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Legume Silage as a Poultry Feed

University of Tennessee Agricultural Experiment Station

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THE UNIVERSITY OF TENNESSEE
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By

P. W. ALLEN, M. JACOB, N. O. SJOLANDER
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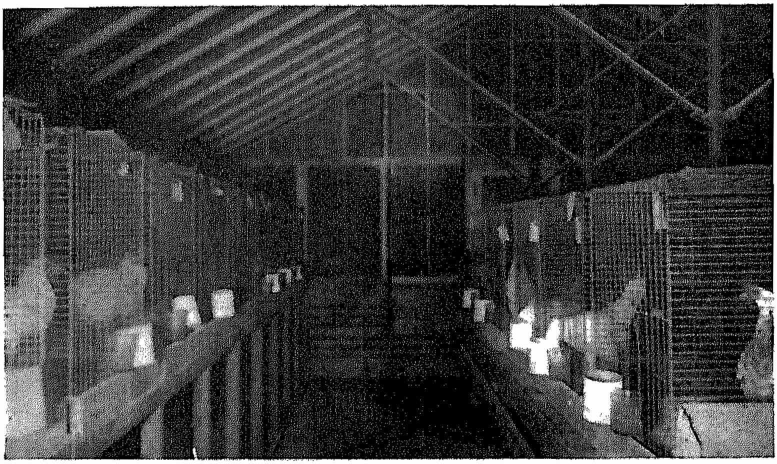

Laying hens in experimental house

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LEGUME SILAGE AS A POULTRY FEED

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INTRODUCTION

VALUE OF GREEN FEED FOR POULTRY

The value of succulent green feed in the diet of poultry has been well known for many years. Poultrymen have recognized the fact that green feed throughout the year is desirable. In different parts of the country different methods have been employed to keep it before poultry at all times. Green pasture in winter is often obtained by the growing of oats, rye, or other suitable cover crops. When available, alfalfa, red clover, crimson clover, white clover, or grasses serve well. Many poultrymen believe that ranges well covered with these crops, furnishing plenty of succulent green pasture, make possible a saving in grain. In winter, green pasture is not generally used, and it often pays, from the standpoint of egg production, to find some other source of succulent green feed. The average farmer, with a small flock of poultry, has difficulty during the cold winter months in keeping his poultry in good physical condition and in maintaining egg production.

Low egg production in winter months is related directly to the fact that egg laying at this time of year is unnatural. With fowls in the wild state, the laying of eggs is a seasonal activity, carried on during the summer. In their natural habitat poultry depend upon food and climatic conditions to aid them in hatching their young, and upon buds, seeds, insects, and worms to make possible the maturing of the young. They await the coming of spring before mating and starting to lay. Formerly it was said that Nature would not permit hens to lay eggs during seasons when outdoor conditions were unfavorable to the hatching and rearing of a brood of chicks. This theory, of course, was incorrect; under proper control, poultry in the coldest parts of the United States make winter egg-laying records irrespective of weather or seasonal conditions.

The poultry husbandman today is struggling with the same problems — nutrition and production — that face growers of other domesticated animals. Not many decades ago America had very little market milk during the coldest winter months. The contrast between the milk flow of a cow freshened in December, having only hay and grain as feed, with the milk flow when she freshened in a season providing pasture of succulent green grass, was so unfavorable to late-fall freshening that this was little practiced. When the silo was introduced to American dairying, however, and green, succulent, lactic-acid corn silage was made available, milk-production conditions underwent a great change, and dairymen began to produce

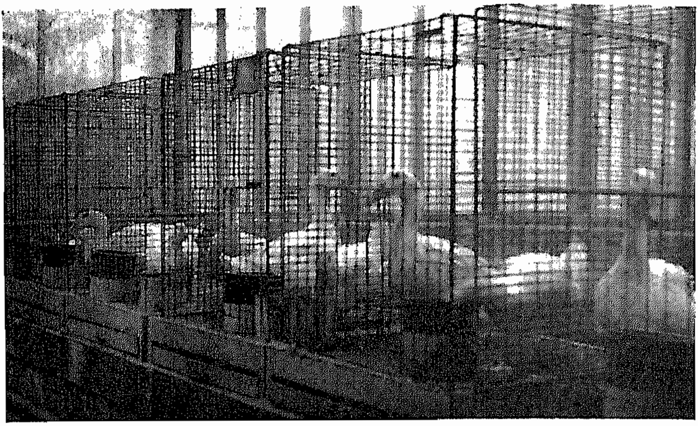

Fig. 1—Ducks in experimental house.

as much milk as could be marketed advantageously irrespective of season. The poultry business has followed the dairy business in creating a longer season of production, in spite of the fact that for years it was supposed that cold weather, short days, and cloudiness would force hens inevitably into a yearly phase of rest from egg laying.

DEMAND FOR GOOD GREEN POULTRY FEED

During the last few years a definite demand has developed for poultry feed combining palatability, greenness, and succulence with high protein and vitamin content. Much headway in this direction has been made. Drying alfalfa by artificial methods has been found to prevent the destruction of vitamins which takes place when alfalfa is cured in the field under the rays of the sun. By this method also greater palatability has been maintained. These qualities, combined with the high protein content of alfalfa, give alfalfa meal great value when it is mixed in poultry feed. Many poultrymen, however, have found that clean, sound, mold-free legume hay, such as alfalfa, red clover, Korean lespedeza, sericea, soybeans, and cowpeas, is excellent feed for poultry. The hay should be placed in a slatted rack or hopper so that it can be eaten without becoming soiled. Some poultrymen have secured legume feed for their flocks by sacking the leaves of alfalfa and clover that shatter and collect on the floor during the feeding of these hays to other livestock. The shattered leaves are fed to poultry by being placed in a feeder that does not allow wastage or contamination with feces.

FEASIBILITY OF LEGUME SILAGE AS A POULTRY FEED

During the last five years, the feasibility of feeding legume silage to poultry has been investigated at the Tennessee Agricultural Experiment Station, with the idea that such a poultry feed combines the qualities of succulence, palatability, high protein content, greenness, high lactic-acid content, and considerable amounts of vitamins A, E, and G, especially A. At the beginning of this work it was thought probable that there were many points at which the employment of silage in poultry feeding would coincide with the newer and more constructive policies in American agriculture. Following are some of these general policies, aided by the introduction of legume silage into poultry feeding:

1. Checking depletion of nitrogen in soils by utilization of crops which effect the fixation of atmospheric nitrogen.

2. Prevention of erosion by furthering production of crops other than annuals.

3. Production of more valuable animals and animal products by use of feeds of larger vitamin content.

4. Preservation of crops at their proper stage and when most valuable, irrespective of weather conditions.

5. Prevention of feeding of moldy, larvae-infested, and putrefactive feeds.

6. Production of feeds of greater palatability, due to succulence, greenness, and other factors.

7. Production of feeds containing lactic acid, which has a definite value in the diet of poultry.

8. Lowering of production costs by cheaper sources of food essentials.

SURVEY OF PRESENT KNOWLEDGE OF LEGUME SILAGE

FOOD PRESERVATION BY FERMENTATION

A very common method of preserving foods is that of pickling—encouraging certain fermentations and discouraging others. This practice is as old as history. It has been applied to stock feeds, however, only a little over half a century, and to but a few of these feeds. That so little use has been made of this method is not surprising when one considers how short a time we have had any knowledge of microbes. Within the last few years there has begun to develop a world-wide application of fermentation as a method of preserving stock feeds. It appears to be destined to revolutionize the agriculture of many regions. In other words, the successful ensiling of legumes is an integral part of the programs of erosion control, soil fertility, growth of livestock, production of milk and eggs, human growth and development, and prevention of human poverty. In fact, the successful growing and preservation of legumes, and keeping of livestock, are closely associated, and are the foundation stones of most systems of permanent agriculture.

When we ensile any kind of crop, we are practicing food preservation by microbial fermentations, and these fermentations are of the same nature as those used in making pickles from fresh cucumbers, or sauerkraut from fresh cabbage leaves. Let us see how pickles are made from cucumbers.

There are armies of microbes which, it might be said, have sworn vengeance upon every vegetable food known to man; and they are not slow in destroying unprotected foods. A ripe cucumber will soon become a mushy, rotten mass. Green cucumbers rot a little more slowly, but take the same route. All animal and vegetable foods not protected by man's ingenuity give way before the onslaught of microbes of putrefaction and decay.

Man has been watching this obvious situation for thousands of years, and has objected strenuously to the deeds of these microbes, knowing that wholesale rotting of foods may mean wholesale starvation of human beings. In a multitude of ways man has done something about it.

LEGUME SILAGE AS FEED FOR CATTLE

During the last forty years in America the use of corn silage for the feeding of cattle has gradually become an accepted practice, especially in those areas where milk or beef production is the main business of the farms. This practice had its beginnings in 1879, when J. B. Brown, of New York, published a translation of a French book by Goffart describing the preparation of silage made from corn cut in the dough stage.

Within a few years after the appearance of Goffart's book the ensiling of numerous green crops was tried, with many successes and many failures. At a number of places in Europe and America during this period silage and hay made from the same crop were compared. Some of the earliest results were obtained by Woodman and Amos, who found that green oats and vetch when made into hay and fed to cattle had considerably less food value per acre than when made into silage. They found that the silage was approximately equal to the green forage fed directly after cutting.

Today these leads are being followed, and numerous methods of preserving green legumes as silage have already been developed. The different methods undoubtedly will have special advantages in different agricultural regions of the world. Just now, agriculturists in general are interested in trying them out, and in determining the real values and advantages of legume-silage making. The use of hay by no means will be superseded, especially since methods have been found of drying hay artificially. Many questions, however, are still being studied, such as production of protein per acre, vitamin content of feed produced, loss due to method of preservation, loss due to shattering, palatability of feed, and value of lactic acid. It will take years to determine the comparative nutritional, sanitary, and economic values of these qualities in feeds; and it is not to be expected that all of the determinations can be made in any one piece of research.

PREPARATION OF LEGUME SILAGE FOR CATTLE

There are a number of rules which must be observed rigidly when legumes are made into silage. Once these rules are laid down, the making of successful silage becomes a mere rule-of-thumb procedure, in which the legumes are mixed with sufficient other materials, cut, and packed in the silo. Unless definite rules are followed, however, more or less dissatisfaction with legume silage results because of spoilage, moldiness, increase in larvae content, damage to palatability, presence of foul odors, loss of fresh-green color, and loss of succulence. Legume silage improperly put up may develop all the characteristics, as to appearance and chemical change, of animal manure.

In the making of legume silage where no mineral acids are added, approximately 1 percent of free organic acid must be produced during the fermentation which takes place in the silo within the next week or two after silo filling. In the production of corn silage there is enough fermentable carbohydrate present in the substance and juices of the corn plant at time of cutting so that microbes can proceed immediately in the silo to produce approximately 1 percent of organic acid. When we come to place chopped legumes into a silo, the amount of "organic acid-producing fermentable" which these crops contain is usually below that amount which, when fermented, will produce the minimum of organic acid required for satisfactory preservation. A number of methods for correcting this deficiency are practiced. Which is most advantageous depends upon the agricultural conditions surrounding the individual farmer. Organic acids usually have been observed to increase the zest with which animals eat silage.

Some of the methods for increasing the acid content of legume crops to a point satisfactory for silage making are given in the following brief descriptions:

Crop-admixture method.—Crops containing considerable amounts of sugars, starches, and other readily fermentable carbohydrates are added to legume crops, thus guaranteeing to the acid-producing microbes sources from which they can make enough organic acids to preserve the silage. Some of the crops which when mixed with legumes make possible a very satisfactory silage, are: sorghum, grass, corn meal, ground grains, cull sweetpotatoes, apples, pumpkins, oats, and ryegrass in early maturity.

A. I. V. method.—Twenty gallons of a double normal solution containing hydrochloric and sulfuric acids is added to each ton of green legume to be ensiled. This is a patented process. The cost is said to be a little over a dollar per ton for the mineral acids used, plus a royalty to the owners of the patents.

Phosphoric acid method.—Phosphoric acid becomes the preserving agent. About 30 pounds of 50-percent acid is used for each ton of green legume. The method is not patented; hence, no royalties need be paid for its use. It is reported that this method can be used at a cost of about $1.50 for each ton of legume silage produced. The feeding of this kind of silage increases the fertilizer value of the manure.

Molasses method.—Up to the present time, this method has been used more extensively than any other. It calls for the addition of 60 to 120 pounds of blackstrap molasses, diluted and sprayed upon the green legume as it goes into the cutter on its way to the silo.

Powdered-buttermilk method.—In making silage by this method, John McBee, in 1937, found that by adding from 2 to 5 pounds of powdered buttermilk per 100 pounds of cut green legume packed in 56-gallon barrels, he was able to produce silage of fine quality.

Skim-milk method.—The cut green legume is placed in 56-gallon barrels and packed down; then enough soured skim milk is added to make the silage moist when pressure is applied with the hand upon the mass in the filled barrel.

Combination methods.—Many combinations of the foregoing methods have been used. All of these, under favorable conditions, have been found to produce good silage for cattle. Valuable data have accumulated on the effect of each kind upon meat production, milk production, and health of animals; color and vitamin content of milk and butter; effect of time of cutting legumes upon next season's crop, types and construction of silos, percentage spoilage and loss of fodder, palatability of ensilage, and most desirable fermentation.

MICROBIOLOGY AND CHEMISTRY OF LEGUME-SILAGE MAKING

Working with typical microbes which cause putrefaction of proteins, Kendall, in 1915, established the fact that the digestive juices by which microbes attack proteins are not produced when sugar is present in silage. There is the further fact that the typical microbes which cause putrefaction of proteins are unable to work when such acids as lactic and acetic are produced by other microbes from the sugars in silage crops.

The explanation of any kind of silage making is a description of the "protein-sparing" action of the organic acid-producing fermentations which go on in green fodder cut and packed in the silo. The chemical reactions which represent the activities of the two great antagonistic groups of microbes that compete for the possession of the energy in legume silage are very different.

These facts are not merely parts of an academic question; the satisfactory production of legume silage on the farm is a practical application of them. Here lies the reason for the addition of hydrochloric and sulfuric acids to silage in the A. I. V. method, and the phosphoric acid in the phosphoric acid method. These facts also determine the amount of molasses to be added in the molasses method. In other words, the amount of "blackstrap" added to material to be ensiled is that amount which will furnish enough sugar to induce microbes to use it as food instead of the protein of the legume. This insures acid production rather than protein decomposition, thus giving an acidity to silage which inhibits the activity of protein-putrefying microbes.

In the acid methods of making legume silage, the facts concerning the amounts of hydrochloric, sulfuric, and phosphoric acids to be added are definitely determined, as these are methods of food preservation by the addition of putrefaction preventives acting as germicides. In the molasses and crop-admixture methods, the preserving effect being due to acid fermentations which dominate the silage, the amount of sugar to be added, in the form of blackstrap or in the form of sugar-bearing crops, depends upon the crop being ensiled. In the molasses method of making silage, 70 pounds of molasses per ton of crop usually is satisfactory, while in the crop-admixture method very little investigation has been done with a view to the exact determination of the proper amount of sugar-bearing crop to be added to the legume crop. Most farmers who have experimented with legume-silage making know of the considerable loss of silage at the top and sides of the silo due to putrefaction and molding. In a silo properly constructed, and filled with a proper admixture of legume and sugar-containing material, loss and uncertainty are avoided.

TYPES OF LEGUME SILAGE

At least three distinct types of legume silage result when different legumes are chopped, mixed with molasses, acids, or sugar-bearing crops, and packed under various conditions. These three types may be called the black, brown, and succulent-green types.

The black type usually results when the legume made into silage is fairly mature and, because of greater fiber content, is difficult to pack closely. This condition allows air to circulate through the silage in the silo, thus thoroughly oxidizing and to some extent drying the chopped legume. The more thoroughly oxidized the chopped legume becomes the blacker it grows. While succulence largely is lost and little lactic-acid fermentation takes place, this type of silage makes a fair feed for cattle and probably is superior to the same legume cured in the field. The greatest difficulty found with this kind of silage is that it frequently becomes moldy with a fine gray mold and loses palatability. Often there is considerable loss of silage, due to extreme moldiness in the upper part and in many places around the sides of the silo. It is a combination between air-curing in the silo and organic-acid preservation.

The brown type of legume silage usually results when the chopped legume to which has been added acid or molasses is young enough and tender enough to pack closely and allow a small amount of air to circulate through it. Fermentation gases remain trapped within it, and less oxidation and darkening take place. Such silage is common in silos which allow the draining away of juices at the bottom of the silo. The lactic-acid content of this type of silage usually is low, as no vigorous fermentation has taken place. This kind of silage makes good feed. It sometimes, however, develops moldy and fly larvae-infested spots. The bottom half of this type of silage always is of much better quality than the top half. The juices lost at the bottom of a silo that drains represent some of the most valuable nutritional constituents of the legume.

The succulent-green type of silage differs distinctly from the customary black and brown types. It is true pickling of the succulent-green legume plant in a silo. In its production no oxidation or molding occurs, owing to the fact that nearly all air is excluded from the silage by fine cutting, close packing, and addition of liquid until a moist condition reaches to the top of the silo. No drainage or loss of juices is allowed. The top of the silo is sealed with tar paper. The paper is covered with dirt, which is wet down and sowed to oats. This is the type of silage which has been found, in this investigation, to be especially valuable as a feed for poultry. It has a high organic-acid content, excellent palatability, deep greenness, and exceptional succulence. Apparently this is a method of preserving succulent green legume forage with the least loss of nutritional values.

One reason for the difficulty in translating nutritional data concerning legume silage is that no differentiation has been made between these different types of silage, the term "legume silage" having been used to designate a specific and unvarying entity, when as a matter of fact the nutritional and chemical data concerning one type probably have little application to another type.

PURPOSE OF THIS INVESTIGATION

The purpose of this investigation is to develop methods of making legume silage especially adapted for use as a poultry feed, and to measure the value of legume silage as a poultry feed from the standpoint of weight production and egg production.

RESULTS

FORMULAS FOR MAKING LEGUME SILAGE FOR POULTRY

In the course of this investigation it has been found that when legumes—alfalfa, red clover, sericea, crimson clover, or cowpeas—are cut in the early blossom stage, they can be made into legume silage for poultry by any of the following methods—the quantities indicated being added to each 100 pounds of chopped legume packed in a barrel or a silo:

Molasses method.—Blackstrap molasses, about 3½ pounds dissolved in warm water.

Skim-milk method.—Thoroughly soured skim milk added to cut and packed legume until mixture becomes moist.

Powdered-buttermilk method.—Powdered buttermilk, 2-5 pounds, dissolved in 4 gallons warm water.

Crop-admixture method (any one of the crops listed below).—

Carrots, 8-10 pounds, well crushed and mixed during cutting of legume.

Cull sweetpotatoes, 8-10 pounds, well crushed and mixed during cutting of legume.

Green sorghum cane, 6-8 pounds, mixed and cut up with legume.

Apples, 12-16 pounds, well crushed and mixed during cutting of legume.

Corn, 20-30 pounds, in dough stage, mixed and cut up with legume.

Cabbage, 15-20 pounds, mixed and cut up with legume.

Ryegrass, 10-12 pounds, mixed and cut up with legume.

Sugar beets, 8-10 pounds, well crushed and mixed during cutting of legume.

Succulent green grass, 12-15 pounds, mixed and cut up with legume.

METHOD OF MAKING MOLASSES-LEGUME SILAGE FOR POULTRY

On the basis of results obtained in this investigation, molasses-legume silage, made by the following method, is recommended for poultry:

1. Harvest the legume when it is coming into first bloom.

2. Cut it immediately into half-inch lengths in a cutter.

3. Thoroughly pack the cut legume in barrels or a small silo. (In the Experiment Station laboratory, 56-gallon wooden barrels were used).

4. Dissolve the blackstrap molasses in warm water, using sufficient water to make the chopped legume moist after the solution is added and the legume is packed down tight. This will require about

3½ pounds of molasses per 100 pounds of the legume, or 70 pounds per ton.

5. Fill the barrels to a point one foot below the top, allow to stand 12 hours, then complete the filling to within 2 inches of the top. This process is advised because usually there is a sudden fermentation during the first 12 hours after packing.

6. Seal with a covering of tar paper or burlap over the chopped legume. Fill the remaining 2 inches with puddled clay. After some days, the clay will shrink around the edges and the space will need to be filled with more clay to prevent air from getting into the barrel.

It is very important that no juice leak out of the barrel, and no air get in. If these points are observed, the silage will remain bright green, succulent, and free from putrefactive odor and darkening. This method prevents oxidation, molding, development of larvae, and loss of valuable juices. These precautions are found to be necessary in order to produce silage of the greatest nutritional value and palatability.

METHODS OF FEEDING LEGUME SILAGE TO POULTRY

In the feeding of legume silage to poultry, certain practices have been found to be successful. Poultry are like other farm animals in that they become accustomed to particular feeds in certain forms, and require a few days to adjust themselves to a change. In introducing legume silage to poultry it is best to mix the moist silage with the dry mash or with whatever feed the birds have been getting. The lactic acid in the silage at first is somewhat strange to poultry unless they happen to be accustomed to receiving buttermilk or other lactic-acid feed.

INFLUENCE OF LEGUME SILAGE UPON HEALTH OF POULTRY

During the last five years, while the Station has been experimenting with the feeding of silage to poultry, a careful watch has been kept on the 200 fowls which have eaten it, to note any ill effect upon their health. So far as observed, the fowls receiving legume silage during the winter months have had better health than those kept under identical conditions but without the addition of legume silage to their diet. These observations have been made on the basis of alertness, appetite, condition of plumage, and color of legs and comb. While these signs are not an absolute index to health, they may be taken as indications.

WEIGHT INCREASE IN POULTRY FED LEGUME SILAGE

Weight Increase Series 3, 1937

In a series of experiments having to do with poultry sanitation during the last few years, it was found that the severity of the action of intestinal parasites on infected fowls depended to some extent upon the diet. A diet of sour milk reduced the severity of attacks by pullorum organisms, coccidia, ascarids, cecal worms, tapeworms, and other pests. It was assumed that this beneficial effect was due, at least in part, to the lactic acid in sour milk, and that other feeds containing considerable amounts of lactic acid might well be considered in the feeding of poultry, as all poultry have more or less intestinal infection. Accordingly, sauerkraut and legume silage were tried out in the summer of 1935, being given ad libitum in addition to a basic poultry ration. Sauerkraut has little nutritive value and its use cannot be expected to reduce the amount of other feed required.

In legume silage the case was different; here was a high-protein feed of considerable possibilities. After a special legume silage of high lactic-acid content was produced, the poultry ate it with zest.

In the summer of 1937, some specially fermented legume silage was fed to white Leghorn cockerels. They ate this silage so eagerly that in the spring of that year 4,000 pounds of legume silage was made in barrels holding about 400 to 500 pounds each, to be fed experimentally to poultry. This silage was made by the addition of 70 pounds of blackstrap molasses to one ton of cut green legume. Sericea, alfalfa, and red clover were made into silage.

It had been discovered in the course of these experiments that there are two different fermentations which may take place in the making of legume silage—one in which the cut legume becomes dark in color, with the top half drying out considerably and tending toward putrefaction and molding. Special care was taken, in making the legume silage for this experiment, to see that the bright-green color and the lactic-acid fermentation were obtained. A study of this type of fermentation is partly completed and will be reported later.

The fowls used for this legume-silage experiment were 45 white Leghorn cockerels about 6 weeks of age. All were from the same flock, and averaged a little less than one pound. They were divided into 3 groups, as follows:

Group A consisted of 18 cockerels, which were given a basic poultry mash, and in addition as much legume silage, consisting of a mixture of alfalfa, red clover, and sericea, as they would eat. The mash and silage were mixed together, and the average cockerel ate 4 ounces of mash and 4 ounces of silage per day.

Group B consisted of 9 cockerels, which were given a basic poultry mash, and in addition as much sour milk as they would eat. The average cockerel ate 4 ounces of mash and 4 ounces of sour milk. Excess mash was accessible at all times.

Group C consisted of 18 cockerels, which were given a basic poultry mash and no other feed. The average cockerel ate 4 ounces of mash. Excess mash was accessible.

Every factor which it was possible to control was controlled. Each cockerel was kept in a separate cage. All had the same kind of cage, the same temperature and air movement, the same amount of sunshine, the same ration, and the same management. The glass roof of the poultry house is made of "vita glass," allowing 90 percent of the active rays of the sun to enter. All birds were found free from pullorum infection by blood testing at the beginning of the experiment.

While the fact is recognized that a feed advantage should be demonstrated on the basis of a large number of fowls before final conclusions are drawn, initial experiments on 45 fowls, in which all factors are carefully controlled, strongly indicate directions, which cannot be ignored.

In table 1 are summarized the percentage gains made by the cockerels in the three groups. Post-mortem data concerning fowls in these groups are presented in table 2. The acidity and the microbial content of sericea, alfalfa, and red clover silages are shown in table 3.

TABLE 1—*Percentage gains made by cockerels from the seventh to the sixteenth week, inclusive.*

GROUP A

No. of cockerel	1137	1191	1181	1154	1131	1144	1173	1177	1187
Percentage gain	171	177	207	207	264	162	186	180	133
No. of cockerel	1161	1118	1178	1147	1116	1124	1122	1163	1168
Percentage gain	260	236	169	192	200	400	357	173	183

Average percentage gain for group A, 214.

GROUP B

No. of cockerel	1160	1172	1149	1158	1140	1156	1157	1145	1192
Percentage gain	176	166	244	161	178	245	300	218	255

Average percentage gain for group B, 215.

GROUP C

No. of cockerel	1138	1121	1151	1186	1169	1152	1164	1167	1155
Percentage gain	153	157	150	190	190	150	87	185	137
No. of cockerel	1165	1125	1175	1171	1139	1130	1189	1170	1190
Percentage gain	209	191	160	157	154	172	191	230	133

Average percentage gain for group C, 166.

TABLE 2—*Post-mortem data concerning fowls in groups A, B, and C*

Group	Percentage showing medium to heavy infestation with				
	Tapeworm	Ascaridia	Coccidia	Cecal worms	Gizzard worms
A	18	0	0	0	5
B	20	0	10	37	0
C	14	10	25	25	0

TABLE 3—*Data concerning legume silage*

Crop	Percent of acidity as lactic acid	Plate count	
		Bacteria	Fungi
Sericea	1.8	170,000,000	1,000,000
Alfalfa	2.1	4,500,000	100,000
Red clover	2.0	3,500,000	300,000

Weight-Increase Series 5, 1940

In weight-increase series 5 (1940) white Peking ducks were chosen as the test fowl with the idea that the use of ducks would give a further test of the general value of legume silage as a feed for poultry.

The conditions under which the ducks were kept, the sanitary feeding methods, and the use of basic feed were identical with those in

TABLE 4—*Weight comparison of ducks fed legume silage ad libitum in addition to a basic ration and ducks fed only basic ration.*
Weight-increase series 5, 1940

Duck	April 13	April 20	April 27	May 4	May 13	May 28
SILAGE GROUP						
No.	Ounces	Ounces	Ounces	Ounces	Ounces	Ounces
301	52	65	62	64	64	75
302	46	58	56	63	66	74
303	39	54	54	58	62	71
304	34	57	53	54	60	72
305	50	68	66	69	69	77
306	24	33	31	34	38	52
307	22	32	30	34	38	51
308	23	32	32	36	38	52
309	35	47	46	53	53	67
310	31	39	38	44	48	61
311	38	54	54	62	65	71
312	35	48	44	49	56	64
313	36	46	43	48	53	67
314	42	51	49	52	54	69
315	38	45	46	51	54	70
316	43	53	49	54	57	67
Total	588					1060
NO-SILAGE GROUP						
351	41	56	56	55	58	66
352	40	53	53	54	56	60
353	44	60	58	59	61	64
354	44	52	47	49	52	55
355	50	58	53	53	56	63
356	23	28	26	28	32	35
357	28	33	31	32	34	40
358	23	30	29	32	40	45
359	37	46	40	42	44	46
360	32	39	40	42	48	54
361	34	42	38	40	44	48
362	32	40	37	40	43	50
363	37	45	42	48	52	56
364	32	38	34	36	38	44
365	51	56	53	58	57	60
366	38	44	40	45	48	52
Total	586					838

Silage group gained 80 percent; no-silage group gained only 43 percent.

feeding series 3 (1937), in which white Leghorn cockerels were used.

The increases in weights of ducks in this experiment are shown in table 4.

EGG PRODUCTION OF POULTRY FED LEGUME SILAGE

Egg-Laying Series 4, 1938-9

In the spring of 1938, approximately 6,000 pounds of sericea was prepared in 56-gallon barrels, each containing 400 pounds. This was

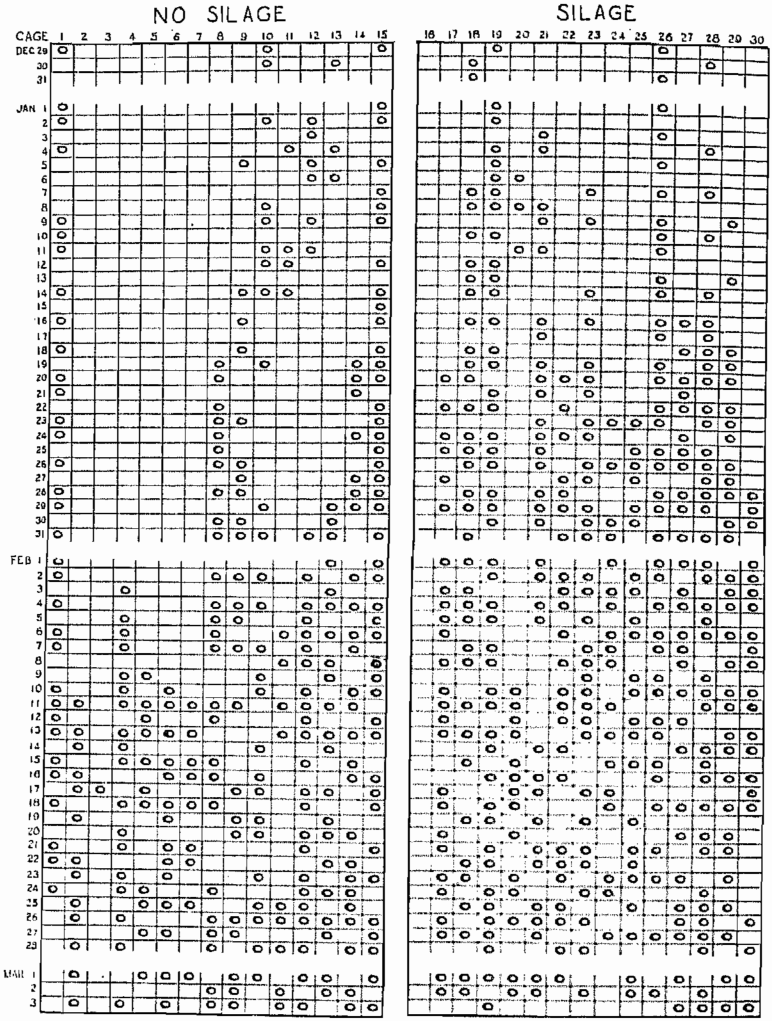

Fig. 2—Egg production, in egg-laying series 4
Each oval represents one egg.

kept until December 29, 1938, when a feeding trial was begun with 30 white Leghorn pullets 8 months old. Each pullet was kept in a separate cage, on wire cloth, and fed a basic ration[1]. One half of the pullets received 4 ounces per day of the sericea silage in addition to the basic ration. Feed and water were provided under strictly sani-

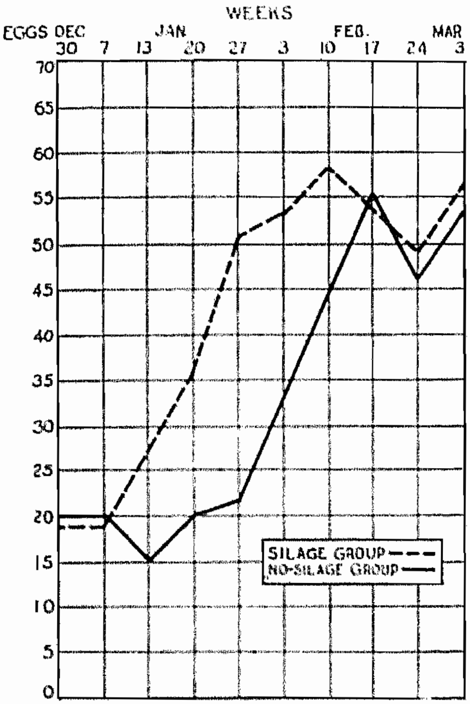

Fig. 3—Increased egg production by hens fed legume silage, in egg-laying series 4, 1938-9

tary conditions. The poultry house was equipped with a roof made of panes of "vita glass," which allows 90 percent of the actinic rays of the sun to enter. Table 5 shows the comparative egg production of the two groups, one receiving legume silage, the other no silage.

[1]Basic ration:

	Pounds
Yellow corn meal	38
Meat meal (55% P)	20
Red Dog flour	15
Ground oats	10
Gluten meal	7
Linseed-oil meal	5
Bran	5
Salt	1
Total	101

Egg-laying Series 6, 1940

In egg-laying series 6 (1940) the main idea was to repeat the egg-laying experiment of 1938-9 under identical feed, housing, and other conditions. It was believed that further data should be obtained concerning the use of legume silage as a poultry feed. The

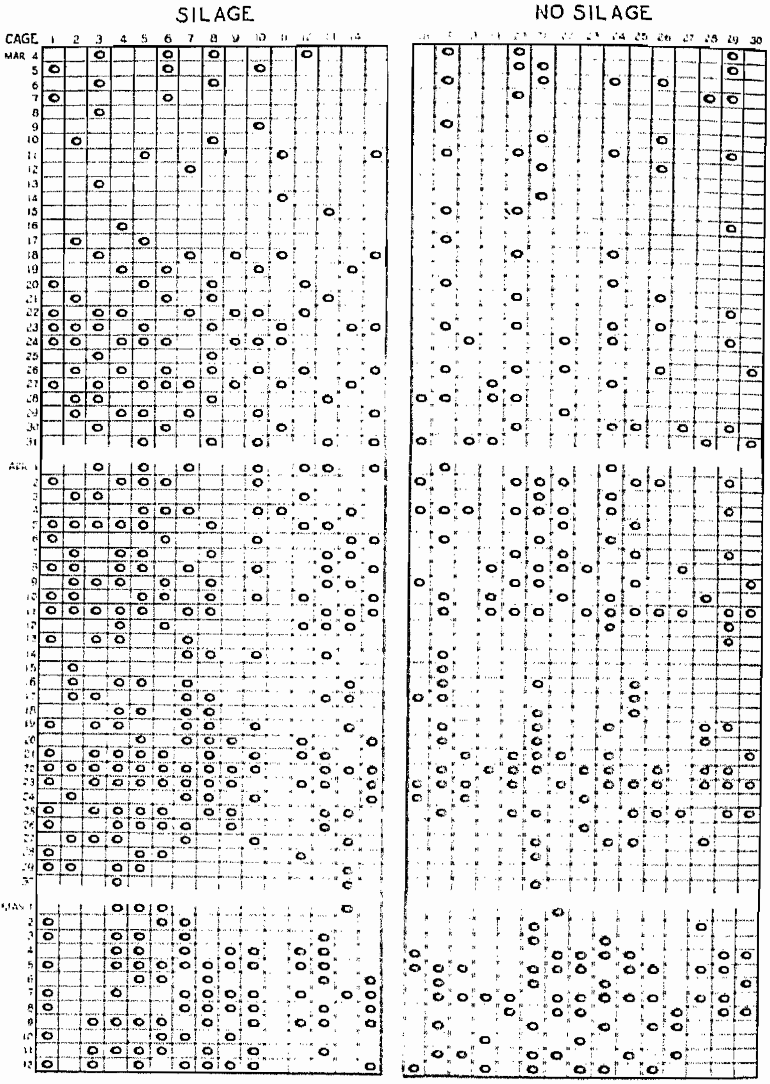

Fig. 4—Egg production, in egg-laying series 6
Each oval represents one egg.

TABLE 5—*Comparative egg production, during 8 winter weeks, of hens fed a basic ration with and without silage.*

Egg-laying series 4, 1938-9

Week	Silage group 15 hens	No-silage group 15 hens
	Eggs	Eggs
Dec. 29 - Jan. 6	18	20
Jan. 7-13	26	15
Jan. 14-20	37	20
Jan. 21-27	51	21
Jan. 28 - Feb. 3	53	32
Feb. 4-10	58	44
Feb. 11-17	54	56
Feb. 18-24	49	45
Feb. 25 - Mar. 3	56	55
Total	402	308

30.5-percent increase in favor of legume-silage group.

only difference in these two experiments was that the egg-laying series 4 was carried out during January and February, while series 6 was carried out during March, April, and May. Table 6 shows the comparative egg production of the silage and no-silage groups.

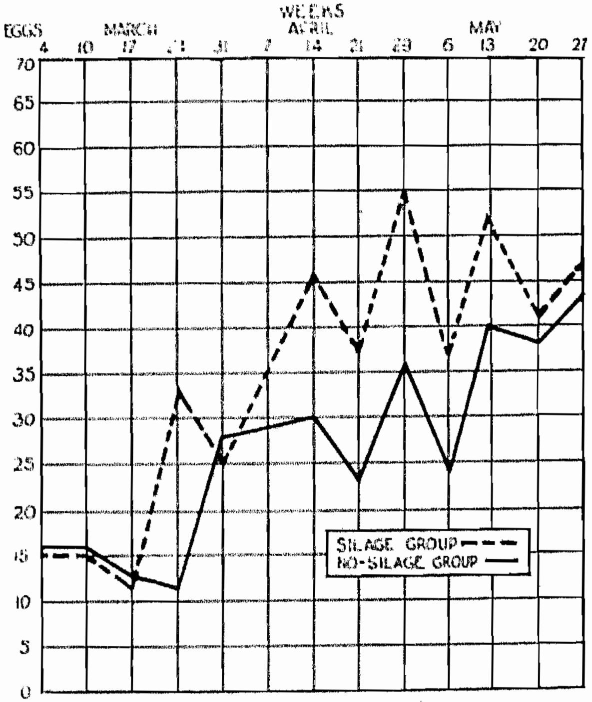

Fig. 5—Increased egg production by hens fed legume silage, in egg-laying series 6, 1940.

TABLE 6—*Comparative egg production, during 12 spring weeks, of hens fed a basic ration with and without silage.*

Egg-laying series 6, 1940

Week	Silage group 15 hens	No-silage group 15 hens
	Eggs	Eggs
March 4-10	15	16
March 11-17	10	10
March 18-24	34	12
March 25-31	25	28
April 1-7	40	29
April 8-14	46	30
April 15-21	38	23
April 22-29	55	37
April 30 - May 6	36	23
May 7-13	52	40
May 14-20	41	38
May 21-27	47	44
Total	439	330

33-percent increase in favor of legume-silage group.

DISCUSSION OF RESULTS

There has been very little investigation of the actual influence of lactic acid in the diet of poultry, and for that reason much that might be written on this subject would be mere speculation. Some facts, however, should be pointed out, as they undoubtedly have a direct relation to the beneficial effects of buttermilk, sour milk, and legume silage upon the alimentary tracts of fowls.

Acids, in larger or smaller amounts, enter into the diets of all kinds of birds in the wild condition, living in their natural habitats. Studies of the stomach contents of wild birds, not far removed from our domesticated poultry, show that in addition to seeds they live very largely upon berries, buds, insects, worms, and grasses, all of which contain considerable amounts of organic acids. In addition to these facts, it undoubtedly has been observed by most poultrymen that not only do poultry like buttermilk, but those fowls which are fed buttermilk regularly have, to a marked degree, less putrefactive alimentary tracts.

While one would not be warranted in making any applications of the extensive lactic-acid therapy which has been built upon research concerning the human alimentary tract, still every poultry pathologist associates an excessive proteolytic microbial flora, accompained by inflamed lining walls and extreme stench, with a pathological condition. On the other hand, health of fowl and sanitary tone of alimentary tract usually run parallel. These facts are pointed out here to draw attention to the likelihood that an acid diet is natural to poultry and that legume silage, which normally contains about 1 percent of organic acids, naturally fits into the diet of poultry.

When legume silage is considered as a poultry feed, its nutritive value must be taken into consideration. The approximate proportion of digestible protein in several legume silages, compared with that in corn silage, is shown in the following table, in which the proportion in corn silage is represented as 1.0:

Corn	1.0
Cowpea	1.8
Red clover	2.7
Alfalfa	3.0
Soybean	3.2
Sericea	3.2
Vetch	3.7

All poultry, irrespective of age, require vitamin A for growth and resistance to infectious and nutritional roup. Legume silages properly made are a good source of this vitamin. It is well known that poultry having access to succulent green alfalfa obtain adequate amounts of vitamin A. When succulent green feed is not available, a ration of which ½ is yellow corn and 1/20 alfalfa meal will supply this vitamin. It seems probable, in consideration of the extensive data obtained concerning legume silage in its use as a feed for cattle, that an adequate supply of vitamin A can be furnished to poultry through the practice of feeding legume silage.

During the last three years, the quality of eggs produced by hens fed legume silage has been compared with that of eggs produced by

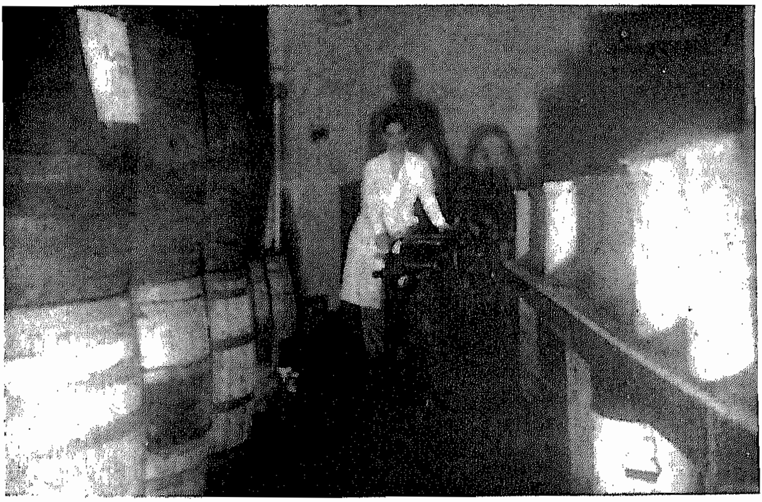

Fig. 6—Laboratory for experimental production of legume silage

hens receiving no silage. Ten people have made these comparisons, and not one has noted any difference in flavor, deepness of yolk color, or firmness of whites.

CONCLUSIONS

The results shown in the tables are initial results, but were obtained under such carefully controlled conditions that the chance for error was not large. If all the facts are taken into consideration, some importnt conclusions may be drawn from this experimentation. When poultry are fed, in addition to a basic ration, a green succulent legume silage made from red clover, alfalfa, or sericea, and have become accustomed to it in their diet, they show the following advantages of silage feeding:

1. Greater zest in eating and more feed eaten per day.

2. Increase in weight over poultry not receiving such silage.

3. Better physical condition, as determined by appearance, vitality, weight production, egg production, and post-mortem examination.

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