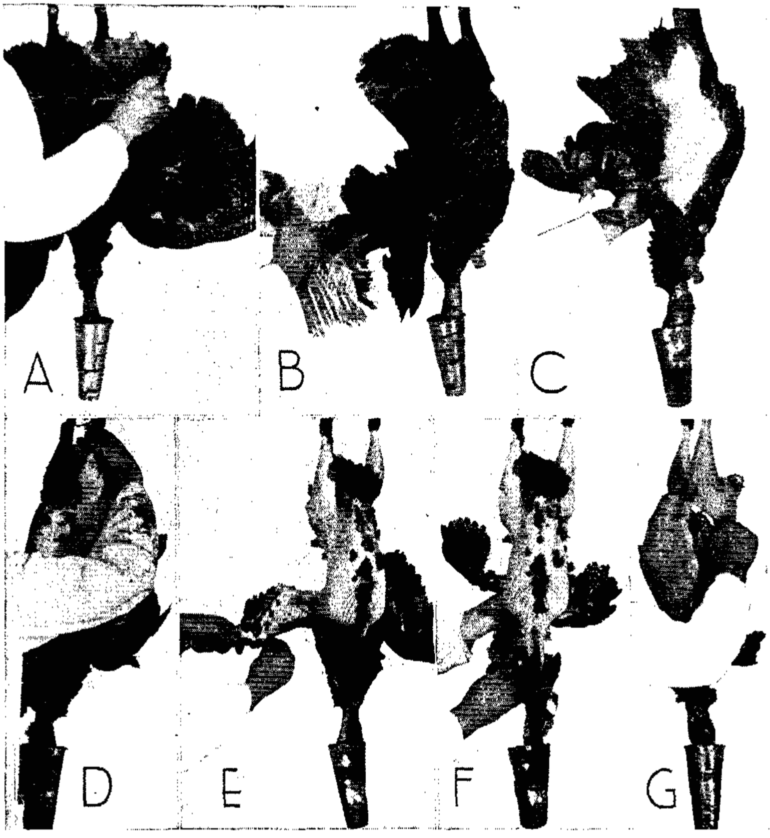


FIG. 34.—Bleeding and brain piercing operations. (A) Knife inserted down the esophagus for the inside cut. (B) The direction the knife should follow to pierce the brain. (C) The weighted blood cup hung in place.

Immediately following the severance of these blood vessels, the point of the knife is inserted into the cleft of the roof of the mouth, pushed through the enclosing bone to the brain. In carrying out this step of the operation, the knife blade should be parallel with the upper mandible to direct the point to the medulla oblongata. In figure 34B is shown the general direction that the knife should follow to reach the base of the brain. When once the posterior brain has been reached, the knife is given a slight twist, withdrawn, and the weighted blood cup inserted in the nostrils. (Fig. 34C.)

The removal of the feathers begins at this point. If the brain has been properly "stuck" the feathers may be removed with a minimum of effort. After some experimentation it was found that a weight of seven pounds proved to be most satisfactory for distending the neck of the average turkey. The blood cup shown in the illustrations was weighted with seven pounds of lead. The turkey should not be permitted to raise its head after the blood Teasels have been severed. Blood may collect in the crop if the head and neck are permitted to bend upward.



Courtesy Bur. Agr. Econ., U. S. Dept. Agr.

Fig. 35—The correct procedure in removing the feathers of a turkey (A) The large tail feathers are removed first. (B) The large wing feathers are removed with a quick downward snap of the hand. Note that the thumb is uppermost. (C) In the third step the feathers of the side and breast are removed. (D) The short thigh feathers are removed next. (E) In the fifth step the feathers from the back, hip, and wings are removed. (F) The feathers on the neck are removed last. The skin on the neck is easily torn. (G) Using the pinning knife.

Throughout the bleeding and brain piercing operation the head of the turkey should be held securely by the left hand, The thumb and first finger will exert most of the force needed to hold the head in place. The grip can be greatly strengthened by placing the thumb and first finger in the depressions of the ear. The remaining three fingers should be folded back so that they will not be brought in line with the diagonal cut across the blood vessels.

Commercial methods used in removing the feathers are: (1) The dry pick method, and (2) the "slack-scald" method. Until recent years the former method was used exclusively. Many modern dressing establishments are now making use of the slack-scald procedure since it is faster and imparts to the carcass a more attractive appearance.

In the dry pick, the removal of the feathers starts immediately after the brain has been pierced and the neck suspended. The picker stands facing the back of the bird and with the left hand holds the bird by the wings as illustrated in figure 35B. The large tail feathers are removed first by a vigorous twist and pull of the wrist. Following this the large wing feathers are removed, the operator grasping as many as possible at one time. Unlike the position of the hand in removing the tail feathers, the thumb is uppermost when the wing feathers are plucked. (Compare A and B in figure 35.) The movement here is a sharp downward one in which the wing feathers are "jerked" or "snapped" from the enclosing follicles. In the next step the operator swings the bird's body so as to be facing its side and removes the feathers of the breast on one side and then either swings the bird's body or steps around the carcass to remove the breast feathers of the opposite side. The leg feathers are removed next followed by the back and hip feathers, neck feathers, small wing feathers, and the few remaining feathers between the legs.

The same procedure of feather removal is used in the slack-scald. The bird is permitted to bleed for a few seconds during which time the large tail and wing feathers are removed. The bird is then immersed for 30 seconds in water heated to 120-125°F. The cuticle of the skin is destroyed if the temperature goes a few degrees above 129°F. On removing the bird from the water bath, the feathers are plucked in the same order as outlined for the dry pick method.

DRESSING SHRINKAGE

Approximately 10 percent is the average loss from live to dressed weight. Data on 1,344 turkeys with the sexes about equally divided show a loss of 9.89 percent in blood and feathers.

PACKING FOR SHIPMENT

Turkeys should not be packed for shipment, until the body heat has been dissipated. While it is desirable to have the internal body temperature reduced to 34°F. this is almost impossible to accomplish on the farm since the producer does not have adequate refrigeraction facilities and must rely almost entirely upon weather conditions. Under no circumstances should the turkey be allowed to freeze. Dressed turkeys should not be stacked in piles if cooling is to be efficient. They should be suspended from racks, head downward, as shown in figure 36.

Any blood that has been smeared over the body should be removed with a damp cloth. Blood clots that have collected in the mouth should be removed. This may be best accomplished by washing the head in water or by snapping the head as the bird is removed from the shackle. Fecal material in the large intestine and cloaca may be removed by the pressure of the thumb.

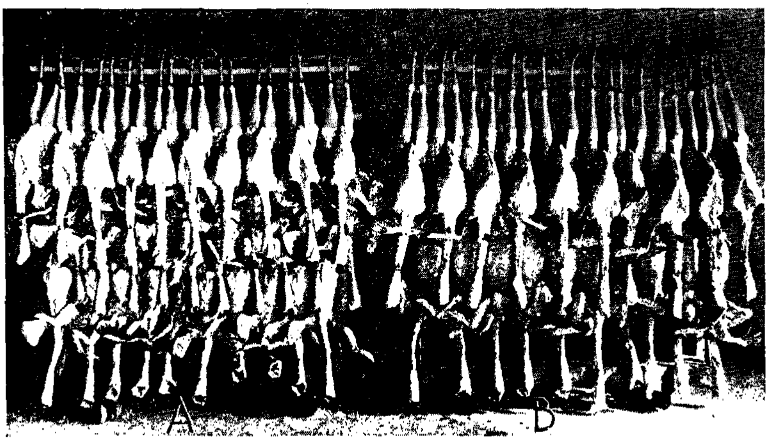
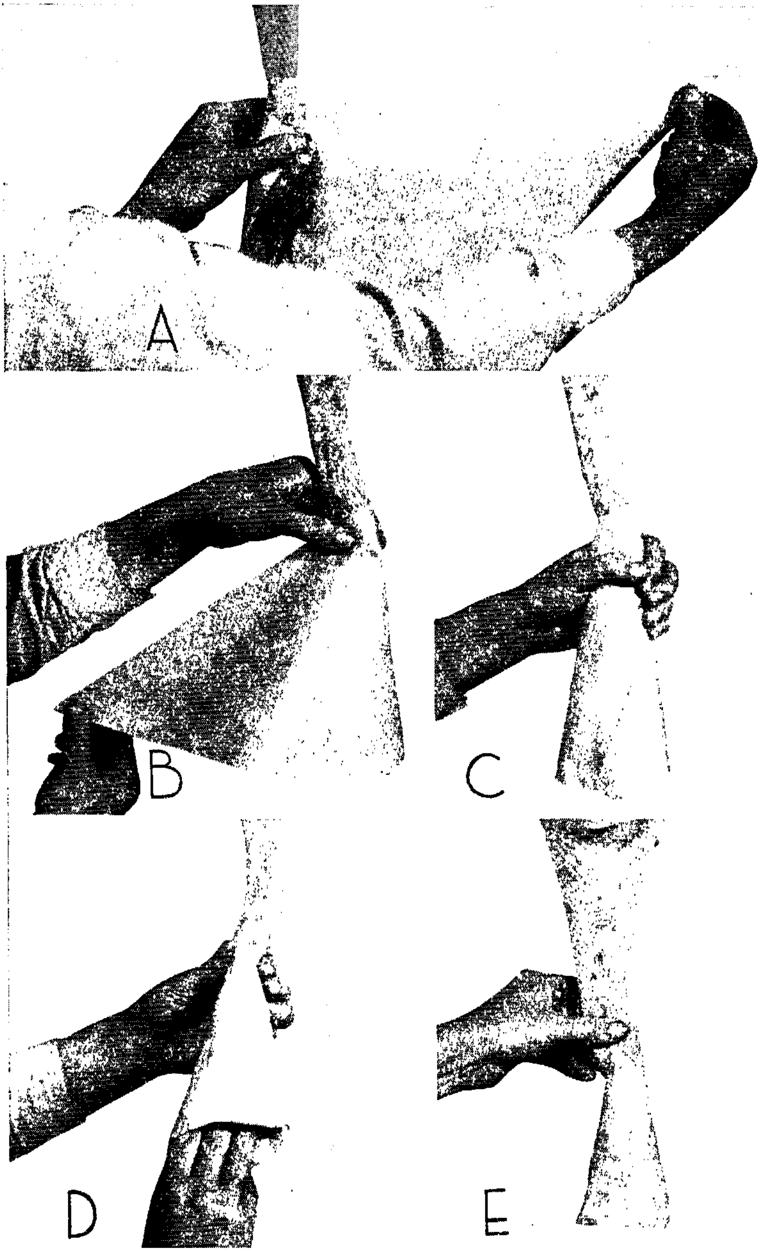


FIG. 36.—A part of the station's turkeys ready to be moved into the chill room preparatory to packing and shipping to an eastern market. (A) Rack of young hens. (B) Rack of young toms.

The heads of all turkeys should be neatly and securely wrapped. A head wrap with dimensions shown in figure 32G will give satisfactory results for a turkey of average size. Two such wraps may be cut from a single strip of paper 9 by 27 inches. The wrap should be made of brown kraft paper that weighs approximately 40 pounds to the ream. The steps for the wrapping operation are given in figure 37.

Both boxes and barrels are used for the packing and shipping of turkeys. While the former container is desirable, barrels are probably the more satisfactory for farm conditions. The barrels should be clean and lined with wrapping paper. Either the side pack or "squat pack" method may be used. If possible the males and females should be packed in separate barrels. A barrel will hold approximately 200 pounds of turkey. The males are usually packed in four layers of three turkeys each and the females in five layers. Each layer should be separated with wrapping paper.



Courtesy Bur. Agr. Econ., U. S. Dept. Agr.

FIG. 37.—Views showing steps in the head-wrap operation. (A) The paper is stretched tightly and folded back over as in (B). (C) The paper has encircled the head twice. (D) The paper at the open end is tucked between the head and the opposite side of the paper. (E) The finished wrap.

When the side pack is used, the legs are folded under the bird, the head folded under the right side, and the turkey placed in the barrel on its right side with the breast toward the center and the back toward the outside. With the "squat pack" the birds are placed in the containers nith their rumps down and their backs toward the barrel. With this method the heads are usually pulled down between the legs which are folded over the breast When the pack is completed, the loose ends of the barrel lining are folded over the top row of turkeys. The container is sealed by placing a strip of burlap over the barrel top and fastening in place with a hoop.

MARKETING COSTS

Larger growers may find it convenient to have the killing, packing, and shipping operations carried out by persons who are skilled in performing these duties. Some indication of the cost of following such a marketing plan is given in Table XXIX. The data represent

TABLE XXIX.—MARKETING COSTS

For 134 turkeys, 1932

ITEM	Total	Per lb. live weight	Per lb. dressed weight
Sales commission, 5 percent	$24.15	$0.0116	$0.0128
Manufacturing costs:			
Dressing labor	8.50	.0041	.0045
General labor, packing, loading, etc	3.50	.0017	.0019
Packing materials	5.00	.0024	.0027
Handling charges, trucking, etc	10.40	.0049	.0055
Plant overhead	18.70	.0090	.0099
Freight and ice	35.00	.0168	.0185
Totals	$105.25	$0.0505	$0.0558

the total cost involved in the marketing of 134 head. The turkeys were sold at an eastern market in 1932 at a cost of 5.1 cents per pound of live weight or 5.6 cents per pound of dressed weight.

PRICE TRENDS

The bulk of the turkey crop is marketed during the months of November, December, and January, and according to Heitze[69] the price paid to farmers for January turkeys has been on an average almost equal to the December price. For the 14 years, 1920-'21 to 1933-'34, the average November 15 price was 25.13 cents per pound; December 15, 25.69 cents; and January 15, 24.93 cents. In eight of

69. Heitz, Thomas W. Dressing and packing turkeys for market. U. S. D. A. Farmers Bul. 1694:1-29. 1934.

the 14 years the Christmas paying price was higher than the Thanksgiving price.

Kansas turkeys are quoted on the New York market as western turkeys. The average-daily price per month for western fresh-killed turkeys on this market is given in figure 38. It is interesting to note that in six of the nine years covered by the chart, the highest monthly quotation occurred in September. This covers the period from 1925 to 1930. In three of the nine years, 1931 to 1933,

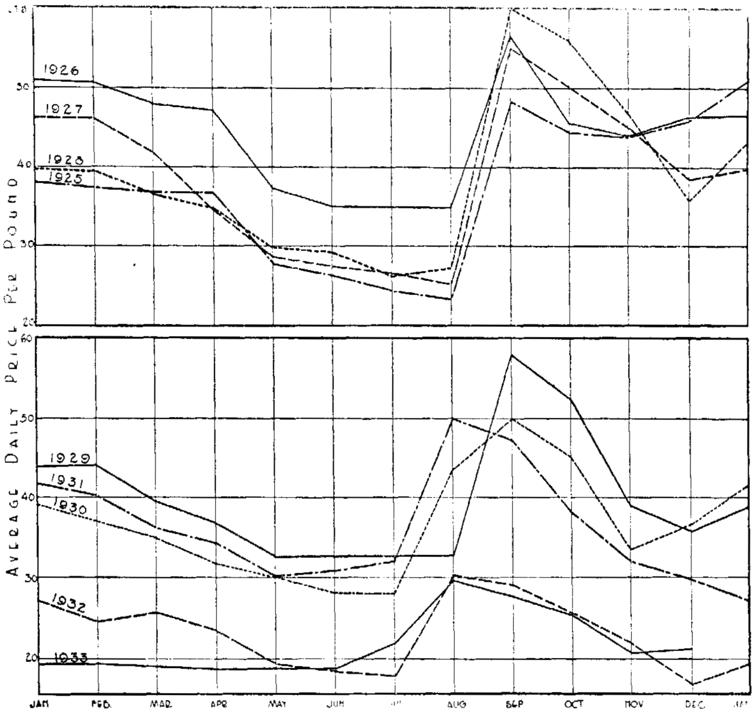


FIG. 38.—Graphs showing average daily price per month for western fresh-killed turkeys on the New York market. (Compiled from the Dairy Produce Yearbook by permission of Dairy Produce Publishers, Inc.)

August was the high month. The advantage of being able to mature turkeys in August or September is obvious. A study of these price tendencies encouraged the use of lights outlined elsewhere in this publication where it was shown that early eggs could be obtained by the correct use of artificial illumination. In four of the nine years, the average December price was above the average November price. With the exception of the year 1931-'32 the average daily January price was equal to or higher than the December price of the preceding year. In three instances, 1926, 1927, and 1931 the average January price was higher than the average November price of the preceding year. The low points in the price curves from April to July are in all probability a reflection of the quality of the stock received since the holdover stock and breeding stock is sold in this period.

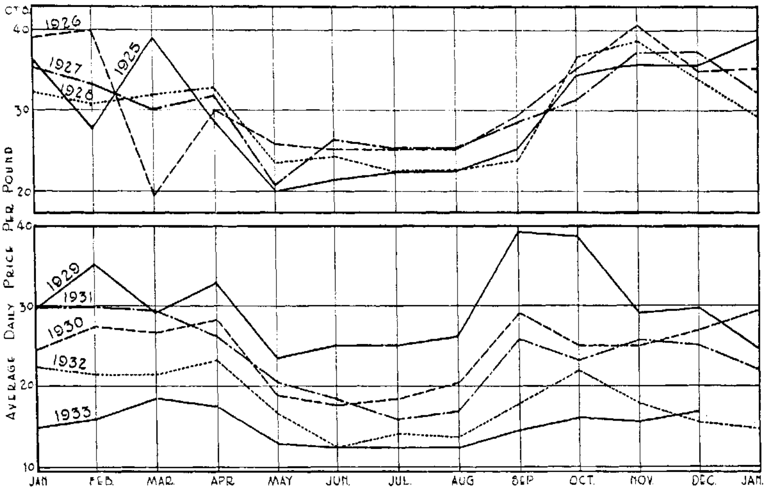


FIG. 39.—Graphs showing average daily price per month for live turkeys on the New York market. (Compiled from the Dairy Produce Yearbook by permission of Dairy Produce Publishers, Inc.)

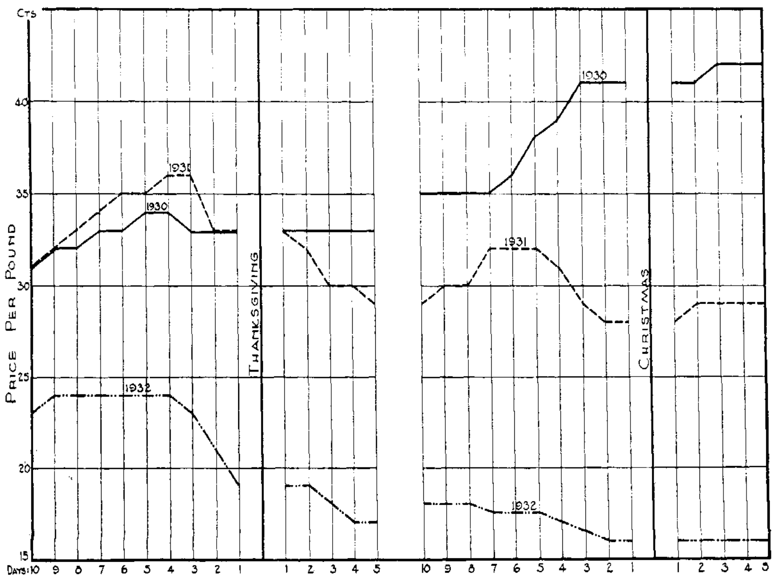


FIG. 40.—Graphs showing New York quotations for western fresh-killed No. 1 young hens 10 market days before Thanksgiving and Christmas and five

Data regarding the price paid for live turkeys on the New York market for the years 1925 to 1933 are given in figure 39, where it is observed that the November price was higher than the December price in five of the nine years. Unlike the quotations on dressed turkeys, the November price of live turkeys is generally higher than the September figure.

In marketing turkeys it is desirable to have them reach their destination well in advance of Thanksgiving day or Christmas day,

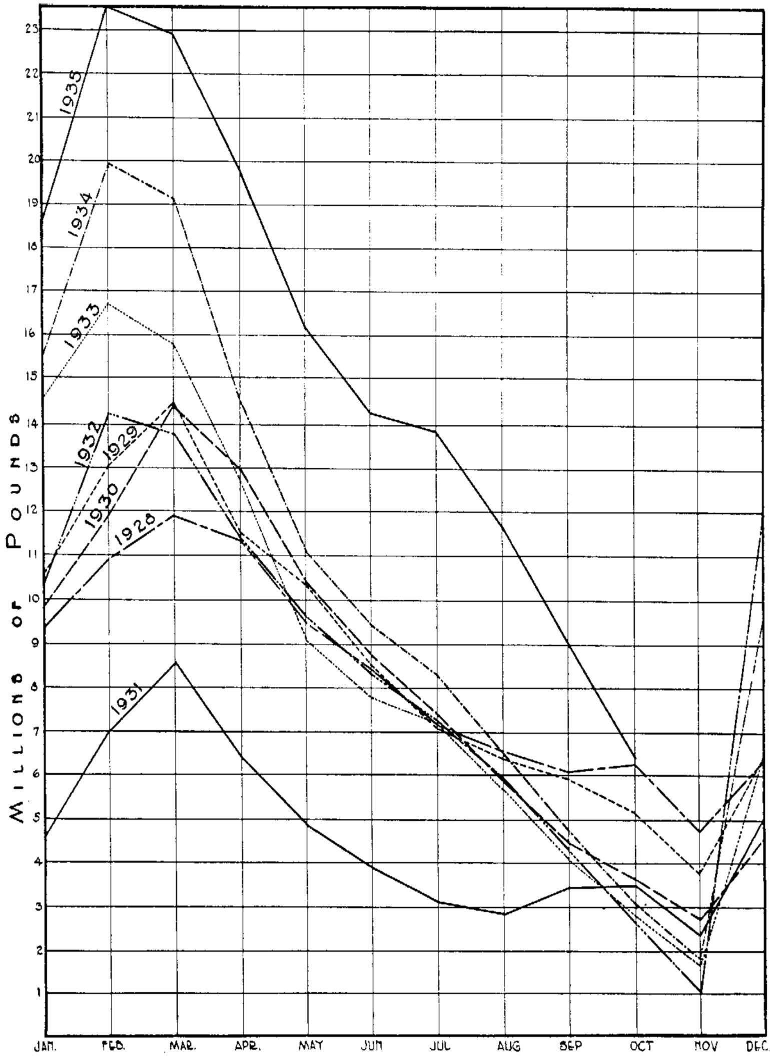


FIG. 41.—Graphs showing storage holdings of turkeys on the first of each month from January, 1928, to October, 1935.

as the price usually tends to take a downward trend four days in advance of these dates. This is illustrated in figure 40, where the quotations have been plotted ten days in advance and five days beyond for each of the two holidays.

STORAGE HOLDINGS

Turkeys move into storage from November to the latter part of February. The high storage point occurs in February or March. From March to November first the stocks are gradually reduced. (Fig. 41.) The average holding on February 1 from 1923 to 1935 was 14,001,610 pounds as compared with 14,390,015 pounds on March 1 for the same period. The average holding on November 1 for the years 1923 to 1934 was 4,331,660 pounds. The storage holdings in 1935 from January to October are well above any of the figures for the comparable months of other years.

IMPORTATIONS OF TURKEYS

Argentina and Canada export significant numbers of turkeys into the United States. Argentina alone in 1931 exported into the United States more than four million pounds of dressed turkeys which is equal to the average United States storage holdings on November 1. Information concerning importations of dressed and live turkeys by countries is given in Tables XXX and XXXI.

TABLE XXX.—GENERAL IMPORTS OF DRESSED TURKEYS INTO THE UNITED STATES*

Pounds from various countries

YEAR	Argentina.	Canada.	United Kingdom.	Uruguay.	Australia.	Mexico.	Total.
1930 (a)...	1,108,458	6,456	54	64,413	0	154	1,179,535
1931......	4,321,742	250,380	439,867	32,313	254,606	87	5,298,995
1932......	252,728	222,000	600	0	0	30	475,358

* By courtesy of G. W. Sprague, agricultural economist, Bur. of Agr. Econ., U. S. Dept. of Agr.
(a) Beginning June 18, 1930.

TABLE XXXI.—GENERAL IMPORTS OF LIVE TURKEYS INTO THE UNITED STATES*

Pounds from various countries

YEAR.	Canada.	Cuba.	Mexico.	Honduras.	Nicaragua.	Total.
1930 (a)..............	67,007	265	72	0	4	67,348
1931..................	134,612	160	104	12	0	134,888
1932..................	45,757	0	10	60	0	45,827

* By courtesy of G. W. Sprague, agricultural economist, Bur. of Agr. Econ., U. S. Dept of Agr.
(a) Beginning June 18, 1930.

IMPROVEMENT PROGRAM

The systematic selection of breeding stock under an improvement program, was first inaugurated in Kansas during the fall of 1935. An approved turkey flock branch of the Kansas Poultry Improvement Association was organized during that year.

In each flock operating under the rules of this organization, the individual birds are passed upon by a state turkey inspector. Each inspector must attend a special training school and pass a satisfactory examination to qualify. Figure 42 illustrates a group of growers at work during one phase of the training period. If acceptable the bird is marked with the official leg band of the Kansas Poultry Improvement Association, During the past year a total of 1,570 head of breeding stock were approved on the farms of 18 breeders. The number of birds banded ranged from 25 to 296 for the various flocks.

FIG. 42.—Turkey growers scruntinizing a flock of Narrangansett turkeys as one phase of the work held in conjunction with the inspectors' school.

To qualify as a breeder, the turkey must meet the following requirements:

A. Free from the following major defects which are of sufficient importance to eliminate birds as prospective breeders.
   1. Low vitality or diseased.
   2. Serious skeletal deformities which include any indication of a crooked keel, deformed back, crooked leg or toe or scissor beak. A slight indentation is not to be classified as a crooked keel.
   3. Not meeting the minimum weight requirement as given in Table XXXII.
   4. Wings not carried in the normal position.
   5. Color of skin, shanks, and feet not typical for the breed.
   6. Off-colored plumage listed as feather color disqualifications in the American Standard of Perfection.

B. Body conformation and maturity.
   1. Keel bone long and straight. Musculature of breast well developed giving this region a rounding fullness in contrast to sharp-keeled birds lacking muscular development.
   2. Back wide and flat. Leg bones stout and relatively short.
   3. Relatively free from pin feathers or green feathers if inspected when 26 weeks of age or more.
   4. Hip and pubic bones and the feather tracts of the breast and neck showing some indication of fat deposition.

C. The plumage color as given in the American Standard of Perfection shall be followed to a reasonable high degree.

Growers have different weight objectives. For any given breed, one grower may emphasize the extremely large size while a second grower may desire to mature a smaller turkey of the same breed. The minimum weight requirement of four popular breeds is given in Table XXXII.

TABLE XXXII.—THE MINIMUM WEIGHT REQUIREMENT ADOPTED FOR THE FLOCK IMPROVEMENT PROGRAM OF KANSAS

BREED.	SEX.	Weight in pounds. 20 weeks.	Weight in pounds. 24 weeks.
Bronze	M.	15.0	20.0
	F.	10.0	12.5
Narragansett	M.	12.5	16.5
	F.	8.5	10.5
Bourbon Red	M.	10.5	14.5
	F.	7.5	9.5
White Holland	M.	11.5	15.5
	F.	8.0	10.0

THE "TURKEN"

The naked-neck chicken of Transylvanian origin frequently has been represented as a cross between the chicken and the turkey and as such has been widely exploited. It is highly improbable that this cross has ever occurred under natural conditions since the two genera differ so in mating habits as well as in body size. The peculiar nonfeathered neck of the "turken" is due to a single dominant genetic factor. (Fig. 43.) Thus a naked-neck bird when mated to a normal feathered one will give all or half-naked-neck progeny.

The naked-neck chicken has none of the qualities of a turkey nor is there any particular advantage to be obtained in breeding the naked-neck chicken over the more common recognized breeds of chickens.

Attempts have been made to produce turkey-chicken hybrids by artificial insemination. Warren and Scott[70] have fertilized chicken

70. Warren, D. C., and Scott, H. M. An attempt to produce turkey-chicken hybrids. Jour. of Heredity 26:105-107. 1935.

eggs with the semen of the turkey and the turkey egg with chicken semen. None of the cross fertilized eggs hatched, the hybrid embryos having died at various developmental stages of the incubation period.

FIG. 43.—A naked-necked chicken, the "turken," often exploited as a cross between the chicken and the turkey.

TURKEY DISEASES AND THEIR CONTROL[71]

In no other branch of animal husbandry has disease caused greater havoc than in the turkey industry. For many years, turkey rearing in this country was threatened with extinction by the disease commonly known as blackhead. Through recent scientific investigations, effective control measures have been developed against this disease. As a direct result, the turkey industry has expanded remarkably, but with this expansion other disease problems have been encountered. Some of these diseases may be overcome by the same or similar measures which suffice against blackhead. Others seem to require more drastic steps of the same nature or the institution of different programs.

In preventing and controlling disease, the importance of soundness of body and inherited vigor cannot be overemphasized. Proper nutrition in the sense of complete rations that are reasonably well

71. The author is indebted to Dr. C. A. Brandly and Dr. L. D. Bushnell of the Department of Bacteriology for writing the section on turkey diseases and their control.

balanced is essential for health and efficiency. Suitable surroundings which include proper physical and sanitary protection against injury and disease cannot be stressed too vigorously.

Disease is defined as any change or deviation from health, whether it be a slight illness or one so serious as to endanger life.

Diseases resulting from a ration lacking partly or entirely in the necessary elements are called nutritional or deficiency diseases.

Diseases caused by bacterin, fungi (molds) and viruses are classed as infectious diseases. Among the important parasitic diseases of turkeys may be included those brought about by intestinal worms, coccidia, and the blackhead protozoan.

GENERAL DISEASE PREVENTION AND CONTROL MEASURES

Experience has shown that most outbreaks of turkey diseases can be prevented. Few, if any, individuals affected with disease can be treated successfully or cured. Those which survive an outbreak of infectious disease may remain carriers and spreaders, thus becoming more of a liability than an asset.

Proper sanitation and hygiene usually serve to prevent entrance of infectious and parasitic diseases into a flock. Once having gained a foothold, these diseases may be eradicated only by adhering to the first rules of sanitation and hygiene. Not infrequently the turkey producer, through inexperience or lack of knowledge, has been led to place false trust in "medicines" and so-called "cures" to solve the disease problem. In such instances effective control measures are delayed and disease losses are heavier.

Completely isolated farms or units for turkey production would seem to provide the ideal safeguard against the transmissible diseases. Turkeys as well as other animals in the wild state are seldom subject to the ravages of disease epidemics. Those conditions of crowding and continuous over population of areas which favor the initiation and spread of infectious diseases do not prevail except in the captive or semicaptive state. In addition to greatly increasing the exposure to diseases native to the turkey, domestication subjects them to contact with diseases of chickens and other fowl. Some of these infections and parasites at first do not attack turkeys, but eventually adapt themselves to this species, often with serious results.

The problem of preventing the introduction of disease is thus directly magnified with diminished areas for rearing. Even proper rotation of ranges and more comprehensive sanitary measures may fail to protect the birds adequately from disease. Here ingenuity has devised entirely artificial conditions so that the birds may be kept partly or entirely off the ground on sanitary floors of wire or other materials. Should transmissible diseases be introduced into flocks or units in confinement, these facilities may be invaluable in eliminating the infection. At all times and under all conditions, great alertness on the part of the caretaker is necessary to prevent the introduction of diseases by thE numerous means through which this may occur. Infection may be introduced on the shoes or clothing of people having recently visited diseased flocks or contaminated premises. Dogs, rats, and other animals, chickens and mild birds may bring disease from outside sources. Failure to quarantine breeding or other purchased stock for a period of at least two weeks before introducing them into the flock may spell disaster. Eggs or baby poults from infected stock or contaminated premises as well as contaminated coops and equipment may be the means of introducing disease into the flock.

WHAT TO DO IN CASE OF AN OUTBREAK OF DISEASE

In case symptoms of disturbed health do appear, it should be assumed for the sake of safety that the disease is infectious. All individuals that do not appear normal should be promptly removed from the flock. iF possible, the healthy ones should be removed to clean sanitary quarters or range. In any event, thorough and frequent cleaning and disinfection of the quarters and equipment cannot be conscientiously overlooked. The possibility that the feed and water are being exposed to contamination should be given attention. The addition of a suitable antiseptic to the drinking water is also desirable.

At the same time it is important to reach a definite diagnosis as to the nature and cause of disturbed health. In diseases such as blackhead the lesions in some but not all sick birds are so characteristic that one without a great deal of knowledge of turkey diseases may diagnose the condition. Nevertheless, it should be emphasized that sick birds look very much alike regardless of the disease. Even one familiar with diseases of turkeys by virtue of proper training and long experience may be unable to distinguish between the different diseases on the basis of symptoms. The disease changes, as in fowl cholera and fowl typhoid, also may not allow a definite diagnosis.

Insofar as the immediate control measures are concerned, it may not be essential that cholera and typhoid be differentiated. Nevertheless, for eradication or elimination of the infection from the flock the final steps are quite different. Carriers of fowl typhoid may be readily detected and eliminated by means of the agglutination (blood) test. This method is not applicable in eradicating cholera and hence disposition of all recovered or exposed birds is usually necessary. Frequently a diagnosis may be complicated because two or more diseases, each capable of causing serious trouble, may be existing simultaneously in the same flock.

To minimize the possibility of losses resulting from an improper or incomplete diagnosis, several live sick birds should be examined by a qualified veterinarian or by the diagnostic laboratory of the Kansas Agricultural Experiment Station. Complete information regarding the management, age, feeding, previous outbreaks, symptoms, duration, number affected, and previous treatment should always be provided in order to aid in an early diagnosis. At least, two typical live, sick specimens should be provided for examination. In making express shipments, proper crating to comply with disease regulatory and control measures are essential.

CLEANING AND DISINFECTION

The cleaning and disinfection should be directed toward removing and destroying any sources of infection, such as the droppings and other body excretions. The removal of all litter and droppings from the houses may be followed by thorough scrubbing with a solution of lye in water (a one pound can of lye to each 15 gallons of water). This agent is effective in cleaning as well as in disinfecting and need not under ordinary circumstances be followed by the use of the usual preparations such as the cresol compounds. For disinfection with the latter agents the use of a 3 to 5 percent solution in water applied by means of a spray pump is recommended.

Both lye and cresol solutions are highly irritating and caustic to the skin and mucous membranes of persons. Proper protection with rubber gloves, boots, etc., must be provided and, likewise, the birds should be kept away from the solutions or from floors or equipment that are still wet following application of these agents.

Direct exposure of runs and ranges to sunlight will quite rapidly destroy infection deposited by diseased birds. In shaded areas, particularly on heavy soils, infection or parasites and their eggs may survive from year to year. Droppings contaminated with bacterial or other infection and with coccidia or worm eggs must be properly disposed of. In some circumstances burning is practiced, in others temporary storage in properly constructed manure pits, or immediate removal, for use as fertilizer, to areas so distant that there is no danger to any birds,

Upon reaching a definite and complete diagnosis, additional measures as described in the disease sections should be instituted.

BLACKHEAD

Blackhead *(infectious enterohepatitis)* is an infectious disease chiefly of turkeys, but sometimes attacking other fowls. It is caused by the protozoan *Histomonas meleagridis*. Heaviest losses occur in poults one to three months of age although turkeys of all ages are susceptible. The younger birds may die without showing marked symptoms. There is usually a loss of appetite, increased thirst, ruffled feathers, dropping wings (fig. 44), weakness, and diarrhea. In some but not all cases the skin of the head becomes dark, hence the name "blackhead." This term is misleading not only because all birds suffering with blackhead have a dark head, but birds with fowl cholera and other diseases in which the circulation of the blood is not normal may also show a dark or black color of the skin of the head.

Older birds usually live longer, the symptoms are seldom so marked, and the bird may gradually become very thin and weak before death ensues.

The disease is spread through the droppings of sick and carrier birds. The parasite of the disease which is microscopic in size may be taken up and protected by the small round cecum worms and the eggs of these worms. Blackhead infection may persist on premises from year to year thus necessitating careful sanitary measures to control and limit the infection. Old birds that are known to have had the disease or which have come from infected flocks should be disposed of to avoid danger to younger stock. Because chickens may, without apparent serious injury to them, harbor and spread

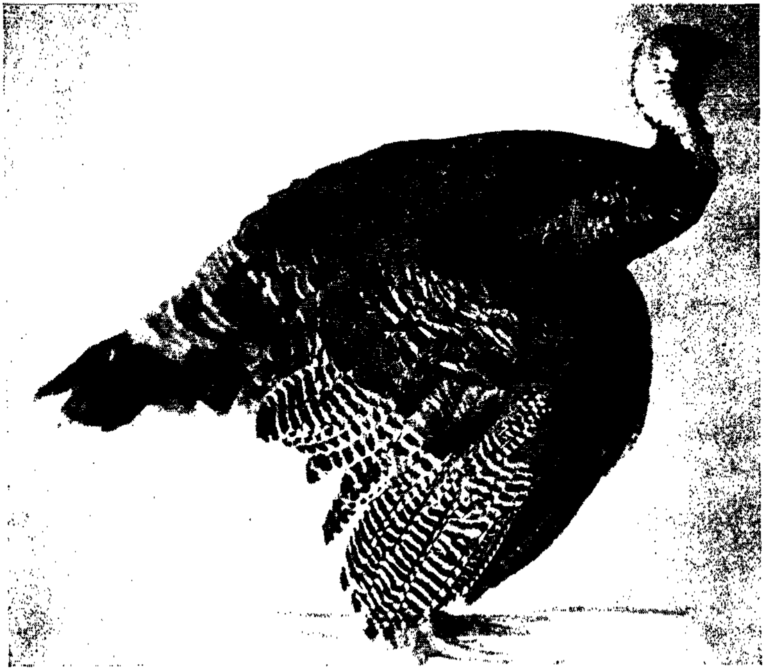


FIG. 44.—The posture of this turkey is characteristic of the advanced stages of blackhead.

blackhead infection, turkeys should be reared entirely apart from the chicken ranges or premises. Blackhead has been observed in grouse, quail, pheasants, partridges, and pea fowl and these birds may at times be responsible for its dissemination.

The significant lesions of the disease are found in the liver and ceca (blind pouches). The ceca are usually enlarged, inflamed, irregular in color and shape, and more or less distended with a cheesy core-like mass. The liver may show slight to extensive changes, including enlargement with round or irregular flat or sunken areas that are white to yellow or salmon in color. (Fig. 45.) The peritoneal membranes adjacent to the liver and ceca are usually inflamed and adhesions between the organs and the membranes are frequently found.

Artificial incubation and brooding eliminates the danger that young poults may contract the disease directly from turkey or chicken hens. Care to avoid exposure to pullorum or other diseases during hatching and brooding may be pointed out here. Many turkey raisers prevent blackhead by rearing the poults in confinement on sanitary wire floors, moving them to new clean range at

FIG. 45.—The blackhead organism has been responsible for the areas of necrosis that appear in this liver. These whitish necrotic spots are typical lesions of blackhead.

about ten weeks of age. For prevention, the continuous use of tobacco dust at the rate of four pounds for each 100 pounds of mash has given good results under certain conditions. The object of this method is to keep the birds free of cecum worms thus reducing the danger of blackhead. Blackhead also may be prevented by surgically removing or tying off the ceca. Since the operation requires much skill, and mortality is quite high because of postoperative complications, this method of prevention is impractical.

Should signs of blackhead appear in the flock, there should be no delay in instituting the fundamental sanitary and hygienic measures already outlined under "General Disease Prevention and Control." That blackhead may be eliminated with the expenditure of reasonable effort and planning has been demonstrated on many farms.

There is no satisfactory or practical drug treatment or preventive for blackhead. The expenditure of money for agents other than the recognized antiseptics and disinfectants is not justified.

Likewise, vaccination against blackhead by means of mixed bacterins or any other biological product now available is to be condemned as useless and undesirable. Certainly there is no substitute for sanitary and hygienic measures and anything which may tend to delay or curtail their application will increase the disease losses.

COCCIDIOSIS

Coccidiosis occasionally causes severe losses in young turkeys, but apparently no species of coccidia affecting chickens is responsible for losses among turkeys. The ceca are primarily affected, showing marked hemorrhage and ulceration. The droppings may or may not be bloody.

It has been observed that coccidiosis is the most difficult disease of poultry to control. This is attributed largely to the great resistance of the coccidia in the oocyst stage or form in which the parasite exists as it is passed out in the droppings of affected birds. Even very strong disinfectants have little, if any effect upon the oocysts.

Prevention and control measures must depend on protection against exposure. The brood or flock must be protected against contact with the droppings of affected as well as recovered birds. After being expelled in the droppings, the coccidia require a period of at least 24 hours under favorable conditions of temperature and moisture for development to the stage where they are infective. Thus any plan which provides dry, clean floors or range and freedom from all contact with infected droppings is highly valuable.

Good results follow the method of replacing the litter in the brooder as often as three to four times a day over a period of four days following the first indication of an outbreak. Likewise, under certain conditions the use of a movable wire unit on the range, thus allowing frequent changing to new areas during the day, has checked serious outbreaks. Outbreaks of coccidiosis have been known to occur and persist even on wire floors where the floors have not been kept entirely free of droppings or where the drinking and feeding utensils have not been properly protected against contamination.

Many drugs have been used against coccidiosis with indifferent results. Any apparent benefit from drug treatment may usually be ascribed to the sanitary and hygienic measures which accompany the use of such drugs, combination of drugs, or feeds.

OTHER DISEASES

Turkeys are also subject to pullorum disease, fowl typhoid, paratyphoid, tuberculosis, fowl cholera, botulism, fowl pox, thrush, aspergillosis, tapeworms, roundworms, colds, and roup. Since the control measures for combating these diseases are similar to those used for chickens, the reader is referred to a publication of the Agricultural Experiment Station on "Poultry Diseases, Their Prevention and Control."

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