SOME ECONOMIC ASPECTS OF TURKEY HATCHING EGG PRODUCTION IN WESTERN OREGON, 1949 WITH SPECIAL REFERENCE TO FERTILITY

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ERICK RONALD KALBERG

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APPROVED:

D. Curtis Mumford

Professor of Agricultural Economics

In Charge of Major

Frank Edmund

Head of Department of Agricultural Economics

Chairman of School Graduate Committee

Dean of Graduate School

Date thesis is presented May 15, 1951

Typed by Mrs. Fred Frick

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SOME ECONOMIC ASPECTS OF TURKEY HATCHING EGG PRODUCTION IN WESTERN OREGON, 1949 WITH SPECIAL REFERENCE TO FERTILITY

INTRODUCTION AND BACKGROUND

SOURCE OF DATA. The information upon which most of this thesis is based came from 77 personal interview survey records taken in the fall and winter of 1949-1950 by the Department of Agricultural Economics, Oregon State College. The main purpose of the Department's project was to obtain the cost of producing a turkey hatching egg from Broad Breasted Bronze turkeys in Oregon for the 1949 season. The project leader of this survey was Professor D. Curtis Mumford, who was assisted by two assistants, Gilbert Dyer, senior, and the author. The author spent a great deal of time helping prepare field schedules, office sheets, taking records and assisting in some of the analysis of the records. The opportunity of assisting in these various phases of the work has been a great aid in preparing this paper and has given considerable knowledge on how to conduct a research project.

This survey was conducted by the Department of Agricultural Economics with the Department of Poultry Husbandry cooperating. It was made at the request of the Oregon Turkey Improvement Association, an organization of turkey producers whose aim is to further develop turkey production and the consumption of turkey meat through the "Eat More Turkey Plan."

WHY THE NEED FOR NEW DATA. The Oregon Turkey Improvement Association and other people interested in the state's turkey industry felt that the data obtained 17 years ago in 1933 by the Department of Farm Management, published in the Oregon Agricultural Station Bulletin

Number 333 entitled "Cost of Producing Turkey Hatching Eggs in Oregon," was out of date and somewhat inadequate because of several reasons:

1. Newer methods of handling breeders and market birds (which is the only outlet for hatching eggs) have resulted in larger flocks and more birds per man.

2. Newer marketing methods which have helped bring about an increase in turkey meat consumption.

3. Competition from other states: California, Texas, Michigan, Minnesota, etc., which means Oregon must produce eggs as economically as other states.

4. Competition from other meats: fryers, broilers, hams, etc.

5. Turkey producers wanted some newer information available to help set egg prices with the hatcheries.

6. Increase in body weight of birds and increase in eggs per hen.

STATUS OF OREGON'S POULTS AND EGGS. Oregon-produced eggs and poults have a high standing among turkey producers in other states because of:

1. Good vitality

2. Freedom from certain diseases

3. Good market uniformity

4. Oregon turkey producers helped considerably in the improvement of the Broad Breasted Bronze. The Broad Breasted Bronze is the most popular variety in the United States mainly because of the ability of this strain to utilize feed to better advantage than the smaller birds (see Tables 1 and 2). The housewife, hotel and restaurant trade have been willing to take the larger birds, but at the present time

the family consumption of the smaller birds is growing very rapidly. The breeders of the Broad Breasted Bronze may have to develop a smaller bird if they plan to hold the spotlight for the family turkey.

Table 1. AVERAGE WEIGHT IN POUNDS, BOTH SEXES

Age in weeks	Broad Breasted Bronze	Beltsville White small type
4	1.2	0.7
8	3.4	2.2
12	6.7	4.4
16	10.3	6.9
20	14.1	9.2
24	17.5	11.2
28	20.1	

Source: (18, p. 38)

Table 2. FEED CONSUMPTION AND EFFICIENCY AS INFLUENCED BY AGE

Age in weeks	Lbs. feed consumed per bird		Lbs. of feed per lb. of gain	
	B. B. B.	Beltsville White small type	B. B. B.	Beltsville White small type
1-4	1.6	1.7	1.5	3.0
5-8	5.1	4.2	2.3	2.8
8-12	8.7	6.6	2.6	3.0
13-16	12.6	9.7	3.5	4.0
17-20	15.8	11.6	4.2	5.1
21-24	19.1	13.5	6.0	6.8
25-28	23.4	---	8.5	---
1-24	62.9	47.3	3.6	4.2
1-28	86.3	---	4.3	---

Source: (18, p. 38)

As shown in the above tables, the Broad Breasted Bronze is a much more efficient utilizer of feed than the smaller turkey. Up to 24 weeks of age the smaller turkey consumed 0.6 of a pound more feed than the Broad Breasted Bronze per pound of gain. This more efficient utilization of feed by the Broad Breasted Bronze has helped to put the turkey on the table.

WHY CONSUMPTION OF TURKEY MEAT HAS INCREASED. The demand for turkey hatching eggs is directly related to the demand of market turkey producers who in turn are dependent upon the per capita consumption of turkey meat. There is no other outlet for turkey hatching eggs as there is with chicken eggs.

There are several things which are probably responsible for the increase in the consumption of turkey meat:

1. Lower costs of production
    a. Sanitation and disease
    b. Nutrition
2. Breeding of better quality and more uniform birds
3. Advertisement
4. Relationship of turkey meat price to other meats
5. World War II; shortages of meats and high national income
6. New methods of handling, wrapping, and freezing turkeys
7. Turkey meat is nutritious and palatable.

1. Lower costs of production

a. Sanitation and disease prevention. A dead bird results in about three losses; (1) the loss of the turkey itself, (2) feed up to time of death and rearing costs, (3) an opportunity to make a profit (23, p. 608). A disease called "blackhead" which raised havoc with the turkey industry a few years ago and put many turkey producers out of business, was controlled through sanitation and has enabled producers to raise much larger flocks. Testing for pullorum has reduced early poult mortality considerably. Fowl pox vaccination has helped reduce

flock losses. These are just a few measures which have helped lower the cost of turkey production and develop the turkey industry.

b. Nutrition. Better knowledge of vitamins and minerals required by the poult has helped cut down losses in poults and increase the hatchability of eggs.

The knowledge of amino acids, minerals, and vitamins contained in various grains and meals has enabled turkey producers to feed a better balanced ration and along with the knowledge of the requirements of the growing poult, have made possible the raising of birds in confinement and larger flocks on range. Research work on the keeping qualities of various vitamins and nutrients has helped give better rations.

L. A. Wilhem, and others, in 1947 fed 200 units of Vitamin D, and sunshine was supplied, to turkeys previously deprived of Vitamin D, with the result of a marked increase in egg production and hatchability. Soft-shelled eggs were inversely related to the level of Vitamin D fed, (32, pp. 565-569). Manganese deficiency in the diet of breeding stock produces high embryo mortality and in diets of poults and chicks it causes slipped tendon according to results obtained at the Kentucky Station (22, p. 459).

It has been found through research that in poultry, Vitamin A is necessary for growth, reproduction, hatchability, and health (22, p. 464).

The elimination of certain fish oils from the growing and finishing rations during the last 10 to 12 weeks before marketing has given better-tasting birds. Pennsylvania State College and the United States Department of Agriculture Research Center showed that fishy flavor from

certain fish meals will remain in the bird's body as long as 11 weeks (22, p. 440).

These are just a few of the accomplishments in the field of nutrition which have given a cheaper and better quality bird to the consumer and helped increase the per-capita consumption of turkey meat.

2. Breeding of better quality and more uniform birds. This has helped Oregon producers get a premium on the eastern markets for a number of years. Oregon-grown Broad Breasted Bronze turkeys are very well liked in the eastern markets because of the excellent fleshing and finish. This has come about through efforts of the Oregon Turkey Improvement Association. Well-fleshed, early-maturing birds are picked for breeders, which means in the eyes of the consumer a better-looking bird and cheaper costs for the producers.

Figure 1 below shows top grade toms and hens commonly raised in Oregon about 10 years ago. Compare these birds to the ones shown in Figure 2. These broad-breasted and well-finished birds have been made possible by selected breeding which has been an important factor in increasing the per-capita consumption of turkey meat.

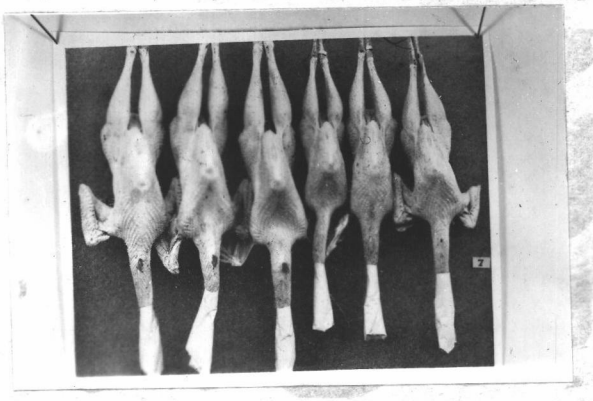

Figure 1. (Photo taken from 9, p.35)

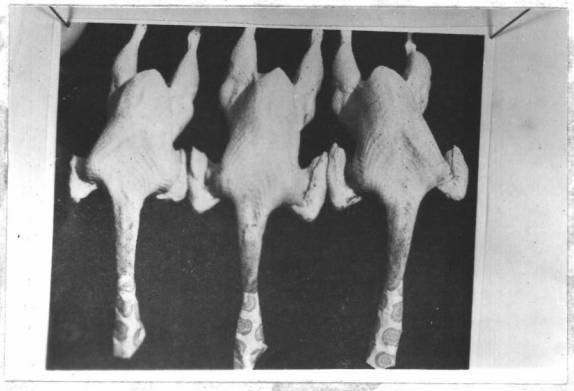

Figure 2. (Photo taken from 9, p. 36)

3. Advertisement. Great strides have been made by the "Eat More Turkey Plan." Under this plan, the producer gives voluntarily one cent per bird marketed. This fund goes to put on drives to put the turkey in the eyes of the consumer and develops hotel and restaurant trade. Turkey legs, steaks, halves, quarters, smoked, and canned turkey all have helped increase the consumption of turkey which in turn expands the market for turkey hatching eggs. Figures 3, 4, and 5 give examples of advertisements used to put the turkey before the people.

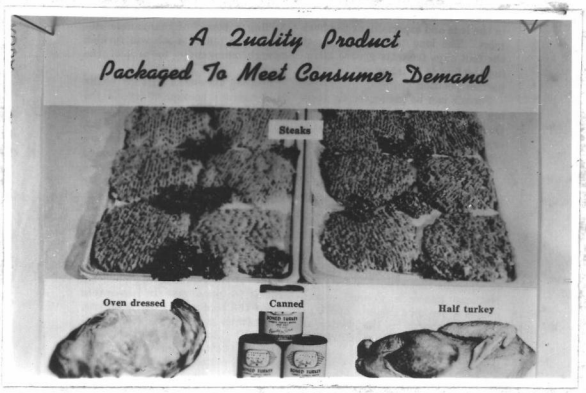

Figure 3. (Photo taken from 36, p. 17)

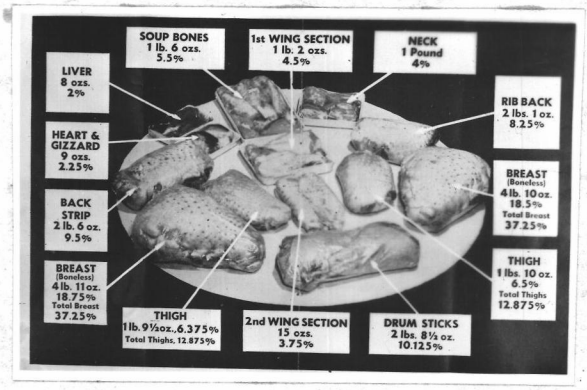

Figure 4. (Photo taken from 37, pp. 8, 9)

Figure 5. (Photo taken from 12, p. 29)

4. Relationship of turkey meat prices to other meats. Figure 6 using indexes with 1935-39 as the base period, shows the relationship of turkey meat price to other meat prices. During 1940-49 (except for the war years 1942-45) the price of turkey meat has been below the index of red meats (beef, veal, pork, lamb, and mutton).

During the war years of 1942-45, red meats were scarce and were put on a ration basis for the civilian. Poultry was not controlled for the civilian consumer. After the civilians used up their meat ration stamps, they turned to poultry meats and this created somewhat of an artificial demand which tended to raise the price of turkey meat and other poultry meat for this period (1942-45).

This difference in relative price of turkey to other meats has helped to increase the consumption of turkey the last few years.

5. World War II, shortages of meat and high national income. As indicated above, red meats were in demand by the military forces and were put on a ration basis for the civilian in the latter part of 1942. Poultry was not rationed. This had a tendency to make people more poultry-conscious and helped increase the consumption of poultry meat (Figure 8).

The national income has increased rapidly since 1940 and people have had more money to spend on food. In the years of 1942-45, the manufacturing of consumer goods was restricted. People could not spend their money for these things. Travel was cut down, gas rationed, building was restricted, so people unaccustomed to high income probably spent more money for food. This high income, the shortage and the rationing of red meats, and the fact that poultry was not rationed,

Figure 6

INDEXES OF FARM PRICE PER POUND OF LIVEWEIGHT FOR RED MEATS, CHICKEN, AND TURKEY FOR THE UNITED STATES, 1930-1949 PERIOD
(1935-39 = 100)

See footnotes given with data on the next page.

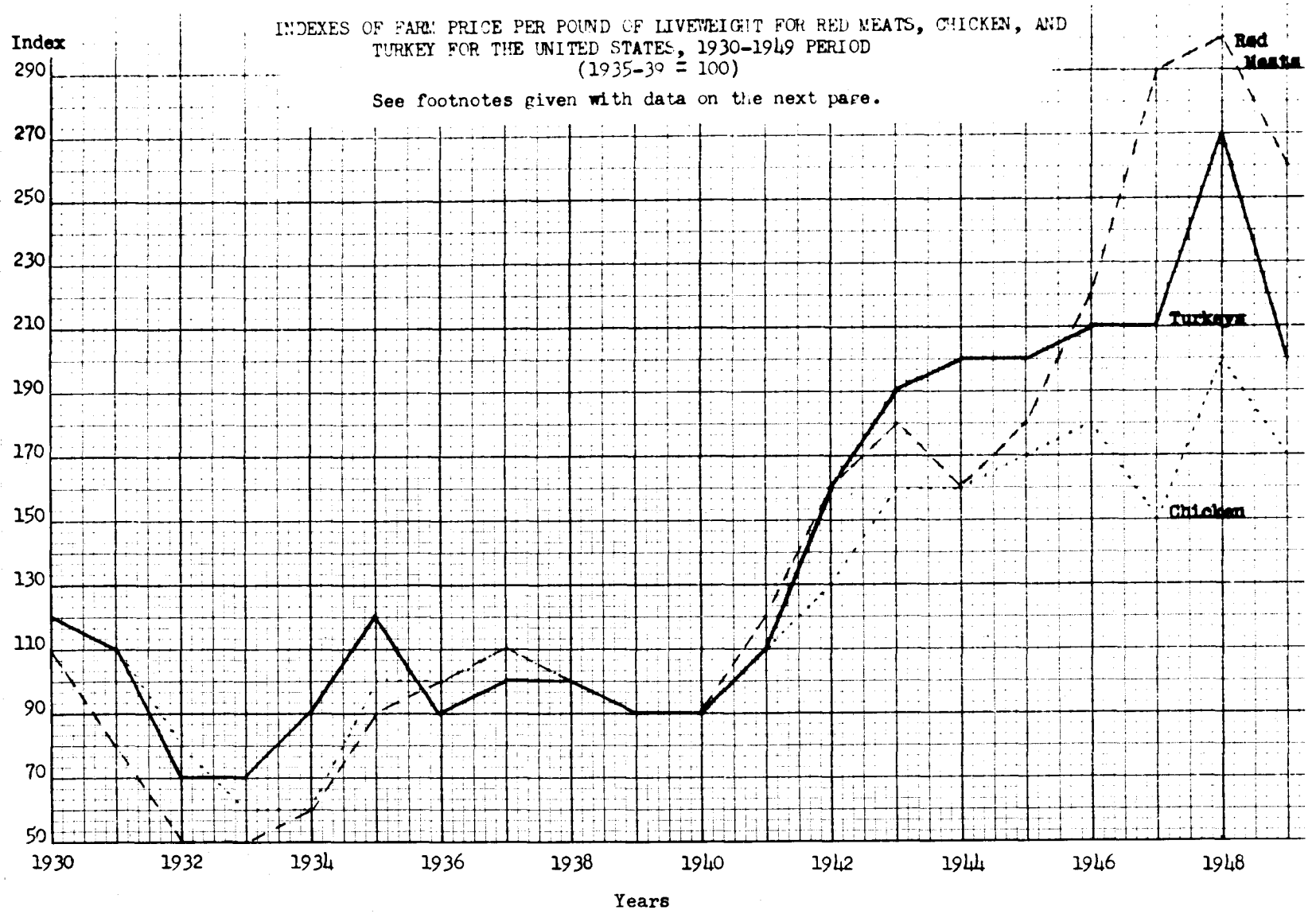

Table 3. INDEX AND FARM PRICE FOR POUND OF LIVE WEIGHT FOR TURKEY, CHICKEN, AND RED MEAT IN THE UNITED STATES, 1930-49 PERIOD (1935-1939 = 100)

year	Farm price per pound of live weight					
	Turkey		Chicken		Red meats	
	¢/lb.	index	¢/lb.	index	¢/lb.	index
1930	20.0	115	18.4	122	8.32	113
1931	19.1	110	15.8	105	5.67	77
1932	12.7	73	11.8	78	3.78	51
1933	11.6	67	9.5	63	3.73	51
1934	15.1	87	11.3	65	4.23	59
1935	20.1	116	14.9	99	7.21	98
1936	15.6	90	15.8	105	7.48	102
1937	18.1	104	15.9	105	8.22	112
1938	17.5	101	15.4	102	7.16	97
1939	15.7	90	13.5	89	6.75	92
1940	15.4	88	13.2	87	6.49	88
1941	19.9	114	15.8	105	9.01	122
1942	27.5	158	19.0	126	11.81	160
1943	32.6	187	24.5	162	12.93	176
1944	34.0	195	24.0	159	12.13	165
1945	33.6	193	26.1	173	13.04	177
1946	36.2	208	28.0	185	16.01	217
1947	36.4	209	26.8	154	21.15	287
1948	46.7	268	30.6	203	22.55	306
1949	35.1	202	25.7	170	19.18	261
1935 - 1939	17.4	100	15.1	100	7.36	100

Source: (31, pp. 352, 365, 380, 451, 467)

all probably helped considerably to increase the per-capita consumption of turkey meat (Figure 8).

6. New methods of handling, wrapping, preparing, and freezing turkey. In the past few years, great progress has been made in handling and preserving turkey meat. Modern quick freezers, eviseration plants under government inspection, use of plastic bags and aluminum foil for preserving turkey in freezers all have helped give a better-tasting turkey to the consumer.

Specialities like smoked turkey, turkey legs, burgers, steaks, quarters, halves (Figures 3, 4, and 5) help to increase per-capita consumption of turkey. Figure 7 shows the use of plastic bags and a freezer display counter. Plastic bags tend to reduce freezer burns and are transparent which enables the consumer to see the product which he is buying.

Figure 7 (Photo taken from 11, p. 13)

PER-CAPITA CONSUMPTION OF TURKEY. The per-capita consumption of turkey in 1949 increased to 228 per cent of the 1930 per-capita

INDEXES OF PER-CAPITA CONSUMPTION OF RED MEATS, CHICKEN, TURKEY, AND DISPOSABLE INCOME FOR THE UNITED STATES, 1930-49 PERIOD
(1935-39 = 100)

See footnotes given with data on next page

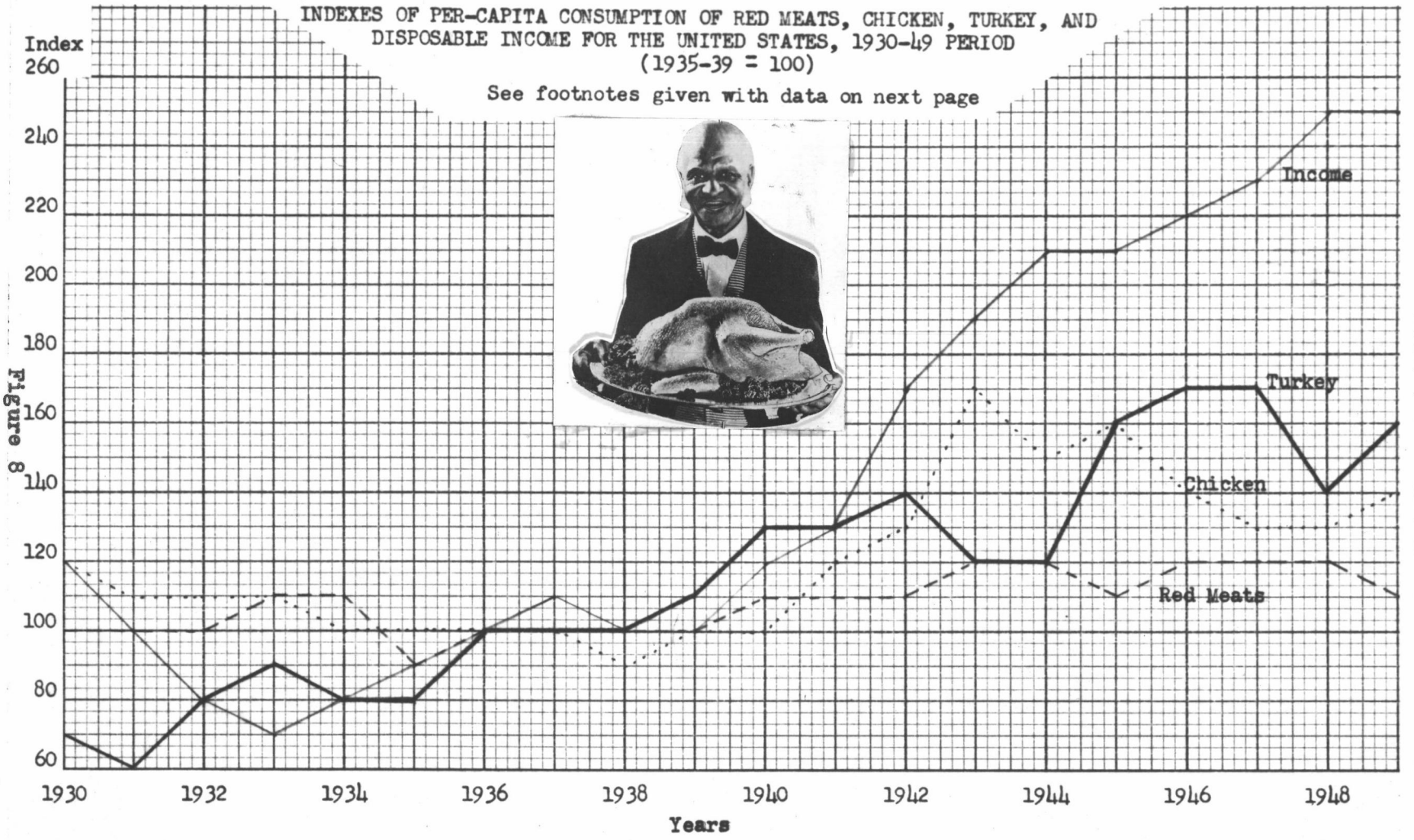

Figure 8

Table 4. INDEX AND PER CAPITA CONSUMPTION IN POUNDS OF MEAT, CHICKEN, TURKEY, AND DISPOSABLE INCOME IN THE UNITED STATES, 1930-49 (1935-39 = 100)

	Meat 1/		Chickens 2/		Turkeys 3/		Income 4/	
year	pounds	index	pounds	index	pounds	index	$	index
1930	128.3	102	21.5	120	1.8	68	595	117
1931	129.9	103	19.4	108	1.7	64	505	99
1932	130.2	103	19.7	110	2.1	80	381	75
1933	135.3	107	20.3	113	2.4	91	358	70
1934	143.1	113	18.8	105	2.2	83	406	80
1935	116.7	92	18.1	101	2.1	80	453	89
1936	129.8	103	18.1	101	2.7	102	513	101
1937	125.4	99	18.0	101	2.7	102	548	107
1938	126.2	100	16.8	94	2.7	102	501	98
1939	132.8	105	18.7	104	3.0	114	533	105
1940	141.7	112	18.7	104	3.5	133	570	118
1941	142.8	113	20.6	115	3.5	133	686	134
1942	139.5	111	23.4	131	3.7	140	862	169
1943	146.0	116	30.5	170	3.3	125	964	189
1944	153.5	122	26.8	150	3.3	125	1058	207
1945	144.4	114	28.8	161	4.3	163	1076	211
1946	153.4	122	25.4	142	4.5	170	1113	218
1947	155.0	123	23.6	132	4.5	170	1187	233
1948	146.4	116	23.0	128	3.7	140	1285	252
1949	143.9	114	25.2	141	4.1	155	1256	246
1935 - 1939	126.2	100	17.9	100	2.6	100	510	100

1/ Beef, veal, lamb, mutton and pork

2/ Approximately at wholesale level of distribution

3/ Dressed weight approximately at wholesale level of distribution

4/ Personal income per capita with taxes deducted

Source: (33, p. 72), (32, p. 15), (Photo taken from 18, p. 1)

consumption. Figure 8 using indexes with 1935-39 as the base period, shows the per capita consumption of turkey meat to other meats. The 1945-49 per-capita consumption of turkey meat was 62 per cent greater than the 1935-39 prewar per-capita consumption. On the other hand the 1945-49 per-capita consumption of red meat was only 18 per cent greater than the 1935-39 prewar per-capita consumption. Turkey meat consumption is increasing and the market for turkey hatching eggs will expand only as the per-capita consumption of turkey meat increases.

TURKEY AS AN EFFICIENT UTILIZER OF FEED. Where does the turkey rank as an efficient utilizer of feed? Information obtained from Martin and Marsden states that the turkey ranks high as an efficient utilizer of grains and animal products, and therefore has its place in furnishing protein to the consumer (24, p. 1).

Table 5. POUNDS OF FEED PER POUND OF GAIN FOR VARIOUS ANIMALS

Animal	Pounds of feed per pound of gain
2.5 lb. chicken broiler	3.5
3 to 3.5 lb. chicken fryer	3.5 to 4.0
Market turkey, 28 wks	4.0 (5 without range)
Young rabbit	5.5
200 lb. hog	5.5 to 6.0
8 lb. capon, chicken	7.0 to 8.0
Spring lamb	11.0
Baby beef	12.0

Source: (24, p. 1).

Of course, it must be remembered that some of these animals use cheaper feeds and generally sell at a lower price per pound of live weight when marketed.

TURKEYS IN OREGON. The cash income from farm sales of turkeys in Oregon for 1949 was $9,927,000 (34, p. 6). This figure does not include sales from poults and eggs. No published information is available for income from turkey eggs and poults. Seventy-seven flocks showed that a hen made a cash income of about $16.78 (33.64 cents per egg and 49.9 eggs per hen). Oregon Turkey Improvement Association figures for 1949 showed 268,996 birds were kept for breeders of which 12.2 per cent (or 32,718) were toms (according to 77 survey records on Oregon flocks). This leaves 236,278 hens which if multiplied by $16.78 gives an additional $3,964,745. which would give a total cash income from farm sales of $13,891,745. from turkeys in 1949.

The data in Table 6 show cash income from farm sales of ten leading states in the United States producing turkeys.

INCOME FROM TURKEYS COMPARED TO THE TOTAL AGRICULTURAL INCOME OF OREGON. Approximately 4 per cent of the total agricultural income in Oregon in 1949 was from turkeys (including hatching eggs). Thirty-nine per cent of the income from poultry in 1949 was from turkeys (using the adjusted figure).

The data in Table 7 give an idea of the place of turkeys in the income from poultry and the income from all agricultural products in Oregon, 1940-49.

Table 6. TURKEYS; CASH INCOME FROM FARM SALES, BY STATES, 1939-1949*

(Farm sales expressed in thousands of dollars)

1939		1940		1941		1942	
Calif.	$7,456	Calif.	$8,826	Calif.	$12,231	Calif.	$19,430
Texas	6,655	Texas	7,281	Texas	9,232	Minn.	14,076
Minn.	6,578	Minn.	6,965	Minn.	9,003	Texas	12,635
Oregon	4,328	Oregon	4,353	Oregon	5,654	Oregon	9,553
Iowa	3,794	Iowa	4,326	Iowa	5,463	Iowa	9,253
N. D.	2,959	Mo.	3,429	Mo.	4,163	Utah	6,018
Okla.	2,818	N. D.	3,243	Utah	3,743	Mo.	5,680
Penn.	2,603	Penn.	2,772	Penn.	3,569	Wash.	5,424
Mo.	2,592	S. D.	2,702	N. D.	3,468	Penn.	4,784
Utah	2,294	Okla.	2,507	Wash.	3,186	N. D.	4,722

1943		1944		1945		1946	
Calif.	$22,272	Calif.	$29,201	Calif.	$39,918	Calif.	$35,221
Texas	15,308	Texas	17,081	Texas	21,302	Minn.	28,105
Minn.	12,803	Minn.	17,021	Minn.	20,496	Texas	21,417
Oregon	12,374	Iowa	14,247	Oregon	19,218	Iowa	21,383
Iowa	9,255	Oregon	13,892	Iowa	16,514	Oregon	14,116
Wash.	6,721	Utah	10,831	Utah	13,712	Utah	11,679
Utah	6,027	Mo.	8,425	Penn.	9,380	Mo.	10,822
Mo.	6,021	Wash.	8,178	Wash.	9,236	Ohio	10,651
Penn.	5,929	Penn.	7,167	Mo.	8,956	Wash.	9,695
Ohio	4,234	Ohio	5,345	Va.	7,119	Va.	8,165

1947		1948		1949	
Calif.	$29,618	Calif.	$41,367	Calif.	$46,227
Minn.	24,059	Minn.	24,272	Minn.	24,210
Texas	18,688	Texas	17,773	Texas	21,293
Iowa	18,803	Iowa	16,656	Iowa	19,281
Oregon	12,537	Oregon	11,477	Utah	11,077
Penn.	10,404	Penn.	11,114	Penn.	10,357
Mo.	8,677	Mo.	9,832	Oregon	9,927
Ohio	8,496	Ill.	9,058	Mo.	8,912
Wash.	8,299	Utah	8,906	Ind.	8,483
Utah	7,878	Wash.	8,811	Va.	8,173

Source: (34, pp. 6, 7)

* Does not include income from eggs or poults.

Table 7. TOTAL AGRICULTURAL INCOME AND POULTRY AND EGGS CASH RECEIPTS FROM FARM MARKETINGS, OREGON, 1940-1949.

Period	Chicken eggs (thous)	Chickens (thous)	Commercial Broilers 1/ (thous)	Turkeys 2/ (thous)	Misc. poultry 3/ (thous)	Total poultry (thous)	Total agric. (thous)
1940	$ 5,160	$1,506	$ 172	$ 4,353	$ ---	$11,191	$112,427
1941	7,463	2,213	298	5,654	---	15,628	151,204
1942	10,282	3,181	497	9,553	95	23,608	206,627
1943	14,280	5,336	835	12,374	118	32,943	263,409
1944	12,950	4,678	939	13,892	136	32,595	289,675
1945	14,749	5,108	1,445	19,218	219	40,739	328,302
1946	14,888	3,723	1,144	14,116	168	34,039	354,739
1947	17,395	4,077	1,150	12,537	4/	35,159 5/	385,078
1948	17,568	5,045	1,562	11,477	4/	35,652 5/	396,873
1949 P	16,368	4,011	1,515	9,927	4/	31,821 5/	363,563

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1/ Income includes value of consumption in household or producers, which is less than 1% of total production.

2/ Does not include income from eggs and poults

3/ Ducks, geese, and guineas

4/ Not available as of April, 1950

5/ Not including miscellaneous poultry

Source: (10 p. 12)

DISTRIBUTION AND PRODUCTION TRENDS OF TURKEYS IN OREGON. Turkeys are raised in all of the 36 counties in Oregon. From 1939 (first year that figures are available) until 1945 there was a steady increase in the number of birds raised in Oregon, the greatest increase being in the Willamette Valley. In the peak production year, 1945, there were 3,105,000 birds raised. Since that time there has been a tendency for turkey production to decline in this state, although the 1949 production was above 1947 and 1948.

Table 8 shows the number of turkeys raised by counties since 1939. The ten-year state average is 1,968,545 birds.

Table 8. ESTIMATED NUMBER OF TURKEYS RAISED BY COUNTIES, OREGON 1939-1949 1/
(Numbers expressed in thousands)

District 1	1939	1940	1941	1942	1943	1944	1945p	1946p	1947	1948	1949p
Benton	120	120	121	125	130	121	140	100	50	40	53
Clackamas	140	140	155	170	250	300	350	250	200	170	288
Lane	190	185	195	200	245	240	285	245	140	120	137
Linn	187	190	187	200	240	250	300	185	150	175	200
Marion	175	184	202	210	300	325	375	325	300	225	250
Multnomah	30	28	25	26	29	25	30	12	12	10	2
Polk	35	35	34	35	45	52	75	40	37	32	35
Washington	65	66	70	90	130	140	190	135	115	98	110
Yamhill	155	152	160	190	245	265	350	240	200	250	300
Total	1097	1100	1149	1246	1614	1718	2095	1532	1204	1120	1375
District 2											
Clatsop	.4	.4	.4	.2	.1	.1	.1	.1	.1	.1	.1
Columbia	23	23	23	25	26	27	30	20	20	15	13
Coos	12	5	5	5.5	6.1	6	5	5	3	3	2.5
Curry	.3	.3	.3	.5	1	2.4	2.5	2	.5	.5	.2
Lincoln	1.8	1.8	1.8	1.5	1.6	1.6	1	1.5	1	.7	.6
Tillamook	.5	.5	.5	.5	.6	.5	.6	.5	.4	.4	.3
Total	38	31	31	33.2	35.4	37.6	39.7	29.1	25	19.7	16.7
District 3											
Douglas	215	195	183	200	227	230	270	140	125	80	140
Jackson	61	60	55	55	55	51	85	50	40	34	55
Josephine	31	25	25	25	30	23	33	30	18	10	15
Total	307	280	263	280	312	304	388	220	183	124	210

(continued on next page)

Table 8. ESTIMATED NUMBER OF TURKEYS RAISED BY COUNTIES, OREGON 1939-1949 1/
(Numbers expressed in thousands)

District 4	1939	1940	1941	1942	1943	1944	1945p	1946p	1947	1948	1949p
Gilliam	5	4.7	4.7	4.5	4.4	3	3.1	1.5	1	1	1.2
Hood River	27	20.5	21.5	20	15	8	9	7	7	7	8
Morrow	13.5	13	11	11	10.5	10	18	10	9	8	3
Sherman	.8	.8	.8	1.6	3	2.5	3	2	3	2	.7
Umatilla	73	71	67	70	80	65	93	90	68	65	75
Wasco	10.5	10	9	12	12.5	11	12	10	8	7	3
Wheeler	2.4	3	3	2	1.5	1.4	2	1	.5	.4	.3
Total	132.2	123	117	121.1	126.9	100.9	140.1	121.5	96.5	90.4	91.2
District 5											
Baker	4	3.8	3.5	3.5	3	2.5	3	2.6	4	3.5	4
Malheur	7.5	6	5.5	6	5.5	5	8	4	6	5	5
Union	2.3	2.1	2	2	2.3	1.5	2	1.8	1.5	1.1	.8
Wallowa	3.2	3.1	3	2.7	3.3	1	1	1	1.5	1	1
Total	17	15	14	14.2	14.1	10	14	9.4	13	10.6	10.8
District 6											
Crook	4.5	4	3.5	3.5	4	4.5	4	3	3	1	1
Deschutes	115	115	105	120	110	98	150	100	91	90	50
Grant	8.6	8.8	9	11	13	9	12	10	3	3	2.5
Harney	1.5	2	2	1.8	2	1	2	1	.5	.5	.2
Jefferson	2.4	2	1.8	2.5	3	2.5	5	2	1.5	1.5	.3
Klamath	38	27.5	30	30	20	14	25	20	18	14	12
Lake	.8	.7	.7	.7	.6	.5	1.2	1	.5	.3	.3
Total	170.8	160	152	169.5	152.6	129.5	199.2	137	117.5	110.3	66.3
State Total	1762	1709	1726	1864	2255	2300	2876 2/	2049	1639	1475	1770

p Preliminary

1/ County estimates prepared by Oregon State College Extension Service and adjusted to state totals by the United States Department of Agriculture, Bureau of Agricultural Economics.

2/ Revised to 3,105,000 in March, 1947 by Bureau of Agricultural Economics

Source: (10, pp. 8, 14) (16, p. 10)

DISTRIBUTION AND PRODUCTION TRENDS OF BREEDERS IN OREGON. The average number of breeders kept for the 1940-1949 period in Oregon was 266,200. Breeder numbers increased until a peak number of 433,000 was reached in 1946. Since that time, there has been a tendency for the number of breeders to decline, but the number in 1949 was considerably higher than in 1948. There are no figures available, as far as the author could determine, on the leading states producing turkey hatching eggs.

Table 9 gives the trend in turkey breeders for the 1940-1949 period.

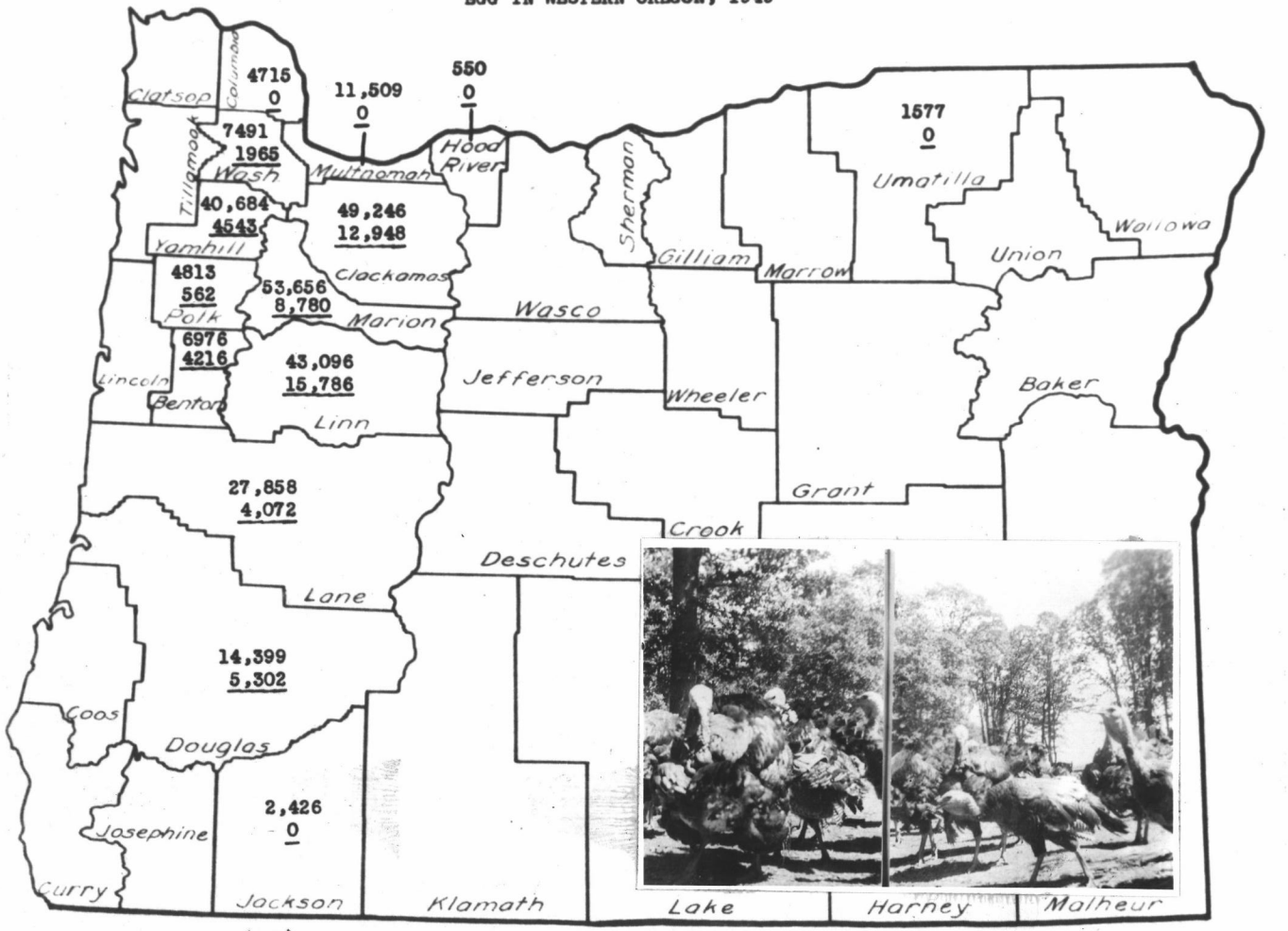
Table 9. TURKEYS RAISED AND BREEDERS KEPT IN OREGON, 1940-1949

Year	Breeders kept	No. of turkeys raised
1940	175,000	1,709,000
1941	131,000	1,726,000
1942	196,000	1,864,000
1943	235,000	2,255,000
1944	331,000	2,300,000
1945	420,000	3,105,000
1946	433,000	2,049,000
1947	299,000	1,639,000
1948	172,000	1,475,000
1949	270,000	1,770,000

Source: (10, p. 8), (16, pp. 8, 10)

In 1949, Oregon kept 268,996 breeders, according to figures taken from the Oregon Turkey Improvement Association. This number of birds was kept in 14 counties. The map in Figure 9 shows the distribution of all turkey breeder birds by counties, and the number of breeders included in the study. This information is summarized in Table 10.

DISTRIBUTION OF THE TURKEY BREEDER POPULATION AND SAMPLE TAKEN TO DETERMINE THE COST OF PRODUCING A HATCHING EGG IN WESTERN OREGON, 1949



Source: ~~(17)~~ (19)
(Figures underlined refer to birds considered in sample.)

Figure 9

Table 10. BREEDERS, 1949

County	Total no.	No. covered in survey	No. of flocks	Per cent fertility
Benton	6,976	4,216	5	74.7
Clackamas	49,246	12,945	22	72.4
Columbia	4,715	---	---	---
Douglas	14,399	5,302	6	74.8
Hood River	550	---	---	---
Jackson	2,426	---	---	---
Lane	27,858	4,072	7	73
Linn	43,096	15,786	16	72.4
Marion	53,656	8,840	11	71.6
Multnomah	11,509	---	---	---
Polk	4,813	562	1	80
Umatilla	1,577	---	---	---
Washington	7,491	3,482	2	75.8
Yamhill	40,684	4,543	7	71.4
Total or Aver.	268,996	58,174	77	71.3

Source: (19)

Along about 1935, the turkey hatching egg industry began to get under way in Oregon. The Willamette Valley has been the area of greatest growth of turkey breeders. The average size of flock has increased from 159 birds in 1934 to 756 birds in this study in 1949.

It was found in this study that 81 per cent of the 77 operators kept market birds as well as breeders. It was estimated that 30% of the labor on the farms studied was used on market birds and about 30% on breeders. The remainder (40%) was used on other livestock and crops.

METHODS USED IN PURCHASING TURKEY HATCHING EGGS. There are at least three methods used in buying turkey hatching eggs, as follows:

1. On a 75 to 80 per cent minimum fertility guarantee
2. On fertile eggs only
3. On live poult basis

1. On a 75 to 80 per cent minimum fertility guarantee. With this method, the hatcheryman pays for eggs meeting this requirement; i. e., if 75 or 80 eggs (whichever the minimum may be) out of 100 eggs are fertile, the grower gets the said price for all 100 eggs; but if the fertility is higher, the producer gets no additional payment. However, if he runs under the minimum, he is docked for each fraction of a per cent under the minimum. The producer is paid for each shipment separately. The high percentages (above the minimum) at the beginning of the season do not get a chance to balance out the low ones later in the season.

2. On fertile egg basis. This is similar to the 80 per cent minimum guarantee except payment runs about 20 per cent higher on the fertile eggs.

3. On live poult basis. The producer is paid on a said price for each live poult. Difficulty arises in keeping each producer's poults separate in the hatchery during the hatching period; the hatching egg producer assumes losses due to hatchery management.

HOW THE PRICE OF A HATCHING EGG IS DETERMINED. Because there is no demand for turkey hatching eggs other than for poults, the producer is dependent upon the hatcheryman and market turkey producer for his outlet.

The price of hatching eggs is based on what the hatcherymen think they can sell the poults for in the spring. The price of a poult is usually about 2 1/2 times the price of an egg. The price will depend on the demand for poults by market bird producers which is influenced by the number of pounds of turkey in storage, national income

(purchasing power of the consumer), accessibility of credit, feed-turkey meat ratio, price of other meats and poultry, and the profitability of alternative enterprises. The demand for poults can go either way depending upon the above factors and the hatching egg producer will gain or lose depending upon the poult demand. Once the egg producer has committed himself, he has to keep producing as long as possible in order to get his costs back. During the laying season, the birds go down in grade, i. e., there are fewer grade A birds after the birds have laid than there would have been if they were marketed when finished out. Also if turkeys are plentiful, the processor tends to grade more birds down than he would if turkeys were scarce. There is also a mortality loss. These are some of the reasons why a producer must keep producing once he has kept over his breeding stock. Many an egg producer has suffered from a short season.

In 1949, there was a wide variation in price paid per hatching egg by the hatcheries. The prices that 77 producers received for their hatching eggs were as follows: 40 cents on 80 per cent minimum fertility, 37 cents on 80 per cent minimum fertility, 35 cents on 80 per cent minimum fertility, and 35 cents on 75 per cent minimum fertility.

LOSSES IN TURKEY HATCHING EGGS IN 1949. On the basis of this study, it is estimated that 17,131 cases of eggs, or 3,426,031 eggs out of a total of 11,813,900 hatching eggs produced in Oregon in 1949, were wasted because of being infertile. This would make up a train about 24 or 25 cars long. In terms of money, assuming a fertile egg to be worth about 47 cents (as found in the study of 77 producers), it would

represent a loss of $1,610,235 for Oregon turkey hatching egg producers in 1949. Figure 10 shows development of a germ at various stages of incubation, an infertile egg and a dead germ at 10 days of incubation. The dead germ at 10 days of incubation is called infertile by commercial hatcheries due to the method used in determining fertile and infertile eggs. Infertility as referred to in this study includes these early dead germs.

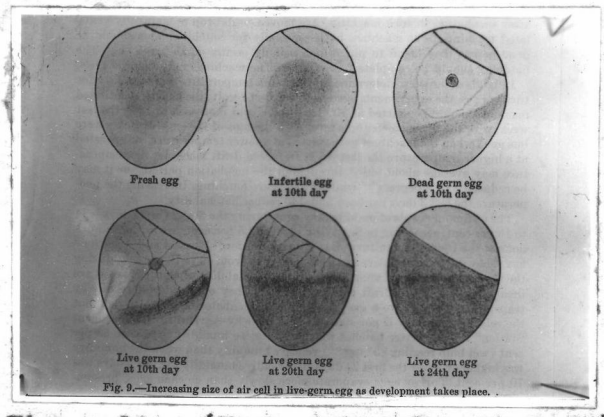


Fig. 9.—Increasing size of air cell in live-germ egg as development takes place.

Figure 10. (Photo taken from 4 p. 24)

EFFECTS OF FERTILITY ON RETURNS. Each year turkey hatching egg producers suffer a tremendous loss because of eggs not being fertile. To demonstrate this a little clearer, let us take an example: Holding all other factors constant but fertility, it can be seen from the figures in Table 11 how quickly a little decrease in fertility affects returns. In this case, we are assuming that the eggs were purchased on an 80 per cent fertility guarantee. It will be noted that the break even point from the standpoint of all costs occurs at 71.1 per cent fertility. The break even point, considering cash costs only, occurs at 60.8 per cent fertility.

RELATION BETWEEN FERTILE EGGS PER HEN AND PROFIT OR LOSS PER HATCHING EGG SOLD. Table 12 shows how many fertile eggs must be produced to make a profit.

Table 11. AN EXAMPLE SHOWING EFFECTS OF FERTILITY ON PROFIT OR LOSS PER 100 EGGS USING ALL COSTS AND CASH COSTS

No. of eggs set	Per cent fertility	Price/100 eggs 1/	Total cost of $32.88/ 100 eggs 2/	Profit or loss for 100 eggs	Cash cost of $28.13/ 100 eggs 3/	Price/100 eggs 1/	Profit or loss for 100 eggs 4/
100	85	$37.00	$32.88	$4.12	$28.13	$37.00	$8.87
100	80	37.00	32.88	4.12	28.13	37.00	8.87
100	75	34.69	32.88	1.81	28.13	34.69	6.56
Break even point considering all costs.	71	32.88	32.88	0.00	28.13	32.88	4.75
100	70	32.38	32.88	-.50	28.13	32.38	4.25
100	65	30.01	32.88	-2.87	28.13	30.01	1.88
Break even point considering only cash costs.	60.8	28.13	32.88	-4.75	28.13	28.13	0.00
100	60	27.75	32.88	-5.13	28.13	27.75	-.38
100	55	25.44	32.88	-7.44	28.13	25.44	-2.69
100	50	23.12	32.88	-9.76	28.13	23.12	-5.01
100	45	20.81	32.88	-12.07	28.13	20.81	-7.32
100	40	18.50	32.88	-14.38	28.13	18.50	-9.63
100	35	16.19	32.88	-16.69	28.13	16.19	-11.94
100	30	13.87	32.88	-19.01	28.13	13.87	-14.26
100	25	11.56	32.88	-21.32	28.13	11.56	-16.57

1/ $.37 per egg on 80% fertility

2/ All costs as determined by study, 77 flocks: 51,844 hens; 6,330 toms; 2,590,164 H. eggs. (Includes credit for cull eggs and manure)

3/ Cash cost per egg excluding operator's labor and unpaid family labor, depreciation on building and equipment and interest on Br., land, buildings and equipment and feed and supplies and manure credit.

4/ Compared to cash costs only. In this study, 85.5 per cent of all costs were cash costs.

Table 12. RELATION BETWEEN FERTILE EGGS PER HEN AND PROFIT OR LOSS PER HATCHING EGG SOLD, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Fertile eggs per hen	Number of flocks	Profit or loss per hatching egg sold	Return to operator per hr. of his labor
Fewer than 30	16	-4.04¢	$-.73
30-39	31	+ .76	+1.36
40-49	26	+4.24	+2.38
50 and more	4	+9.24	+4.16
All flocks	77	+ .76	+1.46

Source: (26, p. 4)

The number of fertile eggs per hen determines what the operator will get for his efforts. In 1949, it took about 35 fertile eggs per hen to break even, i. e., where returns equal all costs. Of the 77 flocks studied, the range in profit or loss per hatching egg sold was a loss of 4.04 cents to a profit of 9.24 cents. The return to the operator per hour of labor ranged from a loss of 73¢ to a gain of $4.16 per hour depending upon the number of fertile eggs per hen. The average return of the 77 flocks studied was $1.46 per hour to the operator for his labor and management, (26, p. 4).

FINDINGS AND DISCUSSION

ANALYSIS OF FERTILITY AS AFFECTED BY VARIOUS MANAGEMENT PRACTICES.

Nearly all of the operators of the 77 flocks used in the 1949 Oregon State College turkey hatching egg cost study sold hatching eggs on a certain minimum fertility guarantee. (Methods of purchasing turkey hatching eggs were discussed on pages 22, 23, and 24.)

Because fertility has been shown to be so very important from the standpoint of profit or loss in the turkey hatching egg business (p. 26) the following analysis deals with fertility and certain factors thought to affect it. Attempts will be made to elucidate why differences in fertility and some of its related factors and costs varied among the 77 flocks.

To analyze these relationships, the following factors thought to affect fertility were calculated:

1. Light days toms got before mating
2. Tom-hen ratio
3. Length of laying season in days
4. Length of holding period for eggs in days
5. Per cent protein in total feed
6. Pounds of feed per bird per day
7. Restriction of feed prior to mating
8. Feeding milk
9. Feeding alfalfa
10. Legume pasture
11. Date lights were turned off
12. Light days for hens

13. Age of toms when mating began
14. Age of hens when mating began
15. Size of flock
16. Per cent hired labor
17. Date of first egg
18. Rotation of toms
19. The crossing of strains
20. Dirty eggs
21. The washing of dirty eggs
22. Per cent mortality of toms
23. Per cent mortality of hens
24. Per cent mortality of flock

For quick analysis, Table 13 was constructed to determine whether or not any significant relationship existed between the degree of fertility in hatching eggs and the above-mentioned factors. The 77 flocks were sorted into four groups representing different degrees of fertility as indicated. Then for each fertility group, a simple average was calculated for each of the factors under consideration (Table 13). An examination of the data in this table would seem to indicate that none of the factors listed had a significant influence upon fertility. However, there would appear to be some indication that the flocks with the higher fertility (1) had shorter laying seasons, (2) were fed slightly less feed per bird per day, (3) were fed more milk, (4) were fed more alfalfa, (5) had fewer birds per flock, and (6) were fed breeder ration longer.

It is recognized, of course, that the data in Table 13 were sorted by "result" rather than by "causal" factors.

Table 13. VARIOUS MANAGEMENT AND FERTILITY FACTORS OF TURKEY HATCHING EGGS, WESTERN OREGON, 1949
(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

ITEMS	Per cent fertility			
	Under 70	70-75	75-80	80 & over
Number of flocks	20	24	22	11
Light toms got before mating, days	10.5	8.9	11.2	10.6
Length of laying season, days	130.8	121.3	120	120
Holding period for eggs, days	6.4	5.7	4.1	6.5
Per cent protein in total feed	15.8	14.5	15.2	16
Pounds of feed per bird per day	0.705	0.691	0.656	0.630
% that restricted feed prior to mating	35.0	20.8	27.4	36.3
Per cent that fed milk	50.0	50.0	54.5	63.6
Per cent that fed alfalfa	25.0	16.6	40.9	54.5
Per cent that had a legume in pasture	20.0	12	36	18
Date lights were turned off	3/28	3/18	3/30	3/15
Light days for hens	99	83	93	105
Age of toms when mating began	33	31	33	29
Age of hens when mating began	34	32	33	32
Size of flock	974	650	774	550
Per cent hired labor	32.4	9.0	22.6	21
Date of first egg	1/11	1/16	1/17	1/16
Per cent that rotated toms	10	25	14	18
Per cent that crossed strains	10	25	9	18
Per cent dirty eggs	19.9	14.0	13.7	17.2
Per cent that washed dirty eggs	80	91	54	90
Per cent mortality of toms	16.6	15.6	10.7	13.5
Per cent mortality of hens	5.5	6.5	5.5	5.5
Per cent mortality of flock	6.5	7.4	6.1	6.6
Breeding ration fed before mating, days	2.2	6.8	16.9	10.2

Therefore, the next step was to select a number of independent factors to see if they were correlated with fertility. A list was made of the 12 factors which were thought to have the greatest influence upon fertility. They were arranged in the order of importance, as follows:

1. Light days old when mating started (toms)
2. Tom-hen ratio
3. Length of laying season (days)
4. Holding period for eggs (days)
5. Per cent protein in total feed
6. Pounds of feed per bird day
7. Feed restricted pre-season holding period
8. Fed milk
9. Fed alfalfa
10. Legume in range
11. Light days during laying season
12. Per cent lay

It was decided to use the method of multiple regression and to determine which of the first six foregoing factors might be correlated with variations in fertility of turkey hatching eggs in the study. In this way it was possible to study each independent variable individually with the effects of the other five independent variables removed.

After the analysis had been completed, the significance of each partial regression coefficient was tested. None of the six proved to be significant. Therefore it would appear that there is nothing in the data obtained in this particular study of turkey hatching egg production to indicate that any of the six independent variables chosen

for this analysis had any significant influence upon fertility of the turkey hatching eggs produced.

The multiple regression analysis considered only six variables and it only considered fertility as the one dependent variable. However, there were several more factors which were thought to have an influence on fertility and furthermore it was desired to study the influence of numerous factors, including some of the six already considered, upon such items as egg production, rate of lay, cost, and returns.

Therefore, where it seemed practical, further analyses were conducted using fertility as a dependent variable and trying to relate it to a number of independent factors. Before discussing this work, however, the reader should be informed on the cost of production and other general characteristics of the 77 flocks studied. Table 14 shows the average cost of producing a hatching egg for all 77 flocks and for the flocks that fall within the four size groups: 100 to 400 hens, 400 to 700, 700 to 1000, and 1000 and over. Table 15 gives a listing of various practices and data of importance in producing a hatching egg. This table also shows the average for all flocks and for the same flock groups stated above. These two tables will be very helpful to the reader as he studies subsequent analyses presented herein because he can compare such findings with these average results of the 77 flocks used in the turkey hatching egg cost study before mentioned.

Table 14. COST OF PRODUCING TURKEY HATCHING EGGS, WESTERN OREGON, 1949 1/

(Based on 77 flocks; 58,174 birds, 2,590,164 hatching eggs)

Item	All flocks	Number of hens in flock			
		100-399	400-699	700-999	1000 & over
Number of flocks	77	19	35	16	7
Number of hens per flock	674	264	522	860	2113
Number of hatching eggs shipped per hen	49.9	55.6	53.5	50.0	43.6
Fertility of eggs set (per cent)	71.3	72.4	71.9	72.9	68.2
Cost of Production per hatching egg:	(cents)	(cents)	(cents)	(cents)	(cents)
Operator's labor, direct	2.53	4.29	3.64	1.84	.81
Operator's labor, indirect	1.17	2.66	1.26	.77	.82
Unpaid family labor	.67	1.06	.85	.74	.16
Hired labor	1.49	.30	.89	1.63	2.75
Total labor	5.86	8.31	6.64	4.98	4.54
Total feed	13.86	12.95	12.87	13.45	16.19
Total miscellaneous	1.34	1.34	1.31	1.30	1.43
Total Depreciation	12.40	10.74	10.37	12.16	16.43
Total interest	.65	.57	.59	.66	.79
Total gross cost	34.11	33.91	31.78	32.55	39.38
Total credit	1.23	1.07	1.18	1.26	1.33
TOTAL NET COST PER EGG	32.88¢	32.84¢	30.60¢	31.29¢	38.05¢
Total net cost per breeder bird	$14.64	$16.30	$14.59	$13.94	$14.79

1/ Source: (26, p. 2)

Table 15. TURKEY HATCHING EGG STUDY, 1949 1/
(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Item	All flocks	Average number of hens			
		100-399	400-699	700-999	1000 & over
Hens/flock (aver. no.)	674	264	522	860	2113
Toms/flock (aver. no.)	82	32	64	106	254
Tom-hen ratio	8.2	8.4	8.1	8.1	8.3
Total lbs. of feed/bird	128.5	128.2	128.2	128.8	128.6
Lbs. of feed/bird day	0.689	0.701	0.666	.671	0.736
% mash of total feed	52	54	59	45	50
% protein in total feed	15.1	15.1	15.5	14.7	15.1
Total hrs. of labor/bird	2.38	3.67	2.72	2.20	1.68
Labor/day/100 birds, hrs.	1.28	2.01	1.41	1.15	0.96
Date hens were hatched	5/13	5/10	5/50	4/30	6/3
Date breeder hens separated	11/16	11/15	11/7	11/8	12/4
Age, hens when selected, wks.	27	27	27	27	26
Breeder hens sold, date	5/20	5/17	5/18	5/18	5/27
Breeding season in days	186	184	193	192	175
Hens first lighted, date	12/25	12/24	12/23	12/18	1/3
Toms first lighted, date	12/13	12/15	12/10	12/7	12/23
Lights turned off, date	3/29	3/27	3/28	3/22	4/8
Lighting sea. for hens, days	95	94	96	95	96
Length of day, hours	14.4	14.2	14.2	14.8	14.5
Date mating started	12/24	12/23	12/21	12/20	12/31
Date laying started	1/19	1/13	1/15	1/14	2/1
Laying season in days	122	125	124	125	116
Per cent lay	43.9	47.2	46.2	42.8	40.9
Eggs laid/hen	53.6	59.0	57.3	53.5	47.4
Farm culls/hen	3.7	3.4	3.8	3.5	3.8
Hatching eggs/hen	49.9	55.6	53.5	50.0	43.6
Hatchery rejects/hen	1.2	1.1	1.1	1.1	1.5
Eggs set/hen	48.7	54.5	52.4	48.9	42.1
Fertile eggs/hen	34.7	39.5	37.7	35.6	28.7
Per cent fertility	71.3	72.4	71.9	72.9	68.2
Mortality of hens, %	7	5	4	9	8
Mortality of toms, %	14	15	13	16	14
Aver. deprec./bird	$5.20	$5.06	$4.67	$5.13	$5.94
Net profit or loss/egg, ¢	+.76	+.52	+2.21	+1.72	-2.37
Return to operator/hr.	$1.46	$1.23	$1.82	$1.75	-69¢

1/ Source: (26, p. 3)

A WORD OF CAUTION. It must be remembered as one compares one group to another within the various tables that are to follow that there were wide differences in depreciation, labor, feed required, and price received per hatching egg among the 77 flocks. The results shown in the following tables may not be too conclusive, but it is believed that they indicate trends or shed some light on different factors which perhaps should be confirmed by experimental work.

DATE OF HATCH. There seems to be, among turkey producers, a question as to when birds that are to be kept as breeders should be hatched, and also what effect the date of hatch has on fertility and cost per hatching egg. Experimental evidence by V. S. Asmundson in 1941 showed that late-hatched birds up to late June, laid at a younger age than early-hatched birds, and that early-maturing birds laid more eggs (3, pp. 51-56). He also found that hens hatched late in June matured later than those hatched in April or May.

The data presented in Table 16 show, especially for the first three groups, that the later the birds were hatched, the younger they were when they commenced to lay. The later the hens were hatched, (before June first) the earlier they matured. Not only that, but they also required less prelighting.

As will be shown later, there is a rapid decline in egg production and fertility in the late spring. Therefore, this group (May 16-31) was hatched late enough to miss a long "holding" period but yet early enough to have a good laying season before the seasonal declines in egg production and fertility became serious.

Table 16. EFFECTS OF DATE OF HATCH ON EGG PRODUCTION, FERTILITY, COST, AND PROFIT OR LOSS WESTERN OREGON, 1949

(Based on 72 flocks; 55,373 birds; 2,454,298 hatching eggs)

Date of hatch of hens	Flocks	Birds	Aver. size of flock	Date of first egg	Age at first egg	Light prior to laying	Rate of lay	Hatch. eggs per hen	Fertility	Net cost/ hatch. egg	Profit or loss/ egg
	no.	no.	no.		wks	days	%	no.	%	cents	cents
Before May 1											
Range 2/19-4/30				11/19-2/24							
Average 4/6	19	12,851	676	1/6	39	26	46.2	57.1	73.8	31.31	+1.21
May 1 to 16											
Range 5/1-5/15				12/16-2/1							
Average 5/8	27	18,574	688	1/4	36	23	43.6	50.3	71.8	33.40	-0.61
May 16 to 31											
Range 5/16-5/30				12/27-3/1							
Average 5/23	15	9,650	643	1/24	35	15	49.1	52.66	72.9	31.88	+2.42
June 1 or after											
Range 6/1-6/30				1/15-2/25							
Average 6/13	11	14,298	1300	2/4	34	31	49.6	49.42	74.5	35.96	-2.28

This table also shows that there is no relationship in fertility between the four groups and age when hens started to lay. The cost per hatching egg decreased as the number of eggs increased, which was to be expected. The birds that were hatched before May 1 had fairly good fertility and they also had the highest number of hatching eggs per hen which accounts for the lowest cost. The May 16-31 group shows the greatest return per hatching egg. The high return was influenced by (1) a high number of eggs per hen, (2) good fertility, (3) less feed, and (4) less labor and other costs because of birds maturing earlier.

Hens hatched in June laid at the youngest age of all three groups, but required the most (31 days) prelighting. If all groups had received the same amount of light, this group would have probably matured considerably later. The hens hatched after May 31 had a good fertility and a high rate of lay, but a high cost. This high cost per hatching egg is probably a result of the large size of flock. The data in Table 14 on page 33 give an explanation for this high cost per egg. Feed cost and depreciation were high.

Just in passing, it is interesting to see if the date of first egg had any influence on fertility.

Table 17. RELATION OF DATE OF FIRST EGG TO FERTILITY WESTERN OREGON, 1949

(Based on 77 flocks: 58,174 birds; 2,590,164 hatching eggs)

Date of first egg	Number of records	Per cent fertility
Before December 26	15	72.7
December 26 to January 9	11	73.7
January 9 to January 23	21	71.9
January 23 to February 6	20	72.7
February 6 and after	10	74.2

These data would indicate that date of first egg does not seem to exert any revealing influence on the fertility of the different groups.

FEED PER BIRD PER DAY. Harper and Parker 1947, found that a laying turkey flock ate on the average of 0.628 lbs. of feed per bird per day with a 49.07% lay (14, p. 2).

The data in Table 18 show feed consumption per bird per day broken down into five groups. The average feed consumption of all 77 flocks was 0.689 lbs. per bird per day (see Table 15). This higher feed consumption per bird per day might be due to the fact that under farm conditions more feed is wasted by spilling, blowing away, becoming moldy, other livestock getting into feed, etc.

The data in Table 18 show that the group that consumed 0.488 lbs. feed per bird per day had the lowest cost per egg and the highest profit per hatching egg (+6.75 cents). This feed consumption is much below the average for the study and below the finding by Harper and

Table 18. EFFECTS OF FEED CONSUMPTION ON EGG PRODUCTION, FERTILITY, COST, AND PROFIT OR LOSS WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Feed per bird per day	Flocks	Birds	Aver. size of flock	Wt. of hens when laying started	Wt. of toms when laying started	Rate of lay	Hatch. eggs per hen	Fertility	Net cost per H. egg	Profit or loss per H. egg
pounds	no.	no.	no.	lbs.	lbs.	%	no.	%	cents	cents
Under 0.58										
Range 0.421-0.563										
Average 0.488	16	11,647	728	16.0	29.7	46.8	52.0	74.6	27.92	+6.75
0.58 to 0.65										
Range 0.587-0.648										
Average 0.618	17	13,394	788	17.2	31.0	42.8	49.7	74.96	32.29	+1.52
0.65 to 0.72										
Range 0.657-0.716										
Average 0.689	17	7,467	439	16.9	30.3	47.6	53.9	72.5	35.50	-3.55
0.72 to 0.79										
Range 0.721-0.779										
Average 0.749	16	13,417	822	16.5	29.4	44.0	49.7	70.1	34.87	-1.88
0.79 and over										
Range 0.793-1.157										
Average 0.912	11	11,253	1023	15.9	29.5	50.4	59.9	71.3	32.62	-0.17

Parker, (14, p. 2) and it may be that these birds made very good use of range. Bennion and others state that green feeds will reduce feed costs from 10 per cent to 20 per cent if an adequate supply of range is at hand and is of good quality (7, p. 3). This group had a higher fertility than the average for the study, which was 71.3 per cent, and a fairly good rate of lay (46.8) which was above the average of all flocks. It may be that this feed was of better quality than the feed for the other groups, so that the birds did not have to consume so much feed to get their nutritional needs.

The 17 flocks that ate 0.618 lbs. of feed per bird per day (average for the study was 0.689), had the highest fertility and the lowest rate of lay.

The flocks that used less than 0.65 lbs. per bird per day, either because of less wastage, superior range, or higher quality feed, tended to have higher fertility, lower costs, and gave a profit per hatching egg.

After working out this table, the question arose as to what, if any, was the connection between feed consumption and per cent protein as related to fertility, so these data were tabulated in Table 19.

Table 19. RELATIONSHIP OF FEED CONSUMPTION AND PER CENT PROTEIN OF TOTAL FEED TO FERTILITY, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Per cent protein of total feed	POUNDS OF FEED PER BIRD PER DAY			
	0.689 lbs. or below		Over 0.689 lbs.	
	Number of flocks	Per cent fertility	Number of flocks	Per cent fertility
Under 14	5	75.7	6	71.3
14 to 16	24	74.8	20	71.0
16 and over	13	72.4	9	71.0

It would appear that the flocks that were fed a lower protein ration had higher fertility. It may be that those flocks that were fed 0.689 lbs. of feed or less and less than 14 per cent protein may have made good use of their range and may have had a high quality of feed. The producers that fed their flocks over 0.689 lbs. of feed per bird per day had a lower fertility than those who fed this amount or under. This is significant. Also, as shown in Table 18, those birds that consumed above 0.689 had a higher cost per hatching egg than birds that consumed feed under this amount. The higher cost may have been partly influenced by a higher feed cost.

EFFECTS OF DIFFERENT PERCENTAGES OF MASH IN TOTAL FEED. There are differences of opinion as to what per cent of the daily feed intake should be mash. Some producers feed a ration entirely in mash form. This simplifies feeding a great deal. The advocates of all mash rations believe that a tom will get more protein this way than they will by a whole grain and mash ration. Semen is mostly protein, and therefore the protein required for toms is high. Toms tend to eat more

grain than mash when whole grains are fed free choice. Some of the producers feel that feeding of some scratch is desirable in that birds can balance their own ration, that farm grains can be fed, and that the weight of the birds can be kept up. Some like to feed a high protein mash, and so on.

Table 20 shows that the turkey producers of this study fed a ration that was from 12 to 100 per cent mash. The greatest profit, 3.02 cents and lowest cost, 31.4 cents, per hatch egg, was made by producers that fed a ration that was 54.6 per cent mash. This agrees with the Washington study which will be discussed a little later, (8, p. 10). This group had a fair fertility and a fair rate of lay.

The group that fed 61 per cent mash lost 2.61 cents per hatching egg and had a very low fertility. As shown by this study, the per cent mash of the total ration does not seem to exert any definite influence on fertility, rate of lay or cost.

Sampson and Wilson, 1944, working with Broad Breasted Bronze turkeys, found the differences between fertility and hatchability were not significant between the all mash ration and the grain-mash ration (27, p. 16). They also found that when whole grains are fed free choice, breeders may eat only 25 per cent mash. As it is shown in Table 20, those birds that were fed only 23.0 per cent mash had a fair rate of lay, good fertility, but had a high cost and lost 0.89 cents per hatching egg. This group had the fewest eggs per hen. It would seem, according to findings in this study, that the desirable balance between mash and whole grain lies between 50 per cent to 60 per cent mash and the rest of the ration whole grain. This finding

Table 20. EFFECTS OF DIFFERENT PERCENTAGE OF MASH TO EGG PRODUCTION, FERTILITY, COST AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Amount of mash in total ration	Flocks	Birds	Aver. size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ egg
%	no.	no.	no.	%	no.	no.	%	no.	¢
Under 30 Range 12-29 Average 23.0	3	3484	1161	44.5	47.9	45.0	73.9	34.75	-0.89
30 to 40 Range 30-39 Average 35.2	9	4441	493	49.3	55.7	53.3	74.1	31.82	+1.45
40 to 50 Range 40-49 Average 44.6	25	20566	823	42.6	53.7	49.5	73.2	33.00	-0.03
50 to 60 Range 51-59 Average 54.6	17	17610	1036	45.2	56.8	53.6	73.8	31.40	+3.02
60 to 70 Range 60-64 Average 61.0	6	3832	639	47.6	64.2	59.3	66.4	34.72	-2.61
70 and over Range 70-100 Average 85.4	17	8241	485	49.9	58.6	54.6	72.5	32.84	-0.03

agrees with Washington state's results (8, p. 10).

The Washington state study, 1944, found that producers that fed about 50-50 mash--whole grain ration made the most per poult produced (Table 21).

Table 21. EGG PRODUCTION AND COSTS PER POULT IN RELATION TO THE PROPORTION OF MASH AND GRAINS FED ON 36 TURKEY FARMS

Birds per flock	No. of birds	No. of records	Percent mash is of total ration	Total eggs per hen	Per cent fertility	Cost of feed/ egg	Total cost of poult
444	3555	8	77.6	42.2	73.0	5.1¢	20.1¢
392	3921	10	53.	42.1	71.5	5.0¢	14.4¢
403	7249	18	28.6	40.8	66.4	4.5¢	17.0¢

Source: (8, p. 10)

State averages:

Eggs per hen 40.8
Cost per egg 16.5¢
Cost per poult 38.5¢

EFFECTS OF PROTEIN IN TOTAL FEED. There is some thinking that the per cent protein of the total feed affects fertility and egg production. Toms tend to eat more grain in their total feed intake than hens. Although the per cent protein of the feed that the toms ate cannot be measured with the data obtained in this study, it was of interest to see if there was any relationship between per cent protein in the total feed and fertility and egg production.

The data in Table 22 indicate no relationship between protein level, rate of lay, and fertility.

Protein is one of the higher-priced nutrients in the feed, and

Table 22. EFFECTS OF PROTEIN ON EGG PRODUCTION AND FERTILITY, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Protein in total feed	Flocks	Birds	Aver. size of flock	Eggs laid per hen	Laying season	Rate of lay	Fertility	Cost per hatch. egg	Profit or loss/ hatch. egg
%	no.	no.	no.	no.	days	%	%	¢	¢
Under 13	3	2,466	822	58.1	125	46.5	72.7	27.78	+4.18
13 to 14	8	4,403	550	55.4	113	49.0	73.5	29.57	+3.72
14 to 15	22	16,280	740	53.3	122	43.7	72.8	34.63	-1.48
15 to 16	22	22,551	1025	55.5	125	44.4	73.4	33.57	-0.27
16 to 17	13	7,966	613	58.9	129	45.7	69.3	33.19	+0.58
17 to 18	7	3,249	464	62.0	119	52.1	75.4	29.50	+2.83
18 and over	2	1,259	630	60.4	128	47.2	71.6	28.96	+6.68

according to the findings of the study, it may be profitable to feed a lower-protein ration.

EFFECTS OF SUPPLEMENTS. Some people believe that the feeding of supplements, (milk products, alfalfa meal, or dried cereal greens) in addition to what is already in the mash, may be beneficial. The Kentucky Agricultural Experiment Station found that riboflavin is necessary for hatchability and that Vitamin D deficiency in breeders results in low hatchability (24, p. 482). Vitamin A was found to be necessary for hatchability (24, p. 463). Sampson and Wilson in 1944, found that fertility was a little higher in pens of birds which received liquid buttermilk (30, p. 17).

L. A. Wilhem and others found that if 200 units of Vitamin D and sunshine were supplied to turkeys previously deprived of Vitamin D, a marked increase in egg production and hatchability occurred (35, pp. 565-569). They also found that soft-shelled eggs were inversely related to the level of Vitamin D fed.

It is estimated by research workers that one-third of the eggs candled as being infertile are fertile when examined by breaking the eggs. This is mentioned because the commercial hatchery candles about the 14th to 24th day and does not break out the eggs. Those embryos that die at an early age are counted as infertile and the death is a result of poor hatchability and not because they were infertile.

With these thoughts in mind, supplemental feeding (feeding of milk, alfalfa, milk and alfalfa) vs. no supplements was compared among the 77 flocks used in the turkey hatching egg study. This data is given in Table 23.

Table 23, EFFECTS OF SUPPLEMENTS ON EGG PRODUCTION, FERTILITY, COSTS AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Weight of birds when hens started to lay												
Toms	Hens	Flocks	Birds	Aver. size of flock	Protein in feed	Supplement fed	Rate of lay	Eggs per hen	H. Eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ H. egg
lbs.	lbs.	no.	no.	no.	%		%	no.	no.	%	¢	¢
Range 25-35	15-19											
Average 30.1	16.7	35	19,211	549	15.4	milk	46.2	56.7	52.7	72.6	33.48	-0.36
Range 26-30	14-18											
Average 28.2	16.5	4	2,889	722	15.2	alfalfa	41.6	57.2	55.6	78.8	29.94	+3.02
Range 25-40	13-22					milk &						
Average 31.7	16.4	24	16,664	694	15.1	alfalfa	46.9	56.1	52.2	72.8	32.24	+1.86
Range 24-40	13-19											
Average 29.2	16.6	14	10,672	762	15.2	none	47.1	55.1	51.8	71.6	32.16	+0.04

Those producers that fed alfalfa had a high fertility, low cost per hatching egg and made a profit of 3.02 cents per hatching egg. This low cost group had the highest number of hatching eggs per hen. It is, however, a small group (only 4 flocks). It is interesting to note that this group had the lightest toms of all flocks. Many people believe that heavy toms are responsible for low fertility and this may be a factor.

Comparing the feeding of supplements to non-supplemental feeding in the case of 14 flocks, there is a difference in cost and return per hatching egg in favor of feeding supplements.

To analyze this on the basis of the relation of feed consumption and feeding of supplements, the data were tabulated in the following manner (Table 24):

Table 24. RELATION OF FEED CONSUMPTION, FEEDING SUPPLEMENTS, AND NO SUPPLEMENTS TO FERTILITY, WESTERN OREGON, 1949
(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Ration	Pounds of feed per bird per day			
	0.689 or below		Above 0.689	
	Flocks	Fertility	Flocks	Fertility
	no.	%	no.	%
Fed milk	21	74.5	14	70.1
Fed alfalfa	2	80.4	2	77.7
Fed milk and alfalfa	12	74.9	12	70.2
Fed no supplements	7	70.7	7	73.1

On the whole, it seems that the feeding of supplements vs. the feeding of no supplements seems to be beneficial for those flocks that received 0.689 pounds per bird per day, but the number of records considered in the feeding of no supplements is low. The feeding of supplements and somewhat less feed seems to be advantageous. It may be that the feed given to the birds that ate above 0.689 pounds per bird per day might have been of poorer quality. Many other factors enter into the fertility picture which cannot be considered in one table or with the data available. The profit or loss per hatching egg is what is important and that has been considered in the previous table.

EFFECTS OF WEIGHT OF BIRDS AND FEED RESTRICTION. Overfatness and lack of exercise is one of the causes of low fertility listed by Martin and Marsden (24, p. 188). Harper and Parker, 1947, found a difference in fertility of one per cent in favor of light toms (14, p. 11).

Various turkey hatching egg producers feel that heavy birds is one reason for low fertility. Some producers restrict feed of turkey breeders prior to mating in order to reduce body weight, and in so doing they eliminate some of the clumsiness and lazyness of males. There is a feeling among other producers that feed restriction is harmful. The data were summarized in such a way as to show the weight of the birds, giving the ranges in each weight group for both hens and toms and also in a way as to show whether or not feed was restricted prior to mating. This information appears in Table 25. A low cost of 30.48 cents and a profit of 3.36 cents per hatching egg was made by the producers whose hens averaged 14.6 pounds at laying time and whose toms at this same time weighed 26.1 pounds. This group had the highest

rate of lay and a fair fertility average. The group that had heavy toms and hens had the lowest fertility of all groups, next to the highest costs and lost the most money in hatching eggs. This may indicate that heavy birds do not mate well and result in low fertility. Heavy birds eat more feed and when one bird dies, it results in a greater loss to the producer than a light bird. (Some of these birds were valued at 64¢ per pound at the beginning of the season and 4 or 5 pounds more per bird counts up.)

In every weight group for the hens, the data show that the heavier toms resulted in a higher cost per hatching egg and made less money for their operator than the lighter toms. The problem may lie in the toms being too lazy or clumsy and that the difference in fertility may be due to the mechanics of mating rather than within the birds themselves. There are often wide differences between hens in their ability to produce fertile eggs even though mated to the same toms. For example, the Pennsylvania station found a difference in fertility from 3.2% to 100% between two different hens, both of which were mated by the same two toms (22, p. 16). Harper and Parker in 1950, using artificial insemination, showed that there are family differences in fertility of turkeys. The range in fertility of eggs in their study after the first insemination was from 100 to 60.9 (15, p. 473).

The producers who restricted feed prior to mating in order to reduce body weight had lighter birds, both hens and toms, than those who did not restrict feed. This group of producers that restricted feed prior to laying had a slightly higher fertility, rate of lay, and lower cost per egg than did those producers who did not restrict

Table 25. EFFECTS OF WEIGHT OF BIRDS AND FEED RESTRICTION ON EGG PRODUCTION, FERTILITY, COSTS, AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 74 flocks; 56,914 birds, 2,528,453 hatching eggs)

Weight per hen when laying started	Weight per tom when hens started to lay	Flocks*	Birds	Aver. size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ h. egg	Profit or loss/ h. egg
pounds	pounds	no.	no.	no.	%	no.	no.	%	¢	¢
	Under 30 Rge. 24-28.5									
----	Aver. 26.1	11 1/	4,944	449	48.63	59.7	56.7	72.2	30.48	+3.63
15 and under Rge. 13-15 Aver. 14.5	----	13	6,100	469						
	30 and over Rge. 30-30									
----	Aver. 30	2 1/	1,156	578	43.1	56.5	50.3	77.6	36.67	-2.98
	Under 30 Rge. 27-29.5									
----	Aver. 27.9	15 2/	10,439	696	47.04	56.7	53.2	73.2	30.26	+2.23
15.1 to 18.0 Rge. 15.5-17.7 Aver. 16.4	----	41	36,893	900						
	30 and over Rge. 30-40									
----	Aver. 31.6	26 2/	26,454	1017	44.05	56.3	52.2	72.6	32.50	+1.24

(Continued on next page)

Table 25. EFFECTS OF WEIGHT OF BIRDS AND FEED RESTRICTION ON EGG PRODUCTION, FERTILITY, COSTS, AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 74 flocks; 56,914 birds, 2,528,453 hatching eggs)

Weight per hen when laying started	Weight per tom when hens started to lay	Flocks*	Birds	Aver. size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ h. egg	Profit or loss/ h. egg
pounds	pounds	no.	no.	no.	%	no.	no.	%	¢	¢
	Under 30 Rge. 26-29									
----	Aver. 27.5	4 3/	2,348	587	45.80	61.0	57.2	75.3	35.09	+2.77
18 and over Rge. 18-22 Aver. 18.4	----	19	13,377	704						
	30 and over Rge. 30-40									
-----	Aver. 31.1	15 3/	11,029	735	45.70	62.7	48.8	70.5	36.61	-4.42
	Feed restricted prior to laying									
Range 13-19 Average 16.2	Range 25-33 Average 28.5	19	13,637	718	46.81	61.3	57.0	72.7	30.86	+1.68
	Feed not restricted prior to laying									
Range 14-22 Average 16.7	Range 24-40 Average 30.6	55	43,277	787	45.6	54.5	50.8	72.6	33.41	+0.16

1/ Breakdown of 16 flocks to show effects of light and heavy toms

2/ Breakdown of 41 flocks to show effects of light and heavy toms

3/ Breakdown of 19 flocks to show effects of light and heavy toms

* Three flocks lacked information on weight of birds

feed prior to laying. This may indicate that feed restriction does not harm the birds; in fact, it may have been beneficial because heavy birds resulted in a higher cost per egg and a lower return per hatching egg.

After studying the foregoing table, it seemed desirable to check the fertility against different weight groups for the toms and hens. This is shown in Table 26.

There is little difference between these weight groups. The problem does not lie altogether in weight of the bird by sexes, but the combination of weights and sexes together as shown in Table 25 giving the effect of weight of birds and feed restrictions on egg production, fertility and returns.

EFFECTS OF MORTALITY OF HENS ON EGG PRODUCTION, FERTILITY, AND COST AND RETURNS. What effect does hen mortality have on cost and returns? A mortality loss of hens under 6% has little effect on returns per hatching egg, as shown in Table 27, but over this figure results in a higher cost per hatching egg and the loss per hatching egg increases. A dead bird naturally accounts for several losses: (1) the bird itself, (2) feed, (3) labor caring for the bird, and (4) an opportunity to make a profit on the bird (22, p. 608). Within this study mortality did not seem to have much affect on rate of lay or fertility (Table 27).

The group that had an average of 12.7%, the highest mortality, lost the most per egg which was 1.74¢ per hatching egg, but had a lower cost per egg than the group that had a hen mortality of 6.3%. This is accounted for in Table 14, page 33. This table shows that the larger size flocks had a higher cost per egg.

Table 26. RELATION OF WEIGHT OF TOMS AND HENS WHEN HENS STARTED TO LAY TO FERTILITY, WESTERN OREGON, 1949

(Based on average of 75 flocks: 57,420 birds; 2,554,801 hatching eggs)

Weight group, lbs.	Number of flocks	Per cent fertility
Toms		
29 and under	29	73.2
29.1 to 32	23	72.4
32 and over	22	72.2
Hens		
15 and under	16	73.7
15.1 to 18	42	72.7
18 and over	18	72.0

Table 27. EFFECTS OF MORTALITY OF HENS ON EGG PRODUCTION, FERTILITY, COST, AND PROFIT OR LOSS WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Mortality of hens	Flocks	Birds	Aver. size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ H. egg
%	no.	no.	no.	%	no.	no.	%	¢	¢
Under 2 Range 0-1 Average 0.7	7	3,802	543	52.3	60.9	57.8	72.7	31.29	-0.38
2 to 4 Range 2-3 Average 2.2	22	12,030	547	47.4	57.9	54.3	73.4	30.84	+2.42
4 to 6 Range 4-5 Average 4.7	17	13,855	815	43.6	53.9	50.2	74.2	31.36	+2.72
6 to 8 Range 6-7 Average 6.3	13	13,703	1054	46.4	54.7	51.0	68.6	35.02	-1.49
8 and over Range 8-47 Average 12.7	18	14,784	821	44.1	55.8	51.9	73.8	34.98	-1.74

EFFECT OF TOM MORTALITY ON FERTILITY. Losses among the toms increases the tom-hen ratio, which makes the remaining toms handle more hens. With this increase in tom-hen ratio, a person would expect to find some relation between tom mortality and fertility. The data given in Table 28 do not show any distinct relationship, but a tom mortality over 20% seems to lower the average fertility a couple of per cent over flocks with less than this mortality figure, and, of course, increases the costs per egg. One reason which may be advanced that might help answer the question why there is no relationship between high tom mortality and low fertility is this: With fewer toms

Table 28. EFFECT OF TOM MORTALITY ON FERTILITY, WESTERN OREGON, 1949 (Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Mortality	Flocks	Birds	Average size of flock	Fertility
%	No.	No.	No.	%
Under 9				
Range 0-8				
Average 3.2	24	14,521	605	74.2
9 to 15				
Range 9-14				
Average 11.2	24	22,289	929	72.6
15 to 21				
Range 15-18				
Average 16.6	9	6,436	715	74.2
21 to 27				
Range 21-26				
Average 23.4	11	9,486	862	70.6
27 and over				
Range 28-56				
Average 37.1	9	5,442	605	71.1

per flock, as a result of death losses, fighting among the toms may have then decreased, and mating may have increased. Also it is possible that the dead toms may have been responsible for some of the poor fertility because of interfering with the functioning of other toms or producing poor quality semen.

After studying the last two tables, it seemed practical to see what was the result of differences in flock mortality as to fertility (see Table 29).

Table 29. RELATION OF FLOCK MORTALITY TO FERTILITY, WESTERN OREGON, 1949
(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Per cent mortality	Per cent fertility
Under 2	73.5
2 to 4	74.7
4 to 6	72.5
6 to 8	69.8
over 8	73.1

The data yielded no relationship between flock mortality and fertility.

EFFECT OF DATE OF HATCH, WEIGHT, AND AGE OF TOMS ON FERTILITY. Date of hatch of toms seems to have no relationship with fertility. Age of toms when hens started to lay had no relationship with fertility, but weight seems to show some relation. In general, the heavier the toms, the lower the fertility (Table 30).

EFFECT OF LENGTH OF DAY ON EGG PRODUCTION AND FERTILITY. There is much discussion among the turkey hatching egg producers as to what length of day seems to be best. Some advocate 13 hours, some 14 hours, and so on. The data shown in Table 31 indicate that a 14-hour day and over seems to be better than a shorter day.

Table 30. EFFECTS OF DATE OF HATCH, WEIGHT, AND AGE ON FERTILITY OF BROAD BREASTED BRONZE TOMS, WESTERN OREGON, 1949

(Based on 69 flocks; 52,197 birds; 2,337,814 hatching eggs)

Date of hatch	Flocks*	Birds	Aver. size of flock	Age when hens started to lay	Wt. when hens started to lay	Fertility
	No.	No.	No.	Wks.	Lbs.	%
Before May 1 Range 2/19-4/30 Average 4/16	17	12,371	728	39	29	74.9
May 1 to 16 Range 5/1-5/15 Average 5/7	24	15,032	626	35	30.5	72.0
May 16-31 Range 5/16-5/30 Average 5/23	16	10,276	642	35	30.8	71.9
June 1 or after Range 6/10-6/30 Average 6/13	12	14,518	1210	34	29.0	74.8

*Information on the hatching date was available for only 69 flocks.

There was a difference in fertility of 4.6 per cent between the longer day and shorter day group. The flocks that had a longer day laid a week earlier, had a higher rate of lay, and a lower cost per hatching egg than those with a shorter day. There was some difference in the profit per hatching egg between the two groups (Table 31).

Table 31. EFFECTS OF LIGHTING ON EGG PRODUCTION, FERTILITY, COST, AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 75 flocks; 57,253 birds; 2,556,394 hatching eggs)

Length of light day	Flocks	Birds	Aver. size of flock	Date of first egg month and day		Hen's age at first egg	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ h. egg
				Range	Aver.							
hrs.	No.	No.	No.			wks.	%	No.	No.	%	cents	cents
14 & over	56	45,496	812	11/19-3/1	1/15	36	46.2	56.8	53.0	73.0	32.17	+0.88
under 14	19	11,757	619	12/15-2/10	1/15	37	45.1	55.8	52.2	68.4	33.26	+0.57

Because the longer day seemed to be beneficial, it seemed only natural that a table showing length of sunlight per day should be presented. So, in order for Oregon producers to know when lights should be turned off in the spring in order to get a 14-hour day of sunlight (daylight), the following table was prepared. April 24 is when a 14-hour day occurs.

Table 32. HOURS PER DAY OF SUNLIGHT FOR OREGON

Date	Dec.	Jan.	Feb.	Mar.	Apr.	May
	H* M**	H M	H M	H M	H M	H M
1	8.54	8.44	9.43	11.07	12.48	14.20
2	8.53	8.44	9.46	11.10	12.52	14.24
3	8.52	8.45	9.48	11.14	12.55	14.27
4	8.51	8.46	9.51	11.17	12.58	14.29
5	8.49	8.47	9.53	11.21	13.01	14.32
6	8.48	8.48	9.55	11.23	13.04	14.35
7	8.46	8.50	9.59	11.26	13.08	14.37
8	8.45	8.52	10.02	11.30	13.11	14.40
9	8.45	8.53	10.05	11.33	13.15	14.42
10	8.44	8.54	10.07	11.37	13.17	14.45
11	8.43	8.56	10.09	11.40	13.20	14.48
12	8.42	8.58	10.13	11.43	13.24	14.50
13	8.41	9.00	10.17	11.47	13.27	14.53
14	8.40	9.01	10.20	11.49	13.30	14.55
15	8.39	9.03	10.23	11.52	13.32	14.57
16	8.39	9.04	10.26	11.56	13.36	15.00
17	8.39	9.07	10.29	11.59	13.39	15.02
18	8.38	9.09	10.32	12.02	13.42	15.04
19	8.38	9.12	10.36	12.06	13.46	15.07
20	8.38	9.14	10.39	12.09	13.48	15.09
21	8.38	9.15	10.42	12.13	13.51	15.11
22	8.38	9.18	10.45	12.16	13.55	15.13
23	8.38	9.20	10.49	12.19	13.58	15.15
24	8.38	9.23	10.52	12.22	14.00	15.17
25	8.39	9.25	10.55	12.26	14.04	15.19
26	8.38	9.27	10.58	12.29	14.07	15.21
27	8.39	9.30	11.01	12.33	14.09	15.22
28	8.40	9.32	11.04	12.36	14.12	15.24
29	8.40	9.35	11.07	12.38	14.15	15.26
30	8.41	9.38		12.41	14.18	15.27
31	8.42	9.41		12.45		15.29
Total	269.55	282.51	301.26	369.59	407.02	464.00
			-11.07			
			290.19			

* Hours
** Minutes

A three-year study at the Umatilla Field Station with use of lights and shelter against natural conditions showed that lighted birds laid 19 more eggs, but had a lower rate of lay and fertility (6, p. 25). Also, the birds under natural conditions had 7.7% higher fertility than those birds that received lights and shelter. This study pointed out that the poults from the lighted hens had 1.7% less mortality.

Table 33. THREE-YEAR AVERAGE OF BREEDERS UNDER ARTIFICIAL LIGHT AND SHELTER COMPARED WITH BREEDERS UNDER NATURAL CONDITIONS 1/

Umatilla Field Station

Item	Lights and Shelter	Natural Conditions
Average number of hens per pen	24	24
Average length of laying period, days	86	51
Average date of first egg	Feb. 1	Mar. 8
Days of light to 50% lay for lighted pen	32	--
Average number of eggs per hen	55	36
Per cent lay	64	71
Per cent fertility	77.8	85.5
Per cent hatchability of fertile eggs	76.0	76.6
Per cent mortality of poults to 6 wks.	6.1	7.8

1/ Source: (6, p. 25)

In most years, the price per hatching egg paid by the hatchery decreases as the season progresses, so it is important to get the flock into production early.

EFFECT OF WHEN LIGHTS WERE TURNED OFF TO EGG PRODUCTION, FERTILITY, COSTS AND RETURNS. The date when lights were turned off

apparently had no relationship to rate of lay, fertility, or cost per hatching egg (Table 34).

Results of this study would indicate that lights should probably be used to around the first of April because this group considers 19,105 birds out of a total of 58,174 birds. The first group had a low cost per hatching egg, but this group comprises such a small part of the total birds, that this group should not be considered as a desirable time to turn off lights. Table 33 shows the length of daylight for the spring months and to obtain a 14-hour day, one should leave the light on until April 24. The finding of two producers that used no light seems to fit in well with work done at the Umatilla Branch Experiment Station (6, p. 25).

Table 34. EFFECTS OF WHEN LIGHTS WERE TURNED OFF TO EGG PRODUCTION, FERTILITY, COST AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,174 hatching eggs)

Date lights were turned off	Flocks	Birds	Aver. size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ H. egg
	no.	no.	no.	%			%	¢	¢
Before March 1 Range 2/12-2/15 Average 2/14	2	1438	719	40.7	53.1	50.8	74.5	30.52	+1.42
March 1 to 15 Range 3/1-3/10 Average 3/3	12	7306	609	47.1	58.7	54.7	70.3	32.61	-2.09
Mar. 15 to Apr. 1 Range 3/15-3/31 Average 3/19	21	14891	709	46.9	57.1	52.8	74.3	32.38	+0.70
April 1 to 15 Range 4/1-4/10 Average 4/2	23	19105	831	47.3	56.4	53.2	74.4	32.06	+2.62
April 15 & after Range 4/15-5/30 Average 4/24	17	14513	854	42.7	55.1	51.3	71.8	33.18	+0.46
2 producers used no lights	2	921	460	50.8	44.9	42.6	73.9	41.22	-7.76

EFFECT OF LIGHT TREATMENT OF TOMS ON FERTILITY. It is common thinking among research workers that toms should be prelighted 21 days before mating. In this study, it was found that 21 flocks did not prelight (one flock lighted birds 45 days after mating and two flocks did not use any artificial lights). Fifty-two producers prelighted toms on the average of 18 days. Of these producers that prelighted, 36 producers prelighted their toms on an average of 22 days. Sixteen producers prdighted on the average of nine days and made profit of 1.85¢ per hatching egg. Those producers that did not prelight toms made 0.39¢ per hatching egg, while those that prelighted made from 1.80¢ to 1.85¢ profit per hatching egg. Prelighting did not help to increase the fertility. These data are shown on the next page.

Table 35. EFFECTS OF LIGHT TREATMENT OF TOMS ON FERTILITY AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 73 flocks; 56,106 birds; 2,508,557 hatching eggs)

Light treatment before mating	Flocks 1/	Birds	Size of flock	Fertility	Profit or loss/ H. egg
	no.	no.	no.	%	¢
All flocks not prelighted	21	13,412	639	73.1	+0.39
All flocks prelighted					
Range 2-45 days					
Average 18 days	52	42,694	821	72.9	+1.82
Prelighted under 2 weeks					
Range 2-13 days					
Average 9 days	16*	12,093	756	71.8	+1.85
Prelighted 14 days and over					
Range 14-45 days					
Average 22 days	36*	30,601	850	73.4	+1.80

1/ Two flocks received no light; hens and toms in two flocks were never separated.

* Breakdown of the 52 flocks that prelighted.

After seeing how these data fell, it seemed desirable to plot age of toms when mating began and amount of light before mating to fertility to see if there was any trend (Table 36).

Table 36. RELATIONSHIP OF AGE OF TOMS WHEN MATING BEGAN AND AMOUNT OF LIGHT BEFORE MATING TO FERTILITY, WESTERN OREGON, 1949

(Based on 67 flocks, 51,050 birds, 2,289,977 hatching eggs)

Light Treatment	Age of toms in weeks					
	Under 30		30 to 32		32 and over	
	Flocks	Fertility	Flocks	Fertility	Flocks	Fertility
	no.	%	no.	%	no.	%
No light	10	74.2	7	71.9	4	74.6
1 to 14 days	2	70.2	4	72.4	8	73.1
14 days and over	2	78.9	4	72.8	26	73.4

There seems to be no relationship in the data, although the birds in the age groups under 30 weeks and 30 to 32 weeks, and that received 14 days and over of prelighting, had a higher fertility than those that received no prelighting. Lighting of toms within these age groups for 14 days and over seems beneficial in increasing fertility, although the number of flocks in these groups (30 weeks and 30-32 weeks) is small.

EFFECT OF RATE OF LAY ON FERTILITY AND COSTS AND RETURNS. A producer must not only get fertile eggs to make a profit, but needs quantity of eggs, too. These two things must be present in the right proportions if the producer is to make money for his efforts.

In Table 37 the data from the 77 flocks is plotted as to rate of lay and fertility, costs and returns. The breaking-even point is estimated to be somewhere around 43 per cent rate of lay, using the assumption given in the 40.1 - 50.0 per cent lay group. Those producers whose flocks had a rate of lay 36.7 per cent had the highest cost per hatching egg and lost 4.27¢ per hatching egg. Those producers whose flocks laid 45.2 per cent made 1.39¢ profit per egg and had a cost of 32.02¢ per egg. Profit per egg increased and cost decreased as the rate of lay increased. Rate of lay seems to have no relationship with fertility.

Table 37. EFFECTS OF RATE OF LAY TO FERTILITY, COST, AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Rate of lay	Flocks	Birds	Aver. size of flock	Eggs per hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ H. egg
%	no.	no.	no.	no.	no.	%	¢	¢
30.1-40								
Range 30.1-39.9								
Average 36.7	17	14,479	852	47.3	43.7	72.9	37.85	-4.27
40.1-50								
Range 40.1-50.0								
Average 45.2	39	34,268	879	55.5	51.7	72.5	32.02	+1.39
50.1-60								
Range 50.4-59.3								
Average 53.3	18	8,280	460	64.4	60.3	71.9	30.49	+1.83
Over 60.1								
Range 60.6-73.4								
Average 66.8	3	1,147	382	69.6	67.3	82.2	24.88	+9.73

INHERITANCE OF EGG PRODUCTION AND HATCHABILITY. As explained earlier in the text, many earlier dead embryos are counted as infertiles and because egg production and hatchability are inherited and affect costs of producing hatching eggs, it is thought that the following work and excerpts from the University of Maryland would be of interest (17, p. 22). The work was done with Beltsville small whites.

Table 38. AVERAGE PRODUCTION PER BIRD IN HIGH AND LOW FAMILIES, RESPECTIVELY, IN EACH OF FOUR PENS DURING 1943, 1944, and 1945.

Pen		1		2		3		4	
	Season	Average egg production per bird by families							
Year	in days	High family	Low family	High family	Low family	High family	Low family	High family	Low family
1943	48	31	8	27	18	33	20	31	15
1944	48	32	19	33	21	30	23	36	22
1945	41	29	11	27	20	27	21	30	17

Source: (17, p. 22)

"The data in the above table show marked differences in many cases between the average egg production of the high family and the average egg production of the low family in each pen. Obviously, you would want to select future breeders from among the progeny of the high families. The average egg production of a family of full sisters is a much better basis on which to select future breeders than individual records of egg production."

Since hatchability is inherited, a few results obtained from the University of Maryland's turkey breeding flocks are given here to emphasize the importance of selecting breeding stock from among the progeny of dams whose eggs hatched well.

> "In one breeding season of eight weeks' duration, dam No. 526 laid 27 fertile eggs, but only 55.6 per cent of them hatched, whereas dam No. 561 laid 36 fertile eggs and 86.1 per cent of them hatched. The next breeding season, five daughters of dam No. 526 and four daughters of dam No. 561 were mated to the same tom. The hatchability of the fertile eggs laid by the five daughters of dam No. 526 was only 53.9 per cent, whereas the hatchability of the fertile eggs laid by the four daughters of dam No. 561 was 90.7 per cent.
>
> "In one breeding season of eight weeks' duration, dam No. 519 laid 41 eggs and all of them hatched. In the next breeding season of the same duration, three daughters of dam No. 519 laid an average of 33 eggs and 82 per cent of them hatched, there being no infertile eggs.
>
> "In one breeding season, two full sisters, Nos. 538 and 550, were mated to the same tom. No. 538 laid 36 fertile eggs, 94.4 per cent of which hatched, and No. 550 laid 30 fertile eggs, 100 per cent of which hatched. The next breeding season, three daughters of dam No. 538 mated to one tom had an average hatchability of 93.1 per cent of their fertile eggs and four other daughters mated to another tom had an average hatchability of 85 per cent of their fertile eggs. Two daughters of dam No. 550 mated to one tom had an average hatchability of 81.1 per cent of their fertile eggs and two other daughters mated to another tom had an average hatchability of 85.7 per cent of their fertile eggs.
>
> "Improving the hatchability of the eggs produced by your breeding flock reduces the cost of producing poults." (17, p. 27)

EFFECTS OF AGE OF TOMS TO HENS AND TO FERTILITY. Most producers save hens and toms from the same hatch. Some producers cross strains and in doing so, they like to get toms older than hens. The following data were tabulated to see if there was any difference in fertility whether toms were older, younger, or same age as the hens.

Table 39. EFFECTS OF AGE OF TOMS WHEN MATING BEGAN TO FERTILITY, WESTERN OREGON, 1949

(Based on 67 flocks; 51,050 birds; 2,289,977 hatching eggs)

Age range	Flocks	Birds	Aver. size of flock	Age of hens when mating began	Age of toms when mating began	Fertility
	no.	no.	no.	wks.	wks.	%
Hens and toms same age	55	44,573	810	32	32	73.5
Toms older than hens	2	1,408	704	34	39	79.9
Toms younger than hens	10	5,069	507	34	31	71.4

There were only two flocks that had toms older than the hens. These two flocks had a fertility average of 79.9%. This high fertility may be because of toms being fully matured at time of mating or because of the crossing of strains. The ten flocks that had toms younger than the hens had the lowest fertility. Although there is not much difference in the fertility of these groups, the data indicate that toms younger than hens will give a lower fertility than the other two groups.

EFFECTS OF ROTATION OF TOMS ON FERTILITY. Washington State people found that rotation of toms was beneficial (8, p. 13). Their findings are listed below:

Table 40. RELATION OF TOM-HEN RATIO AND TOM ROTATION TO FERTILITY 13 TURKEY FARMS IN WASHINGTON, 1942 1/

Item	Less than 10 hens/tom		More than 10 hens/tom	
	Rotated	Not rotated	Rotated	Not rotated
Number of records	5	2	3	3
Number of hens	1,100	520	370	1,380
Number of toms	141	60	33	131
Average hens per tom	7.8	8.7	11.2	10.5
Per cent fertility	75.5	64.7	58.6	55.0

1/ Source: (8, p. 13)

Findings of 77 flocks for this study showed that there was not much difference between rotating and not rotating (Table 41).

Table 41. EFFECTS OF ROTATION OF TOMS ON FERTILITY, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Rotated toms	Number of records	Number of birds	Size of flock	Per cent fertility
yes	14	9,256	661	73.11
no	63	48,918	776	72.74

As shown in the table above, the rotation of toms did not seem to be beneficial in increasing fertility, and it would seem, therefore, that it is an added labor increasing the cost of producing a hatching egg.

EFFECTS OF DATE SOLD AND LENGTH OF LAYING SEASON ON EGG PRODUCTION, FERTILITY AND COSTS AND RETURNS. Seasonal declines in fertility and egg production bring about the question, "When is the proper time to sell breeders?" Egg production and fertility curves will be shown later in the text. Length of laying season exerts an influence on costs of production as well as fertility and rate of lay.

In Table 42, the date breeders were sold had a relationship with fertility. On the whole, the later the breeders were sold, the lower the fertility. The difference in fertility is very small. Within each group, the longer laying season produced more eggs per hen and gave a lower cost per egg.

The most desirable time to sell birds according to the data presented in Table 42, was between May 14 and May 20 if the birds had had a long laying season. This group missed out on part of the rapid decline on fertility and egg production. Figures 16 and 17 on pages 92 and 95 show the seasonal decline in egg production and fertility, respectively.

Table 42. EFFECT OF DATE SOLD AND LENGTH OF LAYING SEASON ON EGG PRODUCTION, FERTILITY, COST, AND PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Selling period / Date	Flocks	Birds	Aver. size of flock	Length of laying season: 122 or less	Length of laying season: Over 122	Rate of lay	Total eggs/ hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss/ H. egg
	no.	no.	no.	days	days	%	no.	no.	%	¢	¢
Before May 14											
Range 5/5-5/13				73-119							
Average 5/9	10	6,930	693	104		46.7	48.5	45.9	74.9	35.65	-1.40
Before May 14											
Range 5/6-5/13					124-145						
Average 5/11	10	4,431	443		135	46.0	61.97	57.01	73.4	31.68	+1.39
May 14 thru May 20											
Range 5/14-5/20				80-121							
Average 5/17	16	11,310	707	108		47.6	51.2	48.3	73.6	35.98	-3.31
May 14 thru May 20											
Range 5/15-5/20					124-157						
Average 5/18	16	11,560	722		136	45.9	62.1	58.6	72.3	28.22	+6.26
After May 20											
Range 5/23-6/4				92-119							
Average 5/27	13	16,055	1235	112		47.4	52.9	49.6	71.9	34.23	-1.41
After May 20											
Range 5/21-5/27					128-190						
Average 5/24	12	7,888	657		144	42.2	60.7	55.1	70.9	30.89	+1.33

EFFECTS OF RELATIVE NUMBER OF TOMS USED TO FERTILITY AND COSTS AND RETURNS. It is a rule of thumb among turkey growers to use a tom-hen ratio of 1:10. When the breeders are picked out in the fall, the number of toms to fill out this ratio are held back with a few extras as reserve toms. The author feels that a study of relative number of toms used in the 77 flocks would yield results of interest.

The tom-hen ratio is plotted in Table 43 for the average for the season, beginning at breeding season, and at the end of the season. The few birds that were eaten by the producers were considered as dead birds. Most of these birds are cripples, and are killed only to salvage the meat.

There seems to be no relationship between fertility and tom-hen ratio, whether figured as an average for the season, or at the beginning or the end.

While the group that had a ratio of only 6.1 hens per tom at the end of the season had a high fertility and a rate of lay comparable to the average for the study, they lost 1.22 cents per hatching egg. This may be due to feeding a relatively large number of toms, a greater mortality of toms, and a higher depreciation caused not only by a higher death loss, but also caused by a greater number of lower-grade toms due to excessive fighting. The average tom mortality for the 77 flocks was 14%, while with hens, this figure was only 7%. No data were available for these 77 flocks for weight of toms when sold, so it was impossible to determine what the loss in weight per tom was. However, Harper and Parker found in their study, 1947, that

Table 43. EFFECTS OF RELATIVE NUMBER OF TOMS (AVERAGE FOR SEASON, BEGINNING, AND END) ON FERTILITY, COSTS, PROFIT OR LOSS, WESTERN OREGON, 1949

(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Tom-hen ratio	Number of flocks	Number of Birds	Average size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Fertility	Net cost/ H. egg	Profit or loss per H. egg
			no.	%	no.	no.	%	¢	¢
Tom-hen ratio; average for season									
Under 7									
Range 4.5-6.9									
Average 6.1	14	11,614	830	46.0	55.5	51.4	75.7	34.53	-1.30
7 to 8									
Range 7.0-7.9									
Average 7.4	10	4,677	468	47.9	57.2	53.9	71.0	34.03	-1.69
8 to 9									
Range 8.1-8.9									
Average 8.5	28	18,199	650	46.0	60.4	56.2	72.5	30.79	+2.09
9 to 10									
Range 9.1-9.8									
Average 9.5	14	16,776	1198	44.6	54.3	51.0	72.0	32.06	+2.43
10 and over									
Range 10.1-11.0									
Average 10.4	11	6,908	628	46.5	48.5	45.5	72.6	34.68	-0.90
Tom-hen ratio at start of season									
Under 7									
Range 4.0-6.9									
Average 6.1	16	12,370	773	47.8	55.5	51.8	75.9	34.05	-0.83
7 to 8									
Range 7.0-7.9									
Average 7.5	14	7,174	512	43.6	55.7	51.6	69.2	35.74	-2.91
8 to 9									
Range 8.0-8.9									
Average 8.3	27	16,598	615	46.2	60.4	56.4	72.8	29.88	+2.72
9 to 10									
Range 9.0-9.8									
Average 9.3	15	19,103	1274	44.5	52.7	49.6	72.2	31.84	+2.75
10 and over									
Range 10.0-10.6									
Average 10.2	5	2,929	586	51.7	48.7	46.1	74.5	37.30	-3.18
Tom-hen ratio at end of season									
Under 7									
Range 5.2-6.8									
Average 6.1	11	9,259	842	45.6	54.9	50.8	76.9	35.29	-1.22
7 to 8									
Range 7.0-7.9									
Average 7.5	11	6,896	627	45.6	54.9	53.9	70.5	34.43	-2.31
8 to 9									
Range 8.1-8.8									
Average 8.4	17	10,817	636	46.8	61.9	58.6	74.0	28.49	+4.40
9 to 10									
Range 9.1-9.9									
Average 9.5	23	16,098	700	46.4	54.7	50.8	72.0	33.77	-0.17
10 and over									
Range 10.0-15.0									
Average 11.8	15	15,104	1007	44.1	52.2	48.7	71.3	32.53	+0.86

the heavier toms lost 3.14 lbs. per bird and the lighter toms lost 1.19 lbs. (14, p. 12).

The flock that had a tom-hen ratio of 1:11.8 at the end of the season made a profit of 0.86¢ per hatching egg even though this group had the lowest number of hatching eggs per hen.

In all three periods used to get the tom-hen ratio, there seems to have been no significant relationship between tom-hen ratio and fertility. This being the case, it may be desirable to use fewer toms and try to maintain good egg production.

The Washington study in 1942 found no relationship between fertility and the number of hens per tom (8, p. 11). Their data are tabulated in Table 44.

Table 44. RELATION OF THE TOM-HEN RATIO TO FERTILITY
58 TURKEY FARMS IN WASHINGTON, 1942

Item	Less than 9.0 hens per tom	9.0 to 10.5 hens per tom	More than 10.5 hens per tom
Number of records	22	23	13
Number of hens	7550	9450	2540
Number of toms	978	959	229
Average hens/tom	7.7	9.9	11.1
Total eggs laid/hen	43.0	32.9	39.7
Total fertile eggs/hen	29.5	26.8	26.6
Per cent fertility	68.6	68.3	67.0

Source: (8, p. 11)

EFFECT OF LEGUME RANGE VS. NON-LEGUME RANGE ON EGG PRODUCTION, FERTILITY, COST AND RETURNS.

The question of legumes vs. non-legume range has been a topic of much discussion among experiment-station workers and turkey hatching egg producers. The feeling is toward a legume range.

The data obtained in this study were not too clear as to type of vegetation in the turkey breeder flock pens, but the data were sorted according to those who had a legume in their range and those who did not. The most prominent legume was subterranean clover in a mixture with Alta fescue grass.

The per cent protein in the total hand-fed ration was the same for both groups.

There seems to be a difference in favor of the legume range in rate of lay, and egg production. Also there appears to be a slight difference in fertility in favor of the legume range, but not enough to be significant.

The data seem to indicate that a legume in the range may be beneficial in that it lowered the cost per hatching egg by 1.95¢.

Table 45. EFFECT OF LEGUME RANGE VS. NON-LEGUME TO EGG PRODUCTION, FERTILITY, COSTS, AND PROFIT OR LOSS, WESTERN OREGON, 1949 (Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Range	Flocks	Birds	Aver. size of flock	Rate of lay	Eggs per hen	H. eggs per hen	Net cost/ H. egg	Fer-tility	Pro-tein in total feed	Profit or loss/ egg
	no.	no.	no.	%	no.	no.	¢	%	%	¢
legume	20	11,625	581	47.5	58.6	54.7	31.23	73.5	15.3	+1.36
no legume	57	46,549	817	45.5	55.4	51.8	33.18	72.6	15.2	+0.31

EFFECTS OF HOLDING PERIOD OF EGGS TO FERTILITY. Some producers feel that eggs should be shipped to the hatchery about every 4 days; others feel once a week is often enough. V. S. Asmundson, using 100 eggs per lot, used 7 lots of 24 hour-old turkey eggs that were set after being held 0, 3, 7, 14, 21, 28, and 35 days at 55° F. and turned once a day (5, pp. 305-307). There was a gradual decrease in hatchability of eggs held for 7 days or longer up to 28 days, with a big decrease from 28 to 35 days and a similar decrease in apparent fertility occurred which was presumably due to greatly increased pre-incubation mortality in eggs held more than 28 days (5, pp. 305-307).

The length of holding period of eggs for the 77 flocks in this study was related to fertility (Table 46). There was a slight decrease in fertility in eggs held over 8 days, but this group was very small and the finding therefore insignificant.

Table 46. EFFECT OF HOLDING PERIOD OF EGGS TO FERTILITY, WESTERN OREGON, 1949
(Based on 77 flocks; 58,174 birds; 2,590,164 hatching eggs)

Length of Holding period	Number of flocks	Per cent fertility
1-4 days	45	72.8
1-7 days	29	72.8
1-8 days and over	3	71.3

EGG PRODUCTION. It has already been shown that to produce turkey hatching eggs economically, it is necessary to have good egg production. The higher the egg production, the lower the cost per hatching egg produced.

Egg production is inherited, (experimental work establishing this fact was shown on page 69) but environment has a great effect on egg production. Differences in ration fed, amount of light hens received before laying and during laying, weather, and management of birds all affect total egg production. Physical differences within the birds, such as; age of first egg (sexual maturity), weight of birds, broodiness, and pauses, all account for differences in egg production.

S. J. Marsden in 1936 found that turkey laying habits are similar to chickens when fed and managed for egg production (23, p. 445). So, with these thoughts in mind, an attempt will be made to point out differences among 5 flocks (taken from the survey records) in Western Oregon, 1949 season, based on daily eggs picked up and other information obtained in a survey to determine the cost of producing a hatching egg.

Seasonal egg production curves for these five flocks are shown on the following pages. The seasonal egg production curve for each flock is plotted on a five-day simple average. Data to be discussed are listed with each curve. The seasonal egg production for five flocks is plotted on page 92 using a five-day simple average. This curve is plotted with findings from experimental work.

Before discussing egg production for the five flocks, a summary of all data of importance to egg production for the five flocks will be shown (see Table 48).

Date of hatch varied from May 1 to June 5, or about 36 days.

SEASONAL VARIATION IN EGG PRODUCTION FOR FLOCK #1 PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PERCENT LAY OBTAINED FROM DAILY EGG RECORD, WESTERN OREGON, 1949 SEASON PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

Date of hatch	June 5	Grain fed free choice	yes
Date of first egg	Jan. 27	Days of art. light before laying	24
Age when started to lay, wks.	34	Length of day, hrs.	18
Weight when started to lay, lbs.	16	Length of laying season, days	112
Date breeding ration started	Dec. 1	Number of hens	428
Feed restricted prior to lay	yes	Percent mortality of hens	1
Feed per bird per day, lbs.	0.660	Eggs per hen	67.9
Percent protein of total feed	14.6	Average percent lay	60.6
Fed milk	yes	Average percent fertility	82.0

See tabulation of data on page

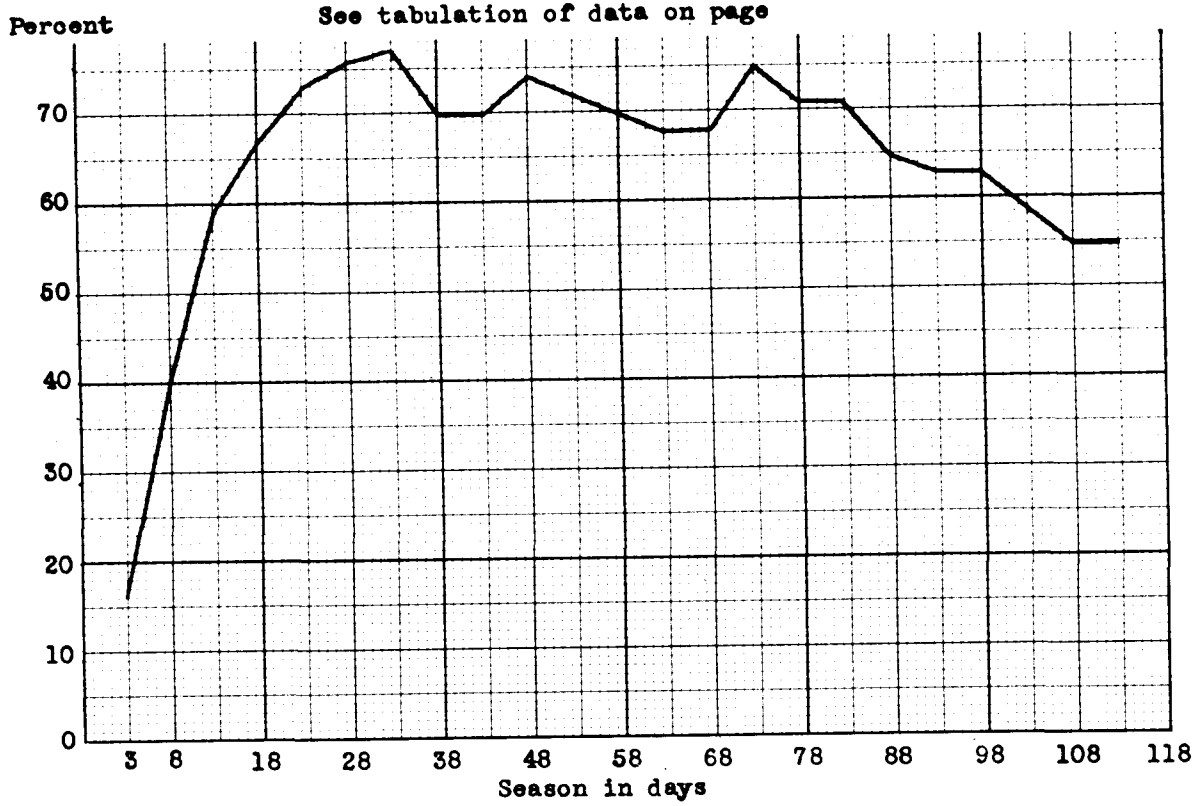


Figure 11

SEASONAL VARIATION IN EGG PRODUCTION FOR FLOCK #2 PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PERCENT LAY OBTAINED FROM DAILY EGG RECORD, WESTERN OREGON, 1949 SEASON PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

Date of hatch	May 4	Grain fed free choice	no
Date of first egg	Jan. 1	Days of art. light before laying	0
Age when started to lay, wks.	35	Length of day, hrs.	13.5
Weight when started to lay, lbs.	17.5	Length of laying season, days	146
Breeding ration started	Dec. 12	Number of hens	507
Feed restricted prior to laying	no	Percent mortality of hens	2
Feed per bird per day, lbs.	0.593	Eggs per hen	71.1
Percent protein in total feed	14.9	Average percent lay	48.7
Fed milk	yes	Average percent fertility	65.9

See tabulation of data on page

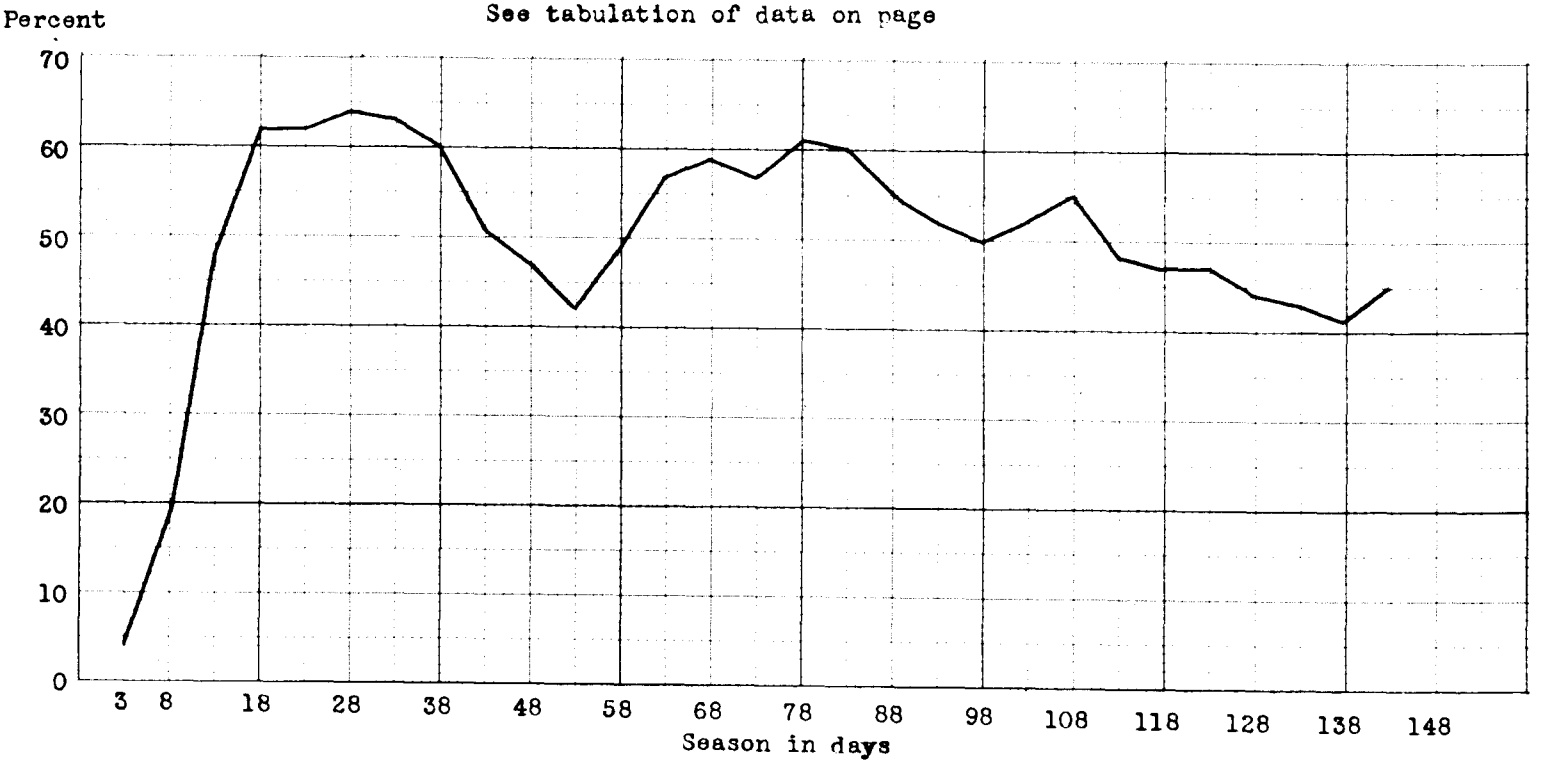


Figure 12

SEASONAL VARIATION IN EGG PRODUCTION FOR FLOCK #3 PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PERCENT LAY OBTAINED FROM DAILY EGG RECORD, WESTERN OREGON, 1949 SEASON PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

Date of hatch	May 18	Grain fed free choice	no
Date of first egg	Dec. 27	Days of art. light before laying	16
Age when started to lay, wks.	32	Length of day, hrs.	14
Weight when started to lay, lbs.	18	Length of laying season, days	145
Date breeding ration started	Dec. 18	Number of hens	422
Feed restricted prior to lay	no	Percent mortality of hens	1
Feed per bird/day, lbs.	0.836	Eggs per hen	75.8
Percent protein of total feed	16.0	Average percent lay	52.3
Fed milk	yes	Average percent fertility	63.0

Percent

See tabulation of data on page

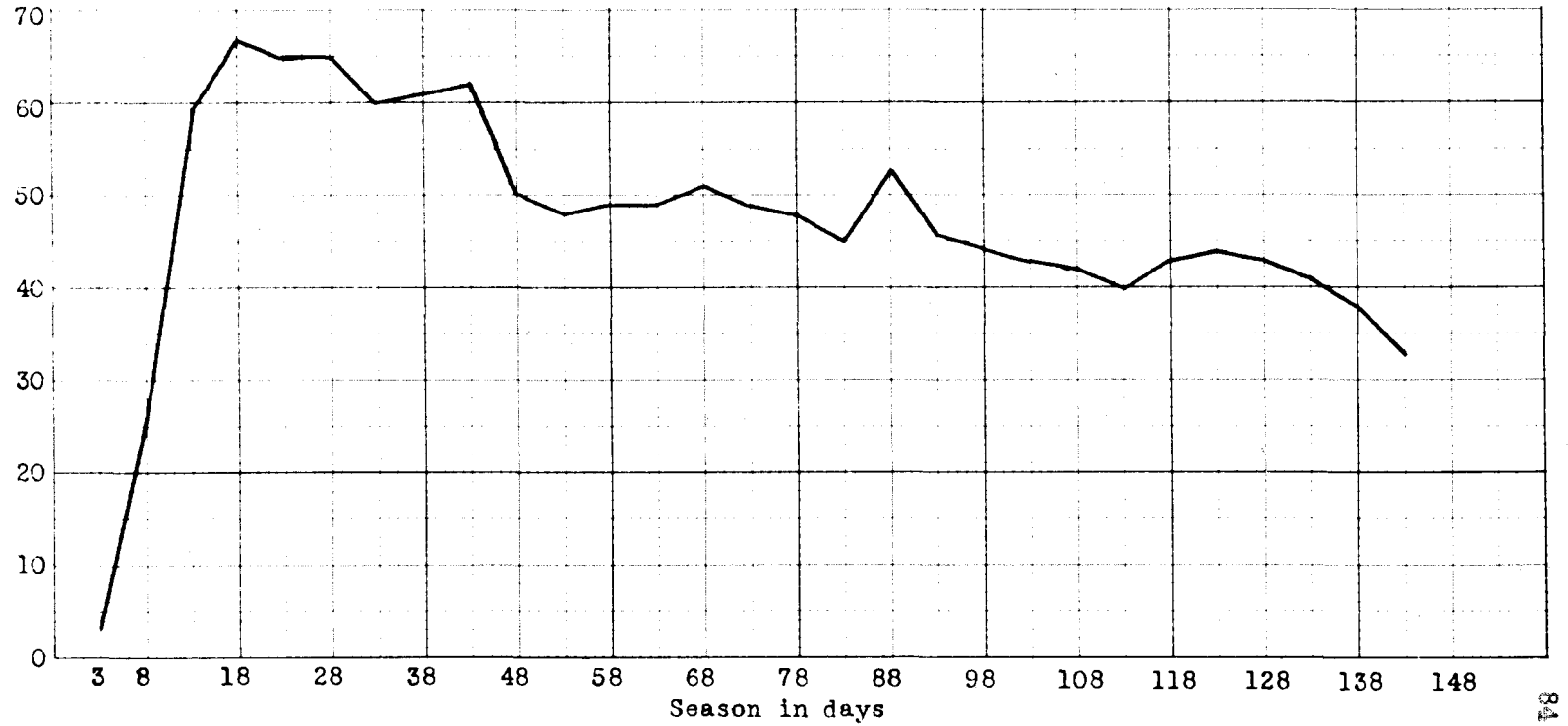


Figure 13

SEASONAL VARIATION IN EGG PRODUCTION FOR FLOCK #4 PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PERCENT LAY OBTAINED FROM DAILY EGG RECORD, WESTERN OREGON, 1949 SEASON PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

Date of hatch	May 1	Grain fed free choice	yes
Date of first egg	Dec. 20	Days of art. light before laying	19
Age when started to lay, wks.	33	Length of day, hrs.	13
Weight when started to lay, lbs.	17	Length of laying season, days	145
Date breeding ration started	Dec. 1	Number of hens	778
Feed restricted prior to lay	no	Percent mortality of hens	3
Feed per bird day, lbs.	0.743	Eggs per hen	56.2
Percent protein in total feed	15.9	Average percent lay	38.8
Fed milk	yes	Average percent fertility	75.4

Percent

See tabulation of data on page

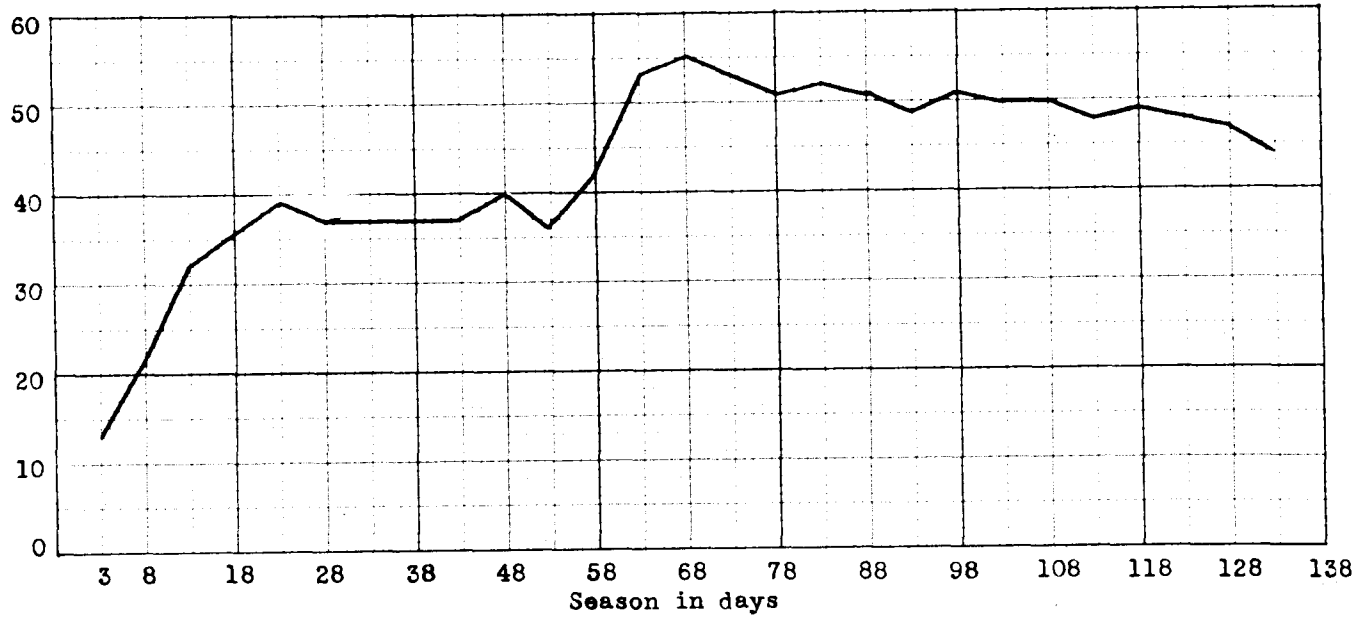


Figure 14

SEASONAL VARIATION IN EGG PRODUCTION FOR FLOCK #5 PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PERCENT LAY OBTAINED FROM DAILY EGG RECORD, WESTERN OREGON, 1949 SEASON PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

Date of hatch	May 1	Grain fed free choice	yes
Date of first egg	Jan. 31	Days of art. light before laying	30
Age when started to lay, wks.	39	Length of day, hrs.	13
Weight when started to lay, lbs.	19	Length of laying season, days	106
Date breeding ration started	Nov. 15	Number of hens	771
Feed restricted prior to lay	no	Percent mortality of hens	5
Feed per bird per day, lbs.	0.705	Eggs per hen	50
Percent protein of total feed	12.1	Average percent lay	47.2
Fed milk	yes	Average percent fertility	72.7

See tabulation of data on page

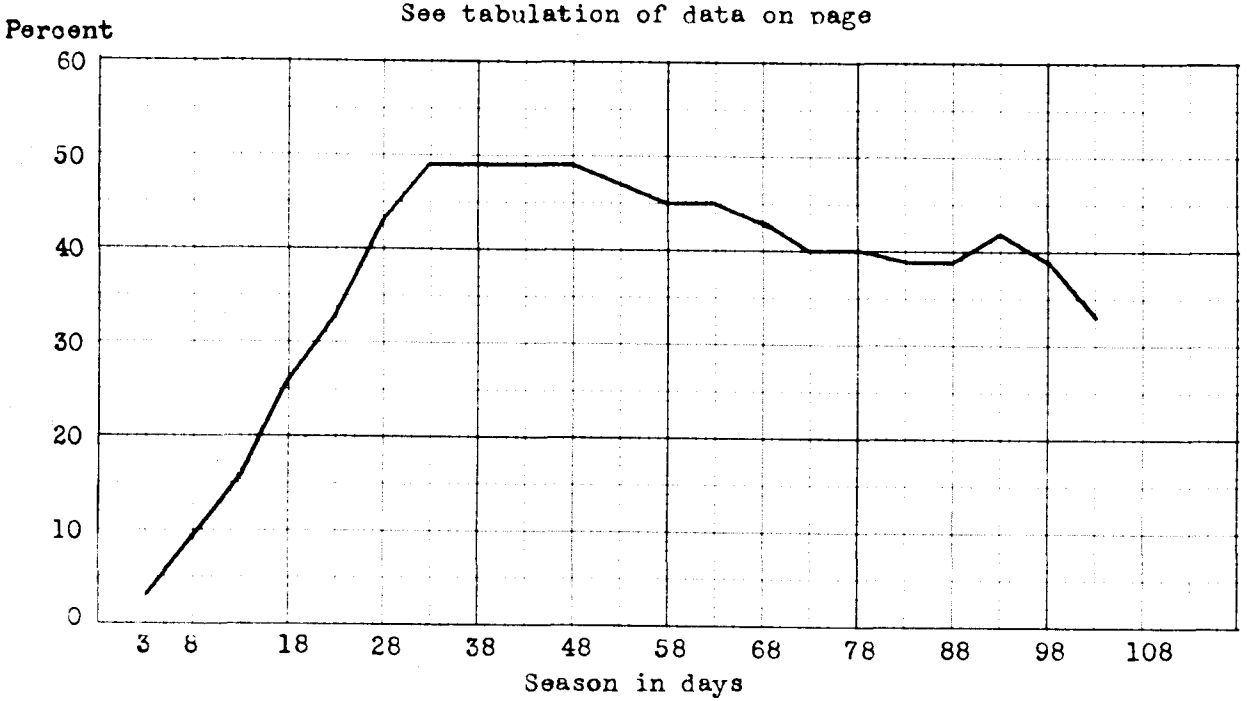


Figure 15

TABULATION OF DATA GIVEN IN FIGURES 11, 12, 13, 14, and 15

Table 47. SEASONAL VARIATION IN EGG PRODUCTION FOR FIVE FLOCKS PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PER CENT LAY OBTAINED FROM DAILY EGG RECORDS, WESTERN OREGON, 1949 SEASON, BROAD BREASTED BRONZE

(Based on 5 flocks; 2,951 hens; 179,305 eggs)

Laying season in days	Per cent lay				
	Flock 1	Flock 2	Flock 3	Flock 4	Flock 5
3	16	4	3	13	3
8	40	19	26	22	9
13	59	48	59	32	16
18	67	62	67	36	26
23	73	62	65	39	33
28	76	64	65	37	43
33	77	63	60	37	49
38	70	60	61	37	49
43	70	51	62	37	49
48	74	47	50	40	49
53	72	42	48	36	47
58	70	49	49	42	45
63	68	57	49	53	45
68	68	59	51	55	43
73	75	57	49	53	40
78	71	61	48	51	40
83	71	60	45	52	39
88	65	55	53	51	39
93	63	52	46	49	42
98	63	50	44	51	39
103	59	52	43	50	33
108	55	55	42	50	
113	55	48	40	48	
118		47	43	49	
123		47	44	48	
128		44	43	47	
133		43	41	44	
138		41	38		
143		45	33		

Table 48. SUMMARY OF FACTORS AFFECTING EGG PRODUCTION FOR FIVE FLOCKS; 2951 HENS, 179,305 EGGS, WESTERN OREGON, 1949, BROAD BREASTED BRONZE TURKEYS

Flock no.	Date of hatch	Date of first egg	Rate of lay,%	Age in wks.	Wt. in lbs.	Days of light to first egg	Fertility %	Mortality %	Length of day, hours	Protein in total feed, %	Lbs. of feed/bird/day	Restricted feed	Eggs per hen	Length of laying season,days
1	6/5	1/27	60.6	34	16.0	24	82.0	1	18.0	14.6	0.660	yes	67.9	112
2	5/4	1/1	48.7	35	17.5	0	65.9	2	13.5	14.9	0.593	no	71.1	146
3	5/18	12/27	52.3	32	18.0	16	63.0	1	14.0	16.0	0.836	no	75.8	145
4	5/1	12/20	38.8	33	17.0	19	75.4	3	13.0	15.9	0.743	no	56.2	145
5	5/1	1/3	47.2	39	19.0	30	72.7	5	13.0	12.1	0.705	no	50.0	106

Age of hen at first egg ranged from 32 weeks to 39 weeks or a difference of 49 days. Flock 3 had 16 days of light to first egg which was laid when the birds were 32 weeks old. Flock 5 had 30 days of light to first egg which was laid when the birds were 39 weeks old. On rate of lay basis, flock 3, the early-maturing birds, had a 52.3 per cent rate of lay while flock 5 had a rate of lay of 47.2 per cent. There was a difference of 25.8 eggs per hen between the two flocks but this is accounted for largely by the difference in length of laying season.

Within these five flocks, date of hatch seemed to have little effect on date of first egg or total egg production. In fact, flocks 4 and 5 were hatched the same time, but had a difference of 6 weeks in date of first egg. Flocks numbered 2, 3, and 4 had about the same length of laying season, but there was a difference of 19.6 eggs between flocks 3 and 4. It is interesting to note that flock 2 matured at 35 weeks, receiving no prelighting. (Date of first egg for flock 2 was laid at a time of year when there was about nine hours of daylight.) If flock 2 had been prelighted at about 30 weeks of age, it would have probably responded to light much quicker than flocks 3 and 4. This agrees with findings by Harper that birds which respond fastest to light lay the most eggs (Table 49). The differences of maturity among the five flocks emphasizes the fact that some birds mature much earlier than others. It was pointed out previously that there was a difference of 49 days in maturity and one can readily picture what effect this difference would have on the cost of producing a hatching egg.

Findings by Harper in 1949 indicated that rate of response of hens to artificial lights is directly related to seasonal egg production

(13, p. 313). High-laying hens exhibit a much faster response to light stimulus than low-producing hens (see Table 49).

Table 49. THE NUMBER OF DAYS AFTER LIGHTING TURKEY HENS TO DATE OF FIRST EGG AND SUBSEQUENT REPRODUCTIVE PERFORMANCE, BROAD BREASTED BRONZE

Days to first egg	Number of hens	Average number of eggs laid	Average number of eggs set	Per cent fertility
19-20	18	63.89	60.77	74.31
21-22	33	56.67	53.82	85.02
23-24	37	47.51	45.16	84.02
25-26	20	41.75	38.55	76.13
27-28	14	42.50	39.86	85.48
29-30	13	35.85	33.15	82.83
31 plus	11	30.64	29.55	89.85

Source: (13, p. 313)

The number of days of light to reach 50 per cent lay (one flock never reached this figure) ranged from 13 days for flock 2 to 79 days for flock 4. The average for the four flocks for days of light to reach 50 per cent lay was 38 days which was 6 days longer than results of work done at the Umatilla Branch Experiment Station for the 1939-41 period (6, p. 25).

It is interesting to note that flock 1 had the lightest hens, and the highest rate of lay and fertility, which agree with findings in Table 25 on page 51 giving the effect of weight of birds and feed restriction on egg production, fertility, costs, and returns. Flocks 2, 3, and 4 also appear to show this tendency for lighter birds to have a higher fertility although not in rate of lay. Flock 1 where feed was

restricted had the lightest birds and the best fertility of the five flocks.

The birds in these five flocks that received the longest day of light had the highest rate of lay. This agrees with the findings in the 75 flocks studied (Table 31).

SEASONALITY OF EGG PRODUCTION OF FIVE FLOCKS COMPARED TO EXPERIMENTAL FINDINGS

Figure 16 gives a five-day simple average curve of the combined seasonal egg production for the five flocks previously discussed and a curve of experimental results by Parker. It took the five flocks (2,951 hens) an average of 16 days to reach 50 per cent production from date of first egg. One flock reached this production figure in 10 days after laying started, whereas another flock never reached 50 per cent lay. Parker's flock (22 hens) took 14 days to reach 50 per cent lay (28, p. 119).

It is interesting to note that 27 days after the five flocks began to lay was the peak of their production. The first dip in this curve was probably due to broodiness. After this dip occurred, egg production picked up somewhat but never reached the peak of 27 days after laying commenced. The curve tends to fall rather steadily after the peak in egg production was reached except for a few ups and downs. Parker's flock reached its peak at about 105 days after laying commenced (28, p. 119). The difference between the two curves could be a result of the size of the sample in each case and variations in management factors.

SEASONAL VARIATION IN EGG PRODUCTION FOR FIVE FLOCKS PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PERCENT LAY OBTAINED FROM DAILY EGG RECORD, WESTERN OREGON, 1949 SEASON PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

	5 Flocks 1/	Parker 2/
Number of hens started	~~2951~~ 2906	22
Percent hen mortality	3.9	2.0
Days of artificial light before laying	18.0	21
Length of day, hrs.	14.5	14
Length of laying season, days	131	140
Total eggs	~~179,305~~ 179,371	1861
Total eggs laid per hen	64.2	86.5
Eggs set per hen	56.76	80.7
Age of hens when laying started, wks	35	38
Average percent lay	49.52	61.8
Average percent fertility	71.8	85.9

See footnotes given with data on next page

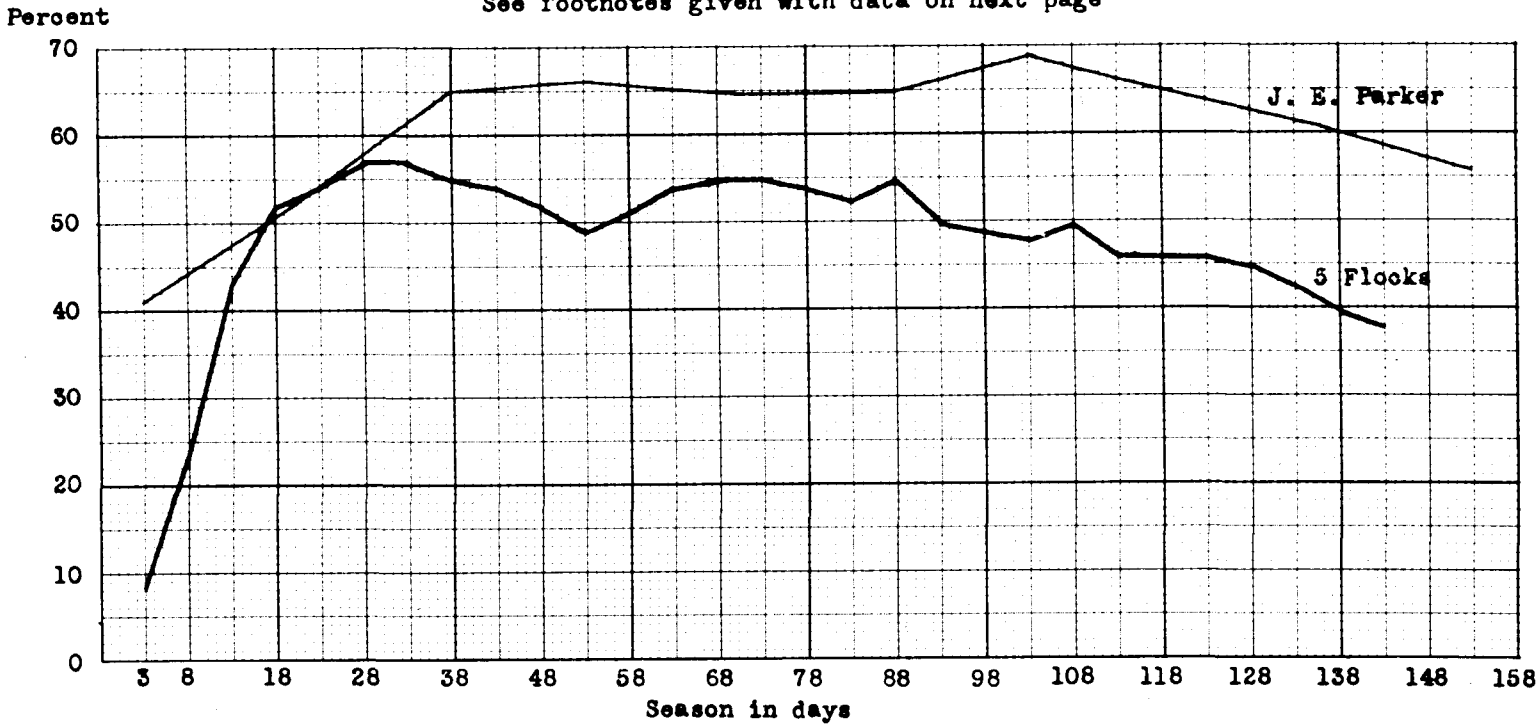


Figure 16

TABULATION OF DATA FOR FIGURE 16

Table 50. SEASONAL VARIATION IN EGG PRODUCTION FOR FIVE FLOCKS PLOTTED ON A FIVE-DAY SIMPLE AVERAGE OF PER CENT LAY OBTAINED FROM DAILY EGG RECORDS, WESTERN OREGON, 1949 SEASON, BROAD BREASTED BRONZE

2,906 Hens; 179,371 Eggs

Laying season in days	Per cent lay	Laying season in days	Per cent lay	Laying season in days	Per cent lay
3	8	53	49	103	47
8	23	58	51	108	50
13	43	63	54	113	46
18	52	68	55	118	46
23	54	73	55	123	46
28	57	78	54	128	45
33	57	83	53	133	43
38	55	88	55	138	40
43	54	93	50	143	38
48	52	98	49		

Source: Oregon State College turkey hatching egg cost study, 1949. All figures except number of hens started and total eggs were calculated on a simple average of 5 records.

Table 51. INFLUENCE OF SEASON ON EGG PRODUCTION, TWO YEAR AVERAGE, 1945-1946 1/, BROAD BREASTED BRONZE: 22 hens; 1,861 eggs

Date	Per cent lay	Date	Per cent lay
Late Jan.	40.9	Early Apr.	65.4
Early Feb.	51.9	Late Apr.	69.1
Late Feb.	64.9	Early May	64.6
Early Mar.	65.6	Late May	61.1
Late Mar.	64.8	Early June	55.5

1/ Source: (28, p. 118-121)

This seasonal egg production curve representing five flocks was plotted to emphasize the decline in egg production which must be kept in mind as one extends the egg season into late spring. As the season progresses, fewer eggs are laid and the number of infertile eggs increases. The economic importance of rate of lay has been shown in Table 37. Egg production for the 77 flocks ranged from a low of 36 eggs per hen in one flock to a high of 80 eggs per hen in another flock.

FERTILITY. Another very important factor, along with egg production, which affects costs and returns is fertility. Turkey eggs are produced for the sole purpose of obtaining poults. Every egg produced costs the producer so much regardless of whether it is fertile or not. Low fertility in any size of flock is costly. In the 77 flocks studied, fertility ran from 52.3 per cent to 84.0 per cent for the season. The cost of production per egg for these two flocks was 33.68¢ for the 52.3 per cent fertility flock whose egg production was 61.5 eggs per hen, and 22.78¢ for the 84.0 per cent flock whose egg production was 80.0 eggs per hen. Table 11 on page 26 shows the results of a decrease in fertility and its effect on returns.

Fertility apparently is not inherited according to some experimental workers, but is a result of management. However, recent findings by Harper and Parker using artificial insemination showed that there are family differences in fertility of turkeys. The range in fertility of eggs in their study after the first insemination was from 100.0 to 60.9 per cent (15, p. 473).

SEASONAL VARIATION IN FERTILITY OF ALL TURKEY EGGS SET FOR 19 FLOCKS, WESTERN OREGON, 1949 SEASON, PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

	19 Flocks 1949 1/	Harper 1947 2/	Parker 1947 3/
Eggs set per hen	54.1 4/	45.9	80.7
Length of laying season, days	131	103	140
Tom-hen ratio	8.1 5/	10	11
Light-days toms got before mating	6	21	21
Age of toms when mating began, wks	32	32	35
Average percent fertility	69.58 6/	81.8	85.9
Hens started	9708	159	22
Percent flock mortality	7.21	7.50	2.0
Percent lay	46.46 4/	49.07 7/	61.8
Total eggs	552,232	7273	1861
Total eggs laid per hen	60.39 4/	49.66 8/	86.5

See footnotes given with data on next page

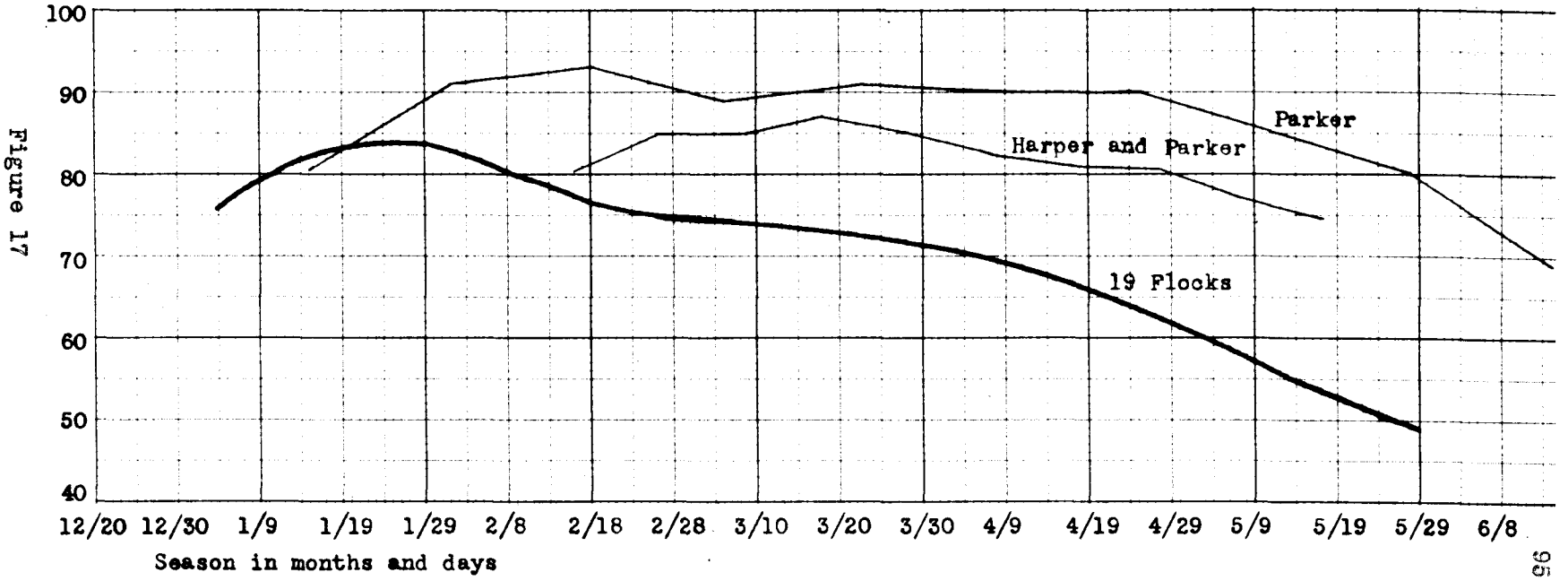


Figure 17

TABULATION OF DATA GIVEN IN FIGURE 17

Table 52. SEASONAL VARIATION IN FERTILITY OF ALL TURKEY EGGS SET FOR NINETEEN FLOCKS, WESTERN OREGON, 1949 SEASON 1/ Broad Breasted Bronze 9,708 Hens; 552,232 Eggs

Date	% Fert.	Date	% Fert.	Date	% Fert.
1/4	76.0	2/23	75.0	4/14	67.4
9	79.5	28	74.7	19	65.7
14	81.7	3/5	74.3	24	64.0
19	83.4	10	74.0	29	61.5
24	84.0	15	73.4	5/4	59.7
29	83.5	20	72.8	9	57.0
2/3	82.0	25	72.0	14	54.8
8	80.4	30	71.5	19	52.6
13	78.5	4/4	70.3	24	50.7
18	76.7	9	69.0	29	49.0

1/ Source: Oregon State College turkey hatching egg cost study, 1949
4/ Calculated on average number of hens
5/ Calculated on average number of toms and hens
6/ Simple average of all flocks

Table 53. INFLUENCE OF SEASON ON FERTILITY OF TURKEY HATCHING EGGS 3/ Broad Breasted Bronze: 22 hens; 1861 eggs

Date	% Fertility	Date	% Fertility
Late Jan.	81.3	Early April	89.6
Early Feb.	90.6	Late April	89.9
Late Feb.	93.2	Early May	85.2
Early Mar.	89.0	Late May	79.6
Late Mar.	91.4	Early June	69.1

3/ Source: (28, p. 119), J. E. Parker, Poultry Science, Volume 26, March, 1947, pp. 118-121.

Table 54. SEASONAL VARIATION IN FERTILITY OF BROAD BREASTED BRONZE TURKEY EGGS 2/ 159 Hens; 7273 Eggs

Date	% Fertility	Date	% Fertility
Feb. 16	80.5	April 7	82.5
26	85.0	17	81.0
Mar. 8	85.0	27	80.3
18	87.0	May 7	77.0
28	85.0	17	75.0

2/ Source: (14, p. 4)
7/ Calculated on hen-day basis
8/ Calculated on hen-housed basis

Seasonal fertility figures were obtained for 19 flocks having a total of 9,708 hens that laid 552,232 eggs. A freehand curve was fitted to these data. The curve is shown in Figure 17 on page 95 along with actual findings by Parker, and Harper and Parker. This curve for the 19 flocks is lower than the findings by experimental work. This difference between these curves is probably due to (1) larger number of birds considered in the 19 flocks and (2) the difference in the candling-out process. It is estimated by experimental workers that one-third of the eggs ordinarily candled out as being infertile are actually found to be fertile when all such eggs are broken out. These dead embryos are due to hatchability causes and not to any lack of fertility. Hatchability will be discussed later in the text. Commercial hatcheries candle out on about the 14th day or the 24th day, but do not break out the eggs as was done in the experiments by Parker and Harper and Parker just referred to. Therefore, it is not surprising to find that the curve representing the 19 flocks is lower than experimental evidence curve.

It has been shown in Table 11 that around 71 per cent fertility tends to be the breaking even point where returns equal net costs, not considering egg production. This figure occurs on the fertility curve for the 19 flocks on about April 1. In this table just referred to, 60.8 per cent fertility is the point where returns equal cash costs. This fertility figure occurs on the fertility curve for the 19 flocks on May 1, after which the fertility falls rapidly.

Because of the increase in number of infertile eggs later in the season, it is of interest to see if semen production by the males

ordinarily declines as the season progresses, and if motility of the sperm remains the same throughout the season. There was no such data available in the survey here reported, so no comparison can be made. However, it is believed that such data have their place in this discussion. For this reason, work done by Parker in 1946 with Broad Breasted Bronze turkeys is cited (see Table 55) (27, p. 65).

The number of sperms per collection continued to increase until the latter part of March after which there was a slight tendency to decline. The motility tended to remain about the same. It would appear, therefore, that the decline in fertility of the hatching eggs produced on the 19 farms studied, which started about February 1 (Figure 17), was due to some factors other than the amount, concentration, or motility of semen produced by the toms.

HATCHABILITY OF ALL EGGS SET. Data on hatchability of all eggs set were obtained for nine flocks, all shipping to the same hatchery. These flocks had a total of 5,316 hens and 292,161 eggs. A freehand curve was drawn to fit the hatchability of all eggs set for these nine flocks (Figure 18). The curve of the nine flocks is compared with work done by Harper and Parker, and unpublished data by Parker.

The three curves follow quite closely in the seasonal decline. It is interesting to note that the curve of hatchability of all eggs set for the nine flocks (Figure 18) and the fertility curve for 19 flocks (Figure 17) are nearly identical except that hatchability runs lower which is to be expected. The seasonal fertility average of the 19 flocks was 69.6 per cent and the seasonal average hatchability of all eggs set was 54.6 per cent.

Table 55. SEASONAL VARIATIONS IN CHARACTERISTICS OF SEMEN PRODUCTION OF BROAD BREASTED BRONZE TOMS

(Data based on the average of six toms)

Date	Toms producing semen	Volume	Density-sperm concentration per cu. mm.	Number of sperm	Motility
	(number)	(cc.)	(millions)	(billions)	(score*)
12/11	3	.053	1.43	0.07	---
12/15	3	.111	1.20	0.15	3.0
12/18	6	.133	1.20	0.16	3.3
1/1	6	.265	4.53	1.34	3.0
1/15	6	.295	5.50	1.58	2.8
1/29	6	.290	6.64	1.90	4.8
2/12	6	.340	6.03	2.05	3.7
2/26	6	.298	8.92	2.73	4.2
3/13	6	.308	7.56	2.34	4.3
3/27	6	.383	10.04	3.84	4.2
4/10	6	.387	8.99	3.51	3.7
4/24	6	.333	9.41	3.23	3.0
5/9	6	.367	9.69	3.51	3.8
5/24	6	.302	10.10	3.00	4.7
6/6	6	.292	9.82	2.82	4.2

*Score of "5" indicated that a large percentage of spermatozoa showed vigorous movement.

Source: (27, p. 65)

These three curves put all the data on a more comparable basis because the difference in the candling out of infertile eggs by the commercial hatcheryman and experimental workers is eliminated.

Experimental work done by the Maryland Station showing that hatchability is inherited and that it can be improved by selective breeding is shown on page 70.

HATCHABILITY OF FERTILE EGGS. Data obtained on hatchability of all eggs set for the nine flocks previously discussed also contained data on hatchability of all fertile eggs set. A freehand curve shown in Figure 19 was drawn to fit the data plotted for the nine flocks which had a total of 5,316 hens and 292,161 eggs giving the hatchability of all fertile eggs from these flocks set by the same hatchery.

Experimental findings by Parker, and Harper and Parker were plotted in curves and compared to the nine flocks (Figure 19). The experimental work gives curves lower than that for the nine flocks. This difference is accounted for in part by the method used in candling out of infertiles which was previously discussed. The reason why the experimental curves drop more towards the end of the season is due to the fact that the number of early dead embryos increases as the season progresses. Work done by Martin at Kentucky in 1935 showed that there is a critical period early in embryonic life and a second such period during the latter part of the incubation period (25, p. 164). He reports that the peak of the first critical period occurred on the fourth day and the peak of the second such period occurred on the 25th day. The early embryonic mortality (up to the fourth day) accounted for about 20 per cent of the total mortality due to hatchability causes.

SEASONAL VARIATION IN HATCHABILITY OF ALL TURKEY EGGS SET BY SAME HATCHERY FOR NINE TURKEY FLOCKS, WESTERN OREGON 1949 SEASON, PLOTTED WITH EXPERIMENTAL EVIDENCE. BROAD BREASTED BRONZE

	Nine Flocks 1949 1/	Harper and Parker, 1947 2/	Parker 1947 3/
Hens started	5316	159	22
Flock mortality, per cent	9.15	7.5	2.0
Percent lay	46.44 4/	49.07 5/	61.8
Total Eggs	292,161	7273	1861
Total Eggs laid per hen	59.05 4/	49.66 6/	86.5
Eggs set per hen	52.22 4/	45.9	80.7

See footnotes given with data on next page

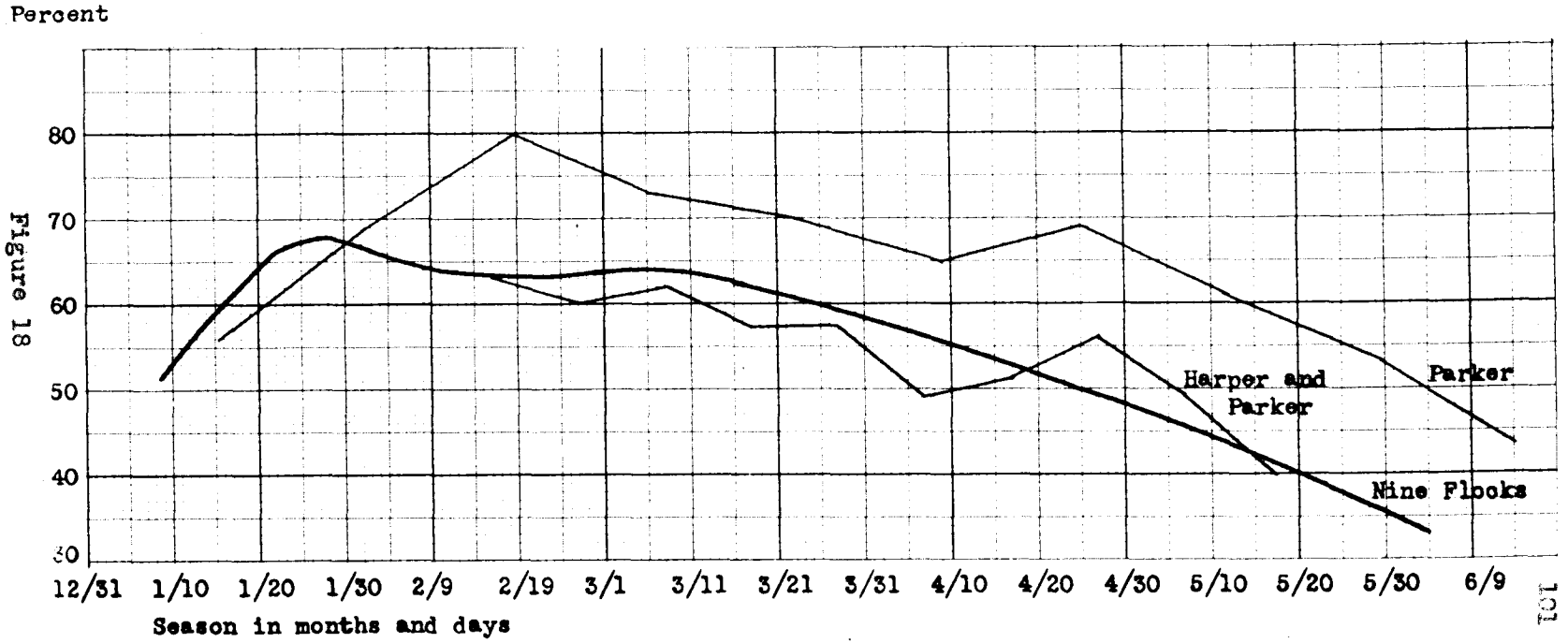


Figure 18

TABULATION OF DATA GIVEN IN FIGURE 18

Table 56. SEASONAL VARIATION IN HATCHABILITY OF ALL TURKEY EGGS SET BY SAME HATCHERY FOR NINE FLOCKS, WESTERN OREGON, 1949 SEASON 1/
Broad Breasted Bronze: 5,316 Hens; 292,161 Eggs

Date	% Hatch.	Date	% Hatch.	Date	% Hatch.
Jan. 10	53.0	Mar. 1	63.8	Apr. 20	51.9
15	59.0	6	64.0	25	50.0
20	64.5	11	63.2	30	48.0
25	67.2	16	62.5	May 5	46.0
30=	67.0	21	61.0	10	44.0
Feb. 4	65.2	26	60.0	15	42.2
9	64.0	31	58.2	20	40.0
14	63.0	Apr. 5	57.0	25	38.0
19	63.0	10	55.1	30	35.5
24	63.2	15	53.7	June 4	33.0

1/ Source: Oregon State College turkey hatching egg cost study, 1949
4/ Calculated on average number of hens

Table 57. THE INFLUENCE OF SEASON ON HATCHABILITY OF ALL TURKEY EGGS SET 3/ Broad Breasted Bronze: 22 Hens; 1,861 Eggs

Date	% Hatch.	Date	% Hatch.
Late January	56.25	Early April	64.85
Early February	69.06	Late April	69.18
Late February	80.06	Early May	61.07
Early March	72.55	Late May	54.05
Late March	69.95	Early June	42.57

3/ Source: (28, p. 119) (The above data, "Hatchability of All Eggs Set," was obtained with the study stated, but was not published.)

Table 58. SEASONAL VARIATION IN HATCHABILITY OF ALL EGGS SET OF BROAD BREASTED BRONZE TURKEY EGGS 2/ 159 Hens; 7,273 Eggs

Date	% Hatch.	Date	% Hatch.
February 16	63.0	April 7	49.0
26	60.0	17	51.2
March 8	62.0	27	56.0
18	57.5	May 7	49.0
28	57.5	17	40.0

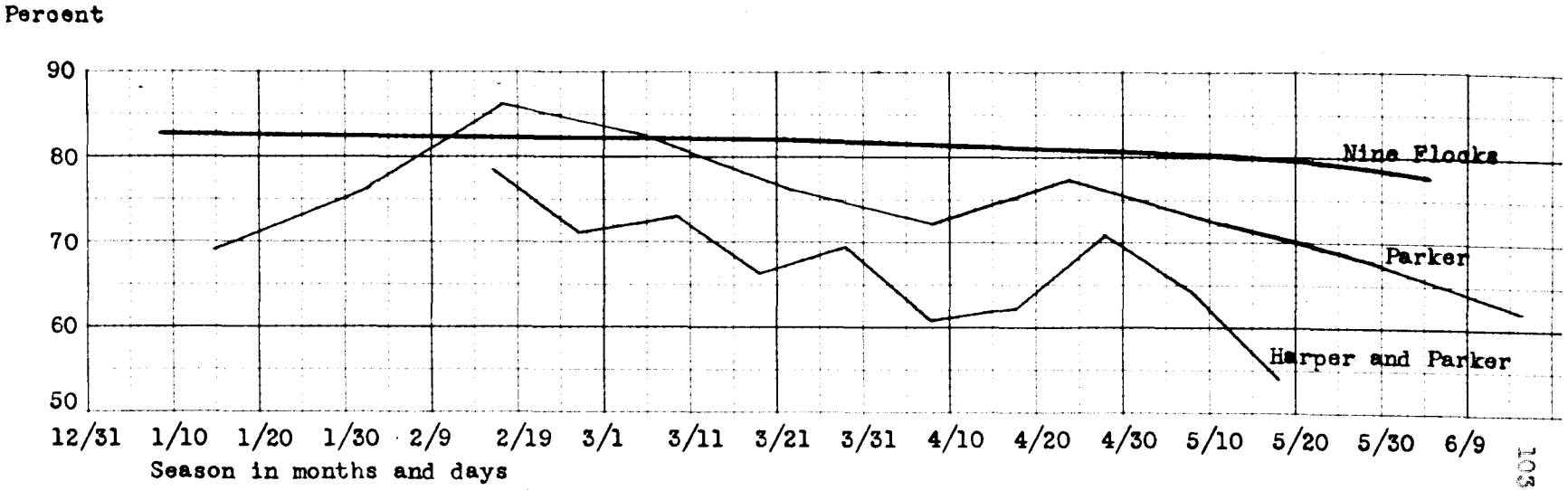
2/ Source: (14, p. 4)
5/ Calculated on hen-day basis
6/ Calculated on hen-housed basis

SEASONAL VARIATION IN HATCHABILITY OF FERTILE TURKEY EGGS SET BY SAME HATCHERY FOR NINE FLOCKS, WESTERN OREGON, 1949 SEASON, PLOTTED WITH EXPERIMENTAL EVIDENCE, BROAD BREASTED BRONZE

	Nine Flocks 1949 1/	Harper and Parker, 1947 2/	Parker 1947 3/
Hens started	5316	159	22
Flock mortality, per cent	9.15	7.5	2.0
Percent lay	46.44 4/	49.07 5/	61.8
Total Eggs	292,161	7273	1861
Total Eggs laid per hen	59.05 4/	49.66 6/	86.5
Eggs set per hen	52.22 4/	45.9	80.7

See footnotes given with data on next page

Figure 19



TABULATION OF DATA GIVEN IN FIGURE 19

Table 59. SEASONAL VARIATION IN HATCHABILITY OF FERTILE TURKEY EGGS SET BY THE SAME HATCHERY FOR NINE FLOCKS, WESTERN OREGON, 1949 SEASON 1/ Broad Breasted Bronze; 5,316 Hens; 292,161 Eggs

Date	% Hatch.	Date	% Hatch.	Date	% Hatch.
1/10	82.5	3/1	81.9	4/20	80.5
1/15	82.5	3/6	81.8	4/25	80.3
1/20	82.5	3/11	81.7	4/30	80.0
1/25	82.5	3/16	81.6	5/5	79.9
1/30	82.5	3/21	81.5	5/10	79.7
2/4	82.3	3/26	81.4	5/15	79.5
2/9	82.2	3/31	81.2	5/20	79.2
2/14	82.1	4/5	81.0	5/25	78.8
2/19	82.1	4/10	80.9	5/30	78.0
2/24	82.0	4/15	80.7	6/4	77.6

1/ Source: Oregon State College turkey hatching egg cost study, 1949

4/ Calculated on the average number of hens

Table 60. INFLUENCE OF SEASON ON HATCHABILITY OF FERTILE EGGS 3/ Broad Breasted Bronze; 22 Hens; 1,861 Eggs

Date	% Hatch.	Date	% Hatch.
Late Jan.	69.2	Early April	72.4
Early Feb.	76.3	Late April	77.0
Late Feb.	85.9	Early May	71.7
Early March	81.5	Late May	67.9
Late March	76.5	Early June	61.6

3/ Source: (28, p. 119)

Table 61. SEASONAL VARIATION IN HATCHABILITY OF FERTILE EGGS SET 2/ Broad Breasted Bronze; 159 Hens; 7,273 Eggs

Date	% Hatch.	Date	% Hatch.
Feb. 16	78.5	April 7	60.6
26	71.0	17	62.0
Mar. 8	73.0	27	70.3
18	66.0	May 7	64.0
28	69.0	17	54.0

2/ Source: (14, p. 4)

5/ Calculated on hen-day basis

6/ Calculated on hen-housed basis

There are many things which affect hatchability which cannot be measured by the data obtained by this survey. Such things as weight of egg, shell texture, shell color, nutritional deficiencies, handling of eggs, conditions during incubation like too high or too low humidity, poor ventilation, and temperature all account for differences in hatchability.

FERTILITY AND HATCHABILITY OF NON-ROOST AND ROOST EGGS. An opportunity presented itself for studying fertility and hatchability of non-roost and roost eggs for one flock. This flock had 641 hens which laid 50,111 eggs. Of this number, 4,273 eggs were roost eggs and 38,675 were non-roost eggs. The remainder were farm culls, hatchery rejects, and custom incubated.

This particular flock was housed at night in a barn shown in Figure 20. Sawdust was used as litter and as it became contamina-

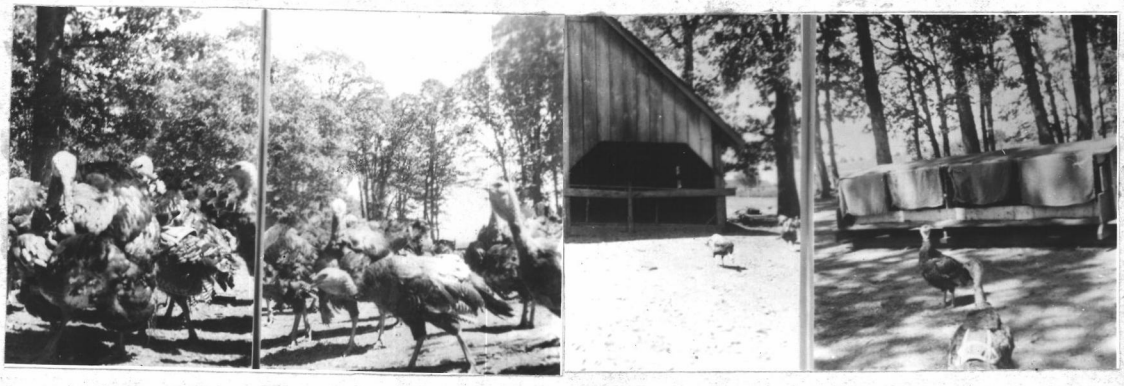


Figure 20.

ted with manure, more sawdust was added to give a built-up litter effect. This built-up litter, according to the operator, helped to keep the birds warm and aided in drying off the birds when they became wet. Grain was fed in the barn at night. Broody pens were

located on the side of the barn which saved considerable labor in handling of broody hens. After the main flock of birds were in the barn at night, the broody hens were chased out of the nests and herded into the broody pens.

In January, 1948, when snow and frost covered the ground, the birds that were housed at night in this barn had a high rate of lay while other flocks in the community dropped off considerably in egg production. Another feature of this setup is that during wet weather the birds get a chance to dry off. The next morning the birds are more active and mating is increased.

This operator has had a good lay the last two years. The seasonal average of fertility for 1949 was 64.8 per cent, but last year it was considerably higher. All nests were kept out in the breeding yard.

Figure 21 presents curves for fertility of non-roost and roost eggs, hatchability of all non-roost and roost eggs set, and hatchability of fertile non-roost and roost eggs.

Fertility of the roost eggs dropped off faster as the season progressed than did the fertility of the non-roost eggs. This is probably because as more manure is added to the litter, the eggs become contaminated with a greater number of bacteria or molds. The same is true for hatchability of all eggs set.

Hatchability of fertile roost eggs dropped a little more as the season progressed than did fertile non-roost eggs, probably because of the contamination with the manure. Hatchability of fertile non-roost eggs is about the same as the curve shown for the nine flocks.

AN INDIVIDUAL EGG RECORD SHOWING HATCHABILITY AND FERTILITY OF ROOST EGGS AND NON-ROOST EGGS, 1949

Hens started	641
Percent flock mortality	4.9
Percent lay	42.1 1/
Total eggs	50,111
Total eggs laid per hen	80 1/
Eggs set per hen	71.8 1/
Days in laying season	190
Tom-Hen ratio	8.2 2/
Days of light toms got before mating	6
Age of toms when hens started to lay	--
Age of hens when laying started, wks.	38
Number of roost eggs set	4,273
Number of non-roost eggs set	38,675 3/

See footnotes given with data on next page

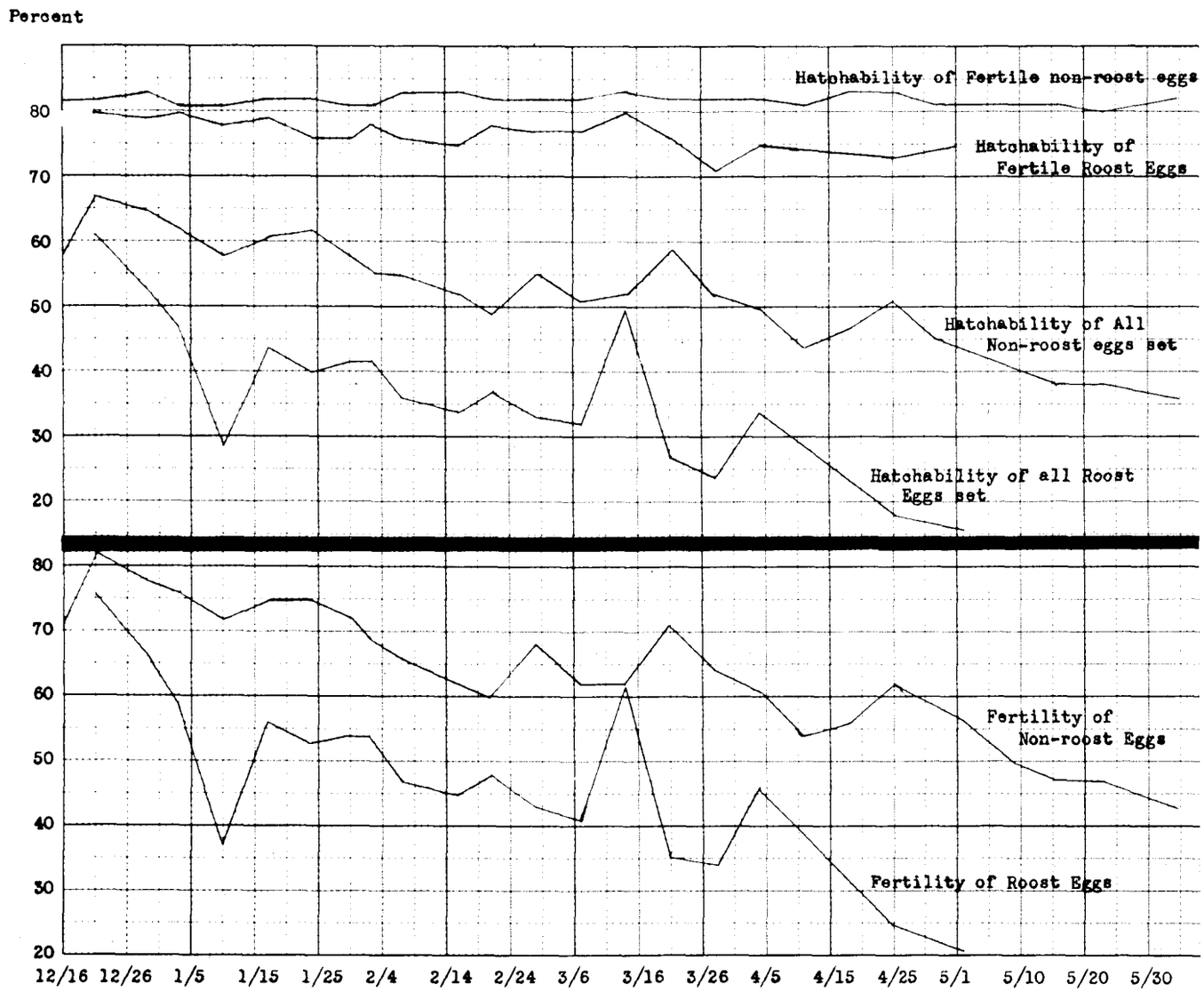


Figure 21

TABULATION OF DATA GIVEN IN FIGURE 21

Table 62. SEASONAL VARIATION IN FERTILITY AND HATCHABILITY OF NON-ROOST EGGS AND ROOST EGGS, ONE FLOCK, WESTERN OREGON, 1949 SEASON
641 Hens; 50,111 Eggs

Date	Fert. of non-roost eggs, %	Fert. of roost eggs, %	Hatch. of all non-roost eggs, %	Hatch. of roost eggs,%	Hatch. of fertile non-roost eggs, %	Hatch. of fertile roost eggs, %
12/16	70.7	-----	58.0	-----	82.0	-----
21	81.5	76.0	66.7	60.8	81.8	80.0
29	78.2	67.3	64.6	53.2	82.6	79.0
1/3	75.9	58.7	61.6	47.0	81.2	80.0
10	72.2	37.0	58.5	28.9	81.0	78.0
17	74.7	55.9	61.3	43.6	82.1	78.6
24	74.8	52.8	61.7	40.3	82.5	76.4
31	71.7	54.3	58.3	41.5	81.3	76.4
2/2	69.0	54.2	55.8	42.2	80.9	77.9
7	66.3	47.2	55.3	35.8	83.4	75.8
16	62.0	45.3	51.6	33.9	83.2	74.9
21	59.7	47.5	48.7	37.2	81.6	78.4
28	67.5	43.0	55.4	33.2	82.0	77.3
3/7	62.3	41.2	51.0	31.9	82.0	77.4
14	62.2	62.2	51.6	49.6	82.9	79.8
21	71.1	34.9	58.7	26.6	82.5	76.3
28	63.6	34.4	52.0	24.4	81.7	70.9
4/4	61.0	45.5	50.1	33.9	82.1	74.6
11	53.9	-----	43.7	-----	81.3	-----
18	56.1	-----	46.6	-----	83.1	-----
25	61.5	24.6	50.9	18.0	82.7	73.2
5/2	56.0	21.0	45.2	15.8	80.8	75.1
9	50.0	-----	40.6	-----	81.3	-----
16	47.0	-----	38.0	-----	80.9	-----
23	47.2	-----	37.6	-----	79.6	-----
6/3	43.3	-----	35.5	-----	82.1	-----

Source: Oregon State College turkey hatching egg cost study, 1949

1/ Calculated on average number of birds for the season

2/ Calculated on average number of toms and hens

3/ Remainder of eggs was farm culls, hatchery rejects, and custom hatched.

Although the number of roost eggs in this case is small, it does represent a loss to the producer. No data were available to compare roost eggs of birds not housed at night to birds housed at night, but it is believed that the percentage of roost eggs for birds not housed at night is lower because the birds get a chance to go to the nest when the lights are turned on, if the birds desire to do so.

SUMMARY AND CONCLUSIONS

Some of the findings in this study may be of considerable aid to various turkey hatching egg producers of Oregon in answering some of their "pet" questions on different breeder flock management practices, such as: "When should breeders be hatched? How much mash should I feed in my total ration? What supplements should I feed? How do my flock's egg production and fertility figures compare to the average? What effect does weight of hens and toms have on fertility? Does feed restriction (to reduce body weight prior to laying) harm the birds? What length of day should I use? What effect does protein content have on fertility?" and so on.

The following statements made may not be too conclusive, but it is believed that they indicate trends or shed some light on the different factors that affect fertility and which should be confirmed by experimental work.

DATE OF HATCH. No relationship was found to exist between date of hatch and fertility, or age when hens started to lay to fertility. Birds hatched early in June will mature early if given proper prelighting.

DATE OF FIRST EGG. There was no relationship between date of first egg and fertility.

FEED PER BIRD PER DAY. Low feed consumption (feed that was hand fed) below 0.649 pound per bird per day gave higher fertility than feed consumption above this amount (0.649 pound per bird per day).

EFFECTS OF DIFFERENT PERCENTAGES OF MASH IN TOTAL FEED. The desirable balance between mash and whole grain lies between 50 and 60 per cent mash and the remainder whole grain. Mash-grain ratios had no relationship to fertility.

PER CENT PROTEIN IN TOTAL FEED. No relationship was found between protein in total feed fed and fertility or rate of lay. Protein is one of the higher-priced nutrients in the feed, and, according to this study, it may be profitable to feed a low-protein ration (under 13 per cent).

EFFECTS OF SUPPLEMENTS. Feeding of alfalfa meal indicates that it may be beneficial to high fertility. Feeding of supplements (milk, alfalfa, and milk and alfalfa) gives better fertility than feeding of no supplements.

EFFECTS OF WEIGHT OF BIRDS AND FEED RESTRICTION. There is some indication that lighter (smaller) toms are associated with high fertility. Furthermore, heavy toms result in a higher cost per egg and less return to the operator for his efforts. Feed restriction to reduce body weight prior to laying did not affect egg production, rate of lay or fertility; in fact, it seemed somewhat beneficial as a lower cost per egg resulted.

EFFECTS OF DATE OF HATCH, WEIGHT WHEN HENS STARTED TO LAY, AND AGE OF TOMS ON FERTILITY. Date of hatch, age of toms when hens started to lay had no relationship to fertility. Weight of toms when hens started to lay showed a slight relationship. The lighter toms resulted in higher fertility.

EFFECTS OF LENGTH OF DAY ON EGG PRODUCTION AND FERTILITY. Longer length of day (14 hours) gave a better fertility, rate of lay, and lower cost per hatching egg. Also, the hens that received the longer day started to lay a week earlier.

EFFECT OF WHEN LIGHTS WERE TURNED OFF UPON EGG PRODUCTION, FERTILITY, COSTS AND RETURNS. The date when lights were turned off had no relationship to rate of lay, fertility, or cost per egg. Lights should be left on until April 24 to obtain 14 hours of daylight.

EFFECTS OF LIGHT TREATMENT OF TOMS ON FERTILITY. Prelighting of toms 22 days before mating gave the best fertility.

EFFECT OF RATE OF LAY ON FERTILITY AND COSTS AND RETURNS. Rate of lay had no relationship to fertility, but it had a direct relationship to returns and an inverse relationship to costs.

EFFECTS OF AGE OF TOMS TO HENS ON FERTILITY. Toms younger than hens gave the poorest fertility. Toms older than hens and crossing of strains gave the best fertility.

EFFECTS OF ROTATION OF TOMS ON FERTILITY. Rotation of toms did not increase fertility enough to warrant the effort required to rotate toms.

EFFECTS OF DATE SOLD AND LENGTH OF LAYING SEASON ON EGG PRODUCTION, FERTILITY, COSTS, AND RETURNS. Flocks with a long laying season (136 days) and sold before May 21 had the lowest cost and made the greatest return per egg. In general, the later the birds were sold, the lower the fertility. No relationship was found between egg production and date sold.

EFFECTS OF RELATIVE NUMBER OF TOMS USED TO FERTILITY, COSTS AND RETURNS. A tom-hen ratio of 1 : 6.9 or less gave the highest fertility; however, no relationship existed between tom-hen ratios and fertility. Egg production exerted a greater influence on cost and return per egg than did fertility. It may be desirable to use fewer toms and try to maintain good egg production for greatest return.

EFFECTS OF LEGUME RANGE VS. NON-LEGUME RANGE ON EGG PRODUCTION, FERTILITY, COST AND RETURN. Legume range gave a better rate of lay, lower costs and a slightly better fertility than non-legume range.

EFFECTS OF HOLDING PERIOD OF EGGS ON FERTILITY. There was a slight decline in fertility in eggs held over eight days.

EGG PRODUCTION. The peak in egg production occurred at 27 days after laying commenced. After about five days of this rate of lay there was a steady decline in egg production for about 20 days. Egg production then increased for about 15 days to slightly below the peak when there was a gradual decline to the last two weeks at which time egg production fell off rapidly. Fifty per cent lay was reached after 16 days of date of first egg.

FERTILITY. Fertility increases at the beginning of the season for about 20 days when the peak is reached. After this peak, there is a gradual decline with a rapid dropping off starting about 25 days before the end of the season.

HATCHABILITY OF ALL EGGS SET. Hatchability of all eggs set curve follows the fertility curve but is generally about 15 per cent lower throughout the season.

HATCHABILITY OF FERTILE EGGS SET. This curve dropped about five per cent for the season.

FERTILITY AND HATCHABILITY OF ROOST EGGS. As the season progresses, the fertility and hatchability of roost eggs drop more than for non-roost eggs. This is probably because of a higher concentration of bacteria and molds as the manure increases and the weather becomes warmer.

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