DECEMBER, 1943 BULLETIN 320

AGRICULTURAL EXPERIMENT STATION
KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE
MANHATTAN, KANSAS

GRASS AND ALFALFA AS SILAGE, FORAGE AND MEAL FOR POULTRY

PRINTED BY THE
KANSAS STATE COLLEGE PRESS
MANHATTAN, KANSAS
1943

TABLE OF CONTENTS

GRASS AND ALFALFA AS SILAGE, FORAGE AND MEAL FOR POULTRY[1]

LOYAL F. PAYNE AND CLARENCE L. GISH[2]

INTRODUCTION

The value of grass in the poultry diet has received new emphasis the last few years. It has been recognized for centuries that green feed was of paramount importance in the poultry diet if birds were to be kept in good health. The fundamental reasons for its value were not known until recently nor are they fully understood now. In addition to more complete knowledge about the nutrients in grass plants, it is also now known at what stage the grass reaches its maximum nutritive value, and how these values can be preserved for an indefinite length of time.[3]

Experiments with different forms of grass, grass silage and alfalfa in the poultry ration were begun at Kansas Agricultural Experiment Station in the spring of 1934 and continued through 1941. The purpose of this bulletin is to present results obtained when these products were fed to growing chickens and turkeys and to laying and breeding stock. The production of cereal grasses and alfalfa for poultry ranges and for their ensiling is also presented together with data on the chemical composition of the grasses.

PRODUCTION OF CEREAL PLANTS FOR PASTURE AND SILAGE

Three types of pasture for poultry are annuals, perennials, and a combination of both. Wheat, rye and barley make good early fall, winter and spring pasture when drilled in September. Oats, when drilled about September 20, yield well and provide good pasture or green feed for silage. They can be depended upon for pasture until freezing weather, which in this section is usually late November. Emphasis has been placed on oats in these investigations since they appear to be more palatable than other grasses, are easily grown, and yield more tonnage than others except Sudan grass.

Oats are preferred for early spring pasture. The first planting can be made in late February or early March, followed by

1. Contribution No. 154 from the Department of Poultry Husbandry.

2. Clarence L. Gish, who was formerly superintendent of the college poultry farm, is now Federal-State Supervisor, State Board of Agriculture, Topeka, Kansas.

Acknowledgment.—The authors wish to acknowledge the assistance of J. S. Hughes, W. J. Peterson, and R. M. Conrad of the Department of Chemistry, for substantial aid in the early work, chemical analyses and hydrogen ion determinations, and F. C. Fenton and Chas. K. Otis of the Department of Agricultural Engineering for help in processing the silage and obtaining temperatures of same.

3. For an extensive review of the literature and a study of the composition of grass and grass silage the reader is referred to two volumes by S. J. Watson, entitled "The Science and Practice of Conservation: Grass and Forage Crops," pages 1-820, published by The Fertilizer and Feeding Stuffs, Fodder Crops, London, 1939.

successive plantings at two-week intervals until mid-April, making available immature grass for pasture until early June when Sudan grass is ready.

Sudan, the most dependable annual for summer pasture, should be drilled in rows 24 to 30 inches apart during the month of May and preferably on ground which has been winter fallowed. When Sudan is broadcast it becomes so dense that the birds can range only on the outside or get lost in a tangled mass. Approximately one month after seeding, it is large enough to pasture or cut and feed by the soiling system. When cut every two weeks, Sudan grass will provide tender green feed all summer and into the early fall, provided there is sufficient moisture. The rows should lead away from the entrance to the house to encourage the birds to range up and down the rows during the day. When used as a pasture only, every other row should be cut occasionally in order that both shade and young, tender, green feed will be provided as illustrated in Figure 1. Sudan is subject to attack by chinch bugs, and losses from these pests may be serious where fields of Sudan are close to wheat or oats when harvested.

FIGURE 1.—Sudan grass can be kept young and palatable for poultry by cutting alternate rows during the summer months. The young grass provides forage while the mature grass supplies shade. This encourages poultry to range more during the heat of the day.

Alfalfa is the most satisfactory perennial for poultry pasture in Kansas. When drilled about August 20 on a good seedbed, it will be ready to range lightly the following spring. While alfalfa is not so palatable as oats or other cereal pastures, birds will eat enough for good results. It has the advantage of pro-

viding green pasture throughout the spring, summer and fall, and maintains a solid turf which can be traveled by man, horse, or truck when servicing brooder houses on the range. The fact that one seeding of alfalfa will last four or five years, provided it is not over-pastured, means less labor in keeping a range crop available for the growing stock. It requires cutting three or four times a season. Alfalfa does not provide shade for the birds during the day, and it is inclined to lodge during wind storms. These facts suggested a combination of alfalfa and Sudan grass for poultry range.

COMBINATION OF ANNUALS AND PERENNIALS

Alternate strips 30 feet wide were drilled to alfalfa in August. The following May the unplanted strips were seeded to Sudan grass. The alfalfa provided early spring pasture and a firm sod to drive over. The Sudan grass, after early June, provided ample shade and green feed in midsummer when the alfalfa was dormant for short periods following a harvest. With this combination it was noticeable how the pullets would range among the rows of Sudan grass during the day and over the alfalfa early in the morning and late in the afternoon.

Unless the newly-sown Sudan was protected for three or four weeks by fencing or by keeping the chickens confined in the houses, it usually was killed before a good start was made.

Where soil and rainfall are suitable, alfalfa should be first choice for reasons given above. Oats, wheat, rye or barley is recommended on less fertile soil.

Ladino clover which has proved popular on portions of the east and west coasts does not do so well in Kansas, due to lack of moisture and high summer temperatures.

PREPARATION OF GRASS AND ALFALFA SILAGE FOR POULTRY

The popularity of grass silage in Europe for dairy cattle and the fairly recent introduction to the United States of the A. I. Virtanen method of preparing such silage raised the question of applying this practice of preserving immature spring grass for poultry. Since less volume is required for poultry than for larger animals, grass can be cut when its nutritive value is highest, for all year around feed if needed, and for winter and early spring use in particular.

Grass silage as the term is used here is immature young oat plant grass finely chopped, mixed with a preservative, stored in suitable containers during the spring when such material is plentiful to provide a good source of fermented greens during later seasons of scarcity.

Early workers in Europe and those in this country at present, who make silage for dairy cattle and other livestock, usually harvest the crop shortly before maturity. This gives increased

tonnage with some sacrifice in quality of product as judged by the carotene and protein content. **For poultry, emphasis is placed on immature grass, cut after the first or second joints appear.** The yield is less but that is not so important for poultry.

Chapman Dairies[4] of Kansas City, Missouri, who hold the A. I. V. patents for the United States, cooperated with the college in making grass silage for poultry. The object was to

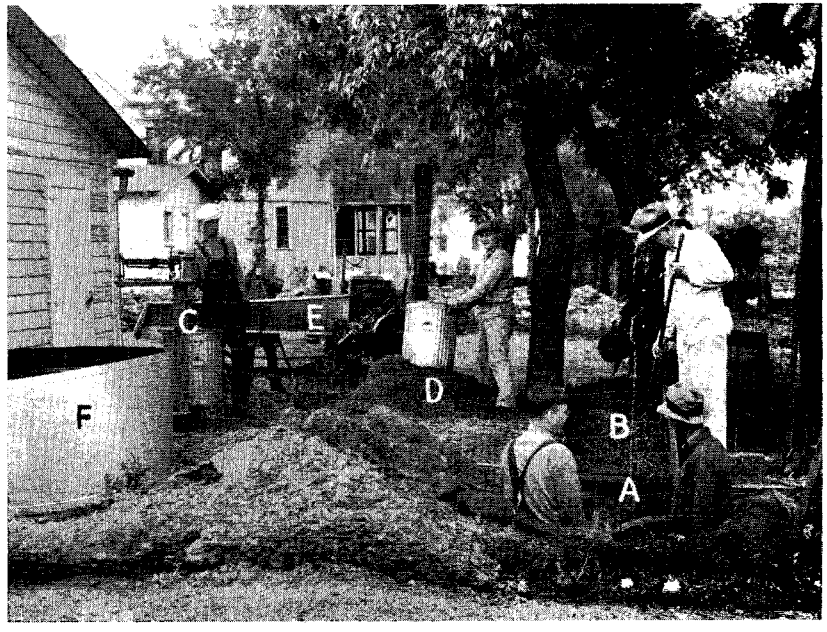


FIGURE 2.—Filling a pit silo with grass silage. The silo is represented by (A); the mixing box (B); the scales for weighing (C); the finely-chopped grass (D); the ensilage cutter (E); and the superstructure (F).

determine the practicability of storing and feeding green oat silage to poultry when treated by the A. I. V. process. This was first attempted May 18, 1934.

The immature oat grass was put through an ensilage cutter and chopped into lengths of about one inch. It was then mixed in a mortar box with acid and water according to the A. I. V. method. From there, it was tramped into a circular pit silo 3 feet in diameter by 6 feet deep. The silo was lined with building paper. A super-structure of galvanized iron 30 inches high was placed around the top of the silo. This was to provide additional capacity for grass and dirt piled on top for protection and for pressure to force air out of the chopped material. (Fig. 2.)

This process did not make good silage. It was concluded

4. Dr. John D. Hungerford, chemist for Chapman Dairies, supplied the acid and directed the preparation of the silage.

that the dry earth absorbed the acid and water before it had time to preserve the grass.

In May, 1937, a 5' by 8' pit silo was used in addition to the smaller one. Equal parts of cane molasses and water were thoroughly mixed with the chopped oat grass before it was tramped into the pits. Eight pounds, or one gallon of liquid, were sprinkled on each 100 pounds of grass. The amount of chopped oat grass placed in the smaller silo with superstructure was 3,250 pounds and in the larger silo, 6,000 pounds.

A Leeds and Northrup resistance thermometer was placed in the center of the larger silo and about 4 feet above the bottom. Temperatures recorded ranged from 78.5° F., May 17, to a maximum of 85.2° F., May 21, thus very little heating occurred. The temperature declined to 69.5° F. on July 12. The moisture content of the oat grass when cut was 83.3 percent. The moisture was increased to 86.5 percent after the molasses and water were added. The dry matter per ton of the material as stored was 270 pounds.

Samples of silage were taken from the larger silo with a soil auger June 7, 14 and 21, July 12, and November 1 and 22 for hydrogen ion (pH) determinations. The pH values for the above dates were 4.2, 4.3, 4.7, 4.9, 5.1 and 5.8, respectively. This showed a continuous rise in the pH reading and a decline in the quality of silage, probably due to the absorption of liquid by the soil surrounding the silage.

The small silo was opened November 17, six months after it was filled, and the silage appeared to be of fairly good quality. It had a pH value of 5.8 and contained only 74 percent moisture. The chemical composition of this silage analyzed November 22, 1937, was found to be as follows:

Protein	4.55 percent	Nitrogen free extract	8.34 percent
Ether extract	1.50 "	Carbohydrates	14.72 "
Crude fiber	6.38 "	pH with glass electrode	5.8 "
Moisture	74.40 "	Carotene, mg./100 gm.	14.76 "
Acidity	1.80 "		
Ash	5.80 "		

A better idea of the amount of settling which occurred in six months can be gained from Figure 3.

From this illustration it will be noted that the silage settled about 5.5 feet. It was necessary to keep this pit filled with dirt to divert surface water. In addition to the breakdown of the plant tissue, much of the moisture had been absorbed into the soil.

The contents of the smaller silo were transferred to three 55-gallon, metal barrels November 26. The barrels, being of small diameter, made it possible to remove a few inches of silage

daily and keep it in a fresh, palatable condition after the containers were opened for use. From this time on, the pit silos were abandoned and the grass silage was stored in barrels.

While this silage appeared to be of good quality and was relished by the birds, about 30 percent of the hens in one lot

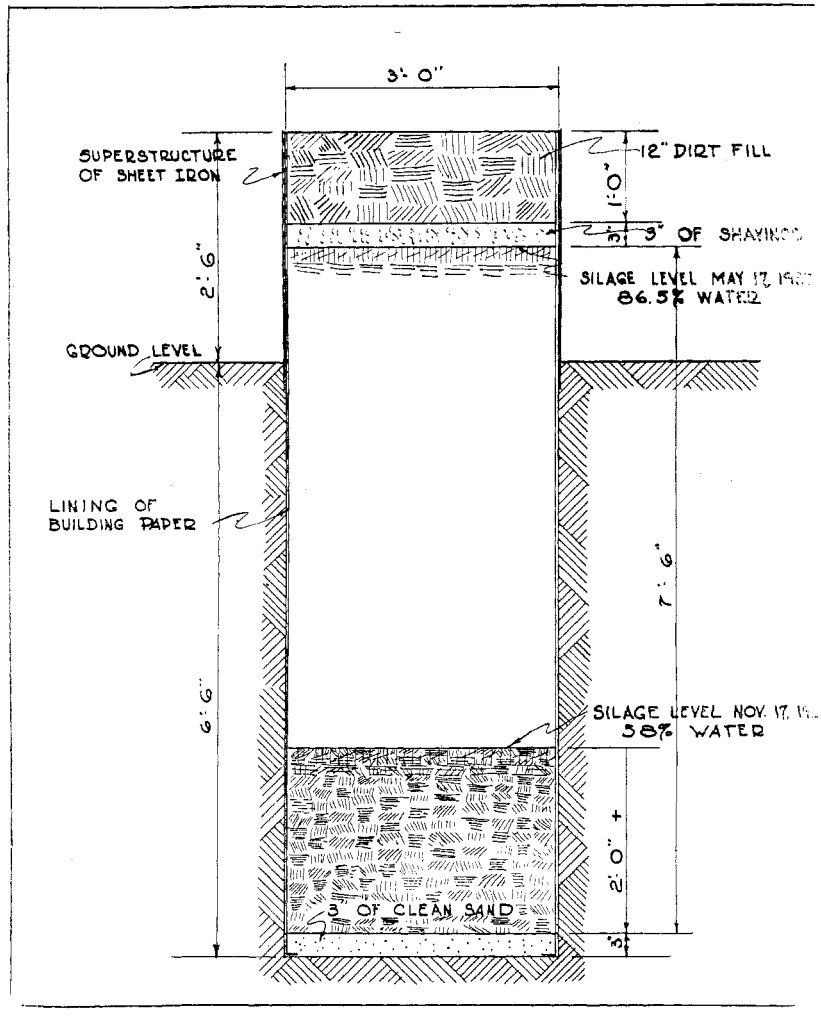


FIGURE 3.—Drawing shows size of pit silo and amount of settling of silage in six months. The grass settled from a depth of 7′6″ to 2′.

produced some eggs with olive-colored yolks commonly referred to on the market as "grass eggs," due to the greenish appearance of the eggs when examined before an egg candle. The off-colored eggs began to appear 10 days after the silage

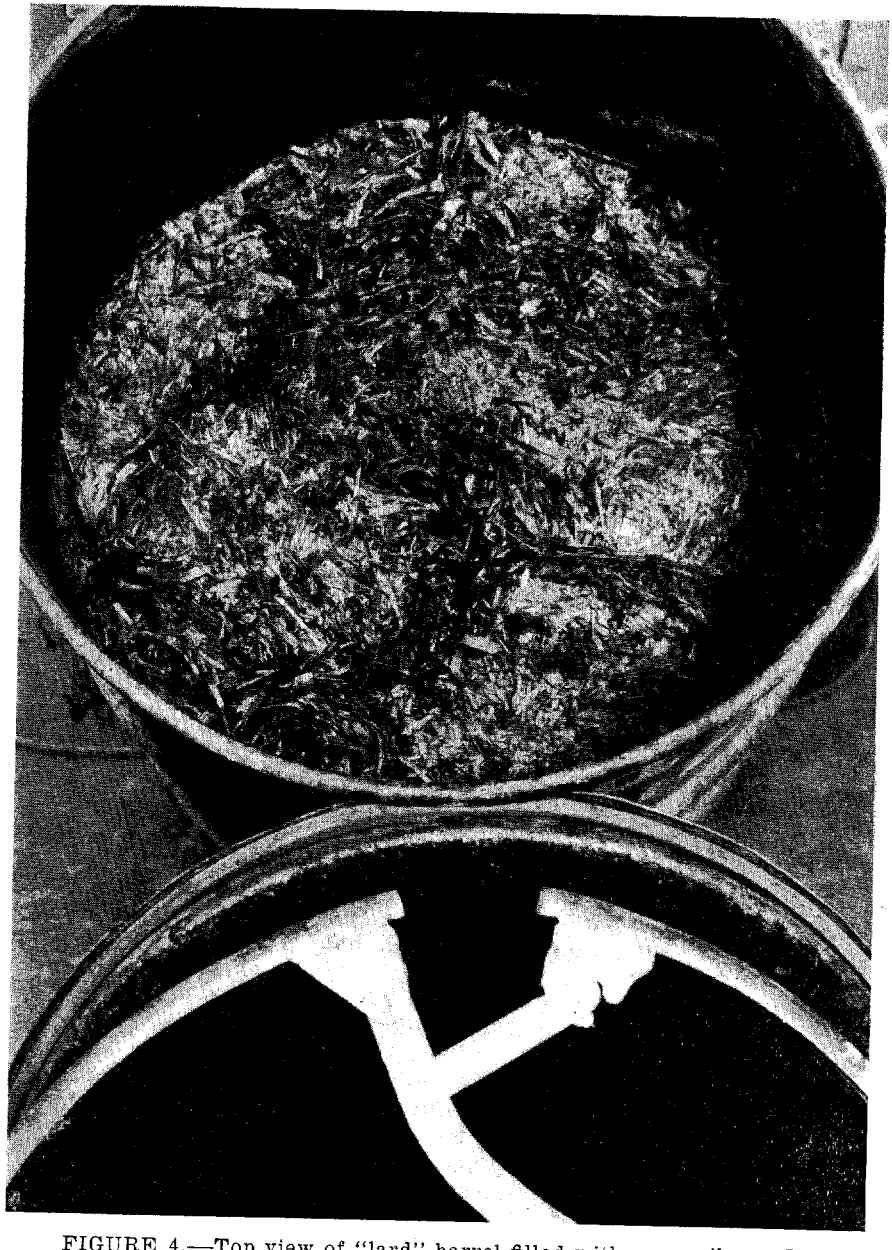


FIGURE 4.—Top view of "lard" barrel filled with grass silage. Lower view, a levered hoop and rubber gasket for sealing lid onto barrel.

was first fed. The number of olive-yolk eggs gradually decreased until three weeks later, when none of the eggs showed this greenish color. The condition indicated that the xanthophyll content of the silage was well preserved, as the egg yolks from the entire flock took on a rich golden color similar to eggs from hens supplied with fresh, green feed.

The 55-gallon metal "lard," barrels referred to above were used for storing oat grass and alfalfa silage far each of the four succeeding years. These cylindrical barrels were, before the war, used to ship fat or lard to bakeries. They have a detachable top held in place by a leveredhoop as shown in Figure 4. By use of a sponge-rubber gasket under the rim an air tight seal resulted.

Wooden barrels were also used as containers. A heavy rock placed on a wooden header pressed the oat grass into the barrel. There was more spoilage on top and around the bulge in the wooden barrels than in the metal containers tightly sealed. From 350 to 400 pounds of chopped oats and 300 pounds of chopped alfalfa could be pressed into a metal barrel and somewhat less into a wooden barrel. Cleaning and painting the inside of the metal barrels after they were emptied made them usable for several years.

TABLE 1.—ANALYSIS OF OAT PLANT SILAGE NOVEMBER 12, 1939, SIX MONTHS AFTER PACKING IN BARRELS.

Barrel No.	Percentage of Preservatives			pH	Ammonia percent	Moisture percent	Carotene mg./100 gm.		Xanthophyll mg./100 gm.	
	Water	Molasses	Phosphoric acid				Wet	Dry	Wet	Dry
1	4.0	4.0	0.0	4.5	.094	81.0	11.34	59.68	24.53	127.53
2	4.0	0.0	1.2	4.9	.188	83.5	12.48	75.64	29.68	179.88
3	4.0	4.0	0.3	4.2	.079	79.5	12.60	61.46	30.71	149.80
4	4.0	4.0	0.0	4.0	.047	71.0	8.28	28.55	16.54	57.28
5	4.0	0.0	1.2	3.7	.041	71.5	8.53	29.93	17.65	61.93
6	4.0	4.0	0.1	3.7	.040	72.5	7.20	26.18	15.69	57.05

In succeeding years of the experiment, molasses, water, phosphoric acid and lime were used as preservatives with good results except for lime which was unsatisfactory.

Oats were harvested at two stages in 1939. The first cutting was May 12, and the second cutting of a different field three weeks later on June 2, when the plants were fully matured and the grain was in the milk stage. The object of the two cuttings was to compare the keeping qualities, palatability, and effect on egg-yolk color of grass silage put up at these two stages. Six metal barrels were used for storing the silage. The preservatives used are listed in Table 1.

The immature oat grass cutting (May 12) was placed in the first three barrels and the later cutting (June 2) in the last three barrels. On November 12, or six months after filling, samples of silage were taken from each barrel for chemical analysis. The results are given in Table 1.

It will be noted that the May 12, or early cutting, stored in the first three barrels contained a higher pH value, more moisture, more carotene and more xanthophyll than the June 2, or later cutting. The latter had a lower or more desirable pH value.

The silage in all barrels was classified as good quality. Of the first three, number 3 (molasses and acid) was rated the best. The silage was palatable to the poultry.

Alfalfa cut May 8, 1939, sometime before any blossoms appeared, and preserved with 8 percent of a molasses-water mixture, gave a quality of silage which compared favorably with immature oats.

The change in pH value of the oats silage, Table 1, shows that the fresh material which was near neutral to begin with, became strongly acid as silage. The barrels when opened were considered excellent silage and this was verified in feeding trials which will be discussed later. The low pH value might have been due to the more mature conditions of the oats when cut. **These, and former results showed that oats made better silage when cut after, rather than before, the first joints in the stalk appear.** While the plants reach their highest nutritive value before jointing, it is not easy to preserve them in that early stage by ensiling. They can be, and are, preserved in that early stage by dehydration, which is commonly practiced commercially.

CONTROL OF MOLD

Sodium propionate, a mold inhibitor, was tested to determine its value in checking mold growth on grass silage. From results it would appear feasible when a barrel is opened in the summer time to saturate the upper layer of the silage from day to day in each barrel with a 20 percent solution of sodium propionate, provided the silage is to be fed during warm weather when molds develop fairly rapidly after the barrels are opened. For winter feeding such treatment is not necessary as mold gives no trouble.

DISCUSSION

Pit silos as used in these experiments did not prove entirely satisfactory, due, it is believed, to the absorption by the surrounding soil of a large percentage of the liquid preservatives used. The immature stage of the oat grass might also have influenced the quality of the silage in the early work. Where large flocks of 1,000 or more birds are to be fed the common stock silo could be used for preparing and storing until cold weather, at which time the silage could be transferred to barrels or other small containers for feeding purposes. Where

such silos are used, the lower one-third should be reinforced because grass silage exerts about 30 percent more pressure than corn silage.

Results from the use of barrels demonstrated that oat grass silage could be preserved in covered barrels with practically no loss. While the open-top barrel gave less satisfactory results, an open-top barrel could be used if necessary. For flocks of 1,000 or more, small concrete or stave silos could be used. The silage could be fed directly from such a container, provided two or three inches of the silage could be used daily. Or where such quantities were not required, the silage could be transferred, after cool weather in the fall, from the silo into barrels. By tightly pressing the silage into the small containers, it would keep satisfactorily. The barrels could then be distributed among the various buildings to simplify feeding.

The thorough mixing of the preserving solution, whether acid or molasses, with the chopped oat grass is necessary to make good silage. High grade silage can be identified by a rather pleasant odor at close range, a uniform greenish brown color, freedom from a slimy appearance and a hydrogen ion content of 3.5 to 4.5.

While sulphuric acid and hydrochloric acid, as used in the A. I. V. method, or phosphoric acid, are good preservatives, these require more knowledge and skill to use and they require more care in handling and applying than molasses and water. The latter when used at the rate of 4 pounds of water and 4 pounds of molasses per 100 pounds of green oat material gave good results. An ordinary water sprinkler can be used to add the molasses and water to the chopped oat grass. The only purpose of the water is to make it easier to mix the molasses with the herbage. Where ensilage cutters are properly equipped for this work the molasses is added by gravity through the blower without dilution. Good mixing usually results. Hydrated lime was of no value for making grass silage.

A rise in temperature from 76.5° F. to 85.2°, or 8.7°, was recorded in the center of one of the silos. This indicated that very little heat was developed even in a large mass of more than three tons of green herbage. Such low temperatures probably would not reduce the feeding value of the silage. In fact most analyses before and after the silage is made show only slight deterioration of certain nutrients.

The carotene which showed some loss was retained in silage at a much higher level than in dried herbage stored in a feed building. There is some breakdown of plant tissue and much shrinkage as indicated by extreme settling under pressure.

Either steel or wood barrels were found to make good containers for small quantities of silage. The steel barrels with sealed top were preferred as there was little, if any, waste when they were used. Sufficient silage can be put up in one day to

supply 2,000 or more hens during the winter months. Silage is inexpensive to make and store but it requires daily feeding which adds to the labor.

Sodium propionate was of value in checking mold growth in silage. This would be a problem only in warm weather in which case it might be advisable to keep the top of the silage sprinkled from day to day with a 20-percent solution of this material.

RESULTS FROM FEEDING IMMATURE GRASS SILAGE TO CHICKENS

As indicated previously, the grass silage put up in 1934 was not used for feeding experiments. The oat silage made in 1935 was of somewhat better quality and was used for a feeding test during the winter of 1935-1936.

Two lots of 20 White Leghorn hens and one cockerel each were used to test the effect of the silage on egg production and hatchability. Both lots received the regular College ration which at that time consisted of the following:

Corn	25 lbs.	Alfalfa leaf meal	10 lbs.
Wheat	25 "	Dried buttermilk	5 "
Oats	25 "	Salt	1 "
Meat scraps	10 "	Cod-liver oil	1 "
		Total	102 lbs.

The above corn, wheat and oats were ground together. In addition, scratch grain consisting of yellow corn and wheat was fed daily.

The birds in lot II received, in addition to the above ration, all of the A. I. V. grass silage they would eat daily. This amounted to about 5 pounds a week per lot, which was fed from November 30, 1935 to March 31, 1936. Egg production, hatchability, and feed records were kept for the two groups of hens during this period.

The silage-fed hens produced egg yolks with a rich golden color, similar to the eggs from hens supplied ample green feed. Five percent of the hens produced eggs with "grass" or olive-colored yolks. This condition continued only for a short time, after which the yolk color returned to normal.

A comparison of the results from the two lots is given in Table 2.

None of the differences which came to light in Table 2 can be regarded as significant. At the time of this experiment it was thought that the control ration might be inadequate. In the light of more recent information, this ration as supplied

TABLE 2.—COMPARISON OF LOTS WITH AND WITHOUT A. I. V. GRASS SILAGE.

	No silage	Silage
Average number eggs produced, Jan. 26 to Mar. 21	31.7	30.8
Grain and mash consumed per bird, above period, pounds	17.4	16.8
Number eggs set	433.0	598.0
Percentage fertile	91.5	89.1
Percentage fertile eggs hatched	81.6	77.5

probably furnished all of the provitamin A and the vitamin G the birds could utilize.

GREEN BUTTERMILK VERSUS OAT SILAGE

The first controlled experiment with green buttermilk was conducted for 16 weeks from December 1, 1935, to March 21, 1936. Green buttermilk was a commercial product prepared by mixing finely-chopped, immature, green wheat with condensed buttermilk for the purpose of conserving the vitamin content of the grass. The purpose of the experiment was to determine the value of green buttermilk on production and hatchability of eggs when fed to laying pullets.

Sixty Rhode Island Red pullets laying at the rate of 25 percent were divided equally into two lots designated by the house numbers as 22 and 23. Lot 22 was the control group which received the regular mash and grain ration fed at the poultry farm at that time. Lot 23 was fed the same ration supplemented with 2 pounds of green buttermilk fed daily. The mash and grain ration fed both lots was the same as given on page 15. The results are given in Table 3.

TABLE 3.—GREEN BUTTERMILK AS A SUPPLEMENT TO THE COLLEGE RATION.

	22 Control	23 Green buttermilk
Number birds at start	34	34
Average number for period	33.9	31.6
Feed consumed, 16 weeks		
(a) Mash	663	541
(b) Grain	418	406
(c) Both	1,018	947
(d) Green buttermilk	....	241
Percentage egg production	58.8	57.3
Average weight of eggs, grams	57.7	57.9
Number eggs set	358.0	315.0
Percentage fertile	87.1	85.5
Percentage fertile eggs hatched	75.8	79.3

(Males were alternated in the above pens weekly.)

As in the silage experiment with White Leghorns reported in Table 2, the differences are probably not significant. There was, however, an increase of 3.5 percent in hatchability in favor of the lot which received green buttermilk.

These results again indicate that the control ration was probably adequate and the additional supply of carotene and riboflavin present in the green buttermilk was not essential.

EXPERIMENTS WITH FORAGE CROPS, GRASS MEAL, ALFALFA MEAL, AND SILAGE, 1936-41

(Reported by years as Experiments I, II, III, IV, V, and VI)

Profiting by experiences in 1934 and 1935 a series of five experiments pertaining to the value of immature grass and alfalfa, both fresh, dry and prepared as silage, were begun in 1936 and concluded in 1941. The results are given in the following pages together with the results of a few miscellaneous experiments on related subjects.

All alfalfa and grass meal used in these experiments was dehydrated unless otherwise specified. The same general procedure with slight variations was followed each year and for each experiment. White Leghorn chicks and pullets were used. Usually the chicks were reared in colony houses on limited range. When mature, the selected pullets were placed in an open-front, straw-loft house divided into four units each 20 feet square. (Fig. 5.) These pens were each equipped with running water and small yards to the rear for exercise and sunshine in favorable weather. The yards were usually covered with a crop of wheat, oats or Sudan grass. (Fig. 8.)

One hundred selected pullets were placed in each lot annually, with one exception, when 95 were placed in each lot in 1936-1937. Losses from leukosis and kindred diseases not

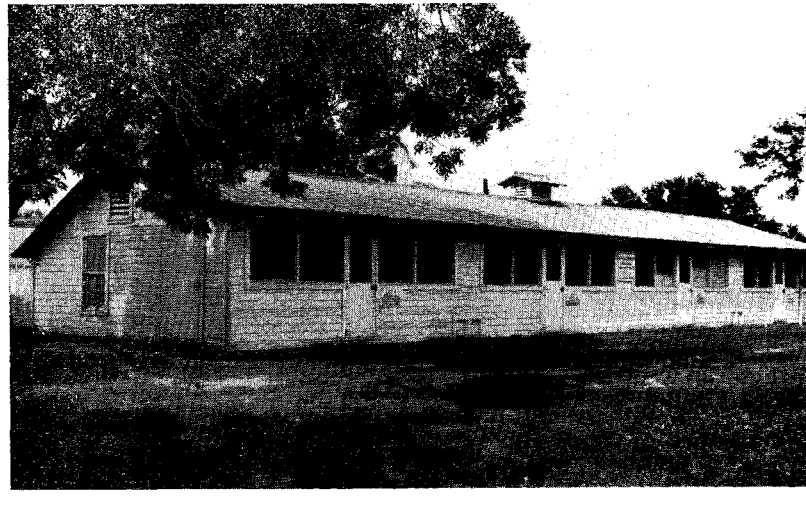


FIGURE 5.—The house where the experiments with laying birds were conducted. It was divided into four lots each 20 feet square. Note uneven-span, metal-covered roof. The open front was equipped with muslin curtains which could be closed one third, two thirds, or fully closed as shown in the second lot from the right. A 1-inch wire mesh ceiling was covered with 12 inches of straw. Rear ventilators were used during the summer.

thought to be related to diets look such a heavy toll each year it was decided to use 100 birds to begin with and take final records on egg production, hatchability, size of birds and size of eggs on those individuals which lived through the entire experiment. The year was divided into 13 periods of four weeks each. Feed records and certain other records were kept on a hen-day basis by four-week periods.

EXPERIMENT I, 1936-1937

DEHYDRATED ALFALFA LEAF MEAL VERSUS DEHYDRATED IMMATURE GRASS MEAL MAKING UP 10, 15, AND 20 PERCENT OF RATION

Twelve hundred White Leghorn chicks were hatched early in April, 1936, and reared on the same ration under uniform conditions to 20 weeks of age, at which time 95 pullets were placed in each of four lots. All pullets received essentially the same basal ration except for vitamin A which was supplied from two sources, dehydrated alfalfa leaf meal and dehydrated immature grass meal. The basal ration for lot I contained 10 percent of the high-grade alfalfa leaf meal while the rations for lots II, III and IV contained 10, 15 and 20 percent, respectively, of dehydrated, immature, oat plant meal.

Chemical analysis showed that the fourth cutting of alfalfa meal contained 23.4 percent protein, while the oat grass meal contained 25.5 percent protein. Both the alfalfa and the oats were grown on similar soil near Lawrence, Kansas, and both were cut and dehydrated by the same firm the latter part of October, 1936. The meat meal in the ration, which analyzed 55 percent protein, and the corn meal were reduced in the last three lots as the grass meal was increased to make the protein level in each lot practically equal. Shelled white corn and wheat were available in hoppers at all times, as was the mash mixture. The mash mixture for each lot was as follows:

Lots	I	II	III	IV
	(Amounts are given in pounds.)			
White corn, ground	25	26	23.5	21
Wheat, ground	25	25	25.0	25
Oats, ground	25	25	25.0	25
Meat scraps	7	6	3.5	1
Fish meal (sardine)	6	6	6.0	6
Alfalfa leaf meal	10	0	0.0	0
Immature grass meal	0	10	15.0	20
Sardine oil	2	2	2.0	2
Salt	1	1	1.0	1
Total	101	101	101.0	101

Results for a period of 24 weeks, November 2 to April 18, are given in Table 4.

There were no marked differences in the results. Nothing was gained by increasing the amount of grass meal above 10 percent. Egg production in lot IV was probably significantly less than production in other lots, while the hatchability in

TABLE 4.—COMPARISON OF RESULTS From LOTS FED DEHYDRATED ALFALFA LEAF MEAL (LOT I) AND IMMATURE GRASS MEAL (LOTS II, III, AND IV) FOR A PERIOD OF 24 WEEKS.

	Lots			
	I	II	III	IV
	10 percent dehydrated alfalfa meal	10 percent dehydrated grass meal	15 percent dehydrated grass meal	20 percent dehydrated grass meal
Number of birds at start	95	95	95	95
Average number for period	79.2	74.4	74.9	75.9
Feed consumed per bird, lbs.	37.8	37.3	38.5	37.5
Average weight of birds at start, lbs.	3.58	3.58	3.57	3.54
Percentage gain in weight	12.3	11.1	7.6	11.1
Average number eggs per bird	82.5	78.6	82.2	73.4
Percentage production	49.1	46.8	48.9	43.7
Percentage fertile eggs hatched	76.0	81.1	79.9	77.7

lot I,which received alfalfa meal, was slightly less than in the lots which received grass meal.

A carotene and xanthophyll determination was made on fresh eggs to ascertain whether these products increased in the egg yolk in proportion to the amount present in the ration. The results are given below:

Lots	I	II	III	IV
		Dehydrated grass meal		
	Dehydrated alfalfa meal, 10 percent	10 percent	15 percent	20 percent
	mg./100gm.	mg./100gm.	mg./100gm.	mg./100gm.
Carotene in egg yolks	0.443	0.180	0.274	0.160
Xanthophyll in egg yolks	2.560	3.130	4.050	3.040

Eggs from the lot which received 10 percent of dehydrated alfalfa meal showed more than twice as much carotene as eggs from the lot which received an equal amount of dehydrated grass meal. Doubling the amount of grass meal to 20 percent did not increase the carotene in the eggs in this experiment. The grass meals did excel in xanthophyll but so far no nutritive value has been found for this carotinoid pigment. It is responsible for the yellow color of the yolk.

EXPERIMENT II, 1937-1938

A COMPARISON OF GREENMELK, CEREAL GRASS AND OAT SILAGE, AND DEHYDRATED ALFALFA LEAF MEAL, PLUS BUTTERMILK FOR LAYING PULLETS

(Including an analysis for carotene and xanthophyll.)

September 22, 1937, 300 good White Leghorn pullets, approximately 24 weeks of age, were selected at random from grass range and placed in three equal groups designated as lots I, II and III. Eight vigorous cockerels from the same stock were placed in each lot at the beginning of the experiment and removed on April 20, 1938. All birds were confined in their 20' by 20' pens from September 22, 1937, until April 24, 1938, at which time lot II was turned out on oat and Sudan grass pasture, while lots I and III were permitted to range in bare yards equal in size to the grass range.

The rations listed below were hopper fed and available to the birds at all times. The corn, wheat and oats were ground together.

Lots	I	II	III
	(Amounts are given in pounds.)		
Yellow corn	20	20	20
Wheat	20	20	20
Oats	20	20	20
Wheat bran	10	10	10
Alfalfa leaf meal	0	0	5
Meat scraps	4.5	5	4
Fish meal	4.5	5	4
Soybean oil meal	4.5	5	4
Corn starch (Argo)	3.5	2	0
Salt	0.5	0.5	0.5
Nopco XX (Fish oil)	0.5	0.5	0.5
Total	88.0	88.0	88.0

The year's supply of Greenmilk and condensed milk was obtained as a special order from the same batch of milk at the creamery. Greenmelk was a commercial product prepared by mixing dehydrated immature grass meal with condensed buttermilk. Since these products and chopped grass could not be mixed with the mash feed, the following system was used:

Lot I Greenmelk was fed daily at the rate of 3 pounds per 100 birds.
Lot II Chopped grass (Oat or Sudan) and silage, 4 pounds daily per 100 birds.
Lot III Condensedbuttermilk at the rate of 3 pounds daily per 100 birds.

Scratch grain consisting of yellow corn and wheat together with oyster shells was available at all times.

The chemical analyses of the above mash mixtures were:

Lots	I	II	III
	(Expressed in percentage)		
Protein	18.50	19.88	18.81
Fat	4.11	4.14	4.04
Fiber	6.37	6.75	7.36
Moisture	10.15	9.72	9.77
Ash	5.33	5.58	5.65
Nitrogen free extract	55.54	53.93	54.37
Vitamin A units per pound	(Expressed in units)		
of ration, grain and mash	8,672	9,068	7,100
Minimum requirements	2,043	2,043	2,043
Surplus	6,629	7,025	5,057

Detailed feed, production and mortality records were kept by four-week periods.

RESULTS FOR A FULL LAYING YEAR

Trapnest egg records were kept on all three lots for 52 weeks. Ten eggs from each bird were weighed in May and the average weight of these was taken as the average for the lot. The eggs were sold on a graded basis to a local packer at prevailing market prices.

The carotene content and xanthophyll content of the rations fed and of egg yolks obtained from the different lots March 1, April 1, and May 1,1938, were obtained and the results are given in Table 5.

TABLE 5.—CAROTENE AND XANTHOPHYLL CONTENT OF FEED AND EGGS IN COMPARING LOTS I, II, AND III.

	Lots		
	I Green-melk	II Grass and silage	III Alfalfa leaf meal, 5 percent
Carotene in mash, mg./100 gm.	0.283	0.272	1.690
Carotene in egg yolks, Mar. 1	0.202	0.272	0.080
Carotene in egg yolks, Apr. 1	0.233	0.395	0.085
Carotene in egg yolks, May 1	0.326	0.303	0.144
Xanthophyll in egg yolks, Mar. 1, mg./100 gm.	1.660	2.400	0.850
Xanthophyll in egg yolks, Apr. 1	1.756	3.155	1.005
Xanthophyll in egg yolks, May 1	2.230	3.420	1.120

Both the carotene and xanthophyll increased as the season advanced. The carotene in the Greenmelk and grass is not given for rations fed lots I and II. It was obviously much higher when added to that contained in the mash than for the last lot, since the eggs from the first two lots contained two to three times as much carotene as those from lot III.

More than 1,500 eggs were set in a forced-draft incubator in April, 1938, and 896 chicks were hatched. This represented a 65 percent hatch of fertile eggs set, for all lots. Retail feed prices were obtained monthly from a local company and these were used to arrive at the cost of feed for the different lots. The condensed results are presented in Table 6.

TABLE 6.—SUMMARY OF RESULTS ON EGG PRODUCTION FOR A YEAR, HATCHABILITY, MARKET VALUE AND FEED CONSUMPTION FOR THREE LOTS OF LAYING PULLETS.

	Lots		
	I Greenmelk	II Grass and silage	III Alfalfa leaf meal plus buttermilk
Number hens placed in laying pens	100	100	100
Average number hens for laying year	78.4	77.51	74.90
Average annual egg production	170.05	163.13	149.46
Percentage egg production	48.20	45.20	40.80
Average weight of eggs, grams	60.15	59.91	60.18
Number eggs set	431	371	384
Percentage fertile	88.4	94.3	85.7
Number vigorous chicks hatched	253	225	204
Hatchability fertile eggs	66.4	64.3	62
Market value of eggs sold	$184.80	$169.19	$151.16
Market value of eggs per hen	2.27	2.15	2.00
Average price received for eggs, per dozen	.163	.163	.163
Pounds mash and grain consumed per bird	80.43	77.01	74.64
Feed cost per bird	$ 1.869	$ 1.385	$ 1.591
Profit per bird over feed cost	.400	.765	.406
Percentage feed consumed			
(a) Mash	36.0	37.4	33.5
(b) Wheat	59.8	55.5	64.5
(c) Corn	4.2	7.3	2.0
Prices paid for feed per 100 lbs.			
(a) Mash	$ 1.84	$ 1.78	$ 1.70
(b) Whole corn	1.28	1.28	1.28
(c) Whole wheat	1.37	1.37	1.37
(d) Greenmelk	5.00	.....	.....
(e) Condensed buttermilk	.....	.....	4.00
(f) Oat plant silage	.....	1.00	.....

DISCUSSION

The adult mortality for all three lots in experiment II was high. An autopsy of all dead birds revealed a preponderance of deaths due to leukosis and associated diseases, followed in order by pullorum, ovarian disorders, cannibalism, chronic coccidiosis, tapeworms and miscellaneous disorders.

Lot I, which received Greenmelk, led in egg production per hen followed by lot II, fresh grass and silage, and lot III, condensed buttermilk. Statistical analysis of the egg production figures indicated positive significance in favor of lot I over II, and lot II over III.

Hatchability from the three lots does not show a wide variation. The application of statistical treatment to the data did not indicate a significant difference between any two of the three lots.

The market value of eggs sold, price received for same and profit per bird over feed cost is self explanatory. It will be noted that lot II, fed grass and silage, produced eggs at a much lower cost which resulted in a profit of 36.5 cents per bird over the other two lots. All profits are small due to high feed costs and low prices for market eggs. The amount of feed consumed was in proportion to the number of eggs produced. The feeding of

grass and silage in lot II did not reduce grain and mash consumption as much as expected.

It is obvious that these Leghorn hens did not care for shelled corn when wheat and mash were available. All lots consumed an average of 34.2 percent mash, 62.1 percent wheat and 3.8 percent corn. Figures similar to these had been obtained from different flocks for a number of years.

The prices paid for feed represented an average of the 12 monthly quotations except for the milk and silage products in which case the year's supply was obtained at the beginning of the experiment.

COST OF MAKING SILAGE, SPRING 1937

The following figures give the cost of producing oat plants and oat silage during the spring of 1937. All labor was employed by the hour at the figures indicated.

Soil preparation, 3 acres	
Plowing	$3.75
Harrowing	3.58
Seeding	
Smut treated seed oats, 9 bu. at $0.75	6.75
Drilling seed and rolling ground, 5 hrs. at $1.25	6.25
Total for 3 acres	$20.33
Average per acre	6.78
Filling silo	
Teamster, cutting and hauling, 16 hrs. at $0.65	$10.40
Ensilage cutter and operator, 6 hrs. at $1.25	7.50
Miscellaneous labor, 34 hrs. at $0.30	10.20
Immature oat grass, 1.4 A. at $6.78	9.49
Molasses, 360 lbs. at $1.35 cwt.	4.86
Total for 1.4 A. or 4.5 tons silage	$42.45
Cost per ton	9.43
Cost per pound	0.0047

While the arbitrary price charged for silage was one dollar per hundred, the above figures show the actual cost to prepare it was 47 cents per 100 pounds, or $9.43 per ton.

"GRASS EGGS"

Previous use of grass silage had caused certain hens to produce eggs with olive-colored yolks. Such eggs have a greenish cast when examined before a "candle", hence the name "grass eggs". They are discriminated against on the market. They are usually most frequent among market eggs early in the spring when new vegetation appears.

In lot II, experiment II, chopped oat grass was fed until November 16, 1937, when silage was substituted for grass. The amount was increased gradually each day until November 20, when the maximum of 4 pounds a day per 100 birds was fed. On November 27, 25.9 percent of the day's production were "grass eggs". Grass eggs continued to be produced, although

the percentage varied, throughout the period silage was fed. They stopped completely when fresh-chopped oat plants were substituted for the silage April 24, 1938. A total of 926 eggs were classified as green by candling but when broken only 813 were found to possess the olive color. A total of 13.3 percent of all eggs laid by the hens in lot II were greenish in varying degrees. Of those hens which produced grass eggs, a total of 30.1 percent of the eggs laid by them possessed the off-colored yolks. Fifty percent of all eggs laid by six hens were green and 87 percent of all eggs laid by two hens showed this objectional color. An examination of the crops of these hens showed them to be gorged with silage 30 minutes after it was fed. The market value of these eggs was discounted 3.5 cents a dozen. This amounted to only $2.36 for the 155 days. This amount was deducted from the gross returns from lot II. While the chemical changes which take place to produce "grass eggs" are not definitely known, marked improvement has been made in eliminating such eggs from silage fed birds. In 1938, as previously indicated, 13 percent of all eggs from silage fed hens were grass eggs. In 1939, silage made at the jointing stage produced 1.91 percent grass eggs, while silage made from oats which had matured and was headed out gave only 0.22 percent off-colored eggs. The silage fed in the fall and winter of 1941 gave no off-colored eggs.

EXPERIMENT III, 1938-1939

GRASS VERSUS ALFALFA PASTURE FOR GROWING CHICKENS AND EFFECT OF REARING ON BARE GROUND

The object of this experiment was to ascertain what effects, if any, different kinds of green feed supplied during the growing period might have on rate of growth, mortality and performance through the first laying year, or to 74 weeks of age. The green feeds tested were alfalfa and immature cereal grasses.

Twelve hundred April-hatched White Leghorn chicks were divided into four lots of 300 each and brooded under electric hovers in four 10' by 12' colony brooder houses. All lots received the College all-purpose ration given below:

1. All-purpose mash in pounds.

Yellow corn, ground	20.0
Wheat, ground	20.0
Oats, ground	20.0
Wheat bran	11.8
Alfalfa leaf meal	10.0
Meat scraps (55% protein)	5.0
Fish meal	5.0
Soybean oil meal	5.0
Calcium carbonate	2.0
Salt	1.0
Fish oil (Nopco XX)	0.2
Total	100.0

Scratch grain consisted of equal parts cracked yellow corn and wheat fed as a supplement to the mash after the pullets were 4 weeks of age, and when young turkeys were 8 weeks old. See turkey experiment page 37. White corn was substituted for cracked corn at 16 weeks of age.

Each yard was 0.3 of an acre in size, the only variable in this experiment being the kind of forage or pasture provided. It was as follows:

Lot I Alfalfa pasture and chopped alfalfa daily.
Lot II Alfalfa pasture and chopped grass daily.
Lot III Oat and Sudan pasture and chopped grass daily.
Lot IV No pasture. Chicks ranged on the bare ground.

On July 13, 14, and 15, weights were recorded of the amount of chopped green feed consumed by each of the first three lots of birds. The greens were fed in V-shaped troughs at 6 a. m. daily (Fig. 6) and that which remained at 10:30 a. m. was weighed back. The difference in weight represented the amount consumed, wasted and lost from evaporation of water. September 6, 7 and 8, weights were again recorded of the amount of chopped green feed consumed. The grass was then put out

FIGURE 6.—Sudan grass pasture supplemented with chopped grass fed in V-shaped troughs to growing chickens early each morning. Note eagerness with which the birds ate the chopped grass in the midst of ample pasture.

at 6:30 a. m. and weighed back at 8:00 a. m. The pullets were 20 weeks old when these observations were made. The results for the two periods were as follows:

Lots	I	II	III	IV
Pullets 12 wks. old				
Number	120	142	126	140
Kind of green feed supplied	Alfalfa pasture plus alfalfa	Alfalfa pasture plus grass	Oat and Sudan pasture plus grass	Bare yard
Average amount consumed daily, per lot, grams	183.00	1,083.00	807.00	.....
Average amount consumed daily, per bird, grams	1.52	7.62	6.40	.....
Pullets 20 wks. old				
Number	112	136	115	135
Kind of green feed supplied	Alfalfa	Sudan	Sudan	None
Average amount consumed daily, per lot, grams	766.00	1,276.00	1,324.00	.....
Average amount consumed daily, per bird, grams	6.83	9.38	11.51	.....

The above figures indicate for pullets 12 weeks old and pullets 20 weeks old, chopped grass was more palatable than chopped alfalfa. At the age of 12 weeks, the pullets in lot II consumed five times more grass daily than was consumed of alfalfa in lot I, while at age 20 weeks the differences were not so great but still favored the grass lots. It is a matter of common observation that cultivated grasses are usually completely consumed for a wide area around a brooder house soon after the chicks are given free range. This is not the case around the house in an alfalfa yard. This is partly due to the fact that the alfalfa is better established, hence harder to kill. Being less palatable probably also accounts in part for this condition.

When 22 weeks of age (Fig. 7), 100 selected pullets from each of the above lots were placed in four laying pens and continued on the same all-purpose ration through the laying year of 50 weeks. Records on the laying pens began October 7, 1938, when the pullets were 24 weeks of age. The birds were confined until April 8, 1939, at which time each group was given a limited range on wheat pasture. After early July, Sudan pasture was available for all lots. All pullets were trapnested and all eggs were sold on a graded basis. The condensed results are given in Table 7.

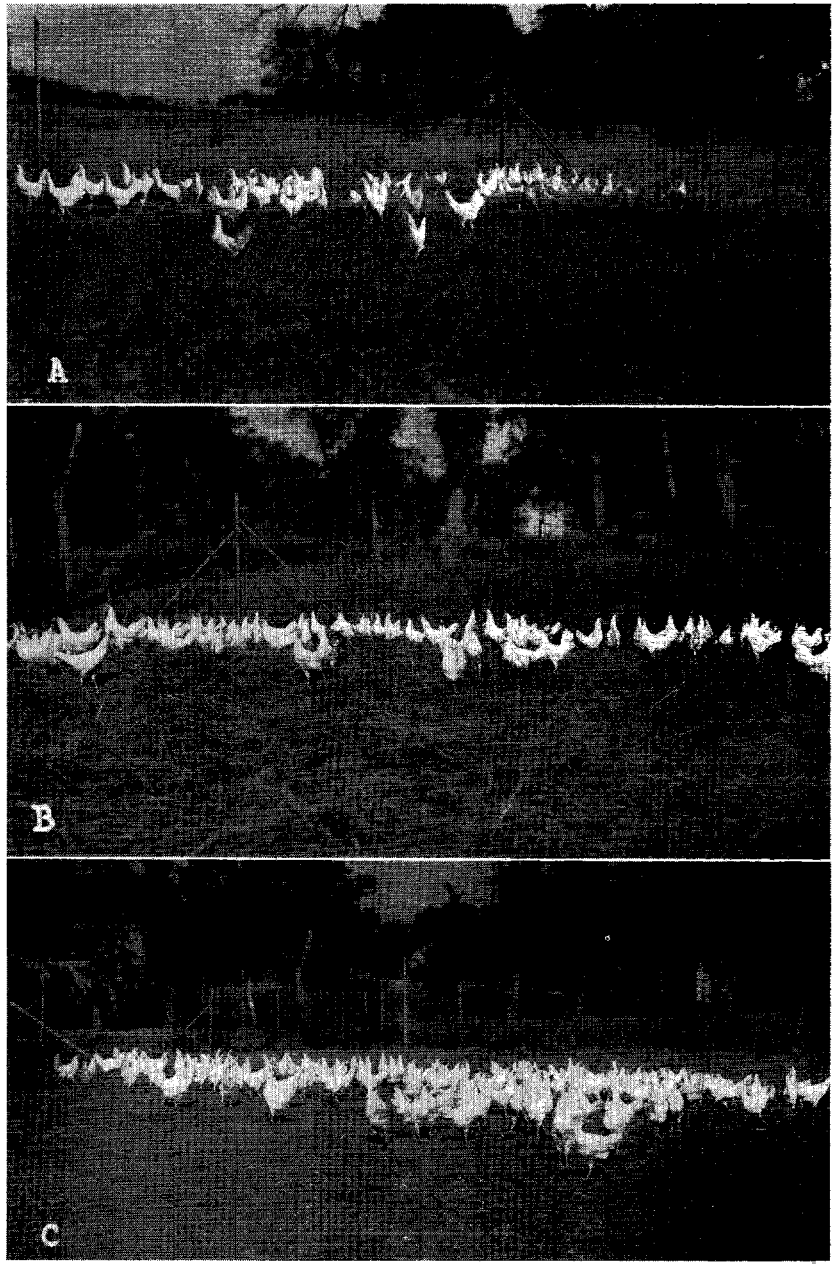


FIGURE 7.—Pullets reared on alfalfa range (A); Sudan range (B); and on bare ground with no herbage (C).

TABLE 7.—RESULTS FROM PULLETS REARED ON GRASS, ON ALFALFA AND ON NO PASTURE.

Lots	I	II	III	IV
Range crop	Alfalfa	Alfalfa pasture plus grass	Oat and Sudan pasture plus grass	Bare yard
Summary for growing pullets to 24 weeks of age				
Average weight pullets, lbs.	3.12	3.07	3.10	3.21
Percentage mortality	11.70	10.70	11.30	9.70
Pounds feed consumed per pullet	17.60	17.10	18.70	18.50
Cost of feed per pullet	$ 0.23	$ 0.22	$ 0.25	$ 0.26
Summary for laying hens (50 weeks)				
Number placed in laying pens	100	100	100	100
Average number birds for the year	81	79	82	84
Average number eggs, final hen basis	185.2	189.7	188.6	163.2
Average egg size (grams)	56.0	56.4	57.0	57.2
Percentage of eggs in top grade	42.0	45.5	53.1	51.0
Average body weight at 74 weeks, lbs.	3.85	3.69	3.74	3.77
Hatchability, fertile eggs	63.7	72.3	75.2	68.0
Feed consumed per bird, lbs.	73.3	74.0	73.5	71.8
Receipts for eggs per hen (graded)	$ 2.14	$ 2.20	$ 2.20	$ 1.87
Feed cost per hen	0.89	0.91	0.90	0.88
Income above feed cost per hen	1.25	1.29	1.30	0.99

DISCUSSION

Egg production in lots I, II and III was significantly greater than in lot IV. The difference in egg-size was not significant. However, the percentage of eggs in the top grade was in favor of lots III and IV. The hatchability of eggs from lots II, III and IV was significantly greater than that from lot I. The hens in lot IV, no herbage, had the least mortality and their eggs were third in hatchability. As pullets, this no-herbage lot ranked highest in body size and lowest in mortality. The two phases in which they ranked lowest were in average number of eggs laid and in income above feed cost. Thus, in comparing the herbage versus no-herbage lots, there was a difference in favor of the birds reared on green feed, however, the variation in results was not great.

A comparison of the alfalfa and cereal grass lots shows slight differences in egg production, egg size, percentage of top-grade eggs, hatchability and income above feed cost in favor of the grass lots. The alfalfa lot led in body size and livability. When one considers the additional cost of maintaining immature grass pasture during the growing season, the competition with weeds, wet weather or lack of moisture, and other numerous problems which arise, the advantages in Kansas seem to be in favor of alfalfa. One seeding will last four or five years; it provides early spring, summer and late fall pasture with a firm turf at all seasons which can be driven over without cutting up the field. In those localities where alfalfa does not grow well, cereal grass can be utilized to good advantage.

EXPERIMENT IV, 1939-1940

GRASS VERSUS ALFALFA PASTURE FOR GROWING CHICKENS REPEATED

The object of this experiment was to repeat the work of the previous year and to handle one lot of pullets according to the methods used for all young chicks started at the college poultry farm. That is, to keep them in battery brooders three weeks then transfer to electric hovers in a long brooder house and finally move to the grass or alfalfa range at 8 weeks of age. In this experiment the control group was moved to a grass range.

Twelve hundred White Leghorn chicks hatched April 14, 1939, were divided into four lots of 300 each and three of the lots were brooded under electric hovers located in 10' by 12' colony brooder houses. As stated above the other group was started in a battery brooder. The different lots and treatment given were as follows:

Lot I Brooded under electric hover with access to alfalfa range.
Lot II Started in battery brooder, moved to grass range when 8 weeks old. Usual method at the college poultry farm.
Lot III Brooded under electric hover with access to oat and Sudan grass range.
Lot IV Brooded under electric hover with access to a bare lot. No herbage.

All lots received the College all-purpose ration throughout the growing period and through the first laying year.

The two variables in 1939 contrasted with 1938 were, (1) lot II was started in a battery brooder and moved to a grass range when 8 weeks of age: (2) there was no hand feeding of chopped grass or alfalfa until the latter part of the experiment.

Feed consumption, body growth and mortality records were kept on all four groups. All males were removed from the experiment at 8 weeks of age. The College all-purpose ration modified to contain 5 percent alfalfa leaf meal instead of the 10 percent generally used in the absence of herbage and 20 percent of shorts in place of an equal amount of ground wheat, was fed to all lots. Cracked yellow corn and whole wheat were hopper-fed as scratch grain after the birds were 4 weeks of age.

A hot dry summer and a severe attack of chinch bugs curtailed the cereal grass crops severely. To overcome this handicap it was necessary to obtain Sudan grass from another source, chop and feed it daily in quantities the birds would clean up in about 30 minutes. Even this grass was not of good quality. In order to make the experiment comparable, alfalfa was also chopped and fed to lot I daily.

An attack of coccidiosis in lot II, before it was placed on the range, interfered with normal growth and livability. The results with growing pullets kept on range to 24 weeks of age and for the same birds kept through the first laying year on the same rations are presented in Table 8.

TABLE 8.—COMPARISON OF PULLETS REARED ON GRASS, ALFALFA AND NO HERBAGE RANGES.

Lots	I	II	III	IV
Range crop	Alfalfa	Grass after 8 wks.	Grass	Bare lot
Summary for growing pullets to 24 weeks of age				
Number pullets	136	106	136	133
Average weight, both sexes, at 8 wks., lbs.	1.15	1.09	1.28	1.30
Average weight, pullets at 24 wks., lbs.	3.364	2.915	2.932	3.182
Percentage mortality	14.7	21.0	15.3	10.6
Pounds feed consumed per pullet	19.09	18.77	19.46	19.34
Cost of feed per pullet, cents	25.11	24.38	25.35	25.45
Summary for laying hens, 52 weeks				
Number placed in laying pens	100	100	100	100
Average number birds for the year	76.9	78.4	78.8	82.8
Average number eggs, final hen basis	200	205.6	207.7	193.1
Average egg size, grams	57.98	56.51	58.31	58.51
Percentage of eggs in top grade	45.9	44.0	57.3	53.9
Average weight, Sept. 29, 1939, lbs.	3.27	2.98	3.17	3.29
Average body weight at 76 wks., lbs.	3.97	3.84	4.02	4.02
Hatchability, fertile eggs, percent	74.1	77.1	83.3	74.6
Feed consumed per bird, lbs.	76.8	75.2	77.9	76.4
Receipts for eggs, per hen	$2.43	$2.41	$2.48	$2.35
Feed cost per hen	1.19	1.17	1.21	1.19
Income above feed cost per hen	1.24	1.24	1.27	1.16

DISCUSSION

The pullets reared on alfalfa range, lot I, showed a slight advantage in size at 24 weeks of age over all the others, and for a second year the bare yard, lot IV, had the highest livability and a larger average weight than either of the grass lots. Statistical treatment of differences in body weight of pullets placed in laying quarters at 24 weeks of age showed lots I and IV to be significantly larger than lots II and II.

This indicates that the College all-purpose ration was adequate without a green feed supplement. In comparing the grass and alfalfa lots it should be kept in mind that the grass pasture was of practically no value to the birds after they were half grown and the chopped grass was of inferior quality. The alfalfa pasture was more dependable and of better quality. While alfalfa suffered from drought it was not attacked by chinch bugs. Following a dormant period, caused by lack of moisture, it recovered quickly, whereas Sudan grass as a rule did not recuperate to provide late summer and early fall pasture.

A comparison of results during the first laying year showed but little difference in the average number of birds which lived through the year. Those reared without green feed, lot IV, showed the least mortality. The two grass-reared groups, II and III, led in egg production and hatchability. The bare-lot group was lowest in egg production but tied with the alfalfa flock in hatchability. Statistical treatment of egg-production figures showed no significant differences between any of the lots.

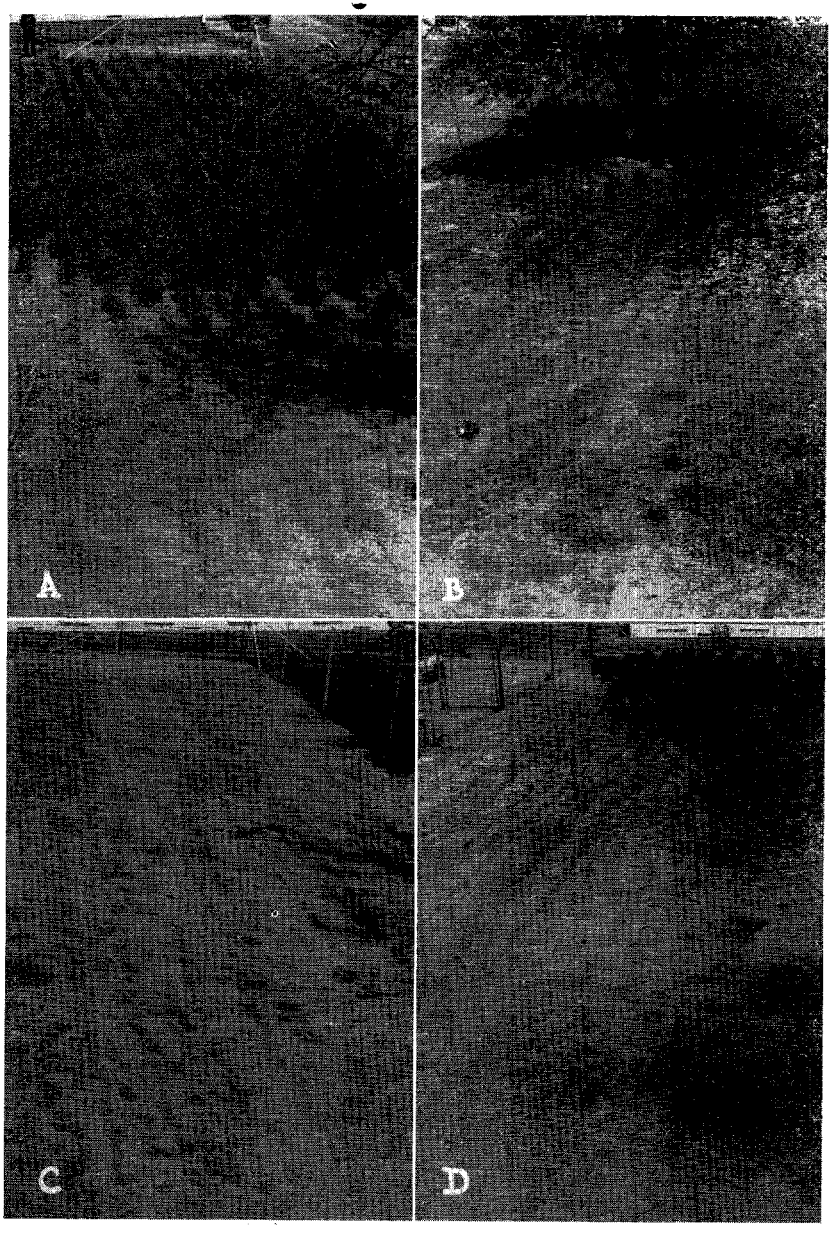


FIGURE 8.—Yards showing amount of grass consumed by laying hens in five and one half weeks. Birds in lot (A) were reared on alfalfa pasture 1 to 24 weeks of age; those in lot (B) were reared on Sudan grass after 8 weeks of age; lot (C) oats and Sudan grass 1 to 24 weeks of age; and (D) bare yard throughout the growing period.

The four laying flocks showed considerable differences in the amount of grass consumed when given access to oat pasture in the spring of 1940. Each lot of about 85 hens was turned into yards 28' by 118' in size March 29. The photographs in Figure 8 were taken May 7, or 39 days later. It will be noted that the hens reared on alfalfa, lot I, (A) had consumed the least grass, while those reared on oat and Sudan grass, lot III, (C) consumed the most grass. The grass in this lot had been entirely consumed a few days when the picture was taken. This verified other observations, that is, if chickens are to consume large quantities of grass during the growing period and after maturity, they should be given an opportunity to form the habit of eating liberal quantities of palatable, immature grasses early in life. In other words, teach them as chicks what they should eat as adults.

It was again obvious from these results that there were advantages in supplying either grass or alfalfa pasture to young stock during the growing season but that these advantages, while not as pronounced, were shown in the number of eggs produced and in the income above feed cost for eggs sold the first year of production. It was also evident that grass pasture was less dependable than alfalfa during a drought season or a chinch bug invasion.

EXPERIMENT V, 1940-1941

GRASS SILAGE VERSUS DEHYDRATED AND SUN-CURED ALFALFA MEAL WITH AND WITHOUT BUTTERMILK FOR LAYING PULLETS

For a final study of the role of grass, grass silage, and alfalfa in the poultry diet, it was decided to compare grass silage with dehydrated and sun-cured alfalfa meal. While high-grade dehydrated alfalfa leaf meal has generally been recommended for the College all-purpose ration in order to provide sufficient vitamins A and G, it is well known that many poultrymen depend upon sun-cured alfalfa as a substitute for the leaf meal. The value of grass silage as a substitute for alfalfa meal in the ration was also studied.

Twelve hundred White Leghorn chicks hatched at weekly intervals for about six weeks were reared together on a range which consisted of alternating strips of alfalfa and Sudan grass. The year 1940 was a favorable year for grass and alfalfa growth. There was no shortage of green forage for range, hence no additional green feed was supplied by the soiling method as was practiced the previous year. The College all-purpose ration was fed throughout the growing period.

On October 21, when most of the birds were 24 weeks of age or older, 100 pullets were selected for each of four laying pens. However, instead of continuing with the same ration as in the last two tests, four different rations were fed as follows:

Lots	I Grass silage	II Sun-cured alfalfa meal	III Dehydrated alfalfa meal	IV Sun-cured alfalfa meal plus 4 percent dried buttermilk
	lbs.	lbs.	lbs.	lbs.
White corn, ground	20	20	20	20
Wheat, ground	20	20	20	20
Oats, ground	20	20	20	20
Wheat bran	11	11	11	11
Alfalfa leaf meal	0	0	10	0
Sun-cured alfalfa meal	0	10	0	10
Grass silage	*-	0	0	0
Meat meal	5	5	5	4
Fish meal	5	5	5	4
Soybean oil meal	5	5	5	4
Dried buttermilk	0	0	0	4
Starch	1	1	1	0
Calcium carbonate	2	2	2	2
Salt	1	1	1	1
Manganese sulphate	Trace	Trace	Trace	Trace
Total	90	100	100	100

*Grass silage was not mixed with the mash but was fed daily at the rate of 4 pounds per 100 hens.

Vitamin D was provided by exposure four hours daily to S-4 sun lamps, until mid-winter, after which time Delsterol was added to the mash to provide an optimum vitamin D unitage.

To provide uniformity in all rations, pre-mixes were made of (a) the basal ingredients, i.e., corn, wheat, oats, bran, calcium and salt; (b) protein supplements, meat scraps, fish meal and soybean oil meal; (e) other supplements, as for example dehydrated or sun-cured alfalfa, dried milk, and starch: (d) final operation consisted of combining the above pre-mixes to give the formulas above for each of the different lots.

The carotene content was determined by chemical analysis for the silage and alfalfa meals- with the following results:

Product	Carotene mg./100 gm.	International vit. A units/lb.	Moisture content
Oat plant silage	5.7 beta carotene	43,092	77.8%
Sun-cured alfalfa meal	4.36 " "	32,983	7.7%
Dehydrated alfalfa leaf meal	36.20 " "	273,670	2.4%

This experiment was terminated 40 weeks after the pullets were placed in the laying pens. It was soon obvious that the sun-cured alfalfa did not contain sufficient carotene to maintain normal livability. Autopsies of the birds which died showed that most of the losses in lots II and IV were due to A-avitaminosis. The addition of 4 percent dried buttermilk supplied an adequate amount of riboflavin or vitamin G, but it could not compensate for the deficiency of carotene, the precursor of vitamin A, in the ration.

The results of the four lots are given in Table 9.

It is obvious from these results, as indicated by low egg production, heavy mortality, and low income, that 10 percent of sun-cured alfalfa meal (second cutting) in the mash mixture,

TABLE 9.—COMPARISON OF GRASS SILAGE, DEHYDRATED AND SUN-CURED ALFALFA MEAL IN THE LAYING RATION FOR 40 WEEKS.

Lots	I	II	III	IV
Basal ration plus	Oat plant silage	Sun-cured alfalfa meal	Dehydrated alfalfa meal	Sun-cured alfalfa meal plus dried buttermilk
Number placed in laying pens	100	100	100	100
Average weight pullets at 24 wks.	3.41	3.34	3.43	3.37
Average number for 40 wks.	78.8	64.0	83.0	65.8
Average number eggs, final hen basis	166.4	136.2	163.9	138.2
Percentage egg production	59.4	48.6	58.5	48.3
Average body weight at 68 wks., lbs.	3.84	3.50	3.73	3.67
Hatchability, fertile eggs, percent	59.6	66.5	74.1	43.3
Feed consumed per hen, lbs.	65.4	63.4	71.1	65.9
Percentage mash consumed	29.7	27.2	27.4	27.4
Percentage grain consumed	70.3	72.8	72.6	72.6
Receipts for eggs, per hen	$2.29	$1.69	$2.36	$1.88
Feed costs per hen	1.08	0.90	1.05	0.94
Income above feed cost	$1.21	$0.79	$1.31	$0.94

as fed to lot II when consumed at the ratio of approximately 27 percent mash to 73 percent scratch grain, does not provide an adequate supply of carotene for laying hens. Wheat and oats were hopper-fed, free choice as scratch grain and the birds consumed five to seven times as much wheat as oats.

Grass silage excelled dehydrated alfalfa leaf meal in egg production per hen and in body size at conclusion of the experiment but the birds in lot III excelled those in lot I in livability, hatchability and income above feed cost. The differences are small and probably not significant when comparisons are made between the silage and dehydrated alfalfa lots. Lots II and IV which received the sun-cured alfalfa gave results significantly below the lots fed silage and dehydrated alfalfa. Forcing the hens to consume a larger proportion of mash or supplying 20 percent ground yellow corn in the mash and 50 percent cracked or shelled yellow corn in the scratch would add considerably to the carotene content of a ration in which it was desired to use sun-cured alfalfa meal. When alfalfa meal is used it should be of the best quality available, as indicated by a bright-green color, small stems and a large proportion of leaves. Fourth or fifth cutting, cured quickly, is generally the best quality for feeding poultry. They have the further advantage of escaping the intense summer heat which is very destructive to the carotene content of the plant.

EXPERIMENT VI, 1940-1941

GRASS SILAGE VERSUS DEHYDRATED AND SUN-CURED ALFALFA MEAL FOR PRODUCING BROILERS, WITH AND WITHOUT BUTTERMILK

After an experiment embodying grass silage, dehydrated and sun-cured alfalfa got under way in 1940, with four lots of Leghorn pullets, (see page 33) it was decided to feed the same

ration to four lots of broilers. While it was unusual to expect baby chicks to consume enough grass silage to supply their vitamin A and G requirements, such a test was made in order to determine the results.

White Plymouth Rock chicks in the number of 408 were equally divided into four lots of 102 chicks each and placed in 8' by 10' pens in a large brooder house. Each pen was equipped with an electric hover. The lots were numbered V, VI, VII and VIII, and the broilers received rations similar to those supplied the Leghorn pullets in lots I, II, III and IV in experiment V. The only change in the chick rations from those fed the pullets was in the source of vitamin D. Instead of the S-4 lamps used on the pullets, Delsterol was added to the ration of each lot at the rate of 36 grams per 100 pounds of mash feed and the milk fed lot V for a short time.

The experiment was begun November 6, 1940, and continued for 12 weeks or until January 29, 1941. The results are given in Table 10.

TABLE 10.—COMPARISON OF GRASS SILAGE, DEHYDRATED AND SUN-CURED ALFALFA MEAL FOR BROILER PRODUCTION.

Lots	V	VI	VII	VIII
Basal ration plus	Oat plant silage plus milk	Sun-cured alfalfa meal	Dehy-drated alfalfa meal	Sun-cured alfalfa meal plus 4 percent dried buttermilk
Number placed in each lot	102	102	102	102
Number of broilers at 12 wks.	88	90	96	97
Mortality to 12 wks., number	14	12	6	5
Average weight, broilers at 12 wks., lbs.	2.49	2.25	2.48	2.32
Feed, grain and mash per chick, lbs.	6.28	6.91	7.70	7.37
Silage per chick, lbs.	1.96	.....	.....	.....
Pounds grain and mash per lb. gain	2.65	3.20	3.22	3.25
Pounds silage per lb. gain	.85	.....	.....	.....
Cost of all feed per chick	12.24¢	11.04¢	12.97¢	12.04¢
Cost of feed per lb. gain	4.86¢	4.94¢	5.23¢	5.18¢
Price received per lb. for broilers	16¢	16¢	16¢	16¢
Market value of all birds	$35.06	$32.40	$38.09	$36.01
Chick cost, feed and fuel	$21.38	$20.55	$23.06	$22.29
Labor income, per lot	$13.68	$11.85	$15.03	$13.72
Labor income per broiler	15.55¢	13.17¢	15.66¢	14.14¢
Labor income per pound broiler	6.24¢	5.85¢	6.31¢	6.09¢

At about 4 weeks of age, 22 of the chicks in lot V developed "curly toes" which indicated a vitamin G deficiency. These were placed in a separate lot and given a ration which contained 5 percent of dried milk. In four days, all 22 chicks were up and about, acting normally. After a week on the ration with milk they were returned to their original lot for the completion of the experiment. The fact that no other vitamin G deficiencies appeared would indicate that grass silage might be depended upon for this important growth-promoting vitamin after chicks are 4 or 5 weeks of age.

One chick in lot VI showed vitamin deficiency at 4 weeks of age. Lot VII was uneven in size and lot VIII was uneven, and feathers were ruffled. At 8 weeks of age the broilers averaged 1.26, 1.26, 1.33 and 1.17 pounds each for lots V, VI, VII and VIII, respectively, all being well under 1.5 pounds which is about standard weight for birds 8 weeks old, New Hampshire chicks kept in the same quarters at about the same season, and fed the lot VII ration (basal ration plus dehydrated alfalfa meal), averaged 1.62 pounds each at 8 weeks. This indicated that the strain and variety of birds used in the silage experiment probably were partly responsible for the small size.

The sizes of broilers at 12 weeks of age were largest on the silage and dehydrated alfalfa meal rations, lots V and VII. Four percent of dried buttermilk added to the ration in lot VIII improved the size of chicks only 0.07 of a pound over those on a similar ration in lot VI but without buttermilk. Grass silage somewhat reduced the amount of grain required per bird and per pound gain. Due to the very lowcost of the sun-cured alfalfa meal ($13.00 per ton), the total feed cost was lowest for lots VI and VIII.

The chicks cost $7 per hundred, and the electric consumption was $3.61 per brooder. Since the brooders were occupied by less than half capacity, the fuel cost is higher than normal. In calculating labor income per bird nothing was deducted for depreciation of equipment, interest, tax or insurance. The broilers in lots V and VII showed the largest labor income per bird. The mortality was highest in lot V which received the silage. This fact reduced the income from this lot since there were fewer birds to sell.

It was obvious from this broiler experiment that baby chicks did not consume enough silage to provide their vitamin G requirements during early growth but they did, after recovering from this deficiency, make gains slightly better than birds supplied dehydrated and sun-cured alfalfa, with or without, dried buttermilk.

In the absence of high-quality alfalfa meal or other inexpensive sources of vitamins A and G, grass silage could be depended upon for these nutrients after the chicks are a few weeks old.

GRASS VERSUS NO GRASS FOR GROWING TURKEYS

In the spring of 1938, 25 Bronze turkeys 6 weeks old were placed in each of two yards of equal size (0.3 acre). Those in lot I, between the ages 6 to 28 weeks, had access to a luxurious growth of oat and Sudan grass. (Fig. 9.) They also received a liberal quantity of finely-chopped, fresh, immature grass early each morning.

The poults in lot II ranged in a bare yard with no herbage available. They received no chopped green feed. Both lots received the College all-purpose ration, which had been found

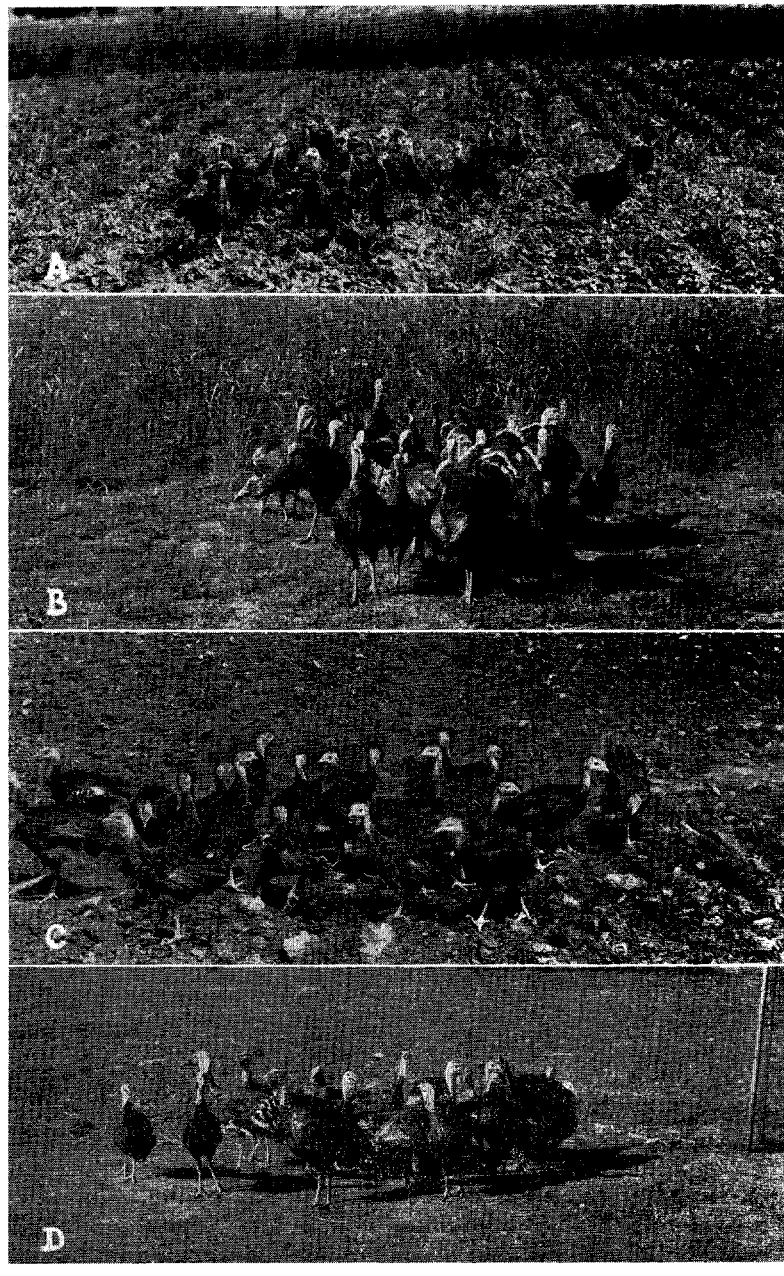


FIGURE 9.—Upper two views show flocks of turkeys 7 and 24 weeks of age reared on Sudan grass pasture; lower two views, turkeys of the same ages reared on bare yards without herbage.

adequate for chicks without a grass supplement. This ration, which was used and recommended by the poultry department of the Kansas Agricultural Experiment Station for chickens and turkeys of all ages is given on page 25.

Also during the spring of 1939, Bronze turkeys 4 weeks old were divided into three groups of 31 each and placed in three colony brooder houses each of which was surrounded by a yard 0.3 of an acre in size.

The yard for lot I contained a good stand of Sudan grass; yard for lot II was summer fallowed to keep down all vegetation. Lot III yard was well covered with alfalfa. All lots received the College all-purpose ration throughout the growing period. The results for the two years are given in Table 11.

TABLE 11.—COMPARISON OF TURKEYS REARED ON GRASS, BARE YARDS, AND ALFALFA RANGE.

Lots (1938)	**I**	**II**	
Kind of herbage	Oat and Sudan grass	No herbage	
Number poults started, 6 wks. old	25	25	
Mortality	2	6	
Average weight, lbs., 28 wks.	19.04	17.19	
Feed consumed per bird, between ages 6 and 28 wks.	71.76	83.85	
Cost of feed per bird	$0.98	$1.19	
Cost of feed per lb. (cents)	5.14	6.92	
Lots (1939)	**I**	**II**	**III**
Kind of herbage	Sudan grass	No herbage	Alfalfa
Number poults started, 4 wks. old	31	31	31
Mortality	1	7	4
Average weight, lbs., 28 wks.	19.2	19.8	17.6
Feed consumed per bird between ages 4 and 28 wks.	70.6	80.2	65.8
Feed cost per bird	$0.99	$1.13	$0.89
Cost of feed per lb. gain (cents)	5.2	5.7	5.1

During the first year's work with turkeys, the oat and Sudan grass pasture was in excellent condition throughout the summer. Supplying chopped grass daily caused the birds to consume much more than they would by foraging alone. A three-day record taken when the turkeys were 21 weeks old showed an average daily consumption of 41 grams or 1.44 ounces per bird. In this case grass proved to be a good supplement to the grain ration. The birds on grass range not only lived better and gained more on less feed, but there was a saving of 21 cents per bird on feed cost.

In repeating and expanding the experiment in 1939, there was no hand-feeding of grass or alfalfa. The birds gathered what they wanted by foraging. The Sudan grass in the yard of lot I was killed by chinch bugs about six weeks before the project ended, hence this yard was deficient in green feed during the period when the turkeys made their greatest gains.

STABILITY OF CAROTENE IN DEHYDRATED MEALS AND SILAGE

The frequent statement that carotene, the precursor of vitamin A, disappears from alfalfa and grass meals at a fairly rapid rate prompted the authors to have monthly tests made for a period of one year in order to determine the facts.

DEHYDRATED ALFALFA AND GRASS MEAL

A representative 100-pound bag of No. 1 dehydrated alfalfa leaf meal and a similar quantity of dehydrated immature oat plant meal were selected from quantity shipments in October, 1936, for this study. These two bags were stored in the attic of the nutrition building at the poultry farm. This was the hottest place available during the summer months.

Three representative samples were taken monthly, except August, from each bag. The dates samples were taken and the carotene content of alfalfa and grass meal tested monthly for one year are given in Table 12.

TABLE 12.—CAROTENE COMPOSITION OF ALFALFA AND IMMATURE GRASS MEAL.

Dates sampled	Milligrams carotene per 100 grams meal	
	Dehydrated oat plant meal	Dehydrated alfalfa leaf meal
Nov. 4, 1936	40.8	32.2
Dec. 14, 1936	40.8	32.2
Jan. 6, 1937	39.0	35.5
Jan. 11, 1937	39.9	36.0
Feb. 18, 1937	25.6	23.8
Mar. 3, 1937	28.8	24.5
Apr. 6, 1937	20.1	18.0
June 2, 1937	17.9	13.7
July 12, 1937	13.0	9.4
Sept. 27, 1937	7.8	8.6
Nov. 1, 1937	8.4	10.8
Loss, 1 year	32.4	21.4
Percentage loss	79.4	66.1

According to these figures there was a pronounced drop in carotene in February, after which the decline was more gradual until June, when the loss became more pronounced. The grass meal which contained more carotene than alfalfa meal at the beginning, showed a higher percentage loss. While losses of 66 and 79 percent of carotene for alfalfa and oat plant meal, respectively, seem high, both bags still possessed more carotene at the end of a year than was found in many samples of freshly-made, sun-cured hay. On November 1, 1937, the oat plant meal contained 63,600 units of vitamin A per pound while the alfalfa leaf meal contained 81,600 units per pound.

OAT AND ALFALFA SILAGE

The spring of 1941 was a favorable season. Oats drilled March 4 made rank growth and were harvested for silage May 8. The yield was 4.8 tons per acre. Alfalfa seeded in August, 1940, made good growth. The alfalfa was also cut for silage May 8. Representative samples were taken from each field for chemical analysis. The comparative growth and height are shown in Figure

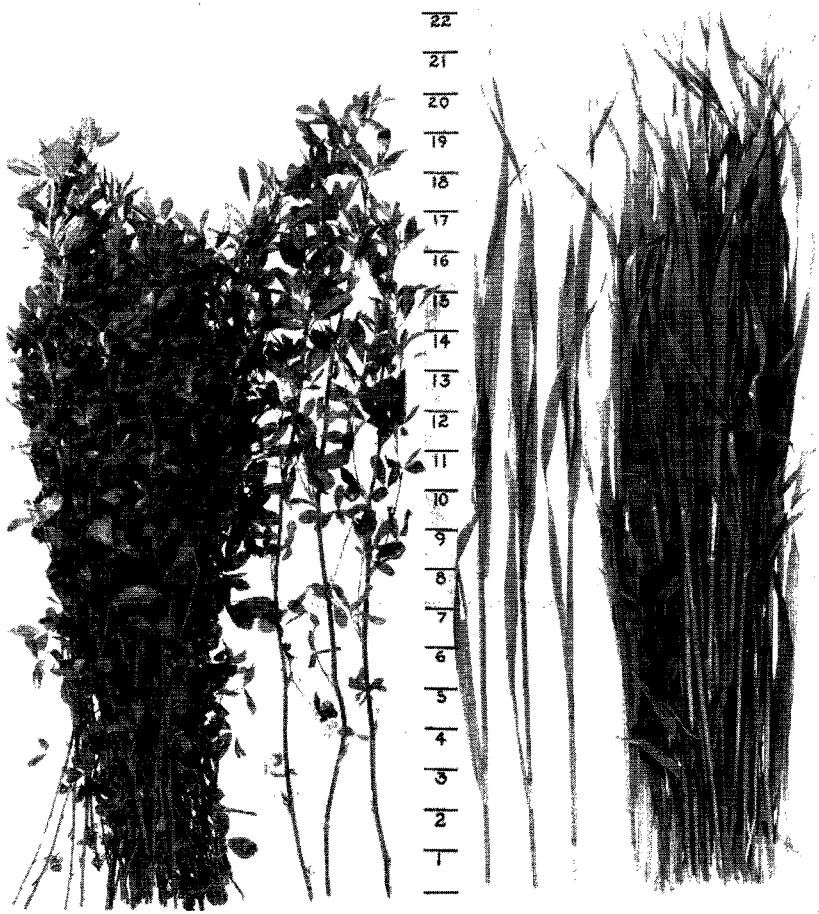


FIGURE 10.—A comparison of alfalfa (left) and oats (right) cut May 8, 1941, or about 60 days after the oats were drilled.

Both crops were made into silage. The composition of the fresh material and that of the silage one year later are given in Table 13.

TABLE 13.—COMPOSITION OF FRESH OAT PLANTS AND ALFALFA, AND SILAGE FROM SAME MATERIALS SAMPLED ONE YEAR LATER.

	Fresh plants May 8, 1941		Silage May 8, 1942	
	Oat plants	Alfalfa	Oat silage	Alfalfa silage
Protein	2.95	5.48	2.59	5.08
Ether extract	0.61	0.46	0.72	0.86
Fiber	3.38	4.73	3.79	4.88
Moisture	85.00	78.00	84.60	79.50
Ash	1.74	2.51	1.89	2.48
Nitrogen free extract	6.32	8.82	7.21	8.85
Carbohydrates	9.70	13.55	11.00	13.73
Carotene, mg./100 gm. (wet basis)	7.16	3.14	6.44	2.82
pH	6.48	6.08	3.81	4.05

There was a loss of 11.5 percent of protein in the oat silage and a loss of 7.3 percent in the alfalfa silage during the year's storage. The loss of carotene amounted to 10.1 percent for the oats and 10.2 percent for the alfalfa. The moisture content of both the fresh and the ensiled product remained nearly constant when stored in sealed barrels.

CONCLUSIONS

1. In these investigations, oats grass has appeared to be more palatable than other grasses for summer pasture. Sudan grass is dependable. Alfalfa is the most satisfactory perennial for poultry pasture in Kansas. (Page 5.)

2. Straight-sided metal barrels holding 350 to 400 pounds of chopped material are convenient and practical for preparation of silage for poultry. (When the barrels are available.)

3. While both mineral acids and molasses can be used to make grass silage, the use of molasses is simpler. Molasses is easier to handle and usually is less expensive. (Table 1.)

4. Sodium propionate in 20-percent solution is of value in checking mold growth in silage during the warm weather of summer.

5. A single test comparing the feeding of immature grass silage to laying hens brought to light no significant differences either in egg production or hatchability. (Table 2.)

6. A comparison between green buttermilk and oat silage showed no significant difference between the two, except that eggs from hens receiving green buttermilk hatched a little better. (Table 3.)

7. Dehydrated grass meal shows no significant advantages over dehydrated alfalfa meal when fed to laying pullets. (Expt. I.) (Table 4.)

8. Leghorn pullets which received Greenmelk show a slight advantage over grass and silage and alfalfa leaf meal lots in number of eggs produced, with no significant difference in hatchability of eggs.

Laying pullets, supplied grass and grass silage as a substitute for Greenmelk and alfalfa meal plus buttermilk, showed a profit above feed cost of 76 cents per bird compared to 40 cents per bird for each of the other lots. (Expt. II.) (Table 6.)

9. The cost of producing a crop of oats and making it into silage was $9.40 per ton in 1937. (Page 24.)

10. "Grass eggs" which result from feeding poor silage can be eliminated by feeding high-grade silage or by restricting the use of silage to 2 or 3 pounds daily per 100 hens. (Page 24.)

11. Contrary to common opinion, growing pullets, supplied all grass or alfalfa they would eat, consumed practically as much grain and mash as pullets which received no green feed. This was not true of turkeys.

Pullets reared on green feed gave significantly greater egg production than pullets reared on a bare lot without green feed. The grass-fed pullets gave better hatchability of eggs than the lots reared on alfalfa or bare ground. (Expt. III.) (Table 7.)

12. Dehydrated alfalfa leaf meal and grass silage, as sources of vitamins A and G for laying pullets, showed a marked advantage over sun-cured alfalfa meal with or without dried buttermilk. (Expt. V.) (Table 9.)

13. Baby chicks being fed to produce broilers did not consume sufficient silage to prevent vitamin G deficiency. However, after recovering from this deficiency at one month of age, they returned about as much profit per bird as broilers as a similar group fed dehydrated alfalfa leaf meal. (Expt. VI.) (Table 10.)

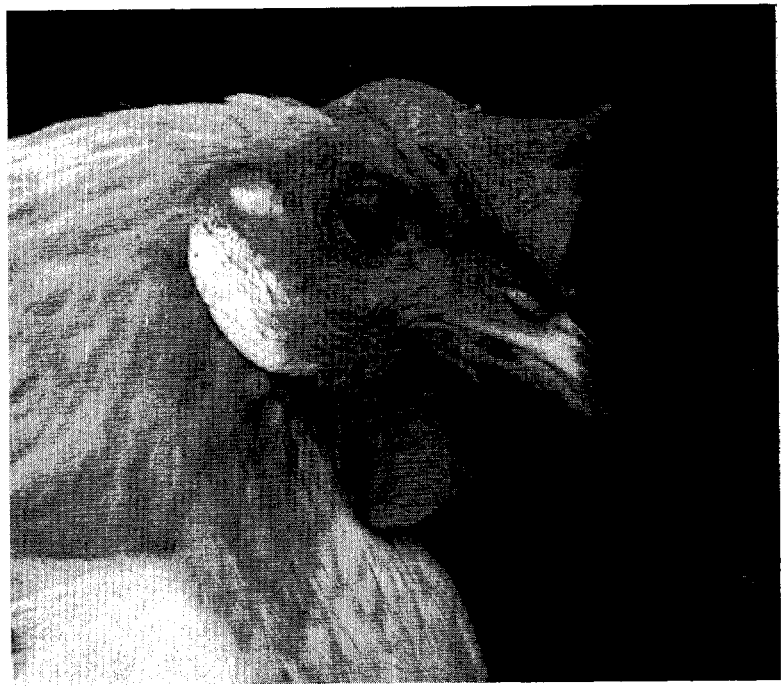
14. Turkeys, reared on grass range and fed chopped grass daily, made much better gains and returned more profit per bird than a similar lot which received the same rations but were kept in a bare lot.

Turkeys that received ample green feed consumed 12 pounds less grain up to 28 weeks of age than the birds without green feed. (Table 11.)

15. Pullets and turkeys on alfalfa and Sudan grass pasture will consume large amounts of chopped alfalfa and grass daily in addition to the amount obtained by grazing. (Fig. 6.)

16. Carotene is much less stable in dehydrated alfalfa or grass meal than in grass silage. Alfalfa meal lost 66.1 percent of its carotene in one year while grass meal lost 79.4 percent. At the end of a year the dehydrated alfalfa leaf meal contained 10.8 mg. per 100 gm., while the dehydrated grass meal contained 8.4 mg. per 100 gm.

Oat-plant silage lost 10 percent of its carotene when stored in barrels for one year. Alfalfa silage experienced approximately the same loss. (Tables 12, 13.)



Good breeding together with physically "fit" flocks, well housed and receiving reasonably good care as to feeding and general management. help to assure profitable poultry and egg production on Kansas farms.