

South Dakota State University
**Open PRAIRIE: Open Public Research Access Institutional
Repository and Information Exchange**

Bulletins

South Dakota State University Agricultural
Experiment Station

6-1-1944

Turkey Egg Hatchability in South Dakota

F. R. Sampson

W. O. Wilson

Follow this and additional works at: http://openprairie.sdstate.edu/agexperimentsta_bulletins

Recommended Citation

Sampson, F. R. and Wilson, W. O., "Turkey Egg Hatchability in South Dakota" (1944). *Bulletins*. Paper 375.
http://openprairie.sdstate.edu/agexperimentsta_bulletins/375

This Bulletin is brought to you for free and open access by the South Dakota State University Agricultural Experiment Station at Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. It has been accepted for inclusion in Bulletins by an authorized administrator of Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. For more information, please contact michael.biondo@sdstate.edu.

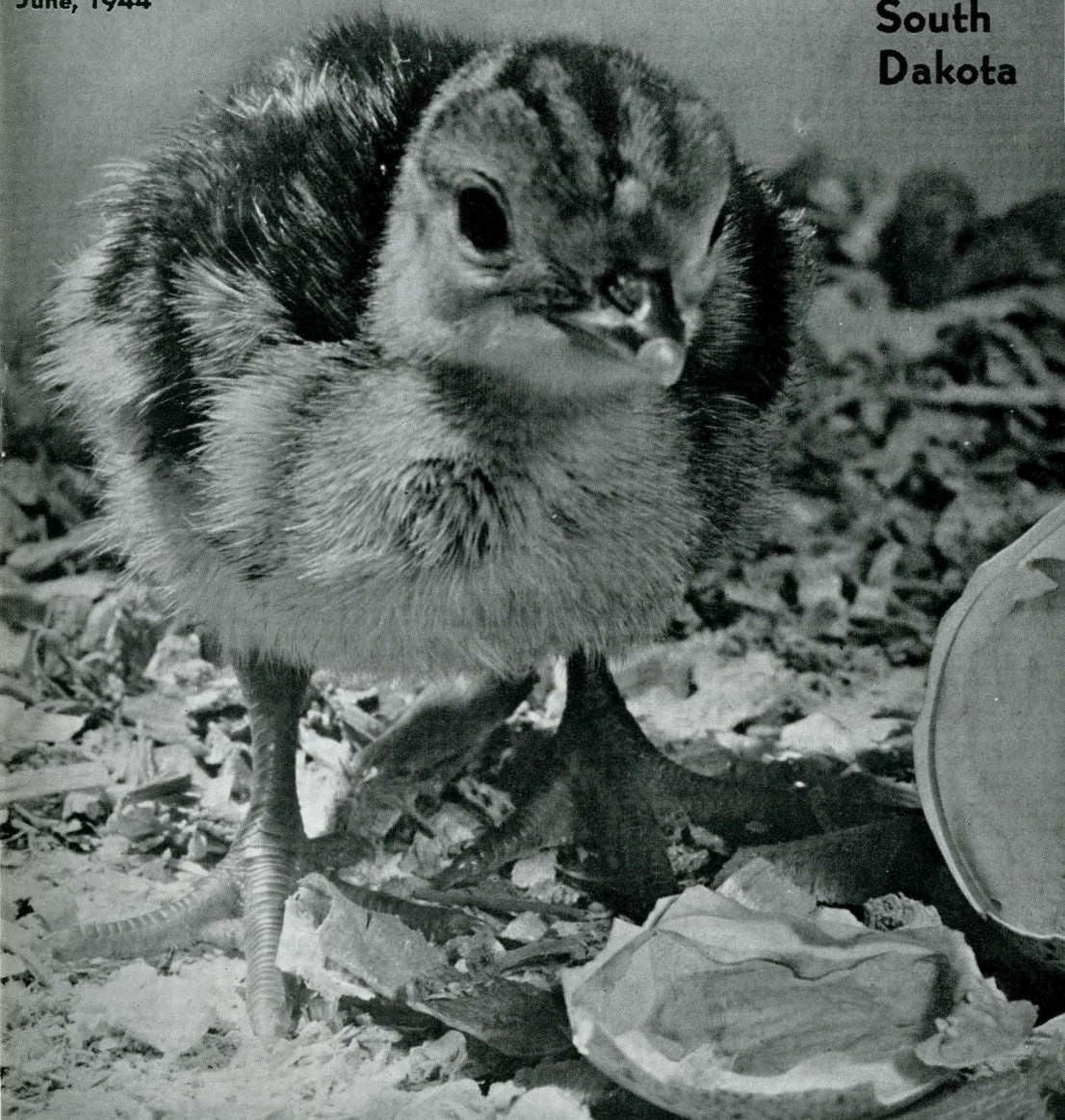
Turkey Egg

Hatchability

in
South
Dakota

Bulletin 375

June, 1944



Agricultural Experiment Station
SOUTH DAKOTA STATE COLLEGE ♦ BROOKINGS

CONCLUSIONS

In eggs held 7 days or less the percent hatchability was greater and the percent cripples decidedly less than those eggs held between 7 and 14 days.

Breed differences were observed between the Beltsville Whites and Bronze, both breeds being raised and managed under the same environment and the eggs being incubated in the same machine. The results are shown in Fig. 5, Page 8.

The heating of turkey laying houses did not justify the cost.

Breeders that were allowed range with enclosed shelter for housing took more feed, had higher fertility, but produced considerably less poults per bird during the hatching season.

It was found that mash prepared and mixed at the National Agricultural Research Center did not produce better results than a like mash made from South Dakota feeds.

There is no advantage in feeding alfalfa silage to turkey breeders.

The addition of 10% liver meal to the mash did not increase the hatchability significantly as compared to a 10% fish meal ration, and as compared to a control ration the hatchability and fertility were less in the liver meal lot.

Soybean oil meal can be satisfactorily used in a turkey breeder mash up to 25% of the total ingredients.

Amber cane is satisfactory as a mash ingredient and scratch grain.

Fertile eggs exhibited a 3.86% less moisture loss than did infertile eggs during the first 24 days of incubation.

Wheat germ oil when fed 2% in the mash did not produce conclusive results.

The breeding or the inherent reproductive ability of the turkey hen appears to be a very important factor in a study of the causes that affect fertility and hatchability.

Turkey Egg Hatchability In South Dakota

By F. R. SAMPSON and W. O. WILSON¹

Turkey eggs that do not hatch are a problem which is of great importance to turkey producers. This problem is especially important to producers who depend on the sale of poults for part of their income. It has been estimated that the loss to the turkey producers in South Dakota through eggs that fail to hatch is nearly one-half million dollars annually. Among factors which contribute to fertility and hatchability are (1) incubation of eggs, (2) management, (3) environment, (4) care of eggs, (5) breeding, and (6) nutrition.

The maintenance of a large turkey breeding flock and the use of artificial incubation for reproduction is a deviation from nature and thus intangible and inherent factors must be reckoned with in attempting to cope with this problem.

This publication presents results of experimental work dealing with these influences on the fertility and hatchability of turkey eggs.² The work at the South Dakota Agricultural Experiment Station was carried on during the hatching seasons of 1935 to 1944 inclusive.

Throughout this bulletin, fertility refers to the percentage of fertile eggs and hatchability refers to the percentage of fertile eggs that hatched.

Review of Literature

Several other experiment stations have published results of experiments with turkey egg hatchability. In brief the results are as follows:

Work at the Cornell and Kentucky Experiment Stations indicated that the best hatches were produced at very close to 99° F. in the forced draft machine.

Extensive incubation trials at the North Dakota Station resulted in the best hatches coming off with eggs held at 99° F. in the forced draft machine.

Recent work done at the North Dakota Station bears out a recommendation of 102° F. at the tops of the eggs throughout the hatch in the still-air machine.

According to Marsden and Martin's text on turkey management, the wet-bulb reading should be approximately 12° below the dry-bulb reading during the first 24 days of the incubation period. During the last 4 days it is usually raised to 90° F. This temperature change gives a

¹ F. R. SAMPSON, Assistant Poultryman; and W. O. WILSON, Poultryman. The experimental studies prior to 1942 were under the direction of Dr. W. E. POLEY, Head of the Poultry Department.

² In the analysis of data wherein differences are stated as significant, the Chi square test was used to establish this significance.

relative humidity of 60 percent and 70 percent respectively during the two stages of incubation.

The findings at the Idaho Experiment Station suggest that eggs under the proper moisture condition will lose weight due to evaporation as follows:

Number of days eggs are in incubator	Total weight loss <i>perct.</i>
6	3—4
12	6½—7½
18	9½—10½
24	13½—14½

Work at the Kentucky Agricultural Experiment Station involving over 8,000 turkey eggs found that a weight range of 71 to 98 grams produced the best hatchability. A decided decrease in hatchability resulted when weight went beyond those limits. Very large or very small eggs failed to hatch as well as the medium-sized eggs.

Experimental Procedure

In the course of the investigational work starting in 1935, a flock of 35 to 150 breeding turkeys have been maintained each year. The earlier work had to do with a study of the comparative hatchability of turkey eggs incubated in the still air machines and those incubated in the agitated air or forced draft machines (Fig. 1).

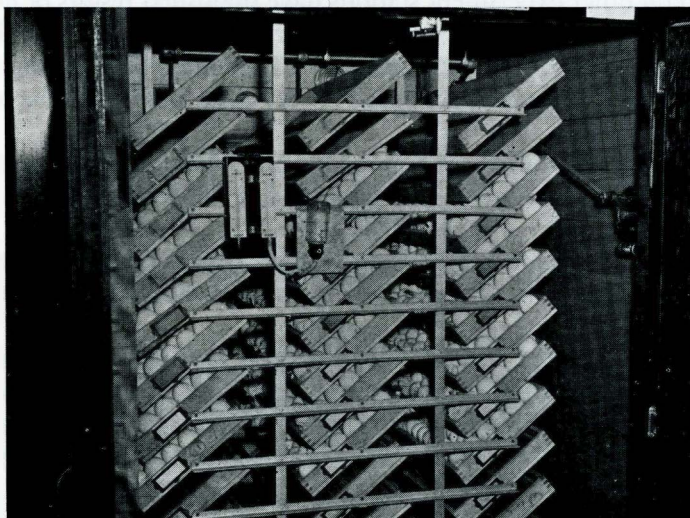


Fig. 1. Turkey eggs in forced draft incubator. Turkey eggs should be hatched separate from chicken eggs.

Selection of breeding stock. The original bronze turkeys were purchased from a near-by turkey grower. Breeding stock was selected from this stock. In the selection of breeders, emphasis was placed on those characteristics which influence the market quality of a bird (Fig. 2). Birds with standard disqualifications were not used. The best birds of each year's crop were used the following year as breeders (Fig. 3).

In 1938 Broad Breasted Bronze stock was imported from a west-coast breeder. The Broad Breasted toms were mated to the native stock the following 2 years. In 1942 Beltsville Whites were imported from the National Agricultural Research Center at Beltsville, Maryland. These turkeys should not be confused with White Hollands.

Since 1939, a measuring device which was developed at this station was used in the selection of breeding stock. This device consists of calipers to measure the length of shank and depth of body and a dial to give the turkey a grade. This grade is based on the two measurements in relation to a given body weight. It enables the producer to use the total score method of selection, which has been shown to be effective.³

Environment before breeding season. The turkeys were kept on range and housed in range shelters until weather prohibited this environment, about December 1.

After this, until the breeding season started, the breeders were housed in colony houses or in a rammed-earth poultry house.

Nutrition before breeding season. The turkeys raised at the South Dakota Station are practically all used in nutrition trials either on starting or growing rations. Those turkeys not used on tests are fed the standard college turkey starting, growing, and finishing rations. The rations (Table 6) or their modifications were fed in the tests.

In all tests oyster shell and grit were kept before the birds at all times. Grit is necessary for the normal process of breaking down feedstuffs prior to digestion and assimilation. Oyster shell is made available mainly for the purpose of supplying calcium. During a 5- to 6-month breeding season a turkey hen will consume 4½ to 7 pounds of oyster shell and ½ pound to slightly more than 1 pound of grit.

Since it has been proved many times that manganese is necessary for normal development and hatchability of the poults, this ingredient has always been a part of the experimental rations. Since 1938 the manganese dioxide was added to the ration through salt, which served as a medium. In recent years iodized salt has been used. The salt mixture was made by adding 800 grams of manganese dioxide to 100

³ A detailed description of this method can be had by writing to this station.



Fig. 2. Typical Broad-Breasted Tom. Male should be selected on basis of early maturity and balanced body conformation.

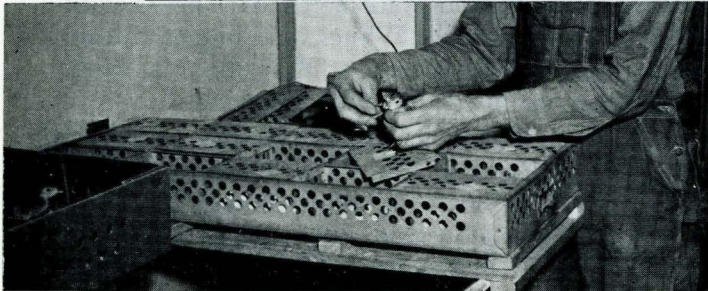


Fig. 3. Wing banding poults. The identity of the poults can be kept and a sound breeding program carried on.

pounds of iodized salt. One percent of this mixture in the mash adds 88 parts per million of manganese to the ration.

Equipment in breeding pens. Prior to 1940 the turkey breeders were housed in colony brooder houses and earth and frame continuous brooder houses. Both of these latter brooder houses have facilities for heating by use of hot water. Since the winter of 1940, a large, gable-roof earth house was used for the breeding stock.

This house contained five pens 18' x 12'. In each pen regular turkey trapnests were used. These were 2' x 2' x 1½'. One nest was provided for every three to four hens. Each pen was equipped with dropping pits. The roosts were placed 2 feet apart and on a slope, as can be observed from the picture, Fig. 4. The pens were well lighted with two 2' x 5' windows in the front and one 2' x 5' window in the back. When the temperature was above 15° F., the turkeys were allowed the run of small yards.

Management of males. From the observation of the studies made since 1938 with different methods of rotation, the deduction cannot be made that any one method is better than another. The rotation of toms

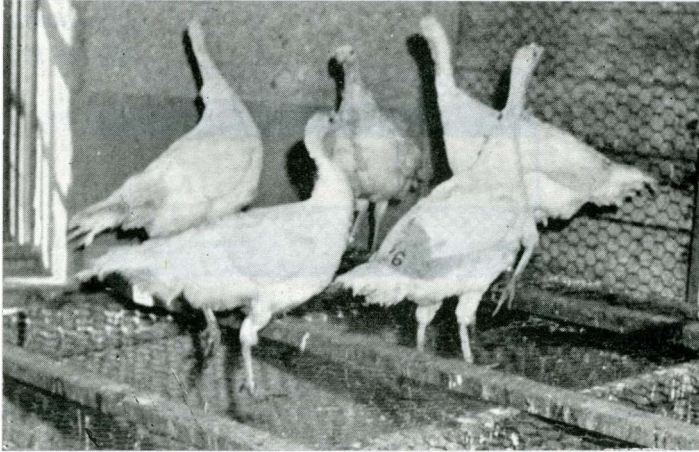


Fig. 4. Beltsville white turkey breeders in experimental pen. Wire used should be 12-14 gauge to support considerable weight. Note wide spacing of perches.

was practiced to equalize the differences in breeding abilities of the males. The following methods were used in rotating the breeders:

<i>Year</i>	<i>Method</i>	<i>Year</i>	<i>Method</i>
1938	Males rotated daily	1941	Males rotated three times per week
1939	Males rotated every other day	1942	Males rotated twice per week
1940	Males rotated two times per week	1943	Males rotated once per week

One tom was generally used with 12 females. The females were all equipped with canvas saddles to prevent their becoming lacerated during mating. Clipping toe nails of males also tends to reduce the degree of injury to the female, but the use of canvas saddles is generally more acceptable.

Investigators as well as turkey breeders are not in complete agreement as to the management of males during the breeding season. Most breeders are in agreement that males should be rotated in some manner. Some breeders use a modified system of stud mating, wherein the hens have access to the enclosure in which the tom is placed. This method reduces fighting to a minimum.

A number of turkey breeders seem to be able to increase fertility by using younger males during the latter half of the breeding season. It has also been found advisable in some instances to separate breeding pens at least 50 feet. This eliminates fighting and appears to lessen the degree of preferential mating.

Typical egg production under lights. It is generally accepted—and the work here at the Station bears out this fact—that turkey pullets will begin laying approximately 4 weeks after being put under lights.

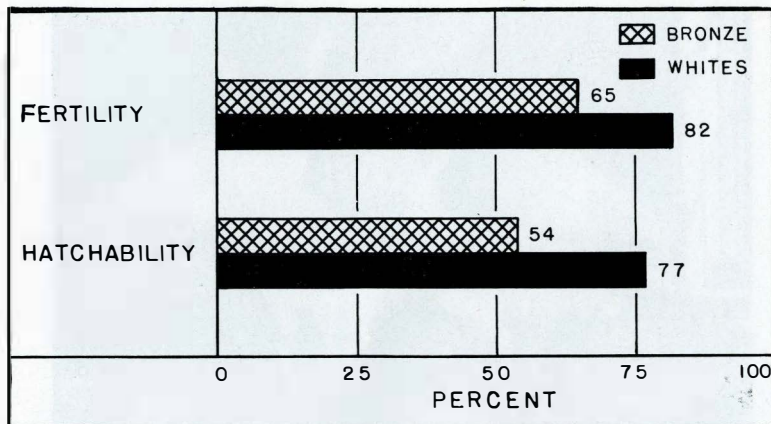


Fig. 5. Fertility and hatchability of Broad Breasted Bronze turkeys and Beltville Whites for 1942 and 1943. Eggs were produced and hatched under the same environment and conditions.

During the breeding season the egg production is about 50 percent. The trap nest record of a typical high producing Beltville White pullet (No. 415) for the 1942 season follows:

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	
FEBRUARY								x		x	x	x			x	x	x			x	x		x	x	x	x							14
MARCH	x		x	x	x		x	x		x	x	x		x		x			x	x		x	x	x	x			x	x	x	x		22
APRIL			x					x		x	x	x		x		x			x	x		x	x		x	x		x	x	x	x		16
MAY		x	x	x	x	x		x			x	x		x	x	x	x			x	x		x	x	x	x			x	x	x		21

In all station experimental work normal-sized turkey eggs were set. A normal weight for Bronze turkey eggs is approximately 80-85 grams (about 3 ounces).

Breed differences. Breed differences were observed between the Beltville Whites and Bronze, both breeds being raised and managed under the same environment and the eggs being incubated in the same machine. Results are shown in Fig. 5. Technically both bronze and white turkeys are considered as varieties.

Results and Discussion

Incubation of Eggs

Still air vs. forced draft incubators. Investigations were conducted in 1935, 1936, and 1937 on the use of forced draft and still air incubators for hatching turkey eggs. One half of each hen's eggs was set weekly in a still air sectional incubator and the other half set in an incubator where the air was constantly agitated with reels. Both incu-

bators were heated by electricity. In these tests in which a grand total of 4,559 fertile eggs were incubated, there were no significant differences in hatchability.

An electrically heated, still air, 400-egg capacity machine was used. The forced draft machine had a capacity of 6,000 eggs and the incubator hatcher a capacity of 2,000 eggs.

The temperature of the still air machine was held at 100° F. the first week, 101° the second week, 102° the third week, and 103° the fourth week. In the forced draft machine the temperature was held at 100° F. for the 4 weeks. These temperatures were recommended by the manufacturers at that time.

However, since these tests were conducted it was found that 99° F. to 99½° on the forced draft machine produced satisfactory hatches. This range of temperature is also in agreement with other studies made. With these temperatures a separate hatcher was used for the last 4 days of incubation (Fig. 6). The hatcher was operated at a dry bulb temperature of 99° and a wet bulb of 86° to 89° F.

Most investigators hold to the recommendation for the still air machine of 100° F., 101°, 102°, and 103° for the first, second, third, and

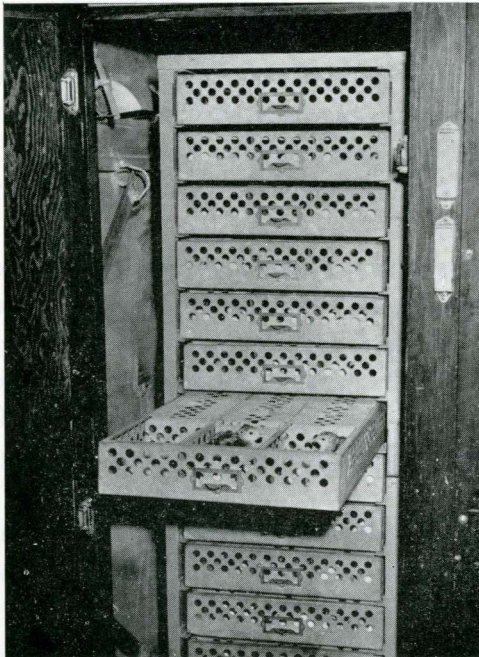


Fig. 6. Hatcher used in experimental studies. Note separate hatching compartments for pedigreed eggs of each hen.

fourth weeks, respectively. The temperature is taken about $1\frac{7}{8}$ inches above the bottom of the tray.

It should be emphasized that the manufacturer of an incubator or hatcher is vitally concerned with the kind of hatches that his machine

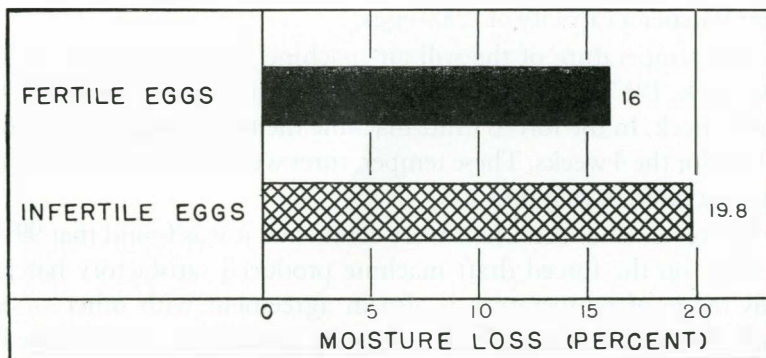


Fig. 7. Moisture loss from fertile and infertile eggs.

turns out. With this in mind the operator should study carefully the latest recommendations of the manufacturer. Incubator recommendations should be interpreted in the light of the following: (1) make and model of the machine, (2) circulating system, and (3) distance between trays. The nutrition and breeding of the flock, as well as the care and handling of the hatching eggs prior to incubation, affect the hatchability. The incubation process is highly complicated, and most recommendations must be interpreted with local conditions in mind.

Moisture loss. Investigations have substantiated the fact that the rate of evaporation of moisture affords an indication of whether the incubator contains sufficient moisture. In moisture-loss studies conducted in 1939, it was found that the percent moisture loss of fertile eggs by trays ranged from 15.1 to 16.9 with an average loss of 16.0 percent. The infertile eggs gave an average loss of 19.8 percent. (Fig. 7).⁴

It is very important to have sufficient moisture during the incubation period. Since the size of the air cell indicates the rate of evaporation, the operator can check it to determine moisture loss.

⁴ The difference between these two averages is significant as shown by the "t" test for paired observations.

Management of Eggs and Breeders

Hatchability and length of holding eggs. The recommended period that turkey eggs can successfully be held prior to incubation is 7 to 14 days.

In the late spring of 1943 a test was made to ascertain if differences existed between the hatchability of eggs, as well as the number of cripples

TABLE 1. EFFECT OF PERIOD OF HOLDING EGGS ON HATCHABILITY AND NUMBER OF CRIPPLES PRODUCED (1943)

Period eggs were held	Number	Hatchability	Cripples
		<i>perct.</i>	<i>perct.</i>
0 to 7 days	475	72.60	12.26
8 to 14 days	502	64.11	25.54
Breed Differences			
Whites			
0 to 7 days	65	84.6	-----
8 to 14 days	121	76.0	4.41
Bronze			
0 to 7 days	410	67.2	16.0
8 to 14 days	381	58.5	37.9

pled or spraddle poults, and the length of time eggs were held before incubation. Some cases of eggs were held 0 to 7 days and others 8 to 14 days at 50° F. The cases were propped against the cooler wall and turned end for end daily while the hatching eggs were being saved. Another method of turning the hatching eggs is shown in Fig. 8.

A total of 977 eggs (186 from Beltsville Whites and the rest from Bronze) were involved in this study. The results together with the differences in percentages of cripples and in hatchability for the Bronze and Whites, are shown in Table 1. A similar study was made in the late spring of 1944. For the Bronze, the trend of results was substantially the same as in the 1943 tests.

Effect of lights on males. It has been definitely proved that by placing the birds under light, development and function of the sexual organs is stimulated. In a study at the South Dakota Station during the 1942-43 breeding season, the toms were placed under all-night lights December 28, 1942. The birds were stimulated daily to obtain seminal fluid.

Examined under the microscope, the fluid showed normal and highly motile sperm. All males with one exception produced seminal fluid. The median time required was 16 days.

In another study three males produced semen the day following

lighting, which was on January 12, 1943. Previously, these males had been with the turkey hens.

Artificial insemination. A number of turkey producers feel that artificial insemination has its place in a turkey breeding flock. In instances where low fertility is caused by an ineffective mating or when the female is not responsive to certain males, artificial insemination is known to have produced decided increases in fertility. In studies carried on during the 1943 season, the fertility was increased from 11 to 20 percent with artificial insemination. However, with some birds there was no increase in fertility.

Diluting the seminal fluid with various types of dilutents did not prove satisfactory. In one instance a male was discovered from which no seminal fluid could be procured. Upon an examination it was discovered that one of the testes was atrophied.

Fertility of first egg. In 1943 the first egg of each turkey hen was incubated for 24 hours to determine whether it was fertile. The subsequent fertility record of each hen was then kept. This study was made to determine if a correlation existed between the fertility of the first egg and subsequent fertility record of the hen. It was reasoned that if a hen's first egg was infertile it would likely show high infertility throughout the season. For 1943 results, see Fig 9. Twenty-nine of 120 hens produced infertile first eggs in the 1943 season. In 1944

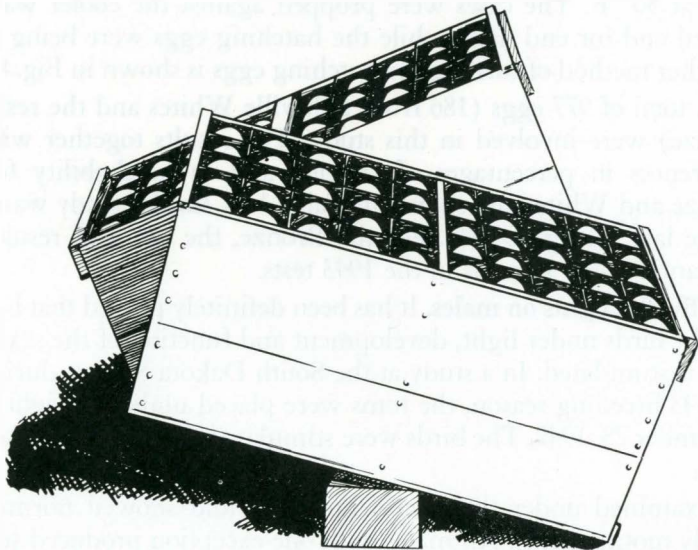


Fig. 8. Easy method of turning eggs prior to incubation. A 4-inch square block can be used and the tilted end reversed at least once a day.

this study was continued and only 5 of 104 Broad Breasted Bronze turkey breeders laid infertile first eggs. The subsequent fertility record of these hens for the 1944 season was 47.1 percent while the fertility of the hens that laid fertile first eggs was 88.2 percent. Definite conclusions cannot be drawn from the 2 years' work because of the low number of hens producing infertile first eggs in the 1944 season.

Maintenance rations for winter. This study was designed to test the effect of a yellow corn ration with a white corn ration on body weight of turkey hens. One lot had yellow corn both in the mash and fed free choice, and the other lot had white corn both in the mash and fed free choice.

At the start of the test the females in both lots averaged 12.8 pounds each. At the end of the test the birds fed white corn averaged 15.7 pounds, and those fed yellow corn averaged 15.5 pounds. The test lasted from November 11, 1937, to January 3, 1938. The differences in weight and condition of the birds are not considered significant.

Heated vs. unheated houses. Two years' work on this problem demonstrated that there were no significant differences in fertility, hatchability, and production of eggs produced by hens that were kept in heated houses and hens that were kept in unheated houses.

The results on hatchability and fertility were not consistent from year to year. In 1940 the fertility was higher in the unheated house while the opposite was true in 1939. In 1940 the hatchability was greater in the heated house, while in 1939 the opposite was true. The birds in the heated houses laid 30.54 eggs per bird while those in the unheated houses laid 28.12 eggs. This difference would hardly justify the extra expense for heating the house (Fig. 10).

Confinement vs. range. In these tests the birds were subjected to all-night lights; a 40-watt bulb was the source of illumination. Some of the birds were allowed to run out-of-doors with enclosed shelters for housing. In other lots the breeders were confined to unheated poultry houses. In still other lots the breeders were confined with enough heat to keep the inside temperature above freezing.

Results in 1939 and 1940 were substantially the same. In 1940 from January 5 to April 5 the birds confined to houses produced an average of 26 eggs per hen while the breeders on range produced only an average of six eggs per hen. The feed consumption was considerably greater for the birds on range.

During this period in 1940 the confined birds produced 7.3 poults per bird. Birds allowed to run out-of-doors produced 2.3 poults per bird (Fig. 11). There were no significant differences in the hatchability

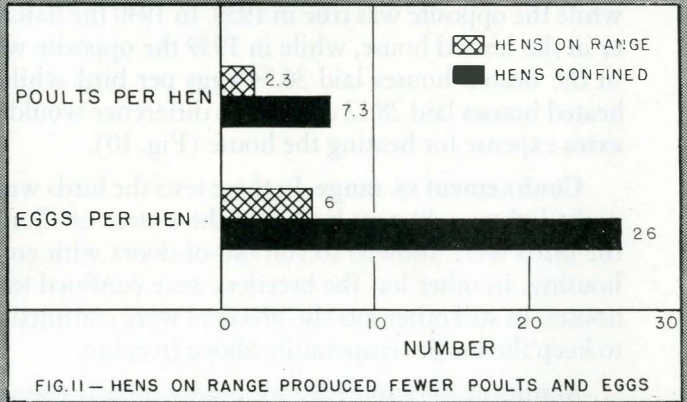
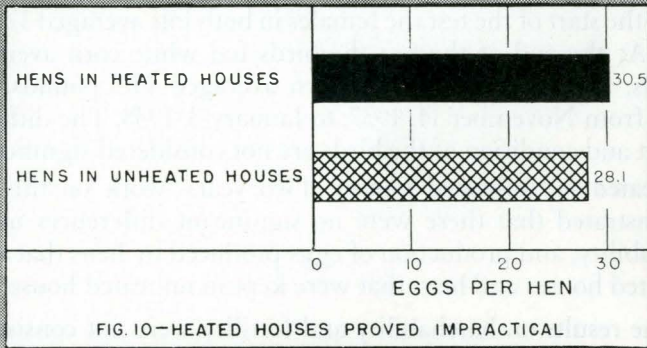
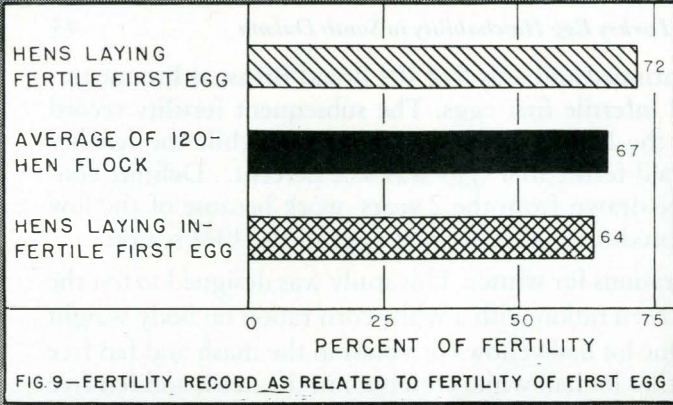


Fig. 9 is based on results obtained in 1943 (See page 12)

Fig. 10 shows 1939 and 1940 results. (See page 13)

Fig. 11 gives results obtained in 1940 (See page 13)

of eggs from the confined and the range breeders. Fertility was considerably higher in the range breeders each year.

The feed consumption records are as follows:

	AVERAGE FEED PER BIRD (January 5 to April 5)		
	Mash	Grain	Mash
	<i>lb.</i>	<i>lb.</i>	<i>perct.</i>
Heated houses	20.9	16.3	56.1
Nonheated houses	21.7	19.3	52.9
Range	16.0	36.4	30.5

Previous environment, egg production, and hatchability. Since very little investigational work has been done relative to the effects of rearing practices on egg production and hatchability, a study was designed in 1941-42 to test if any relationship existed. The winter test was started December 16, 1941, and ended April 20, 1942. All pens received the same mash, which was the control ration used in 1941. The breeders used in this test were grown to maturity under controlled growing conditions.

Starting April 21, 1942, and ending June 2, 1942, a continuation of this test was conducted, and in addition the breeders were allowed access to either green range or a yard free of vegetation. The results showed no significant difference between the lots on green range and the lots on bare ground (Table 2). The eggs from hens fed yellow corn hatched significantly better than the eggs from hens fed white corn.⁵ Further work on this subject is planned.

TABLE 2. EFFECT OF PREVIOUS ENVIRONMENT OF TURKEYS ON FERTILITY AND HATCHABILITY OF EGGS (1942)

Previous ration (growing)	Breeder ration (Dec. 16 to April 20)	Number of eggs set	Fertility	Fertile eggs hatched	Breeder ration (April 21 to June 1)	Number of eggs set	Fertility	Fertile eggs hatched
Yellow corn, no range	No green feed	516	70.93	63.93	Bare ground	445	67.4	55.3
Yellow corn, and range	Silage, wet mash	644	75.31	69.28	Rye, alfalfa	541	46.7	41.5
White corn, no range	No green feed	608	66.28	55.09	Bare ground	509	61.2	45.8
White corn, and range	Silage, wet mash	612	71.90	65.45	Rye, alfalfa	641	51.7	45.7
Yellow corn, and range	No green feed	522	64.56	50.74	Rye, alfalfa	392	57.3	38.2
Yellow corn, and range	No green feed	707	86.85	75.90	Rye, alfalfa	639	76.9	70.1

⁵ Both the difference between the lots on bare ground and the lots on green range and differences between the lots on white and yellow corn were analyzed by the analysis of variance, and individual hatchability records were used. The percentages were transformed into arc sine as described by Baten and Henderson.

Nutrition of Turkeys

Restricting grain for breeders. In cold weather turkeys prefer grain to mash. The mash contains the proteins, minerals, and vitamins necessary for hatchability.

The purpose of this test was to determine if hatchability could be increased by restricting the length of time birds had grain before them.

TABLE 3. FEED CONSUMPTION PER BIRD WITH DIFFERENT FEEDING METHODS (1939)

Feeding method	Mash	Grain	Total	Mash	Fertility	Hatch-
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>perct.</i>	<i>perct.</i>	<i>perct.</i>
Grain restricted (outside)	20.5	33.1	53.6	38.3	80.0	41.0
Grain unrestricted (outside) ..	11.5	39.7	51.2	22.4	79.3	50.7
Grain restricted (housed)	23.2	14.4	37.6	61.7	56.3	44.4
Grain unrestricted (housed) ..	19.2	21.4	40.6	47.3	53.0	52.9

In the restricted grain-fed lots the hopper feeding of corn was limited to a 30-minute period daily beginning at 4 p.m.

The 1939 test indicated that feeding turkey breeders a restricted grain diet was no more advantageous than feeding in the conventional hopper method. There appeared to be no great differences in total grain and mash consumption. However, the birds on the restricted grain diet consumed about 15 percent more mash than those not restricted. There were no significant differences in fertility and hatchability (Table 3).

All-mash rations. Two lots of 25 turkey breeders each were fed all-mash rations. Grain was hopper-fed in four control lots. No differences were noted in body weight. Differences in fertility and hatchability were not significant (Table 4).

Data secured from these tests indicate that methods of feeding mash and grain are not so important as either the constituents of a mash or the breeding and reproductive ability of the breeders. The egg production was slightly lower in the all-mash lots for the first period, starting January 4 and continuing to April 19.

Concentrate for breeders. A ration consisting of 32-percent protein concentrate fed free choice with yellow corn, oats fed free choice, and liquid buttermilk, resulted in fewer hatchable turkey eggs than the control ration containing 25 percent protein.

The lot receiving concentrate had only 48.55 percent hatchability,

TABLE 4. EGG PRODUCTION, FERTILITY, AND HATCHABILITY WITH VARIOUS RATIONS (5 HATCHES) (1941)

Ration	Eggs per hen	Number of incubated	Fertility	Hatchability*	
				of 5 hatches	of last 3 hatches
			<i>perct.</i>	<i>perct.</i>	<i>perct.</i>
Native Hens and Broad Breasted Toms					
Control ration	41.4	821	75.5	69.2	64.0
USDA all-mash formula, Washington feeds.....	38.1	725	76.7	50.5	65.0
Control ration and silage	45.0	883	72.3	60.8	50.0
10% liver meal	42.2	839	73.5	65.2	60.0
USDA all-mash formula, S. D. feeds	36.5	716	75.7	66.6	65.0
Control ration and liquid buttermilk	36.0	672	77.7	64.4	60.0
Broad Breasted Hens and Toms					
10% fish meal and silage	47.2	754	63.3	49.3	44.0
10% liver meal and silage	35.8	622	72.4	52.2	50.0

* Hatchability with the Washington formula and feeds is not accurate for the five hatches because cod-liver oil was accidentally omitted in the ration for the first two hatches. For a more accurate record for the Washington formula and feeds, see the column to the extreme right for the last three hatches.

while the control lot had 59.04. The fertility of the lot fed concentrates was 71.49 percent and of the lot fed the control ration, 69.75 percent. Egg production was approximately the same.

The concentrate-fed birds consumed less than half of the amount of concentrate that the mash-fed birds consumed in the control ration. A concentrate must be fortified not only with proteins but with vitamins and minerals as well. The results of this test suggest that since the principal source of vitamins conducive to high hatchability is found in concentrate, the low consumption of concentrates may have been the contributing factor that caused low hatchability.

Liquid buttermilk. The results obtained in 3 years' work on the effect on hatchability of liquid buttermilk instead of water in the breeder ration do not warrant its recommendation. However, 1 year's work (1940) indicated a decided increase in egg production and, consequently, a higher average number of poults per hen for the lot fed liquid buttermilk.

The investigations in 1941 and 1943 showed no advantage in feeding liquid buttermilk. The test in 1943 gave lower hatchability in the lot fed buttermilk and 32-percent protein concentrate than in the lot fed the control ration. The fertility was slightly higher in the pen in which the birds received liquid buttermilk.

Flavin concentrate in breeder mash. This study was designed to test the effectiveness of a flavin concentrate ration with a normal vitamin content ration or one that had been giving fair success. In 1938 both rations gave practically the same fertility—89.06 percent for the control lot and 89.82 percent for the flavin-concentrate lot. The hatchability of fertile eggs from the control ration was 51.43 percent and from the flavin concentrate ration 63.83 percent. These results are significant.

In 1939 the effects of these rations were tested with breeding hens not confined but allowed free range. In the test there was no significant difference in hatchability of the eggs produced from the two rations.

Alfalfa silage. The results of 3 years' work indicate quite conclusively that the feeding of alfalfa silage to turkey hens does not increase egg production, fertility, or hatchability.

In 1939 a pit silo was constructed to preserve alfalfa for feeding as alfalfa silage. The alfalfa was cut during the early bloom stage and immediately processed into silage. Molasses was used as the preservative. Silage did not appear to be very palatable to turkeys. Chickens, on the other hand, seem to relish it. The feed consumption of a pen of 25 turkey breeders was only about 4 to 7 pounds of silage weekly.

Liver meal. Significant results were not obtained by an addition of 10 percent liver meal. Since liver meal is known to be higher in vitamin content, especially in vitamins of the B-complex, a study was made in 1941, starting January 4 and continuing through April 19, relative to the effect on hatchability of 10 percent liver meal in the mash.

In one test wherein Broad Breasted x Native hens were used and the liver meal tested against the regular control ration, the percent hatch of fertile eggs of the control ration was 69.2 while the percent hatch of the liver-meal lot was 65.4. A total of 1,660 eggs were set.

During this same period a comparison was made wherein Broad Breasted Bronze hens were used and the 10 percent liver meal in the mash was tested against 10 percent fish meal in the mash. The lot receiving the 10 percent fish meal had a hatchability of 49.3 percent while the 10 percent liver meal lot had a hatchability of 52.2 percent. A total of 1,376 eggs were set (Table 4).

Soybean oil meal. These tests were started in 1939. A 10 percent addition of soybean oil meal in the mash resulted in 9 percent increase in the hatchability of fertile eggs in all lots of birds having access to green range. There was practically no increase in egg production or fertility.

In 1940 tests were designed wherein lots of breeders were fed soybean oil meal in the mash in levels of 10 and 20 percent. The birds were housed in outside shelters and allowed free range. The test started January 4 and ended April 19.

The results indicated that 20 percent soybean oil meal would be satisfactory in the breeder ration. However, numbers in this test were small, and definite conclusions cannot fairly be drawn.

In 1943 so-called war emergency rations were tested using various levels of soybean oil meal in the mash. A mash consisting of 25 percent soybean oil meal gave slightly inferior hatchability to a mash containing 10 percent soybean oil meal and 15 percent meat scraps. A difference in hatchability of 4 percent was noted in these tests. However, with a 25 percent soybean mash fed to Beltsville White turkeys, the hatchability was 80.80 percent.

It would appear that soybean oil meal can be used as the principal source of protein in a turkey breeder mash up to 25 percent.

Feed consumption. Feed represents one of the major items of expense in the maintenance of a turkey breeding flock. The consumption of feed does not appear to be consistent by the month, but by the season the total feed intake is quite comparable as evidenced by feed consumption records over a period of years (Table 5).

The body weights of breeders vary throughout the season. The birds appear to reach their peak weight in February and from then on show a decline. The range in individual weight of native hens during 1941-43 was from 14.3 to 16.1 pounds; Broad Breasted Native Cross F₁ from 14.2 to 16.5 pounds; Broad Breasted Native Cross F₂ from 15.9 to 18.0 pounds; Pure Broad Breasted from 14.9 to 17.2 pounds. The Beltsville Whites for the last 2 years ranged from 9.0 to 11.2 pounds.

It should be pointed out that important vitamin and mineral elements necessary for hatchability are found in the mash and that since the comparative consumption of mash is low as compared to grain,

TABLE 5. RANGE IN MONTHLY FEED CONSUMPTION OF TURKEY BREEDERS PER BIRD (1941, 1942, 1943)

Month	Bronze Turkeys		Beltsville White Turkeys	
	Mash	Grain	Mash	Grain
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
January	1.86—3.98	14.83—16.26	0.75—2.09	11.89—12.73
February	3.03—4.30	12.83—13.51	1.78—2.74	8.22—10.80
March	2.71—4.12	11.46—13.45	1.44—3.16	9.17—13.20
April	2.83—4.06	11.72—15.27	2.09—3.21	8.19—11.98
May	2.08—5.48	13.99—15.85	1.06—3.80	9.97—11.69
Year	Seasonal Consumption (January through May)			
1941	17.45	71.45	*	*
1942	15.91	65.51	9.86	50.02
1943	17.33	72.37	12.26	57.82

*No Beltsville Whites

the mash should contain all the essential amino acids, minerals, and vitamins necessary for good hatchability. The protein content of the control rations used since 1940 in the experimental studies is about 25 percent.

Effect of origin of feed. In order to determine whether the origin of feed affected the hatchability of eggs, arrangements were made with the National Agricultural Research Center at Beltsville, Maryland, to ship prepared breeder mash to this station.

The test started January 4 and ended April 19, 1941. The lot receiving the USDA formula with Washington feeds hatched poorly the first two hatches. In the course of this test it was noted that the birds receiving the Washington feeds consumed an unusually large amount of oyster shell. The egg-shell texture also declined in quality quite rapidly, the egg shells becoming noticeably soft. It was discovered that cod-liver oil had been omitted through an error. When cod-liver oil was added, the shell texture improved and the hatchability for the last three hatches considerably improved. Starting April 19 the turkeys had access to green range.

These results (Table 4) indicate that the breeder ration prepared in Washington (which gave excellent results there) was no more efficient than the breeder ration composed of South Dakota feeds. It can also be noted that the strain of Broad Breasted hens and toms when mated together did not give as good hatchability as when Broad Breasted toms were used with native hens.

Amber cane. In 1943 a comparison was made between a standard control ration and one in which black amber cane comprised 19 percent of the mash and the sole scratch grain. Yellow corn was hoppersed in the control lot.

The results showed that the control ration was 4 percent more efficient in hatchability and 6 percent more efficient in fertility. From this test it would appear that amber cane may be slightly less desirable for a turkey breeder ration than yellow corn. However, definite conclusions cannot be made from a single year's work. Feeding trials are being continued.

Wheat germ oil. Each of the breeders including the toms, were given approximately 10.cc of wheat germ oil per day fed in the mash. In comparison with the control lot, this pen showed a 8.21 increase in fertility, and a 2.1 decrease in hatchability of fertile eggs. The average egg production per bird from January 4th to March 31st, 1940 in the control pen was 35.4 eggs per hen, while in the lot fed with wheat germ oil, the average number of eggs produced per hen was 31.5. Results are not considered conclusive.

TABLE 6. MASH RATIONS FORMULAS USED AS CONTROL (IN POUNDS)

Ingredients	1938	1940	1941	1941 (all-mash)	1942	1943
Yellow corn	32	33	20	30	20	25
Oats				20		
Wheat bran	15	15	15	5	15	15
Wheat middlings	15	15	15	23	15	14
Meat and bone scraps	15	15	15	4	15	15
Alfalfa leaf meal	10	10	10	*5	*10	*5
Soybean oil meal			10		10	10
Dried buttermilk	10	10	10	5	10	10
Sardine meal				3		
Salt	1	1		.5		
Cod liver oil†	2					
Fish oil conc. 400-D		1	½	½	½	½
Iodized salt mixture‡			1		1	2
Ground limestone			3½	4	3½	3½
Scratch grain:						
Yellow corn	X	X	X		X	X
Oats			X		X	X
Manganese PPM§	154	196	88	88	88	88
Oyster shell	X	X	X	X	X	X
Grit		X	X	X	X	X

* Dehydrated.

† Stearine 175 A.O.A.C. vitamin D units and 1,800 U.S.P. vitamin A units per gram.

‡ .015 percent potassium iodide.

§ Manganese PPM refers to the parts per million of manganese that were added to the mash.

The above breeder mash rations were used as controls in tests conducted. It should be pointed out that the 1941 mash mixture which is described as all-mash is not to be confused with the other wash mixtures in which scratch is fed in addition. A detailed summary sheet giving mash formulas used in the tests which are reported in this publication will be sent to those requesting it.

PRACTICAL RECOMMENDATIONS

Breeding

Select breeders from stock which has had high livability.

Select breeders that are well balanced and show early maturity as well as meat market requirements.

Test turkey breeders for pullorum disease. It may be necessary to test twice.

Pay considerable attention to high hatchability when buying new stock.

Avoid using excessively heavy toms.

Feeding

Feeding all mash rations to turkey breeders is becoming quite popular. A small amount of grain fed daily may be necessary in addition if weight goes down.

Providing succulent pasture during growing and breeding season will reduce feed cost as well as supplying nutrients that may be lacking in the ration.

Many successful operators provide third or fourth cutting leafy alfalfa hay to the breeders.

Mash should contain about 25% protein if grains are hopper fed.

According to the USDA the requirements for breeding stock are as follows: Expressed as proportion of total feed: phosphorus, 1%; calcium, 2.4%. Expressed as vitamins per pound of total feed, Vitamin A, 4720 I.U.; Vitamin D, 540 A.O.A.C. chick units; Vitamin G (riboflavin), 1250 gammas; and manganese 50 expressed in p.p.m. in total feed.

When whole farm grains are fed free choice breeders may eat only 25% mash. It may therefore be necessary to restrict grain in order to get sufficient mash consumption.

Grit and oyster shell should be kept before the birds all the time.

Management

Separate breeding pens by a solid partition at least 3½ feet high to prevent fighting of toms.

Prevent dirty eggs by using plenty of straw in the nests.

During freezing temperatures water with the chill removed should be provided.

Do not clip wings of breeding males.

Regular cleaning of the breeding pens is necessary especially if breeders are confined.

Place breeders under lights one month before onset of egg production is expected.

Do not hold eggs over 10 days and keep eggs at a temperature of between 50° and 60° F. with a humidity of 60 to 65 per cent.

Provide one male for every 12 hens.

Rotate males weekly or more often if fertility is low.

Equip all female breeders with saddles.

Select hatching eggs that weigh about three ounces with sound shells.

Place toms with hens at least three weeks before eggs are produced.

Break up broody hens as soon as detected.

Incubation

Turn eggs five times daily during first 24 days of incubation.

Keep a room temperature of between 70° and 75°.

Hatch turkey eggs separate from chicken eggs.

Do not hold eggs over 10 days.

Pipped eggs not hatching may be due to too high temperature in hatcher or insufficient moisture during incubation.

Poults hatching too early is usually an indication of too much heat during incubation.

Fumigate hatching compartment during and after each hatch.

Eggs being saved should be packed large end up.

Turn eggs daily while saving. See Figure 8.

Interpret all recommendations in light of local conditions.

Follow the latest directions of the manufacturer.

References

- Anonymous, University of Idaho Agricultural Experiment Station Bulletin 179, Pp. 1-47 (1931)
- Anonymous, University of Idaho Annual Report, Bulletin 197, P. 49 (1933)
- Baten, W. D., and Henderson, E. W., *A Method of Handling Rations by the Analysis of Variance*, Poultry Science 20:227-231 (1941)
- Goodearl, Geo. P., *The Effect of Temperature on the Hatchability of Turkey Eggs*, Bulletin 317, North Dakota Agricultural Experiment Station (1942)
- Insko, W. M. Jr., MacLaury, Donald W., and Baute, E. A., *Weight of Turkey Eggs in Relation to Hatchability*, Bulletin 449, Kentucky Agricultural Experiment Station, (1943).
- Insko, W. M. Jr., MacLaury, Donald W., and Ringrose, Arthur T., *Effect of Relative Humidity and Amount of Turning on Hatchability of Turkey Eggs and Liveability of Poults*, Bulletin 438 Kentucky Agricultural Experiment Station, (1942)
- Marsden, S. J., and Martin, J. Holmes, *Turkey Management*, 2nd edition, The Interstate Publishing Co., Danville, Illinois (1944)
- Romanoff, A. L., *Influence of Incubation Temperature on the Hatchability of Eggs, Post-Natal Growth and Survival of Turkeys*, Journal of Agricultural Science 25, Pp. 318-325, Cornell University (1935)
- Titus, Harry W., U. S. D. A. Yearbook of Agriculture (1939)