

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
PROJECT OUTLINE

1956: ST-11-17
~~1956: ST-21-24~~

Project No.	952 - 1119
Date	
Submitted	
Approved	
Revised	Sept. 1949

1. Title

Study of the Effect of Fertilization on the Nutritional Quality of Forage.

2. Objective(s)

- (1) To determine the effect on the health and well-being of animals of applications of certain fertilizers on forages grown in areas known to be associated with nutritional deficiencies.
- (2) To produce forages which may be used in the study of trace element deficiencies in livestock.
- (3) To study possible harmful effects of intensive fertilization on the nutritive value of the plant.

3. Reasons for undertaking Investigations*

There are large areas of land in eastern North Carolina which at the present time return little or no revenue, but do produce natural grass and reeds in abundance. In these areas, beef cattle have been shown to be especially efficient in converting native growth into products available for human consumption, providing proper supplemental minerals were fed. Little is known about the possibilities of improving the use of these lands for livestock grazing, especially in relation to use of tame pastures and for the production of other sources of feed.

Indications are that forages grown on these soils are deficient in one or more mineral elements and possible other factors of nutritional importance.

*Including economic justification

4. Previous work and present status of investigations in the field of this project:

The introduction of better plant species and increased yields has been the objective of most fertilizer programs in forage improvement work. The effect of such programs on the nutritional quality of the forage produced is not ordinarily considered. There are certain initial considerations that are evident from many field observations by persons working with grazing animals in different parts of the country. These include (1) the occurrence of troubles which are apparently deficiencies caused by certain "minor" elements; (2) the occurrence of troubles particularly ascribed to phosphorus deficiencies in soils; and (3) the occurrence of troubles associated with intensive pasture and forage fertilization. It is proposed to study initially the effects of phosphorus deficiencies.

During the past several years, many observations have been made of breeding difficulties in beef cattle, sheep and swine on the North Carolina Coastal Plain. In these areas clinical observations and chemical analyses of forages have shown that phosphorus, cobalt and manganese are abnormally low and that copper, iron and other trace elements may also be involved in the nutritional difficulties observed.

5. Outline of Procedure:

Location. The new Tidewater Farm located near Plymouth has been chosen since its soils have been shown by analysis to be definitely deficient in phosphorus. Nutritional difficulties of livestock have been observed in this area.

Animals. Two groups of 25 lambs each with their dams will be placed on pasture in the spring—one group on pasture fertilized with superphosphate, the other group on pasture not given an application of superphosphate. All pastures will have an application of lime and potash.

Feeds. Since fertilization of a permanent pasture would probably modify the species distribution and thus complicate the experiment, no permanent pasture will be used. Grazing will be provided by winter oats and a succession of soybean plantings during the summer. Oats will supply pasture, grain and bedding. Soybeans will provide pasture, hay and soybean oil meal. Inasmuch as there will be an interval of perhaps five to six weeks between the close of the oats grazing season and the time that soybean grazing would be available, a temporary pasture of Italian rye grass will be furnished. Since this will be reseeded each year, the likelihood of species modification due to fertilization would be slight. Feeds will be grown with and without phosphate fertilization. It is the intention that this shall provide a continued supply of feed throughout the year for each group of animals. No imported feeds except a high grade salt will be used throughout the experiment.

5. Outline of Procedure: - Continued

Estimate of feed required. About thirty (30) acres of unphosphated soybean pasture and fifteen (15) acres of phosphated soybean pasture will be provided. Successive plantings will be made so that grazing will be available during the entire normal grazing season. About five (5) tons of soybean hay will be required from each treatment--two and one-half (2-1/2) tons for paired feeding and digestion trials, and three (3) tons to carry ewe lambs through a winter of five months. The hay will be cut at an immature stage. Provision will be made for producing at least five hundred (500) pounds of soybean oil meal from both fertilized and unfertilized crops. One (1) ton of oat grain will be required from each treatment. Oat pasture for winter grazing will also be required.

Feeding studies to be conducted. As the soybean hay differentially fertilized with superphosphate is harvested, 10 pairs of wether lambs will be selected for a paired-feeding trial, leaving the remaining lambs on pasture. Weekly weights will be obtained during the feeding trial of 100 days. Digestion and nitrogen-balance trials with the soybean hay will be conducted following this time with 6 or more pairs of these lambs if facilities permit. At the end of this time, it will be decided whether it is desirable to make carcass evaluations and/or blood and tissue analyses. Throughout this entire study, blood analysis of no less than 10 representative animals in each group will be made at monthly intervals. If time and facilities permit, blood analyses of all animals is recommended at these intervals.

Of the remaining 30 lambs, the ewe lambs will be bred in the fall and carried through reproduction. During the winter months, groups will be fed soybean hay-oats-soybean oil meal diet differentially fertilized with superphosphate. The lambs from these ewes may be carried through another year of feeding forage and grain differentially fertilized with superphosphate.

All practical measures will be taken to avoid parasitic infestation of the animals. Fecal samples will be taken and counts made at desirable intervals during the course of the experiment.

Future work

Future work would include studies of intensive nitrogen fertilization and the effects of liming on the nutritive value of pasture and hay. As an immediate step toward this, small plots could be set out to test the effect of these treatments on composition.

SUBPROJECT I

Title: A Survey of the Mineral Deficiencies in the Coastal Plain of North Carolina

A. Farm animal studies.

1. Detailed description of symptoms observed in livestock.
2. Such studies of length of oestrus cycle as are feasible will be carried out. Frequent observations may not be possible since almost constant attention of an experienced worker would be required.
3. Hemoglobin levels and Ca, P, Mn, Co, Fe, Cu, protein, and phosphatase contents of the blood will be ascertained. The determination of hemoglobin, protein, phosphorus, and phosphatase and the preparation of filtrates or ashes will be done at North Carolina State College.
4. Slaughter of affected animals and post-mortem examination for gross lesions, especially parasites. Organs and bones will be shipped to Ithaca for chemical and histological examination. Animals for slaughter could probably be obtained from farmers in the vicinity. The mineral mixture being fed the herd in the Hoffman Forest keeps them in reasonably good condition.

B. Seasonal analyses of reed forage in the Hoffman Forest and Wenona.

Samples will be sent to Ithaca for trace element analysis.

C. Survey of forage crops in the Coastal Plain.

Samples of native and cultivated forage plants will be collected in close relationship to the occurrence of troubles in animals. The data will be plotted on maps, and working closely with the Agronomy Department, the data will be used to map as accurately as possible the mineral deficient areas of the Coastal Plain section of the state. Protein, fat, fiber, nitrogen-free extract, ash, and lignin will be determined at the North Carolina station. Mineral constituents will be determined at Ithaca.

D. Digestion trials.

Since dried forage may be unpalatable, digestion trials on native forages, such as reeds, will probably have to be conducted with cattle grazing fenced areas, using the lignin ratio technique. The lignin ratio technique should be compared with the standard techniques, but since such a large quantity of reed forage would be required for steers, sheep would probably be a better test animal for this purpose.

E. Energy requirements.

If it becomes evident that lack of energy or any other factor is responsible for the deficiency symptoms observed, the effect of appropriate supplements will be studied.

F. Small animal studies.

Small animal work, possibly with rabbits, will be initiated at North Carolina State College to supplement the chemical work on forages.

6. Probable Duration of Project: 3 years
7. Date of Initiation: July 1, 1945, present organization July 1, 1942
8. Personnel: (July 1, 1949)

Name	Department	Relation to Project
G. H. Wise	Animal Industry (Nutrition)	Leader
G. Matrone	U.S. Plant, Soil, and Nutrition Lab.	Co-leader
F. H. Smith	Animal Industry (Nutrition)	Co-leader
F. W. Sherwood	Animal Industry (Nutrition)	Co-leader
W. W. G. Smart, Jr.	Animal Industry (Nutrition)	Assistant
Hartlee M. Baxley	Animal Industry (Nutrition)	Assistant
Virginia Weldon	Animal Industry (Nutrition)	Assistant
E. H. Hostetler	Animal Industry (Animal Husbandry)	Cooperator
R. L. Lovvorn	Agronomy	Cooperator
W. W. Woodhouse, Jr.	Agronomy	Cooperator
J. L. Rea, Jr.	N. C. Dept. of Agriculture	Cooperator
D. W. Colvard	Animal Industry	Adviser
K. C. Beeson	U. S. Plant, Soil, and Nutrition Lab.	Adviser
H. L. Lucas	Experimental Statistics	Adviser
W. J. Peterson	Agric. and Biol. Chemistry	Adviser

9. Cooperation:

a. Interdepartmental

Animal Industry Department
Agronomy Department

b. Other Agencies

U.S. Plant, Soil and Nutrition Laboratory
North Carolina Department of Agriculture

10. Financial Support:

a. Proposed Budget 7/1/49 to 6/30/50

Items	ALLOCATION OF FUNDS					
	Bankhead-Jones	Purnell	Adams	State	Other	Total
1. Salaries						
F. H. Smith				4,272		
G. H. Wise				3,510		
Hartlee M. Baxley				1,392		
E.G. Haywood				1,232		
2. Labor				1,334		
3. Travel				200		
4. Equipment & Supplies				1,481		
5. All Other				725		
Total				\$14,146		

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income
1950-1951	\$ 11,740	\$ 14,146	
1951-1952	11,740	14,146	
1952-1953	11,740	14,146	

11. General Remarks:

This project was initiated under the leadership of Dr. W. J. Peterson, who formerly was head of the Animal Nutrition Section. The outline herein is as originally presented.

SIGNATURES OF APPROVAL

1. Approval of Project Leaders

Date *October 11, 1949**George H. Wise*

Title

*Professor Animal Industry (Nutrition)*Date *Oct. 12, 1949**Gerrard Watson*

Title

*Chemist, U.S.D.A.*Date *Oct. 12, 1949**F.W. Sherwood*

Title

*Research Professor, Animal Industry (Nutrition)**Oct. 12, 1949**J.H. Smith**Senior Research Prof. Animal Industry (Nutrition)*

2. Approval of Heads of Departments or Cooperating Agencies

Date

Head,

Date *10-15-49**W.E. Coe well*

Head,

Agronomy

Date

Head,

3. Approval of Committee on Experiment Station Projects

Date

Chairman of Committee

4. Approval of Director

Date

Director, North Carolina Agricultural
Experiment Station

5. Approval of U. S. D. A.

Date

Chief, Office of Experiment Stations

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

PROJECT OUTLINE

1456: H-17
1456: B324

Project No.	BJ2L-A12
Date	
Submitted	December
Approved	
Revised	December, 1949

1. Title

Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.

2. Objective(s)

- a. To study the effect of different fertilizers on the composition (minerals, vitamins, nitrogen and carbohydrates) of whole plants, soybeans, lespedeza, bull grass (*Paspalum bosciannum*), rye grass and related forage plants.
- b. To make similar composition studies on various parts of soybean plants and other legumes.
- c. To study the interrelationships of fertilization and maturity on the composition of the plants under study.
- d. To determine at definite intervals throughout the grazing season the changes in chemical composition of grazed forages differentially fertilized.
- e. To study the nutritive characteristics of the plants by feeding and metabolism studies with laboratory animals.

3. Reasons for Undertaking Investigations*

The initial phase of this investigation singles out for special study those particular plants that are grown in connection with Project 352-A119 (Influence of Fertilization on the Nutritional Quality of Forage), which emphasizes the responses of farm animals, principally sheep, to forages grown on differentially-phosphated plots. In order to establish a more comprehensive basis for appraisal of animal responses, this present project will be concerned primarily with more extensive studies of the chemical composition of the same feeds.

To arrive at basic information concerning the effect of fertilization on the nutritive composition of forages, detailed studies are needed on individual forage species. In conjunction with this phase of the study an evaluation of the effects of fertilization on the rate of maturity and on the change in the relative proportions of nutrients in plant parts is desirable.

It is well known that fertilization often affects the kind and ratio of species in mixed pastures. Nonetheless, many of the data in the literature are of the type from which it is impossible to separate the effect of fertilization on the change in botanical composition from the effect of the treatment on the composition of a specific forage. Such data still leave unanswered questions:

- a. Which plant nutrients are affected by various fertilizer treatments?

*Including economic justification

- b. To what extent, if any, are the relative amounts of nutrients modified?
 c. What effects do the changes in the plant components have on the feed value?

The studies outlined herein are designed to obtain some of this basic information on the effect of fertilization and managerial treatments on characteristics of various individual forage species.

4. Previous work and present status of investigations in the field of this project:

This project is a substitute for an earlier one (BJ24-A12) which is being discontinued. The state of knowledge in this field up to 1943 was reviewed briefly, with references, in this earlier project and a few additional citations are given in a publication dealing with some of the results from this earlier project ("The Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pasture Herbage," Jour. Amer. Soc. Agronomy, 39:841-858, 1947).

Both the results presented in the aforementioned paper and those, as yet unpublished, demonstrate an effect of fertilization on a mixed pasture herbage. The extent of the effects varied considerably from year to year, due apparently to changes in the meteorological conditions. It has not been possible to determine whether the alterations in chemical composition resulted from changes in botanical composition or changes in the chemical components of the different species.

Other results from this project have shown differences in the chemical composition of lespedeza due to variety, stage of maturity and to fertilization.

These findings together with those cited in the literature point to the desirability of working with pure species rather than with mixtures such as commonly occur in pastures. There is also a need for assessing the significance of changes in chemical composition in terms of nutritive value as determined by controlled feeding experiments.

The forage species, enumerated in Objective a of this project, have been grown in connection with Project S52-A119 in differentially-phosphate-fertilized plots which have received the same fertilizer treatments for the past five growing seasons. In the third-crop year, the phosphate-fertilized plots produced soybean hay which was higher in protein, calcium and phosphorus than the soybean hay produced on the nonphosphate-fertilized plots. The results of the first two years have been published ("Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep," Jour. An. Sci., 54:1-51, 1949).

5. Outline of Procedure:

a. Source of samples.

(1) Phosphated vs. non-phosphated.

(a) Location of experimental areas: The plant materials needed either have been or will be grown in connection with Project S52-A119. The plots are located at the Tidewater Experimental Farm at Plymouth, N. C. The Bladen soil on which these plots are located is extremely low in soil phosphorus.

- (b) Fertilization: The fertilizer variable is phosphorus. As needed, calcium, potassium and nitrogen are equalized across all plots.
- (c) Field layout: (See figures I and II.)
- (1) Soybeans for hay: The soybeans for hay will be grown on fields H_1 and H_2 in a randomized block design consisting of a total of six replications.
 - (2) Bull grass: Some native bull grass will be allowed to grow in each of the six replications described above and separated for analysis.
 - (3) Italian Rye grass: This grass will be grown from early fall to late spring on fields G_1, G_2, G_3 and F_1 and F_2 (not shown in diagram) in a randomized block design consisting of a total of four replications.
 - (4) Lespedeza: This legume will be grown on two pasture plots, F_1 and F_2 (not shown in diagram) from late winter to fall.
 - (5) Soybeans for pastures: Grazed soybeans will be obtained from G_1, G_2 and G_3 from late spring to fall.
 - (6) Corn: Corn will be grown in H_3 in two replications.
- (2) Pure species of forage plants: This second phase will supplement agronomic investigations of new forage plants. A study will be made of composition and nutritive value of pure species from garden plots in which such factors as geographical location, soil type and fertility, fertilizer and management treatments and meteorological conditions are considered.
- b. Preparation of samples and chemical analyses: All samples will be dried at 60° - 65° C. and subsequently ground and bottled for chemical analysis.
- Individual parts of plants, leaves, pods, stems, etc., will be separated and weighed. The number of plants involved in the sample will also be recorded. In this manner, it will be possible to calculate the proportions of the various parts to the whole plant.
- Since it was found previously that phosphate fertilization affected calcium, phosphorus, magnesium and nitrogen of the soybean plant, all samples will be analyzed for these elements. Additional analyses (fat, crude fiber, lignin, carotene, riboflavin, iron, copper and manganese) will be made in pilot studies to ascertain whether or not continuation and expansion are warranted.
- c. Nutritive value: Laboratory animals, primarily rabbits, will be employed as a means of indicating the feed value of various plants or parts thereof in the pure-species studies. Nutrient utilization will be estimated by feeding trials, balance trials and digestibility studies.
- d. Analysis of data: The data will be analyzed statistically to facilitate interpretation.

6. Probable Duration of Project: **Five years**

7. Date of Initiation: **Immediately**

8. Personnel:

Name	Department	Relation to Project
F. W. Sherwood	Animal Industry (Nutrition)	Leader
F. H. Smith	Animal Industry (Nutrition)	Co-leader
G. Matrone	U.S. Plant, Soil and Nutrition Laboratory	Co-leader
W. W. Woodhouse, Jr.	Agronomy	Co-leader
W. W. G. Smart, Jr.	Animal Industry (Nutrition)	Assistant
Virginia Weldon	Animal Industry (Nutrition)	Assistant
H. L. Lucas	Experimental Statistics	Cooperator
G. H. Wise	Animal Industry (Nutrition)	Adviser

9. Cooperation:

a. Interdepartmental

Agronomy Department
Institute of Experimental Statistics

b. Other Agencies

U. S. Plant, Soil and Nutrition Laboratory, Ithaca, New York

10. Financial Support:

a. Proposed Budget **7/1/49** to **6/30/50**

ITEMS	ALLOCATION OF FUNDS					
	Bankhead-Jones	Purnell	Adams	State	Other	Total
1. Salaries						3,980
F.W. Sherwood	1,440					
F.H. Smith	1,200					
Associate (to be appointed)	1,200					
E.G. Haywood	140					
2. Labor	160					160
3. Travel						
4. Equipment & Supplies	600					600
5. All Other (Transportation)	20					20
Total	4,760					4,760

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income
1950-1951	3,980	4,760	
1951-1952	3,980	4,760	
1952-1953	3,980	4,760	
1953-1954	3,980	4,760	
1954-1955	3,980	4,760	

11. General Remarks:

SIGNATURES OF APPROVAL

1. Approval of Project Leaders

Date Dec. 13, 1949F. W. SherwoodTitle Research Professor Animal Industry (Nutrition)Date Dec. 13, 1949J. H. SmithTitle Assoc. Research Professor, Animal Industry (Nutrition)Date Dec. 13, 1949J. MatroneTitle Research chemist
W. W. Wallace to Assoc. Prof. Agron.

2. Approval of Heads of Departments or Coöperating Agencies

Date 12/13/49L. D. ColvardHead, Animal IndustryDate 12/14/49W. E. ColwellHead, Agronomy

Date

Head,

3. Approval of Committee on Experiment Station Projects

Date

Chairman of Committee

4. Approval of Director

Date 12/15/49R. W. Cummings
Assoc. Director, North Carolina Agricultural
Experiment Station

5. Approval of U. S. D. A.

Date

R. M. Fullinger
Chief, Office of Experiment Stations

PROJECT TERMINATION REPORT

North Carolina

INSTRUCTIONS: For Federal-Grant projects, send 3 copies to State Experiment Stations Division, ARS, at time of closing.

PROJECT NUMBER
H-17FUND Hatch, State, U.S. Plant,
Soils & Nutrition Lab.1. TITLE
Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.2. DATE OF ORIGIN
May 29, 1943DATE REVISION
Dec., 1949COMPLETION
June 30, 1963

3. REASON FOR TERMINATION

 PROJECT COMPLETED LEADER LEAVING FUNDING EXHAUSTED PROJECT ABANDONED OTHER (Specify): Change in emphasis4. ESTIMATE OF TOTAL PROJECT COST (Give by sources of funds and amounts)
B.J. and Hatch, \$95,000; State, \$180,000; Misc. Gifts, \$70,000; U.S.D.A., \$100,0005. INITIATING DEPARTMENT, OTHER DEPARTMENTS AND AGENCIES COOPERATING
Dept. of Animal Industry and Dept. of Agronomy

6. PROFESSIONAL PERSONNEL

G. Matrone, F. W. Sherwood, F. H. Smith, W. W. Woodhouse, Jr., V. W. Smart,
H. L. Lucas and G. H. Wise.

7. CRITICAL APPRAISAL OF DEGREE TO WHICH PROJECT OBJECTIVES WERE ACCOMPLISHED

The broad objectives of the project were attained, i.e., The effects of the macro fertilizer elements on nutritive value of plants were in the main predictable from chemical analyses of the plant. The subtle effects of fertilization were found to involve the area of trace element interactions.

8. MAJOR RESULTS AND CONCLUSIONS, INCLUDING FUNDAMENTAL & PRACTICAL BENEFITS DERIVED (See back page if necessary)

Fertilizers applied to soil could affect mineral composition of plants. Animal response to forages grown on soils of varying fertility treatments may be predicted from chemical analyses of plant material. Lime gave animal response not explained by plant analysis. Calcium or Molybdenum added to soil increased Molybdenum in plants and increased its nutritive effect as measured by animal growth. Molybdenum added directly to the diet was ineffective. Soybean hay - soybean meal diets, regardless of the fertilizer treatment, when fed to ewes and rabbits lowered fertility. One of the factors involved was genistein. The manganese-iron interaction, first demonstrated in plants, was shown to be similar in animals. (See back page)

9. PUBLICATIONS ISSUED AS A DIRECT OR INDIRECT RESULT OF WORK DONE ON THIS PROJECT (See back page if necessary)

1. Matrone, G., R. L. Lovvorn, W. J. Peterson, F. H. Smith and J. A. Weybrew. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep. Journal of Animal Science, 8: 41-51. 1949.
2. Beeson, E. C. and G. Matrone. The Nutrient Element Content of Native Forages in Relation to Land Forms and Soil Types in North Carolina Coastal Plain. Copper Metabolism, A Symposium on Animal, Plant & Soil Relationships. Johns Hopkins Press, Baltimore. 1959.
3. Carter, Melvin W., W.W.G. Smart, Jr., & Gennard Matrone. Estimation of Estrogenic Activity of Genistein Obtained from Soybean Meal. Proc. of the Society for Experimental Biology & Medicine, 84: 506-507. 1953. (See back page)

10. PREPARED BY

G. Matrone

11. APPROVED (Director)

H. A. Stewart

12. APPROVED (Department Chairman)

W. W. Woodhouse, Jr.

13. DATE

8. Major results & conclusions, including fundamental & Practical benefits derived - (cont'd)

The basic factor involved was the effect of manganese on the oxidation state of iron.

9. Publications (cont'd)

4. Matrone, Gennard, Va. B. Weldon, W.W.G. Smart, Jr., F.W. Sherwood, F.H. Smith and G. H. Wise. Effects of Phosphate Fertilization and Gustyary Mineral Supplements on the Nutritive Value of Soybean Forage. Journal of Nutrition, 52: 127-136. 1956.
5. Miller, W. J., R. K. Waught and G. Matrone. Comparison of the Digestibility of Certain Pasture Forages in the Fresh and Dried States. Journal of An. Sci., 13: 283-288. 1954.
6. Matrone, G., F. H. Smith, V. B. Weldon, W. W. Woodhouse, W. J. Peterson and K. C. Beeson. Effects of Phosphate Fertilization on the Nutritive Value of Soybean Forage for Sheep and Rabbits. USDA Tech. Bulletin, No. 1086. 1954.
7. Carter, M.W., G. Matrone & W.W.G. Smart, Jr. Effect of Genistin on Reproduction of the Mouse. Jour. of Nutrition, 55: 639-646. 1953
8. Hawkins, G. E. Jr., G. H. Wise, C. Matrone, R. K. Waugh & W. L. Lott. Manganese in the Nutrition of Young Dairy Cattle Fed Different Levels of Calcium and Phosphorus. Journal of Dairy Science, 38: 536-547. 1956.
9. Hartman, R. H., G. Matrone and G. H. Wise. Effect of High Dietary Manganese on Hemoglobin Formation. Jour. of Nutrition, 57: 429-439. 1955.
10. Matrone, G., W.W.G. Smart, Jr., M.W. Carter, V.W. Smart and H. V. Garren. Effect of Genistin on Growth and Development of the Male Mouse. Journal of Nutrition, 89: 235-241. 1956.
11. Gray, Louise P., Mary Speirs and G. Matrone. The Nutritive Value of Several Foods Grown at Different Locations. Jour. of Nutr., 63: 345-360. 1957.
12. Magee, Aden C. and G. Matrone. Estrogenic Activity of Soybean Forage. Journal of Animal Science, 17: 787-791. 1958.
13. Matrone, G., R. L. Lovvorn, W. J. Peterson, F. H. Smith and J. A. Weybrew. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep. Jour. of An. Sci., 8: 41-51. 1948.
14. Matrone, G., R. H. Hartman and A. J. Clawson. Studies of a Manganese-Iron Antagonism in the Nutrition of Rabbits and Baby Pigs. J. Nutr., 67: 309-317. 1959.
15. Matrone, G. Intertelationships of Iron and Copper in the Nutrition and Metabolism of Animals. Federation Proc., 19(2): 659-665. 1960
16. Magee, Aden C. and G. Matrone. Studies on Growth, Copper Metabolism and Iron Metabolism of Rats Fed High Levels of Zinc. J. Nutr., 72(2): 233-242. 1960
17. Carter, M. W., G. Matrone and W.W.G. Smart, Jr. The Effect of Genistin and Its Aglycone on Weight Gain in the Mouse. British J. Nutr., 14: 301-304. 1960.
18. Smart, W.W.G. Jr., G. Matrone, Weldon O. Shepherd, Ralph H. Hughes and Frank E. Knox. The Study of the Comparative Composition and Digestibility of Cane Forage (*Arundinaria* Sp.). N.C. Agr. Expt. Station Tech. Bulletin No. 140. 1960.
19. Matrone, G., E. L. Thomason, Jr. and Clara R. Bunn. Requirement and Utilization of Iron by the Baby Pig. Journal of Nutrition, 72: 459-465. 1960
20. Judd, Joseph T. and G. Matrone. Sheep Erythrocyte Life Span in Estimation of Hemoglobin Turnover in Iron Metabolism Studies. J. of Nutrition, 77: 264-268. 1962.

ADDENDUM

21. Sherwood, F. W., J. G. Halverson, W. N. Woodhouse and F. H. Smith. Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pasture Herbage. J. Am. Soc. Agr., 29: 841-859. 1947.

Graduate Student Theses

1. Matrone, Gerard. Effect of Phosphate Fertilization on the Nutritive Value of the Soybean Plant. Ph.D. Thesis, 1950.
2. Hawkins, George E. Manganese, Calcium and Phosphorus Interrelationships in the Nutrition of Dairy Calves. Ph.D. Thesis, 1952.
3. Carter, Melvin W. Studies of an Estrogen-like Substance in Soybean Meal. M.S. Thesis, 1954.
4. Hartman, Robert H. Effect of Various Dietary Levels of Manganese upon the Growth and the Mineral Components in Tissues of Lambs Fed a Fortified Milk Diet Containing Different Levels of Magnesium. M.S. Thesis, 1954.
5. Carter, Melvin W. Studies on the Effect and Mode of Action of Genistin on the Growth of Animals. Ph.D. Thesis, 1956.
6. Hartman, Robert H. A Study of the Mode of Action of Manganese in the Utilization of Iron by Rabbits and Lambs. Ph.D. Thesis, 1956.
7. Magee, Aden C. An Investigation of Soybean Forage for Estrogenically Active Substances. M.S. Thesis, 1957.
8. Magee, Aden C. An Investigation of Growth, Copper Metabolism, and Iron Metabolism of Rats Fed High Levels of Zinc. Ph.D. Thesis, 1960.

North Carolina

PROJECT TERMINATION REPORT

INSTRUCTIONS: For Federal grant projects, send 4 copies to State Experiment Stations Division, ARS, at time of closing.

PROJECT NUMBER
 H-17

FUND Hatch, State, U.S. Grant,
 Soils & Nutrition Lab.

TITLE
 Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.

2. DATE OF CLOSURE
 May 29, 1943

ANT. REVISION
 Dec., 1949

COMPLETION
 June 30, 1963

3. REASON FOR TERMINATION

PROJECT COMPLETED LEADER LEAVING FUND TERMINATED UNDESIRABLE OTHER (Specify) Change in emphasis

4. ESTIMATE OF TOTAL PROJECT COST (Give by sources of funds and amounts)
 B.J. and Hatch, \$95,000; State, \$180,000; Misc. Gifts, \$70,000; U.S.D.A., \$100,000

5. INITIATING DEPARTMENT, OTHER DEPARTMENTS AND AGENCIES COOPERATING
 Dept. of Animal Industry and Dept. of Agronomy

6. PROFESSIONAL PERSONNEL

G. Matrone, F. W. Sherwood, F. H. Smith, W. W. Woodhouse, Jr., V. W. Smart,
 H. L. Lucas and C. H. Wise.

7. CRITICAL APPRAISAL OF DEGREE TO WHICH PROJECT OBJECTIVES WERE ACCOMPLISHED

The broad objectives of the project were attained, i.e., The effects of the macro fertilizer elements on nutritive value of plants were in the main predictable from chemical analyses of the plant. The subtle effects of fertilization were found to involve the area of trace element interactions.

8. MAJOR RESULTS AND CONCLUSIONS, INCLUDING FUNDAMENTAL & PRACTICAL BENEFITS DERIVED (use back page if necessary)

Fertilizers applied to soil could affect mineral composition of plants. Animal response to forages grown on soils of varying fertility treatments may be predicted from chemical analyses of plant material. Lime gave animal response not explained by plant analysis. Calcium or Molybdenum added to soil increased Molybdenum in plants and increased its nutritive effect as measured by animal growth. Molybdenum added directly to the diet was ineffective. Soybean hay - soybean meal diets, regardless of the fertilizer treatment, when fed to ewes and rabbits lowered fertility. One of the factors involved was genistein. The manganese-iron interaction, first demonstrated in plants, was shown to be similar in animals. (See back page)

9. PUBLICATIONS ISSUED AS A DIRECT OR INDIRECT RESULT OF WORK DONE ON THIS PROJECT (use back page if necessary)

- Matrone, G., R. L. Lovvorn, W. J. Peterson, F. H. Smith and J. A. Waybrew. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep. Journal of Animal Science, 8: 41-51. 1949.
- Beeson, E. C. and G. Matrone. The Nutrient Element Content of Native Forages in Relation to Land Forms and Soil Types in North Carolina Coastal Plain. Copper Metabolism, A Symposium on Animal, Plant & Soil Relationships. Johns Hopkins Press, Baltimore. 1959.
- Carter, Melvin W., W.W.G. Smart, Jr., & Gennard Matrone. Estimation of Estrogenic Activity of Genistein Obtained from Soybean Meal. Proc. of the Society for Experimental Biology & Medicine, 84: 506-507. 1953. (See back page)

10. PREPARED BY

G. Matrone

11. APPROVED (Director)

H. A. Stewart

12. APPROVED (Department Chairman)

M. W. Carter

13. DATE

8. Major results & conclusions, including fundamental & Practical benefits derived - (cont'd)

The basic factor involved was the effect of manganese on the oxidation state of iron.

9. Publications (cont'd)

4. Matrone, Gennard, Va. B. Weldon, W.W.G. Smart, Jr., F.W. Sherwood, F.H. Smith and G. H. Wise. Effects of Phosphate Fertilization and Dietary Mineral Supplements on the Nutritive Value of Soybean Forage. Journal of Nutrition, 52: 127-136. 1956.
5. Miller, W. J., R. K. Waught and G. Matrone. Comparison of the Digestibility of Certain Pasture Forages in the Fresh and Dried States. Journal of An. Sci., 13: 283-288. 1954.
6. Matrone, G., F. H. Smith, V. B. Weldon, W. W. Woodhouse, W. J. Peterson and K. C. Reason. Effects of Phosphate Fertilization on the Nutritive Value of Soybean Forage for Sheep and Rabbits. USDA Tech. Bulletin, No. 1086. 1954.
7. Carter, M.W., G. Matrone & W.W.G. Smart, Jr. Effect of Genistin on Reproduction of the Mouse. Jour. of Nutrition, 55: 639-646. 1953
8. Hawkins, G. E. Jr., G. H. Wise, G. Matrone, R. K. Waugh & W. L. Lott. Manganese in the Nutrition of Young Dairy Cattle Fed Different Levels of Calcium and Phosphorus. Journal of Dairy Science, 38: 536-547. 1956.
9. Hartman, R. H., G. Matrone and G. H. Wise. Effect of High Dietary Manganese on Hemoglobin Formation. Jour. of Nutrition, 57: 429-439. 1955.
10. Matrone, G., W.W.G. Smart, Jr., M.W. Carter, V.W. Smart and R. W. Garren. Effect of Genistin on Growth and Development of the Male Mouse. Journal of Nutrition, 89: 235-241. 1956.
11. Gray, Louise P., Mary Speirs and G. Matrone. The Nutritive Value of Several Foods Grown at Different Locations. Jour. of Nutr., 63: 345-360. 1957.
12. Magee, Aden C. and G. Matrone. Estrogenic Activity of Soybean Forage. Journal of Animal Science, 17: 787-791. 1958.
13. Matrone, G., R. L. Lovvorn, W. J. Peterson, F. H. Smith and J. A. Weybrew. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep. Jour. of An. Sci., 8: 41-51. 1948.
14. Matrone, G., R. H. Hartman and A. J. Clawson. Studies of a Manganese-Iron Antagonism in the Nutrition of Rabbits and Baby Pigs. J. Nutr., 67: 309-317. 1959.
15. Matrone, G. Interrelationships of Iron and Copper in the Nutrition and Metabolism of Animals. Federation Proc., 19(2): 659-665. 1960
16. Magee, Aden C. and G. Matrone. Studies on Growth, Copper Metabolism and Iron Metabolism of Rats Fed High Levels of Zinc. J. Nutr., 72(2): 233-242. 1960
17. Carter, M. W., G. Matrone and W.W.G. Smart, Jr. The Effect of Genistin and Its Aglycone on Weight Gain in the Mouse. British J. Nutr., 14: 301-304. 1960.
18. Smart, W.W.G. Jr., G. Matrone, Weldon O. Shepherd, Ralph H. Hughes and Frank E. Knox. The Study of the Comparative Composition and Digestibility of Cane Forage (*Arundinaria* Sp.). N.C. Agr. Expt. Station Tech. Bulletin No. 140. 1960.
19. Matrone, G., E. L. Thomason, Jr. and Clara R. Bunn. Requirement and Utilization of Iron by the Baby Pig. Journal of Nutrition, 72: 459-465. 1960
20. Judd, Joseph T. and G. Matrone. Sheep Erythrocyte Life Span in Estimation of Hemoglobin Turnover in Iron Metabolism Studies. J. of Nutrition, 77: 264-268. 1962.

ADDENDUM

21. Sherwood, F. W., J. O. Halverson, W. W. Woodhouse and F. H. Smith. Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pasture Herbage. J. Am. Soc. Agr., 39: 841-859. 1947.

Graduate Student Theses

1. Matrone, Conrad. Effect of Phosphate Fertilization on the Nutritive Value of the Soybean Plant. Ph.D. Thesis, 1950.
2. Hawkins, George E. Manganese, Calcium and Phosphorus Interrelationships in the Nutrition of Dairy Calves. Ph.D. Thesis, 1952.
3. Carter, Melvin W. Studies of an Estrogen-like Substance in Soybean Meal. M.S. Thesis, 1954.
4. Hartman, Robert H. Effect of Various Dietary Levels of Manganese upon the Growth and the Mineral Components in Tissues of Lambs Fed a Fortified Milk Diet Containing Different Levels of Magnesium. M.S. Thesis, 1954.
5. Carter, Melvin W. Studies on the Effect and Mode of Action of Genistin on the Growth of Animals. Ph.D. Thesis, 1956.
6. Hartman, Robert H. A Study of the Mode of Action of Manganese in the Utilization of Iron by Rabbits and Lambs. Ph.D. Thesis, 1956.
7. Magee, Aden C. An Investigation of Soybean Forage for Estrogenically Active Substances. M.S. Thesis, 1957.
8. Magee, Aden C. An Investigation of Growth, Copper Metabolism, and Iron Metabolism of Rats Fed High Levels of Zinc. Ph.D. Thesis, 1960.

North Carolina

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1958

(Three copies to be given to the SES examiner)

1. PROJECT (Fund, number, and title): Hatch H-17, EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS.
2. DEPARTMENTS AND COOPERATING AGENCIES: Animal Industry, Soils and Biological Sciences
3. PERSONNEL: G. Matrone, H. J. Evans, N. T. Coleman, Virginia W. Smart, F. H. Smith, W. W. G. Smart, Jr., and G. H. Wise
4. RESEARCH ACCOMPLISHMENTS OF THE YEAR (Confidential information should be so marked):

The rabbit-growth assay of soybean forages grown in 1956 on plots of a 2 x 2 lime x Mo study was completed. The assay was conducted in two parts. Rabbits were fed the usual assay diet containing a supplement of egg albumen the first 7 weeks and then continued for 6 weeks on the diet modified by deleting the egg albumen and replacing it with glucose. Significant differences in growth were not obtained in the first 7-week period, but in the second 6-week period the rabbits fed the forages grown on the Mo plots appeared to grow better than those fed forages from plots without Mo. Xanthine oxidase activity of the livers of experimental rabbits was not correlated with treatments. The preliminary data of the rabbit growth assay being currently conducted on the 1957 crop indicates a response similar to that obtained with the 1956 crop.

5. USEFULNESS OF FINDINGS (Benefits to agriculture and the general public and contributions to science):

Information obtained should lead to production of crops of higher nutritive value.

6. WORK PLANNED FOR NEXT YEAR:

Planting and harvesting of a new crop. Initiation of animal assays to determine the causative factor(s).

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

None

8. Prepared by G. Matrone Approved _____ (Director).

Date March 5, 1958 Date _____

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 19 60

(Three copies to be given to the SES examiner)

1. PROJECT (Fund, number, and title): **HATCH, H-17, EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS**
2. DEPARTMENTS AND COOPERATING AGENCIES: **Animal Industry, Soils and Biological Sciences**
3. PERSONNEL: **G. Matrone, H. J. Evans, E. I. Coleman, Virginia W. Smart, F. H. Smith, W. W. G. Smart, Jr., and G. H. Wise.**
4. RESEARCH ACCOMPLISHMENTS OF THE YEAR (Confidential information should be so marked):

Rabbit-growth assays of soybean forages grown in 1958 confirm results obtained with forages grown in 1956 and 1957. Thus, it would appear that the beneficial effect of No fertilization or of liming the Bladen soil at Plymouth, North Carolina, on the nutritive value of soybean forage is established. Neither protein concentration and quality nor molybdenum concentration per se appear to be the active factor.

5. USEFULNESS OF FINDINGS (Benefits to agriculture and the general public and contributions to science):

Information obtained raises possibility concerning feasibility of using No fertilizer for increasing nutritive value of forages grown on certain soils.

6. WORK PLANNED FOR NEXT YEAR:

Project is to be revised. Emphasis will be in area of mineral nutrition and metabolism of animals.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

Data of past three years are being prepared for publication.

8. Prepared by G. Matrone Approved _____ (Director).
Date March 15, 1960 Date _____

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 19 61

(Three copies to be given to the SES examiner)

HATCH, (and STATE, St-H-17)

1. PROJECT (Fund, number, and title): **H-17, EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS.**
2. DEPARTMENTS AND COOPERATING AGENCIES: **Department of Animal Industry, Department of Soils, Department of Poultry**
3. PERSONNEL: **Gennard Matrone, F. H. Smith, N. T. Coleman, C. H. Hill, V. W. Smart, C. R. Bunn, E. G. Haywood, I. Cotton, P. F. Heinstejn, R. E. Cathey, W. C.**
4. RESEARCH ACCOMPLISHMENTS OF THE YEAR (Confidential information should be so marked): **(a) Additional rabbit-growth assays of soybean forages were conducted to find the causative factor(s) for the nutritional superiority of the forages fertilized with molybdenum or lime, but the active principle was not identified. (b) Work on the Mn-Fe antagonism in the nutrition of animals has been concerned with the mechanism of interference. Present results suggest that Mn affects the ferritin system which is involved both in absorption and storage of iron. (c) Zinc toxicity interferes with iron metabolism as well as with copper. Radiocopper studies indicate that the zinc increased urinary excretion of copper. (d) The requirements of iron and copper, respectively, for chicks are approximately 40 and 4 ppm.**

5. USEFULNESS OF FINDINGS (Benefits to agriculture and the general public and contributions to science): **Obtain knowledge of the nutrition and metabolism of micronutrient elements.**

6. WORK PLANNED FOR NEXT YEAR: **Project to be revised. Emphasis will be in area of mineral nutrition and metabolism of animals.**

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

- A.C. Magee and G. Matrone. Studies on Growth, Copper Metabolism and Iron Metabolism of Rats Fed High Levels of Zinc. *J. Nutrition*, 72:233-242, 1960.**
G. Matrone. Interrelationships of Iron and Copper in the Nutrition and Metabolism of Animals. *Fed. Proc.*, 19:659-665, 1960.
G. Matrone, E. L. Thomson, Jr., C. R. Bunn. Requirement and Utilization of Iron by the Rat. *Fig. J. Nutrition*, 72: 459-465, 1960.

Date **March 28, 1961**

(Director)
Date _____

N C H-17 Anim Indus Composition and Nutritive Value of Plants for Livestock Feed

1. STATE 2. PROJ. NO. 13. DEPT. 4. ABBREV. TITLE 5. REF. TITLE
 7. TITLE, PROJECT OBJECTIVES AND DESCRIPTION OF WORK PROPOSED 6. ABBREV.

EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS -- Study effect of different fertilizers on composition (minerals, vitamins, nitrogen and carbohydrates) of whole plants, soybeans, lespedeza, bull grass (*Paspalum boscianum*) rye grass and related forage plants. Make similar composition studies on various parts of soybean plants and other legumes. Study interrelationships of fertilization and maturity on the composition of plants under study. Determine at definite intervals throughout the grazing season the changes in chemical composition of grazed forages differentially fertilized. Study nutritive characteristics of plants by feeding and metabolism studies with laboratory animals.

DESCRIPTION OF WORK

The character of the investigation has changed considerably from its inception. As indicated in last year's report, the emphasis of the work was on trace element interrelationship in nutrition and metabolism of animals. The specific interrelationships studied were copper and zinc, manganese and iron, and iron and copper. In addition, further rabbit assays were carried out on soybean forages from the lime x Mo study.

8. INDICATE TYPE OF PROJECT	HATCH	RRF	AMA	NON-FED.	NEW	REV.	MARKETING	9. DURATION	10. COOPERATION	11. APPROVAL DATES	12. X-REF.
X								58	ARS	1-25-40 12-30-49 5-29-43	
13. STATE	14. PROJ. NO.	15. DEPT.	16. ABBREV. TITLE				17. REF.				
N C	H-17	Anim Indus	Livestock Feed				Composition and Nutritive Value of Plants for/				

18. RECOMMENDED FOR APPROVAL

TITLE

SIGNATURE

DATE

SECTIONS 18, 19, AND 20 NOT APPLICABLE FOR PROJECTS PREVIOUSLY APPROVED BY SESD

19. APPROVAL OF DIRECTOR, AGRICULTURAL EXPERIMENT STATION

SIGNATURE _____ DATE _____

20. FEDERAL-GRANT PROJECTS ONLY--TO BE APPROVED BY STATE EXPERIMENT STATIONS DIVISION, WASHINGTON, D. C.

SIGNATURE _____ DATE _____

INSTRUCTIONS: Complete Items 1, 2, 3, 7, 8, 9, 10, 18, and 19. Under Item 7, show title in caps, itemize objectives and leave space between the objectives and description of work proposed. Forward original of this form with required number of project outlines to State Experiment Stations Division, Washington, D. C. (See reverse side for essentials of an Experiment Station Project Outline.)

SES Form 20
 Dec 1960

U. S. DEPARTMENT OF AGRICULTURE
 AGRICULTURAL RESEARCH SERVICE
 STATE EXPERIMENT STATIONS DIVISION

COVER-ABSTRACT-SIGNATURE PAGE FEDERAL-GRANT & NON-FEDERAL PROJECTS

U. S. DEPARTMENT OF AGRICULTURE AGRICULTURAL RESEARCH SERVICE STATE EXPERIMENT STATIONS DIVISION		AGRICULTURAL EXPERIMENT STATION North Carolina	
PROJECT TERMINATION REPORT			
INSTRUCTIONS: For Federal-grant projects, send 3 copies to State Experiment Stations Division, ARS, at time of closing.		PROJECT NUMBER H-17	FUND Hatch, State, U.S. Plant, Soils & Nutrition Lab.
1. TITLE Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.			
2. DATE OF ORIGIN May 29, 1943		LAST REVISION Dec., 1949	
3. REASON FOR TERMINATION <input type="checkbox"/> PROJECT COMPLETED <input type="checkbox"/> LEADER LEAVING <input type="checkbox"/> FUNDS TERMINATED <input type="checkbox"/> LACK OF PRODUCTIVITY <input type="checkbox"/> OTHER (Specify)			
4. ESTIMATE OF TOTAL PROJECT COST (given by sources of funds and amounts) F. S. and Hatch, \$75,000; State, \$100,000; Misc. Gifts, \$70,000; U.S.D.A., \$100,000			
5. INITIATING DEPARTMENT, OTHER DEPARTMENTS AND AGENCIES COOPERATING Dept. of Animal Industry and Dept. of Agronomy			
6. PROFESSIONAL PERSONNEL G. Matrone, F. W. Sherwood, F. H. Smith, E. W. Woodhouse, Jr., V. W. Marton, H. L. Lucas and G. H. Wise.			
7. CRITICAL APPRAISAL OF DEGREE TO WHICH PROJECT OBJECTIVES WERE ACCOMPLISHED The broad objectives of the project were attained, i.e., The effects of the macro fertilizer elements on nutritive value of plants were in the main predictable from chemical analyses of the plant. The subtle effects of fertilization were found to involve the area of trace element interactions.			
8. MAJOR RESULTS AND CONCLUSIONS, INCLUDING FUNDAMENTAL & PRACTICAL BENEFITS DERIVED (use back page if necessary) Fertilizers applied to soil could affect mineral composition of plants. Animal response to forages grown on soils of varying fertility treatments may be predicted from chemical analyses of plant material. Lime gave animal response not explained by plant analysis. Calcium or Molybdenum added to soil increased Molybdenum in plants and increased its nutritive effect as measured by animal growth. Molybdenum added directly to the diet was ineffective. Soybean hay - soybean meal diets, regardless of the fertilizer treatment, when fed to ewes and rabbits lowered fertility. One of the factors involved was genistein. The manganese-iron interaction, first demonstrated in plants, was shown to be similar in animals. (See back page)			
9. PUBLICATIONS ISSUED AS A DIRECT OR INDIRECT RESULT OF WORK DONE ON THIS PROJECT (use back page if necessary) Matrone, G. R., L. Lovvorn, W. J. Peterson, F. H. Smith and J. A. Waybren. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep. <u>Journal of Animal Science</u>, 8: 41-51, 1949. Beeson, E. C. and G. Matrone. The Nutrient Element Content of Native Forages in Relation to Land Forms and Soil Types in North Carolina Coastal Plain. <u>Copper Metabolism: A Symposium on Animal, Plant & Soil Relationships</u>. Johns Hopkins Press, Baltimore. 1959. Carter, Melvin W., W.W.C. Smart, Jr., & Gennard Matrone. Estimation of Estrogenic Activity of Genistein Obtained from Soybean Meal. <u>Proc. of the Society for Experimental Biology & Medicine</u>, 84: 506-507, 1953. (See back page)			
10. PREPARED BY		11. APPROVED (Director)	
12. APPROVED (Department Chairman)		13. DATE	

8. Major results & conclusions, including fundamental & Practical benefits derived - (cont'd)

The basic factor involved was the effect of manganese on the oxidation state of iron.

9. Publications (cont'd)

4. Matrone, Gennard, Va. B. Weldon, W.W.G. Smart, Jr., F.W. Sherwood, F.H. Smith and G. H. Wise. Effects of Phosphate Fertilization and Dietary Mineral Supplements on the Nutritive Value of Soybean Forage. Journal of Nutrition, 52: 127-136. 1956.
5. Miller, W. J., R. K. Waught and G. Matrone. Comparison of the Digestibility of Certain Pasture Forages in the Fresh and Dried States. Journal of An. Sci., 13: 283-288. 1954.
6. Matrone, G., F. H. Smith, V. B. Weldon, W. W. Woodhouse, W. J. Peterson and K. C. Beeson. Effects of Phosphate Fertilization on the Nutritive Value of Soybean Forage for Sheep and Rabbits. USDA Tech. Bulletin, No. 1086. 1954.
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10. Matrone, G., W.W.G. Smart, Jr., M.W. Carter, V.W. Smart and H. W. Garren. Effect of Genistin on Growth and Development of the Male Mouse. Journal of Nutrition, 89: 235-241. 1956.
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20. Judd, Joseph T. and G. Matrone. Sheep Erythrocyte Life Span in Estimation of Hemoglobin Turnover in Iron Metabolism Studies. J. of Nutrition, 77: 264-268. 1962.

ADDENDUM

21. Sherwood, F. W., J. O. Halverson, W. W. Woodhouse and F. H. Smith. Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pastura Herbage. J. Am. Soc. Agr., 39: 841-859. 1947.

Graduate Student Theses

1. Matrone, Conrad. Effect of Phosphate Fertilization on the Nutritive Value of the Soybean Plant. Ph.D. Thesis, 1950.
2. Hawkins, George E. Manganese, Calcium and Phosphorus Interrelationships in the Nutrition of Dairy Calves. Ph.D. Thesis, 1952.
3. Carter, Melvin W. Studies of an Estrogen-like Substance in Soybean Meal. M.S. Thesis, 1954.
4. Hartman, Robert H. Effect of Various Dietary Levels of Manganese upon the Growth and the Mineral Components in Tissues of Lambs Fed a Fortified Milk Diet Containing Different Levels of Magnesium. M.S. Thesis, 1954.
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8. Magee, Aden C. An Investigation of Growth, Copper Metabolism, and Iron Metabolism of Rats Fed High Levels of Zinc. Ph.D. Thesis, 1960.

N C H-17 Anim Indus Composition and Nutritive Value of Plants for Livestock Feed

1. STATE 2. PROJ. NO. 3. DEPT. 4. ABBREV. TITLE 5. REF. 6. V. REF.

7. TITLE, PROJECT OBJECTIVES AND DESCRIPTION OF WORK PROPOSED
 EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS -- Study effect of different fertilizers on composition (minerals, vitamins, nitrogen and carbohydrates) of whole plants, soybeans, lespedeza, bull grass (*Paspalum boscianum*) rye grass and related forage plants. Make similar composition studies on various parts of soybean plants and other legumes. Study interrelationships of fertilization and maturity on the composition of plants under study. Determine at definite intervals throughout the grazing season the changes in chemical composition of grazed forages differentially fertilized. Study nutritive characteristics of plants by feeding and metabolism studies with laboratory animals.
DESCRIPTION OF WORK

The character of the investigation has changed considerably from its inception. As indicated in last year's report, the emphasis of the work was on trace element interrelationship in nutrition and metabolism of animals. The specific interrelationships studied were copper and zinc, manganese and iron, and iron and copper. In addition, further rabbit assays were carried out on soybean forages from the lime x Mo study.

8. INDICATE TYPE OF PROJECT	HATCH	RRF	AMA	NON-FED.	NEW	REV.	MAR-KETING	9. DURATION	10. COOPERATION	11. APPROVAL DATES	12. X-REF.
X								58	ARS	4-25-40 12-30-49 5-29-43	
13. STATE	14. PROJ. NO.	15. DEPT.	16. ABBREV. TITLE					17. REF.			
N C	H-17	Anim Indus	Livestock Feed					Composition and Nutritive Value of Plants for/			

18. RECOMMENDED FOR APPROVAL

TITLE SIGNATURE DATE

SECTIONS 18, 19, AND 20 NOT APPLICABLE FOR PROJECTS PREVIOUSLY APPROVED BY SESD

19. APPROVAL OF DIRECTOR, AGRICULTURAL EXPERIMENT STATION

SIGNATURE DATE

20. FEDERAL-GRANT PROJECTS ONLY--TO BE APPROVED BY STATE EXPERIMENT STATIONS DIVISION, WASHINGTON, D. C.

SIGNATURE DATE

INSTRUCTIONS: Complete Items 1, 2, 3, 7, 8, 9, 10, 18, and 19. Under Item 7, show title in CAPS, itemize objectives and leave space between the objectives and description of work proposed. Forward original of this form with required number of project outlines to State Experiment Stations Division, Washington, D. C. (See reverse side for Essentials of an Experiment Station Project Outline.)

SES Form 20
Dec 1960

U. S. DEPARTMENT OF AGRICULTURE
 AGRICULTURAL RESEARCH SERVICE
 STATE EXPERIMENT STATIONS DIVISION

COVER-ABSTRACT-SIGNATURE PAGE FEDERAL-GRANT & NON-FEDERAL PROJECTS

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1957.....

(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title): **HATCH 17, EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS.**
2. DEPARTMENTS AND COOPERATING AGENCIES:
Animal Industry, Soils and Biological Sciences
3. PERSONNEL: **G. Matrone, H. J. Evans, H. T. Coleman, Virginia Smart, F. H. Smith, W. W. G. Smart, Jr. and G. H. Wise**
4. PROGRESS OF RESEARCH HIGHLIGHTING PRINCIPAL ACCOMPLISHMENTS OF THE YEAR (Confidential information should be so marked):

A study was undertaken in 1956 to determine the effect of applying lime and of molybdenum (Mo) to the soil (pH 4.5) on the composition and the nutritive value of soybean forage. Either lime or Mo increased the Mo content and decreased the manganese content of the plant. Neither lime nor Mo appeared to affect the copper content of the plant.

An assay, using rabbits as the test animal, of the soybean forages grown on soils receiving the various lime and Mo treatments is near completion.

5. USEFULNESS OF FINDINGS (when results may justifiably be expressed in terms of public benefits):

6. WORK PLANNED FOR NEXT YEAR:

Complete assaying of experimental forages grown in 1956 with rabbits and repeating lime and Mo study for ensuing year.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

8. Prepared by.....**G. Matrone**..... Approved.....
(Director)

Date.....**March 11, 1957**..... Date.....

North Carolina

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1956

(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title): **E-J, Sec. 5, 24, EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS**
2. DEPARTMENTS AND COOPERATING AGENCIES: **Animal Industry (Nutrition), Agronomy, Statistics, U.S. Plant, Soils and Nutrition Laboratory.**
3. PERSONNEL: **F. W. Sherwood, G. Matrone, F. H. Smith, W. W. Woodhouse, Jr., W. W. C. Smart, Jr., Virginia Smart, H. L. Lucas, G. H. Wise.**
4. PROGRESS OF RESEARCH HIGHLIGHTING PRINCIPAL ACCOMPLISHMENTS OF THE YEAR (Confidential information should be so marked):

Phosphate fertilization: Rabbit assays of the 1954 crop of soybean forages grown on soils treated at levels of 0, 40 and 320 lbs. of P_2O_5 /acre revealed, contrary to the results from the 1951 crop, no significant difference in nutritive value between hays from the 40 and the 320 levels.

Calcium:Application: Further chemical characterization of the 1951 crops, in which nutritive value was related to the level of lime applied to the soil, showed that the molybdenum content of forage also was correlated with lime present. Plants from the unlimed areas contained less than 5×10^{-7} Mo. Rabbit assays of the 1954 soybean forages showed no significant differences in nutritive value among forages grown on 0, medium and high levels of lime added to the plots.

Assay Diets: A study of diets that might be used in protein assays of forages revealed that neither glutamic acid nor Na glutamate, either with or without vitamin B12, is suitable as a source of nitrogen for growth of rabbits.

5. USEFULNESS OF FINDINGS (when results may justifiably be expressed in terms of public benefits):
6. WORK PLANNED FOR NEXT YEAR:

Future plans: The 1955 crops which received the same fertilizer treatments as indicated in Results will be assayed chemically and biologically. Cause for difference in results obtained between 1951 and 1954 crops also will be investigated.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

None

G. Matrone

F. W. Sherwood

8. Prepared by..... Approved.....
(Director).

Date..... Date.....

NORTH CAROLINA STATE COLLEGE
SCHOOL OF AGRICULTURE
RALEIGH

Department of Animal Industry


December 1, 1955

MEMORANDUM TO: Dr. J. W. Pou

Subject: Review of Project ST-BJ-24.

During the past decade, much work in the Nutrition Section has been directed toward the study of the effect of soil fertility on the composition and nutritive value of forage plants commonly used for livestock feeding. These investigations have been conducted under two projects originally designated as State - 52 and Bankhead-Jones - 24. There is an obvious need for a critical review of the projects in order to determine whether or not they should be continued. The type of work is fundamental and important in promoting the livestock industry, particularly ruminants. In order that future explorations may be more fruitful, close active collaboration of the soil scientists and the plant physiologists with our Nutrition group seems to be essential. The returns from the present organization of the project raise some doubt about the desirability of continuation unless some drastic changes can be effected. Therefore, the Experiment Station is confronted with the decision of deciding whether or not to terminate the project and to devote funds and labor to other activities or to make arrangements for continuation in such a manner that true relationships between soil, plants and animals may be appraised. Dr. Matrone and I should like to meet with you and with the Director of the Experiment Station to indicate the present status of the projects and to propose possible procedures for the future. Inasmuch as furtherance of the work is contingent on active participation of the soil scientists and the plant physiologists, it would be desirable to have representatives from these professional interests present to aid in reaching a decision. If you should desire to discuss this matter with us prior to your approaching the Experiment Station administrators, we should be happy to do so.

I trust that action may be taken at an early date in order to avoid a degenerating death of the projects involved.


George H. Wise, Head
Animal Nutrition Section

GHW/ctw

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1955

(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title) **B-J Sec. 5, 24 EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS**
2. DEPARTMENTS AND COOPERATING AGENCIES: **Animal Industry (Nutrition), Agronomy, Statistics, U. S. Plant, Soils and Nutrition Laboratory**
3. PERSONNEL: **F. W. Sherwood, G. Matrone, F. H. Smith, W. W. Woodhouse, Jr., W. W. G. Smart, Jr., Virginia W. Smart, H. L. Lucas, G. H. Wise**
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

(a) A new crop of soybean forages was grown on plots that were differentially fertilized according to the plan described in earlier reports. These forages will be fed to rabbits to ascertain the validity of the earlier findings. Attention has been directed especially toward developing a technique for comparing the nutritive values of proteins in soybean hays grown on differentially fertilized plots. Attempts have been made to find a source of non-protein nitrogen that can be utilized by the rabbit and can be used in equalizing the nitrogen content of diets prepared with these different hays. Present results indicate that neither ammonium citrate nor free glutamic acid ~~is~~ suitable, whereas nitrogen balance trials with rabbits indicate that sodium glutamate may be used.

(b) A comparison of the composition of samples of deer-browse collected in the Standing Indian Wildlife Management Area, in the mountains of Western North Carolina, with samples from Holly Shelter, in the Coastal area, indicated lower concentrations of crude protein, phosphorus and cobalt in the latter than in the former.

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified):

(a) May result in an improved technique for assessing protein quality for rabbits.

(b) Deficiencies of browse in the Coastal Plain may account, in part, for the small population of deer.

6. WORK PLANNED FOR NEXT YEAR:

(a) Continuation of the present line of studies.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

U.S.D.A. Tech. Bull. 1086 (May, 1954). Effects of phosphate fertilization on the nutritive value of soybean forage for sheep and rabbits.

Gennard Matrone, Frank H. Smith, Virginia B. Weldon, W. W. Woodhouse, Jr., W. J. Peterson, and Kenneth C. Besson.

8. Prepared by G. Matrone and Approved _____ (Director).
F. W. Sherwood

Date _____ Date _____

an mtr

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1954

(Three copies to be given to the OES examiner)

B35 24, EFFECT OF FERTILIZATION AND MANAGEMENT

1. PROJECT: (Fund, number, and title): ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS.

2. DEPARTMENTS AND COOPERATING AGENCIES: Animal Industry (Nutrition) Agronomy, Statistics, U. S. Plant Soils and Nutrition Laboratory

3. PERSONNEL: F. W. Sherwood, F. H. Smith, G. Matrone, W. W. Woodhouse, Jr., W. W. G. Smart, Jr., Virginia W. Smart, H. L. Lucas, and G. H. Wise.

4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked): Lespedeza and soybean hays were grown on a calcium deficient soil fertilized with varying levels of hydrated lime. Analyses on these hays indicated that the fertilization increased their calcium and phosphorus content, decreased the manganese, but changed neither the magnesium nor the nitrogen content. Rabbits fed the soybean hays that were grown on the soil treated with lime grew faster than those fed the hay from plots to which no calcium was added. The rabbits fed the high calcium soybean hays developed stronger bones, and their livers contained more vitamin A. Rabbits on all of the lespedeza hays grew at about the same rate although the ones on the lespedeza grew faster than any of those receiving soybean hay. There was no difference in bone strength of the rabbits receiving the various lespedeza hays. Vitamin A in the liver was somewhat higher in those fed the higher calcium hays.

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified): No general statements are justified since the results are from one year's crop and one animal species only.

6. WORK PLANNED FOR NEXT YEAR:

Repeat work with crops from other years. Use modified feeding techniques in an attempt to explain the observed biological effects.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

"Effects of phosphate fertilization and dietary mineral supplements on the nutritive value of soybean forage." Gennard Matrone, Virginia B. Weldon, W. W. G. Smart, Jr., F. W. Sherwood, F. H. Smith, and G. H. Wise. J. Nutrition, 52: 127-136 (1954).

8. Prepared by _____ Approved _____

(Director).

Date _____ Date _____

Publications

Work done under our old RM8-A13, Soils Weather Project, which was transferred to Chemistry (Dr. Peterson), does not come under either P16 or BJ5-24.

1. Comparison of four feeding methods for assessing the relative growth-promoting properties of proteins. F. W. Sherwood and Virginia Weldon. *J. Nutrition*, 49: 153-162 (1953).
2. Effects of cooking and of methionine supplementation on the growth-promoting property of cowpea (*Vigna senensis*) protein. F. W. Sherwood, Virginia Weldon and W. J. Peterson. *J. Nutrition*, 52: (Feb.) 1954.

ANNUAL PROGRESS REPORT

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION PROJECTS

1. PROJECT: (Fund, number, and title): S52-Ai19 - Study of the Effect of Fertilization on the Nutritional Quality of Forage
2. DEPARTMENTS AND COOPERATING AGENCIES: Agronomy Department, State Department of Agriculture, U. S. Plant, Soils and Nutrition Laboratory, Ithaca, New York
3. PERSONNEL: G. Matrone, Virginia W. Smart, W. W. G. Smart, Jr., F. H. Smith, F. W. Sherwood, G. H. Wise, Zeta Peters, and W. W. Woodhouse, Jr.
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

Growth studies with lambs on the 1951 soybean hay crops, which were grown on plots fertilized at three different levels of P_2O_5 (0 lbs., 40 lbs., and 280 lbs./acre) indicated that the forage from the 40 and 280 level plots were superior to the forage from the 0 level plots but not significantly different from each other. A determination of phosphorus balance of lambs on the test forages indicated that the availability of the phosphorus of the 40 and 280 level forages were not significantly different from each other.

The foregoing results with lambs differed in some respects from those obtained with rabbits (see last year's report).

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified):

More data needed before generalizations can be made.

6. WORK PLANNED FOR NEXT YEAR:

Effect of liming on nutritive value will be checked on 1954 soybean crop.
Effect of high levels of phosphate fertilization on nutritive value will be checked on 1954 soybean crop.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

Matrone, G., V. B. Weldon, W. W. G. Smart, Jr., F. W. Sherwood, F. H. Smith and G. H. Wise. 1954. Effect of Phosphate fertilization and dietary mineral supplements on the nutritive value of soybean forage. *J. Nutrition*, 52: 127-136.

8. Prepared by _____ Approved _____
(Director).

Date _____

North Carolina AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1953

(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title) **B-J 5, No. 24, Effect of Fertilization and Management on the Composition and Nutritive Value of Plants commonly Used for Livestock Feeds.**
2. DEPARTMENTS AND COOPERATING AGENCIES: **Animal Industry (Nutrition), Agronomy, Statistics, U. S. Plant Soils and Nutrition Laboratory**
3. PERSONNEL: **F. W. Sherwood, F. R. Smith, G. Matrone, W. W. Woodhouse, Jr., W. W. G. Smart, Jr., Virginia Weldon, H. L. Lucas, and G. H. Wise.**
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

Changes in the proximate composition of lespedeza and of soybean plants as a whole and as separated leaf and stem components were followed during the growing season. The plants were produced on plots differentially fertilized.

Further studies on the nutritive value of soybean plants, using rabbits as the assay animal, showed that soybean hay from nonphosphated plots was deficient in P. The addition of 40 lb. of P_2O_5 /acre enhanced the yield of hay, which contained an adequate level of P. Larger amounts of P_2O_5 increased the percentage of P in the hay but did not increase the yield. The additional P in the hay was not so available to the rabbit as that in the hay from the lower level of P_2O_5 fertilization. The difference in the P content of the hays from the differentially phosphated plots was primarily in the inorganic fraction and not in the protein P or lipid P fractions.

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified): **The observations:**
 1. Give additional information on the value of soybeans and lespedeza for grazing as related to the stage of maturity of the plant.
 2. Aid in understanding the effect of fertilization on the nutritive value of soybean hay.
6. WORK PLANNED FOR NEXT YEAR:

Continue the project with more emphasis on characterizing the nutritional deficiencies encountered in rabbits eating these hays and on identifying the factors involved.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

Some of the data are incorporated in a manuscript, "Effect of Phosphate Fertilization on the Nutritive Value of Certain Forages for Sheep and Rabbits," which report has been submitted for publication as a U. S. D. A. technical bulletin.

8. Prepared by _____ Approved _____
(Director).

Date _____ Date _____

ANNUAL REPORT

For December 1, 1949 to November 30, 1950
Department of Animal Industry
Animal Nutrition Section

Project No.: Bankhead-Jones - BJ24 - A12

Title: Effect of Fertilization and Management on the Composition and
Nutritive Value of Plants Commonly Used for Livestock Feeds

Personnel: F. W. Sherwood, F. H. Smith, Gennard Matrone, W. W. Woodhouse, Jr.,
W. W. G. Smart, Jr., Virginia Weldon, H. L. Lucas and G. H. Wise

Cooperation: Agronomy Department; Institute of Statistics

EFFECT OF FERTILIZATION ON THE COMPOSITION AND NUTRITIVE VALUE
OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS

Most of the samples have been analyzed but the data have not
been compiled and studied.

No conclusions are possible at this time.

North Carolina

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1952

(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title): Bankhead-Jones EJ24-A12
Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.
2. DEPARTMENTS AND COOPERATING AGENCIES: Animal Industry (Nutrition), Agronomy, Statistics, U. S. Plant, Soils and Nutrition Laboratory
3. PERSONNEL: F. W. Sherwood, F. H. Smith, G. Matrone, W. W. Woodhouse, Jr., W. W. G. Smart, Jr., Virginia Weldon, H. L. Lucas and G. H. Wise
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

The work of previous years has been continued. The maturity of soybean plants when harvested for hay has varied from year to year. Despite this variation, the per cent, by weight, of stems in the plants remained rather constant averaging 53 per cent in the plants from the unphosphated plots and 56 per cent from the phosphated plots. The per cent leaves varied inversely with that of the immature pods. The sum of the percentages of leaves of immature pods was nearly constant. The percentages of Ca, P, and protein in the leaves were two to three times as large as those in the stems. There were more of these nutrients in both leaves and stems of plants grown on the phosphated plots than in those without phosphatic fertilizer. Despite differences in yield in fertilizer treatment and in the composition of the parts of plants, approximately 2/3 of the P, 2/3 of the protein and 3/5 of the Ca harvested in the hay from an acre of soil was in the leaves and immature pods. The remainder was in the stems

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified):

6. WORK PLANNED FOR NEXT YEAR:

A critical evaluation of all data at hand.
Reorient the project with more emphasis on the animal response to changes in plant composition mediated by fertilization.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

None

8. Prepared by F. W. Sherwood Approved _____
Date mdc 28, 1952 Date _____
(Director).

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1951

(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title): **Bankhead-Jones 24-A12, Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.**
2. DEPARTMENTS AND COOPERATING AGENCIES: **Agronomy Department, Institute of Experimental Statistics, U.S. Plant, Soil and Nutrition Laboratory.**
3. PERSONNEL: **F. W. Sherwood, F.H. Smith, G. Matrone, W. W. Woodhouse, Jr., W. B. Smart, Jr., Virginia Weldon, H. L. Lucas, G. H. Wise.**
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

Work on the effect of phosphate fertilization on the composition of leaves and stems of soybean plants has been pursued, and digestion trials with rabbits on differentially fertilized hay have been run.

Data from observations on the composition of leaves and stems from three crops emphasize the desirability of studying the effects of fertilization on individual parts of the plants rather than on the plant as a whole. When all the parts are combined, fertilizer effects, as measured by Ca or P, may be complicated by different ratios of leaves to stems.

The plants from the non-phosphated plots were smaller but contained a higher percentage of leaves than those from the phosphate treatments. Both the leaves and the stems from the plots receiving phosphate contained larger percentages of Ca and P. than those from the unphosphated plots. In contrast to Ca and P. the protein content of the leaves and stems was more variable and less indicative of fertilizer effects.

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified):

If the quantity of forage is abundant, the observations indicate that animal may, by selection of plant parts, meet its nutritive needs in spite of deficiency of plant as a whole.

6. WORK PLANNED FOR NEXT YEAR:

Continuation of present program.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

None

8. Prepared by F. W. Sherwood Approved.....

(Director).

Date April 11 1951 Date.....

North Carolina State College of Agriculture and Engineering
of the
University of North Carolina
Raleigh

STATE COLLEGE STATION

SCHOOL OF AGRICULTURE AND FORESTRY
AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL EXTENSION SERVICE
RESIDENT TEACHING

DEPARTMENT OF ANIMAL INDUSTRY
ANIMAL NUTRITION SECTION

November 8, 1950

MEMORANDUM

TO: Dr. D. W. Colvard, Head, Department of Animal Industry

FROM: George H. Wise *GHW*

SUBJECT: Conference relative to revision of proposed subproject entitled, "The Effect of the Level of Calcium in the Soil on the Nutritive Value of Forage Crops."

Doctors Woodhouse, Sherwood and Matrone and Mr. Smith and I met to consider the criticisms of the project listed by Dr. Cummings. His comments merit consideration by the various members associated with the project in order to get some of the viewpoints clear.

Seemingly, Dr. Cummings is viewing this project more from the soils angle than was intended originally. It is encouraging, however, that he is interested in this phase of the activity, which has been one of the weak points in the project. Those of us interested in the nutritional aspects feel that it would be highly desirable to fortify the soil segment in this study; therefore, the meeting with Dr. Cummings and other interested individuals should lead to a strengthening of the foundation of the investigation. The aforementioned individuals who discussed the problem this morning are of the opinion that the early part of December would be a suitable time for meeting with you, Dr. Cummings and others who are associated with the project.

GHW/di

Mr. Colvard

Project No. S52 - 4419
Subproject I
Submitted May, 1950

Approved _____

1. Title: The effect of the level of calcium in the soil on the nutritive value of forage crops.
2. Objective: To ascertain the effect of the levels of calcium, ranging from a deficiency to an excess, in the soil on the nutritive value of forage crops.
3. Reasons for undertaking investigations: There is a need for fundamental information on the relationships of the calcium content of the soil and the composition and the nutritive value of the forage. The availability of an adequate acreage of calcium-deficient soils to produce sufficient forages for livestock feeding and the development of improved methods of determining the nutritive value of forages presents an opportunity for gaining needed information in livestock nutrition.
4. Previous work and present status of investigations in the field of this project:

During the past four years, the studies included in this project have been restricted to the effects of one fertilizer variable, phosphorus, on three types of plants, soybeans, corn and pasture herbage. The animal investigations, in which the nutritive value of the crops were evaluated, have been conducted along two general lines: (1) life-cycle studies of sheep and (2) controlled feeding and balance experiments with lambs and weanling rabbits. The data indicate that a comprehensive investigation in which soil, plants and animals are involved necessitates a long-term approach. Since the phosphorus studies have reached a progressive stage, it is expedient to initiate calcium studies at this time.

5. Outline of procedure:

A. Forage production and composition

1. Location of field plots: Six acres of land at the south end of fields H₁ and H₂ at the Tidewater Test Farm, Plymouth, North Carolina will be used for the lime studies. The soil in this area is low in this plant nutrient.
2. Design of field experiment: Three levels of lime X three replications in a randomized block design are to be employed. The treatments are as follows:

<u>Levels of lime treatment</u>	<u>Hydrated Calcitic lime^{1/} lb./acre</u>	<u>0-14-14^{2/} Fertilizer^{2/} lb./acre</u>
None	0	400
Normal	1200	400
Excessive	6000	400

^{1/} = Initial application

^{2/} = Annual application

All the plots will be the same length, but the limed plots will be 42 feet wide and the unlimed, 68 feet. The differences in areas represents an attempt to equalize the total crop production from the respective treatments.

3. Fertilization and planting procedures: The lime and the fertilizer will be broadcast over the respective plots.

Kobe lespedeza, the test crop, will be seeded at the rate of 12 to 15 lbs. per acre.

The possibility of using a pre-planting weed killer to reduce the contamination from other plants will be investigated.

4. Sampling of soil and plants: During the first year, soil samples will be collected at the beginning of the experiment (before lime and

fertilizers are applied), in mid-growing season and immediately after harvesting. Each year thereafter samples will be obtained at periods corresponding to those of the first year. These samples will be analyzed for available phosphorus, pH, base exchange capacity, organic matter, exchangeable magnesium and exchangeable potassium.

The lespedeza will be sampled at definite time intervals throughout the growing season. The samples will be analyzed for the conventional nutrients as well as for calcium, phosphorus, magnesium, manganese and iron.

B. Nutritional studies

Feeding and metabolism trials will be conducted concurrently with and similarly to those on forages from the phosphate-fertilization study. It will not be possible, however, to include calcium in the life-cycle studies.

6. Probable duration of Subproject I: Five years
7. Date of initiation: Spring, 1950
8. Personnel: Same as listed in original project.

6 January 1950

MEMORANDUM TO: Dr. G. H. Wise, Head
Animal Nutrition Section

I am returning herewith a copy of the revised project BJ21, "Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds." This project has been approved by the Office of North Carolina Experiment Station and by U.S.D.A. Office of Experiment Stations. Attached is a copy for your files.

D. W. Colvard, Head
Department of Animal Industry

North Carolina State College of Agriculture and Engineering
of the
University of North Carolina
Raleigh

SCHOOL OF
AGRICULTURE AND FORESTRY
RESEARCH EXTENSION
RESIDENT TEACHING
AGRICULTURAL EXPERIMENT STATION

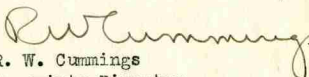
OFFICE OF DEAN AND DIRECTOR

January 2, 1950

MEMORANDUM TO: D. W. Colvard

I am returning herewith two copies of your revised project, BJ24, "Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds," which has been approved by the Office of Experiment Stations.

Very truly yours,


R. W. Cummings
Associate Director

Enclosures

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

PROJECT OUTLINE

Project No.	B521-A12
Date
Submitted
Approved
Revised

1. Title

Effect of Fertilisation and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.

2. Objective(s)

- a. To study the effect of different fertilizers on the composition (minerals, vitamins, nitrogen and carbohydrates) of whole plants, soybeans, lespedeza, bull grass (*Paspalum bosciannum*), rye grass and related forage plants.
- b. To make similar composition studies on various parts of soybean plants and other legumes.
- c. To study the interrelationships of fertilization and maturity on the composition of the plants under study.
- d. To determine at definite intervals throughout the grazing season the changes in chemical composition of grazed forages differentially fertilized.
- e. To study the nutritive characteristics of the plants by feeding and metabolism studies with laboratory animals.

3. Reasons for Undertaking Investigations*

The initial phase of this investigation singles out for special study those particular plants that are grown in connection with Project S52-A119 (Influence of Fertilization on the Nutritional Quality of Forage), which emphasizes the responses of farm animals, principally sheep, to forages grown on differentially-phosphated plots. In order to establish a more comprehensive basis for appraisal of animal responses, this present project will be concerned primarily with more extensive studies of the chemical composition of the same feeds.

To arrive at basic information concerning the effect of fertilization on the nutritive composition of forages, detailed studies are needed on individual forage species. In conjunction with this phase of the study an evaluation of the effects of fertilization on the rate of maturity and on the change in the relative proportions of nutrients in plant parts is desirable.

It is well known that fertilization often affects the kind and ratio of species in mixed pastures. Nonetheless, many of the data in the literature are of the type from which it is impossible to separate the effect of fertilization on the change in botanical composition from the effect of the treatment on the composition of a specific forage. Such data still leave unanswered questions:

- a. Which plant nutrients are affected by various fertilizer treatments?

*Including economic justification

- b. To what extent, if any, are the relative amounts of nutrients modified?
- c. What effects do the changes in the plant components have on the feed value?

The studies outlined herein are designed to obtain some of this basic information on the effect of fertilization and managerial treatments on characteristics of various individual forage species.

4. Previous work and present status of investigations in the field of this project:

This project is a substitute for an earlier one (BJ24-A12) which is being discontinued. The state of knowledge in this field up to 1943 was reviewed briefly, with references, in this earlier project and a few additional citations are given in a publication dealing with some of the results from this earlier project ("The Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pasture Herbage," Jour. Amer. Soc. Agronomy, 39:841-858, 1947).

Both the results presented in the aforementioned paper and those, as yet unpublished, demonstrate an effect of fertilization on a mixed pasture herbage. The extent of the effects varied considerably from year to year, due apparently to changes in the meteorological conditions. It has not been possible to determine whether the alterations in chemical composition resulted from changes in botanical composition or changes in the chemical components of the different species.

Other results from this project have shown differences in the chemical composition of lespedeza due to variety, stage of maturity and to fertilization.

These findings together with those cited in the literature point to the desirability of working with pure species rather than with mixtures such as commonly occur in pastures. There is also a need for assessing the significance of changes in chemical composition in terms of nutritive value as determined by controlled feeding experiments.

The forage species, enumerated in Objective a of this project, have been grown in connection with Project 552-A119 in differentially-phosphate-fertilized plots which have received the same fertilizer treatments for the past five growing seasons. In the third-crop year, the phosphate-fertilized plots produced soybean hay which was higher in protein, calcium and phosphorus than the soybean hay produced on the nonphosphate-fertilized plots. The results of the first two years have been published ("Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep," Jour. An. Sci., 8:441-51, 1949).

5. Outline of Procedure:

a. Source of samples.

(1) Phosphated vs. non-phosphated.

- (a) Location of experimental areas: The plant materials needed either have been or will be grown in connection with Project 552-A119. The plots are located at the Tidewater Experimental Farm at Plymouth, N. C. The Bladen soil on which these plots are located is extremely low in soil phosphorus.

- (b) Fertilization: The fertilizer variable is phosphorus. As needed, calcium, potassium and nitrogen are equalized across all plots.
- (c) Field layout: (See figures I and II.)
- (1) Soybeans for hay: The soybeans for hay will be grown on fields H_1 and H_2 in a randomized block design consisting of a total of six replications.
 - (2) Bull grass: Some native bull grass will be allowed to grow in each of the six replications described above and separated for analysis.
 - (3) Italian Rye grass: This grass will be grown from early fall to late spring on fields G_1 , G_2 , G_3 and F_1 and F_2 (not shown in diagram) in a randomized block design consisting of a total of four replications.
 - (4) Lespedeza: This legume will be grown on two pasture plots, F_1 and F_2 (not shown in diagram) from late winter to fall.
 - (5) Soybeans for pastures: Grazed soybeans will be obtained from G_1 , G_2 and G_3 from late spring to fall.
 - (6) Corn: Corn will be grown in H_2 in two replications.
- (2) Pure species of forage plants: This second phase will supplement agronomic investigations of new forage plants. A study will be made of composition and nutritive value of pure species from garden plots in which such factors as geographical location, soil type and fertility, fertilizer and managerial treatments and meteorological conditions are considered.
- b. Preparation of samples and chemical analyses: All samples will be dried at 60° - 65° C. and subsequently ground and bottled for chemical analysis.
- Individual parts of plants, leaves, pods, stems, etc., will be separated and weighed. The number of plants involved in the sample will also be recorded. In this manner, it will be possible to calculate the proportions of the various parts to the whole plant.
- Since it was found previously that phosphate fertilization affected calcium, phosphorus, magnesium and nitrogen of the soybean plant, all samples will be analyzed for these elements. Additional analyses (fat, crude fiber, lignin, carotene, riboflavin, iron, copper and manganese) will be made in pilot studies to ascertain whether or not continuation and expansion are warranted.
- c. Nutritive value: Laboratory animals, primarily rabbits, will be employed as a means of indicating the feed value of various plants or parts thereof in the pure-species studies. Nutrient utilization will be estimated by feeding trials, balance trials and digestibility studies.
- d. Analysis of data: The data will be analyzed statistically to facilitate interpretation.

6. Probable Duration of Project: **Five years**

7. Date of Initiation: **Immediately**

8. Personnel:

Name	Department	Relation to Project
F. W. Sherwood	Animal Industry (Nutrition)	Leader
F. H. Smith	Animal Industry (Nutrition)	Co-leader
G. Matrone	U.S. Plant, Soil and Nutrition Laboratory	Co-leader
W. W. Woodhouse, Jr.	Agronomy	Co-leader
W. W. G. Smart, Jr.	Animal Industry (Nutrition)	Assistant
Virginia Weldon	Animal Industry (Nutrition)	Assistant
H. L. Lucas	Experimental Statistics	Cooperator
G. H. Wise	Animal Industry (Nutrition)	Adviser

9. Coöperation:

a. Interdepartmental

Agronomy Department
Institute of Experimental Statistics

b. Other Agencies

U. S. Plant, Soil and Nutrition Laboratory, Ithaca, New York

10. Financial Support:

a. Proposed Budget 7/1/49 to 6/30/50

ITEMS	ALLOCATION OF FUNDS					
	Bankhead-Jones	Purnell	Adams	State	Other	Total
1. Salaries						3,980
F.W. Sherwood	1,440					
F.H. Smith	1,200					
Associate (to be appointed)	1,200					
E.G. Haywood	140					
2. Labor	160					160
3. Travel						
4. Equipment & Supplies	600					600
5. All Other (Transportation)	20					20
Total	4,760					4,760

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income
1950-1951	3,980	4,760	
1951-1952	3,980	4,760	
1952-1953	3,980	4,760	
1953-1954	3,980	4,760	
1954-1955	3,980	4,760	

11. General Remarks:

SIGNATURES OF APPROVAL

1. Approval of Project Leaders

Date Dec 13, 1949F. W. SherwoodTitle Research Professor Animal Industry (Nutrition)Date Dec 13, 1949J. H. SmithTitle Assoc. Research Professor Animal Industry (Nutrition)Date Dec 13, 1949B. MatroneTitle Research chemist
W. W. Woodhouse Jr. Assoc. Prof. Agron.

2. Approval of Heads of Departments or Coöperating Agencies

Date 12/14/49A. O. ColvardHead, Animal IndustryDate 12/14/49W. E. ColvilleHead, Agronomy

Date

Head,

3. Approval of Committee on Experiment Station Projects

Date

Chairman of Committee

4. Approval of Director

Date 12/15/49R. W. Cummings
Assoc. Director, North Carolina Agricultural
Experiment Station

5. Approval of U. S. D. A.

Date

R. W. Inlingers
Chief, Office of Experiment Stations

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1950
(Three copies to be given to the CES examiner)

1. PROJECT: (Fund, number, and title): BANKHEAD-JONES Agron., Exp. Stat. BJ24-A12, EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEEDS.
2. DEPARTMENTS AND COOPERATING AGENCIES: Agronomy Department, Institute of Statistics, U.S. Plant, Soil and Nutrition Laboratory, Ithaca, New York.
3. PERSONNEL: F. W. Sherwood, F. H. Smith, G. Matrone, W. W. Woodhouse, Jr., Virginia Weldon, W. W. G. Smart, Jr., H. L. Lucas and G. H. Wise.
4. NATURE OF WORK AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked): The chemical analyses of all samples taken under the original project have been completed.

Preparations have been made for work on the revised project but no samples can be obtained before this coming summer.

The results from the original project are being studied and prepared for publication.

5. BENEFITS realized by farmers or the public through application of findings, stated in dollars, bushels, or other values, where possible: No concrete evaluation of the findings is possible. The indirect benefits are considerable in that these studies furnish considerable information concerning the effects of fertilizers on pastures.
6. WORK PLANNED FOR NEXT YEAR: Proceed as specified in the Project Outline.
7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR: None.

8. APPROVED: F. W. Sherwood

Project Leader.

Director.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
PROJECT OUTLINE

Project No. BJ24 - A12.....
Date
Submitted
Approved.....
Revised.....

1. Title: Effect of Fertilization and Management on the Composition and Nutritive Value of Plants Commonly Used for Livestock Feeds.

2. Objective(s) of Subproject:

- (1) To study the effect of different fertilizers on the composition (minerals, vitamins, nitrogen and carbohydrates) of whole plants, soybeans, lespedeza, bull grass (*Paspalum Boscianum*), rye grass and related forage plants.
- (2) To make similar composition studies on various parts of soybean plants and other legumes.
- (3) To study the interrelationships of fertilization and maturity on the composition of the plants under study.
- (4) To determine at definite intervals throughout the grazing season the changes in chemical composition of grazed forages differentially fertilized.
- (5) To study the nutritive characteristics of the plants by feeding and metabolism studies with laboratory animals.

3. Reasons for Undertaking Investigations

The initial phase of this investigation singles out for special study those particular plants that are grown in connection with Project S52 - A119 (Influence of Fertilization on the Nutritional Quality of Forage), which emphasizes the responses of farm animals, principally sheep, to forages grown on differentially-phosphated plots. In order to establish a more comprehensive basis for appraisal of animal responses, this present project will be concerned primarily with more extensive studies of the chemical composition of the same feeds.

To arrive at basic information concerning the effect of fertilization on the nutritive composition of forages, detailed studies are needed on individual forage species. In conjunction with this phase of the study an evaluation of the effects of fertilization on the rate of maturity and on the change in the relative proportions of nutrients in plant parts is desirable.

It is well known that fertilization often affects the kind and ratio of species in mixed pastures. Nonetheless, many of the data in the literature are of the type from which it is im-

possible to separate the effect of fertilization on the change in botanical composition from the effect of the treatment on the composition of a specific forage. Such data still leave unanswered basic questions:

- (a) Which plant nutrients are affected by various fertilizer treatments?
- (b) To what extent, if any, are the relative amounts of nutrients modified?
- (c) What effects do the changes in the plant components have on the feed value?

The studies outlined herein are designed to obtain some of this basic information on the effect of fertilization and managemental treatments on characteristics of various individual forage species.

4. Previous work and present status of investigations in the field of this project:

This project is a substitute for an earlier one (BJ24 - A12) which is being discontinued. The state of knowledge in this field up to 1943 was reviewed briefly, with references, in this earlier project and a few additional citations are given in a publication dealing with some of the results from this earlier project ("The Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pasture Herbage", Jour. Amer. Soc. Agronomy, 39:841-858, 1947).

Both the results presented in the aforementioned paper and those, as yet unpublished, demonstrate an effect of fertilization on a mixed pasture herbage. The extent of the effects varied considerably from year to year, due apparently to changes in the meteorological conditions. It has not been possible to determine whether the alterations in chemical composition resulted from changes in botanical composition or changes in the chemical components of the different species.

Other results from this project have shown differences in the chemical composition of lespedeza due to variety, stage of maturity and to fertilization.

These findings together with those cited in the literature point to the desirability of working with pure species rather than with mixtures such as commonly occur in pastures. There is also a need for assessing the significance of changes in chemical composition in terms of nutritive value as determined by controlled feeding experiments.

The forage species, enumerated in Objective 1 of this project, have been grown in connection with Project S52 - A119 in differentially-phosphate-fertilized plots which have received the same fertilizer treatments for the past five growing seasons. In the third-crop year, the phosphate-fertilized plots produced soybean hay which was higher in protein, calcium and phosphorus than the soybean hay produced on the nonphosphate-fertilized plots. The results of the first two years have been published ("Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep," Jour. An. Sci., 3, 41-51. 1949).

5. Outline of Procedure:

A. Source of samples

1. Phosphated vs. non-phosphated

- (a) Location of experimental areas: The plant materials needed either have been or will be grown in connection with Project S52--A119. The plots are located at the Tidewater Experimental Farm at Plymouth, N. C. The Bladen soil on which these plots are located is extremely low in soil phosphorus.
- (b) Fertilization: The fertilizer variable is phosphorus. As needed, calcium, potassium and nitrogen are equalized across all plots.
- (c) Field layout: (See figures I and II)
- (1) Soybeans for hay: The soybeans for hay will be grown on fields H₁ and H₂ in a randomized block design consisting of a total of six replications.
 - (2) Bull grass: Some native bull grass will be allowed to grow in each of the six replications described above and separated for analysis.
 - (3) Italian Rye grass: This grass will be grown from early fall to late spring on fields G₁, G₂, G₃ and F₁ and F₂ (not shown in diagram) in a randomized block design consisting of a total of four replications.
 - (4) Lespedeza: This legume will be grown on two pasture plots, F₁ and F₂ (not shown in diagram) from late winter to fall.
 - (5) Soybeans for pastures: Grazed soybeans will be obtained from G₁, G₂ and G₃ from late spring to fall.
 - (6) Corn: Corn will be grown in H₃ in two replications.

5. Outline of Procedure - Cont'd.

2. Pure species of forage plants: This second phase will supplement agronomic investigations of new forage plants. A study will be made of composition and nutritive value of pure species from garden plots in which such factors as geographical location, soil type and fertility, fertilizer and managemental treatments and meteorological conditions are considered.

- B. Preparation of samples and chemical analyses: All samples will be dried at 60° - 65° C and subsequently ground and bottled for chemical analysis.

Individual parts of plants, leaves, pods, stems, etc., will be separated and weighed. The number of plants involved in the sample will also be recorded. In this manner, it will be possible to calculate the proportions of the various parts to the whole plant.

Since it was found previously that phosphate fertilization affected calcium, phosphorus, magnesium and nitrogen of the soybean plant, all samples will be analyzed for these elements. Additional analyses (fat, crude fiber, lignin, carotene, riboflavin, iron, copper and manganese) will be made in pilot studies to ascertain whether or not continuation and expansion are warranted.

- C. Nutritive value: Laboratory animals, primarily rabbits, will be employed as a means of indicating the feed value of various plants or parts thereof in the pure-species studies. Nutrient utilization will be estimated by feeding trials, balance trials and digestibility studies.
- D. Analysis of data: The data will be analyzed statistically to facilitate interpretation.

6. Probable Duration of Project: Five years

7. Date of Initiation: Immediately

8. Personnel:

Name	Department	Relation to Project
F. W. Sherwood	Animal Industry (Nutrition)	Leader
F. H. Smith	Animal Industry (Nutrition)	Co-leader
G. Matrone	U. S. Plant, Soil and Nutrition Laboratory	Co-leader
R. L. Lovvorn	Agronomy	Co-leader
W. W. Woodhouse, Jr.	Agronomy	Co-leader
W. W. G. Smart, Jr.	Animal Industry (Nutrition)	Assistant
Virginia Weldon	Animal Industry (Nutrition)	Assistant
H. L. Lucas	Experimental Statistics	Cooperator
G. H. Wise	Animal Industry (Nutrition)	Adviser

9. Cooperation:

a. Interdepartmental

Agronomy Department
Institute of Experimental Statistics

b. Other Agencies

U. S. Plant, Soil and Nutrition Laboratory, Ithaca, New York

10. Financial Support:

a. Proposed Budget, 7/1/49. to 6/30/50..

1. Salaries.....	3980.00
F. W. Sherwood (1440.00)	
F. H. Smith (1200.00)	
Associate to be appointed (1200.00)	
Edward G. Haywood(140.00)	
2. Labor.....	160.00
3. Travel	
4. Equipment & Supplies.....	600.00
5. All other (Transportation).	20.00
	<hr/>
Total:	\$ 4760.00

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income
1950-1951	3980.00	4760.00	
1951-1952	3980.00	4760.00	
1952-1953	3980.00	4760.00	
1953-1954	3980.00	4760.00	
1954-1955	3980.00	4760.00	

B5-24-414
File

FINAL REPORT, COMPLETED OR REVISED PROJECTS

North Carolina Agricultural Experiment Station

1. Project title, number, and fund:

The Mineral and Vitamin Content of Pasture Plants.
D.S. 24 - A1 2, Bankhead-Jones

2. Departments and cooperating agencies:

Animal Industry (Nutrition) and Agronomy Departments, Tennessee Valley Authority; Appalachian Forest Experiment Station

3. Major personnel:

F. W. Sherwood, J.O. Halverson, F. H. Smith, W. W. Woodhouse, Jr., E.L. Lovvorn

4. Date begun: 1943 Date revised/completed: September, 1949

If discontinued without completion state reasons:

5. Estimated total cost by funds (salaries and maintenance):

Bankhead-Jones, \$24,400

6. The problem (briefly restate its nature, importance, and economic significance):

This project was designed to study the long-time effect of fertilization on the nutritive value of a mixed pasture herbage and of *Lespedeza*. Its purpose was to evaluate and compare the effects of various fertilizer treatments on the production of the specific nutrients, protein, calcium, phosphorus and carotene, and to assess the relative value of these treatments in producing pasturage adequate to meet the nutritional requirements of animals grazing thereon.

7. Major results and conclusions:

Either phosphate or limestone alone, or together, increased the yields of dry matter and the percentage of protein in the pasture herbage. Neither changed the carotene content significantly. The phosphate, but not the limestone, increased the calcium and phosphorus content of the herbage.

The extent of these changes varied from year to year depending, in part, upon meteorological conditions. There was a downward trend in the calcium and nitrogen content over the experimental period while the percentage of phosphorus remained relatively constant for a given treatment.

It has not been possible to separate the direct effects of the fertilizer treatments on the different species in the mixed pasture from the indirect ones resulting from the observed changes in botanical composition.

Differences in the chemical composition of *Lespedeza* have been found to be associated with variety, stage of maturity and fertilizer treatments.

(over)

8. Practical applications and public benefits achieved or in prospect:

The chief benefits to be derived from liming and applying phosphate to a Malwood loam soil are in increasing the yield and promoting the growth of the more desirable species, bluegrass, clover and Lespedeza, and in decreasing the weeds. The phosphate treatment increases the phosphorus content of the herbage from a borderline to a nutritionally adequate soil. The other nutrients studied (protein, carotene and calcium) are present in large enough amounts to meet the needs of grazing cattle provided they eat enough to satisfy their energy requirements.

9. Publications:

"Effect of Fertilization on the Nitrogen, Calcium and Phosphorus Contents of Pasture Herbage" -

F. W. Sherwood, J. O. Halverson, W. W. Woodhouse and F. N. Smith
Jour. Amer. Soc. Agronomy, 38, 841-856 (1947).

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
PROJECT OUTLINE

Project No.	BJ 24-A12
Date	
Submitted	
Approved	
Revised	4/20/43

1. Title The mineral and vitamin content of pasture plants.
2. Objective(s)
- (1) To determine the effect of different fertilizer treatments on the mineral and vitamin content of pasture plants, with particular emphasis on the nitrogen (protein), calcium, phosphorus and carotene content.
 - (2) To determine seasonal changes in the nutritive value of pasture-plants as influenced by fertilizer treatment.
 - (3) To determine the effect of different fertilizer treatments on the mineral and vitamin content of lespedeza.
 - (4) To determine the changes in the mineral and vitamin content of lespedeza at different stages of maturity, and to correlate these changes with differences in fertilization.
 - (5) To compare the nutritive value as measured by the nitrogen (protein), calcium, phosphorus and carotene content, of ^{five} four varieties of lespedeza.
3. Reasons for Undertaking Investigations*
- I. Developments in the science of nutrition emphasize the idea that the best place to begin in improving the diet of humans and of farm animals is the soil.
- In this connection Maynard (1) has said "our feed supply has tended to become poorer in quality because of several developments; one has been a depletion of our soils. The influence of soil depletion on crop yields has been appreciated. — A good yield is essential but it is not enough. We need to pay attention to nutritional quality."
- Other citations of this general tenor could be made but this is enough to show that gross yield data in pasture and other feed or food growing experiments are not enough. Some estimate of the nutritive value should also be made. Therefore one reason for undertaking this investigation is to enlarge and supplement the pasture studies of the Agronomy Department and Cooperators (Project BJ 14-A14) with data on the nutritive value of the pasture herbage.
- Another reason for undertaking this investigation is that the general layout and plan of the pasture studies offer a unique opportunity for studying the seasonal change in nutritive value with fertilization under controlled conditions. The results should help clarify some of the confusion that now exists in the literature.
- II. Lespedeza is one of the principal species used for livestock feed in the State, yet little is known of the comparative feeding values of varieties or how this is influenced by fertilization. Hence any information on this subject should have considerable practical value.

*Including economic justification

4. Previous work and present status of investigations in the field of this project:

The comparatively little work that has been done on the nutritive value of lespedeza has been reviewed in Project B114-114, and will not be repeated here.

The literature on changes in one or more plant constituents with season or with fertilizer treatment is rather voluminous and no attempt will be made to review it completely. Much of it may be found condensed in "Soils and Men" (7) and "Food and Life" (8). A few recent papers which seem especially pertinent are reviewed.

Sotola (5) has found that on a dry matter basis, the crude fiber, nitrogen-free extract and ash in crested wheat grass all tended to increase, though somewhat irregularly, with the stage of growth, while the crude protein and phosphorus decreased.

Sullivan and Garber (6) have reported that the nitrogen content of flowering plants of *Poa pratensis* tended to be higher than that of plants flowering a few days earlier, both at the flowering period and in the aftermath stage. There was a highly significant negative correlation between the nitrogen content and the yield of clover isolations grown in the green house.

Smith and Wang (4) determined the carotene and total nitrogen in 63 samples of white clover, cocksfoot, rye and timothy grasses at different times during the growing season. In all cases the carotene was greatest when the plants were young. It declined slightly at flowering and heading, decreased rapidly during fading or ripening and increased in the aftermath. The effects of fertilization were usually slight but a late dressing of ammonium sulfate increased the carotene content of rye grass 55 percent in the leaves and 17 percent in the heads. The predominating factor influencing both carotene and nitrogen contents, which were closely related, was the stage of growth.

8. Outline of Procedure:

In a series of two articles Moon (2) has reported that the carotene content of mixed grasses from an experimental plot remained constant until flowering when a marked decrease occurred. There were significant correlations between the carotene content and the contents of protein and nitrogen-free extract, which was increased, and with fiber which was proportionately decreased. Less close but significant correlations were obtained with the value for ether extract, with the ratio of true to crude protein and with the content of calcium and phosphorus.

After investigating the carotene content of 7 grasses and 3 clovers at different seasons, this author found that the carotene content usually decreased with the height of the grass and was about the same in all species at flowering. During a summer drought the carotene content of the grasses became low but increased again during autumn when growth was resumed. The carotene content of the clovers was greater than that of the grasses except in early spring and was less affected by drought. In another paper Moon (3) reports that the carotene content of poor pasture grass is increased by monthly applications of ammonium sulfate, sodium nitrate or potassium sulfate, but is not affected by superphosphate or a single application of lime to satisfy the lime requirement of the soil. The ash content was increased by potassium sulfate, superphosphate or lime, the protein content was increased by ammonium sulfate, sodium nitrate or superphosphate and the ether extract was increased by ammonium sulfate or superphosphate. All treatments increased the yield of dry matter.

4. Previous work and present status of investigations in the field of this project: (ct'd)

Under a previous project (T.V.A. 20 (supplement), dated June 6, 1939) the Animal Nutrition Section of the Department of Animal Industry has determined total nitrogen (protein), ash, calcium, and phosphorus in composite samples of all clippings from each of the 120 plots of Field A and of each of the 32 plots of Field B (project BJ14-414- Sub-project E) over a period of three years. The fourth year clippings (1942) is now being analyzed. In addition carotene determinations have been made on selected frozen samples of some of the clippings for Field A on three successive years.

In general the results of the work on Field A show that the application of limestone definitely increased the total yield of dry matter, nitrogen (protein), calcium, phosphorus and carotene. However the increases in the calcium, phosphorus and carotene were due to the increased yield and not to a change in the average composition of the plants. The increase in total nitrogen was caused both by the increase in yield of dry matter and by a larger content in the plants.

The application of phosphatic fertilizers did not increase the yield of dry matter but they did increase the percentage of nitrogen and phosphorus in the plants so that the total yield of these nutrients per acre was enhanced.

There was practically no difference in the effects of the three phosphatic carriers, except that fused phosphate was inferior to either triple superphosphate or calcium metaphosphate in increasing the phosphorus content of the herbage.

In Field B, which was uniformly limed at the beginning of the experiment, neither nitrogen, phosphate nor potash applications had an appreciable effect on the yield of dry matter. The nitrogenous fertilizer decreased the nitrogen and calcium content of the herbage and the phosphate treatment increased the percent of phosphorus in the plants. In two of the three years potash increased the total amount of ash and of phosphorus in the crop.

5. Outline of Procedures

A. Pasture grasses from western North Carolina (Project BJ14-414 Sub-project E. Field A.)

In view of previous results, probably maximum results can be obtained with the available facilities if two of three sources of phosphate be omitted. In this way 16 of the treatment combinations, each in triplicate, will be selected for more intensive study, after consulting with the co-leaders in the Agronomy Department.

Assuming that triple superphosphate is selected the treatment combinations and their numbers (as given in sub-project E, section A.) will be

		Dolomitic limestone, lbs/acre			
		None	1000	2000	4000
Phosphate 400 lbs/acre	None	(1)	(2)	(3)	(4)
	16%	(5)	(6)	(7)	(8)
	24%	(17)	(18)	(19)	(20)
	32%	(29)	(30)	(31)	(32)

If some other source of phosphate is selected the treatment numbers will be changed correspondingly.

5. Outline of Procedure (continued)

Clippings will be taken at approximately monthly intervals by the Agronomy Department. These will be dried and sent to the laboratory for analyses. On three clipping dates, one during vigorous growth in the spring, a second in midsummer and the last in the autumn, samples of fresh herbage will be frozen in the field with dry ice and sent to the laboratory for carotene determinations.

Dried clippings taken at the same time as the carotene samples will be individually analyzed for nitrogen, calcium and phosphorus. In addition portions of all clippings for the season will be composited in proportion to their dry weight and analyzed for nitrogen, calcium and phosphorus.

The clippings from the 3% phosphate or the 4000 lbs. limestone treatments will be analyzed only if time and facilities permit.

B. Grass samples from Bent Creek Watershed No. 3 (Project BJ14-AL4 Sub-project E, Section H.)

Clippings from the eight replications of the four fertilizer treatments will be taken as prescribed for Field A. The carotene in the frozen grass and nitrogen, calcium and phosphorus determinations in the dried material will be made on early summer, midsummer, when lespedeza is in early bloom, and early autumn clippings. In addition a composite of all clippings for the season for each fertilizer treatment will be analyzed for nitrogen, calcium and phosphorus.

The fertilizer treatments are: per acre

- (1) None
- (2) 400 lbs. 0-16-0
- (3) 1 ton limestone
- (4) 400 lbs. 0-16-0 and 1 ton limestone

C. Lespedeza from McCullers Station (Project BJ14-AL4 Sub-project C)

This study will be limited to plants grown on two of the six fertilizer treatment plots (in three replications). The two fertilizer treatments will be (A) no treatment and (B) 400 lbs. 20% superphosphate, 50 lbs. 50% muriate of potash and 1 ton of dolomitic limestone.

Clippings from three of the four varieties of lespedeza (Korean, Kobe, and common) will be made at approximately monthly intervals. These clippings will be dried and at the end of the season all for each variety and fertilizer treatment will be composited and analyzed for nitrogen, calcium, and phosphorus. In addition during vigorous growth in early summer, at early bloom stage and again when the seed are mature, samples of the fresh plants will be frozen in the field and brought to the laboratory for carotene determinations. Dried clippings taken at the same time as the carotene sample will be analyzed for nitrogen, calcium and phosphorus.

D. It is desirable that in the future this project be enlarged to include studies on the trace elements (copper, manganese, cobalt and zinc), and on other vitamins such as thiamin or riboflavin in the plants. If time and facilities permit pilot studies on one or more of these factors will be initiated.

6. Probable Duration of Project: **Three years**

7. Date of Initiation: **Immediately**

8. Personnel:

Name	Department	Relation to Project
F. W. Sherwood	Animal Industry (Nutrition)	Leader
J. O. Halverson	" " "	Co-leader
F. H. Smith	" " "	Co-leader
R. L. Lovvorn	Agronomy	Co-leader
W. W. Woodhouse, Jr.	"	Co-leader
A. O. Shaw	Animal Industry	Advisor
W. J. Peterson	Animal Industry (Nutrition)	Advisor

9. Cooperation:

a. Interdepartmental

Animal Industry
Agronomy

b. Other Agencies

Tennessee Valley Authority
Appalachian Forest Experiment Station

REFERENCES

- (1) Maynard, L. A. 1943. Soil and crop basis of better nutrition. Chem. and Eng. News 21: 217-220
- (2) Moon, F. E. 1939. The composition of grass at various stages of maturity and the changes occurring during hay making with particular reference to carotene content.
The carotene contents of some grass and clover species with a note on pasture weeds.
Empire Jour. Exp. Agric. 7: 225-234; 235-243 (through Nat. Abst. & Rev. 9: 574(1940))
- (3) Moon, F. E. 1939. The influence of manurial treatment on the carotene content of poor pasture grass, and on the relationship of this constituent to the ash and organic fractions. Jour. Agr. Sci. 29: 524-543
- (4) Smith, A. M. and Wang, T. 1941. The carotene content of certain species of grassland herbage, Jour. Agri. Sci. 31: 370-378
- (5) Sotals, J. 1940. The chemical composition and apparent digestibility of nutrients in crested wheat grass harvested at three stages of maturity. Jour. Agri. Sci. 61: 303-311
- (6) Sullivan, J. T. and Garber, R. J. 1941. The nitrogen content of Poa pratensis; its range and relation to flowering date. Jour. Amer. Soc. Agron. 33: 933-937
- (7) 1938. Soils and Men.
Yearbook of Agriculture, U.S.D.A., particularly pages 777-806.
- (8) 1939. Food and Life.
Yearbook of Agriculture, U.S.D.A., particularly pages 925-991.

10. Financial Support:

a. Proposed Budget July 1, 1943 to June 30, 1944.

Items	ALLOCATION OF FUNDS					
	Bankhead-Jones	Purnell	Adams	State	Other	Total
1. Salaries						
F.W. Sherwood	\$1300.00					
J.O. Halverson	1060.00					
F.H. Smith	1000.00					
Statistical Services	113.00					
2. Labor	150.00					
3. Travel	100.00					
4. Equipment & Supplies	650.00					
5. All Other	100.00					
Total	\$4473.00					

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income
1943-1944	\$3473.00	\$4473.00	
1944-1945	3473.00	4750.00	
1945-1946	3473.00	4750.00	

11. General Remarks:

SIGNATURES OF APPROVAL

1. Approval of Project Leaders

Date March 31, 1943 F. W. Sherwood
 Title Associate in Animal Industry (Nutrition)

Date March 31, 1943 J. O. Salmon
 Title Associate in Animal Industry (Nutrition)

Date Apr. 5, 1943 W. C. Woodberry
 Title Associate in Agronomy

2. Approval of Heads of Departments or Coöperating Agencies

Date April 1 '43 A. O. Shaw
 Head, Dept. of Animal Industry

Date April 5, 1943 R. W. Cummings
 Head, Dept. of Agronomy

Date
 Head,

3. Approval of Committee on Experiment Station Projects

Date
 Chairman of Committee

4. Approval of Director

Date 4/20/43 L. O. Baver
 Director, North Carolina Agricultural
 Experiment Station

5. Approval of U. S. D. A.

Date MAY 29 1943 R. M. Tullinger
 Chief, Office of Experiment Stations

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1949.
(Three copies to be given to the OES examiner)

1. PROJECT: (Fund, number, and title): ~~BASKHEAD-JONES~~ **BJ24-112**, THE MINERAL AND VITAMIN CONTENT OF PASTURE PLANTS
2. DEPARTMENTS AND COOPERATING AGENCIES: **An. Ind., Agronomy, Tennessee Valley Authority**
3. PERSONNEL: **F. W. Sherwood, F. H. Smith, R. L. Lovvorn, W. W. Woodhouse, and W. J. Peterson.**
4. NATURE OF WORK AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked): **N. Ca. and P. determinations on the clippings from these mixed pasture plots have been made annually over a period of 10 years (including the 1948 clippings which are not yet complete). Although all of the data have not been studied, casual examination indicates that any additional information which may be obtained by continuing the project in its present form is scarcely worth the effort and cost.**
5. BENEFITS realized by farmers or the public through application of findings, stated in dollars, bushels, or other values, where possible:
6. WORK PLANNED FOR NEXT YEAR: **This project should be completely revised or terminated.**
7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:
8. APPROVED: _____
Project Leader. Director.

file

PROJECT: Influence of Phosphate Fertilization on the Composition and Nutritive Value of Forages.

COOPERATING AGENCIES: U. S. Plant, Soil and Nutrition Laboratory, Ithaca, New York; North Carolina State College, and North Carolina State Department of Agriculture.

Prepared for Field Day at the Tidewater Experiment Station Farm
May 23, 1949

By. G. Matrone

The use of fertilizers in the management of much of our agricultural land is an established custom. In recent years a nationwide interest has developed in fertilizers and their effects on the nutritional quality of our crops. This widespread concern is based on indications that the nutritional quality of our crops indirectly affects the health and well-being of our people and directly affects the productivity of our farm animals. Our present knowledge concerning the inter-relationship of soil management practices and the health of man and farm animals leaves many aspects of this complex problem unsolved. Integrated studies by soil, plant and nutrition scientists are required for a solution of the problem.

The experiment being conducted at the Tidewater Experiment Station Farm and at the State College in Raleigh covers only a small segment of the whole problem. The questions we are primarily concerned with in this project are as follows:

(1) Will the practice of phosphate fertilization on a soil deficient in soil phosphorus improve the health and productivity of successive generations of grazing sheep subsisting solely on crops grown in this soil?

(2) Does applying phosphate fertilizer to a soil deficient in soil phosphorus change the nutritive value of the crops grown thereon?

The field pasture layout for the ewe-lamb life cycle study designed to answer the first question is illustrated in Figure 1. It consists of three field replications making a total of six individual pastures. All six pastures are fertilized with lime, potash and nitrate of soda but only three of the pastures receive superphosphate. One group of ewes has been placed on each pasture. The sheep are furnished a year around pasture consisting of soybeans, rye grass and lespedeza. When necessary, the pasture grazing is supplemented with corn and with soybean hay, which also are differentially fertilized. During the two years this experiment has been in progress, no conclusive differences have been obtained regarding the health and productivity of the sheep in the different groups.

The field layout designed to answer question No. 2 is illustrated in Figure 2. Again, all of the plots receive lime and potash, but half of the plots received superphosphate and half of the plots received none. The nutritive value of the soybean hays and the corn grown on these plots is carefully analyzed and tested in controlled feeding experiments, balance studies and digestion trials using lambs and rabbits at the State College in Raleigh.

Three years of studies covering this phase of the problem have been completed. The crop yields are shown in Table 1. In all cases, the phosphate-fertilized plots produced at least twice as much soybean hay and corn per acre as

the unphosphated plots. During the first two years, there were no clear-cut effects of phosphate fertilization on the chemical composition or the nutritive value of soybean hay. In the third year, the phosphate-fertilized plots produced hays containing more phosphorus, more protein and more calcium than the soybean hays grown on unphosphated plots. When these hays were fed to lambs and rabbits, differences in nutritive value also were in favor of the phosphate-fertilized hays. The limited data indicated that the observed differences in the hays for lambs may be explained by the extra phosphorus content and possibly higher protein content in the phosphate-fertilized hays. The differences in responses of rabbits in favor of the phosphate-fertilized hays cannot be explained by chemical composition. In other experiments with sheep and rabbits, no evidence was obtained that the protein quality and the availability of the phosphorus in these hays were different. Further experiments are being conducted to evaluate the differences.

The results reported here show clearly the necessity of long-term experiments in this field. Continued research along the lines now in progress is necessary before we can obtain sufficient basic information about the effect of fertilizer practices on the nutritional quality of our crops and on the productivity of our farm animals.

Table 1.

EFFECT OF PHOSPHATE FERTILIZATION ON YIELD
OF SOYBEAN HAY AND CORN GRAIN

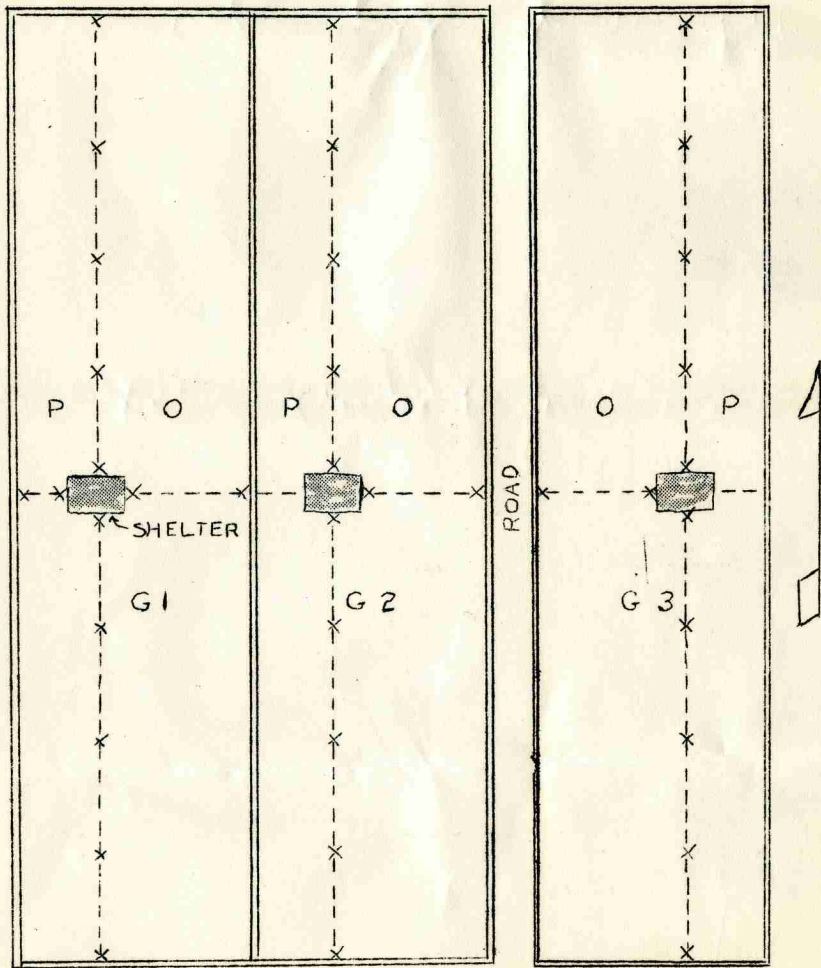
Crop Year	Crop	Fertilization		Difference
		I	II	
		P ₂ O ₅	No P ₂ O ₅	I - II
1945	Soybean Hay lbs./acre	2,000	1,000	+ 1,000
1946	Soybean Hay lbs./acre	2,000	1,000	+ 1,000
1947	Soybean Hay lbs./acre	3,300	1,300	+ 2,000
	Corn bu./acre	60	30	+ 30
1948	Soybean Hay lbs./acre	2,800	1,200	+ 1,600
	Corn bu./acre	50	25	+ 25

PASTURE LAYOUT

FIGURE 1.

PHOSPHATE FERTILIZATION STUDY

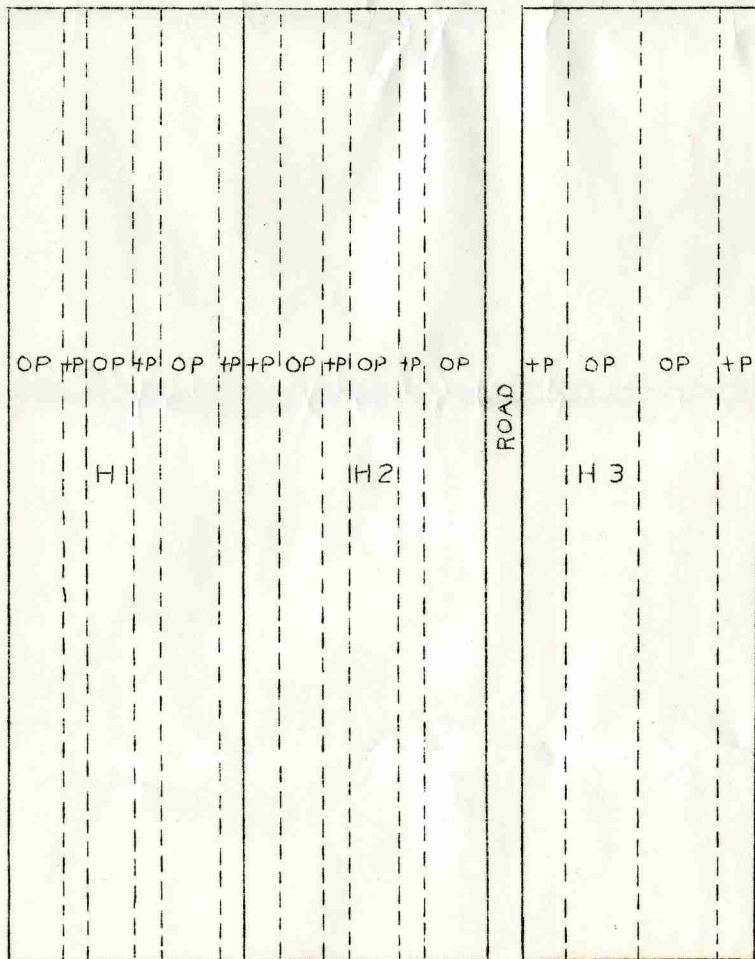
TIDEWATER EXPERIMENT STATION
PLYMOUTH, N. C.



EACH BLOCK = $7\frac{1}{2}$ ACRES

FIGURE 2.

FIELD PLOT LAYOUT
PHOSPHATE FERTILIZATION STUDY
TIDEWATER EXPERIMENT STATION
PLYMOUTH, N. C.



EACH BLOCK = $7\frac{1}{2}$ ACRES

DRY SOLIDS FROM FIELD A. Mean of 3 years.
(1939-1941 incl.)

Mean Total Yields of Dry Solids; lbs/acre

Limestone; lbs/acre	Percent P_2O_5 in Fertilizer			
	None	16	24	32
None	851	1097	1065	1252
1000	1378	1334	1379	1425
2000	1346	1485	1564	1600
4000	1449	1537	1479	1544

Mean increase over no treatment; lbs/acre

None	0	246	214	401
1000	527	483	527	574
2000	495	634	713	749
4000	598	686	628	693

Mean increase as percent of no treatment yields

None	0	29	25	47
1000	62	57	62	67
2000	58	74	83	88
4000	70	81	74	81

Response to phosphate (average of all limestone levels)

Total yields; lbs/acre	1264	1368	1374	1455
Increase over no P_2O_5 (lbs/acre)	0	104	110	191
Increase over no P_2O_5 percent	0	8	9	15

Response to limestone (average of all phosphate levels)

Limestone; lbs/acre	None	1000	2000	4000
Total yields; lbs/acre	1116	1383	1529	1513
Increase over no lime; lbs/acre	0	267	413	397
Increase over no lime; percent	0	24	37	36

Response to phosphate carrier (average of all phosphate and limestone levels)

	None	Triple-Super	Ca meta	Fused
Total yields; lbs/acre	1264	1351	1423	1421
Increase over no P_2O_5 lbs/acre	0	87	159	157
Increase over no P_2O_5 percent	0	7	13	12

PROTEIN FROM FIELD A. Mean of 3 years (1939-1941)

Mean yields of protein; lbs/acre

Percent P_2O_5 in Fertilizer

Limestone; lbs/acre	none	16	24	32
None	129	167	162	203
1000	212	222	232	242
2000	223	257	274	280
4000	253	271	352	268

Mean increase over no treatment; lbs/acre

None	0	32	33	74
1000	83	93	103	113
2000	94	128	145	151
4000	124	142	123	139

Mean increase as percent of no treatment yields

None	0	24	26	57
1000	64	72	80	87
2000	73	98	113	117
4000	96	109	95	108

Response to phosphate (average of all limestone levels)

Total yield; lbs/acre	204	228	229	248
Increase over no. P_2O_5 ; lbs/acre	0	24	25	44
Increase over no. P_2O_5 ; percent	0	11	12	22

Response to limestone (average of all phosphate levels)

Limestone; lbs/acre	None	1000	2000	4000
Total yields; lbs/acre	171	230	265	262
Increase over no lime; lbs/acre	0	59	94	91
Increase over no lime; percent	0	35	55	54

Response to phosphate carrier (average all P_2O_5 + lime levels)

	None	Triple-Super	Ca meta	Fused
Total yields; lbs/acre	204	224	239	242
Increase over no P_2O_5 ; lbs/acre	0	21	35	38
Increase over no P_2O_5 ; percent	0	11	17	18

CALCIUM FROM FIELD A. Mean of 3 years (1939-1941)

Mean yields of calcium; lbs/acre

Limestone; lbs/acre	Percent P ₂ O ₅ in Fertilizer			
	None	16	24	32
None	6.6	8.3	8.7	10.4
1000	11.0	11.0	11.7	12.3
2000	10.6	12.0	12.9	12.9
4000	12.6	13.6	12.8	12.9

Mean increase over no treatment; lbs/acre

None	0	1.7	2.1	3.8
1000	4.4	4.4	5.1	5.7
2000	4.0	5.4	6.2	6.3
4000	6.0	6.4	6.2	6.3

Mean increase as percent of no treatment yields

None	0	25	33	57
1000	66	67	77	88
2000	61	81	96	96
4000	92	96	94	96

Response to phosphate (average of all limestone levels)

Total yield; lbs/acre	10.2	11.1	11.3	12.2
Increase over no P ₂ O ₅ ; lbs/acre	0	0.9	1.1	2.0
Increase over no P ₂ O ₅ ; percent	0	9	11	20

Response to limestone (average of all phosphate levels)

Limestone; lbs/acre	None	1000	2000	4000
Total yields; lbs/acre	8.9	11.5	12.6	12.7
Increase over no lime; lbs/acre	0	2.6	3.7	3.8
Increase over no lime; Percent	0	29	42	44

Response to phosphate carrier (average of all P_2O_5 and lime levels)

	None	Triple-Super	Ca meta	Fused
Total yields; lbs/acre	10.2	10.9	11.7	12.1
Increase over no P_2O_5 ; lbs/acre	0	0.7	1.5	1.9
Increase over no P_2O_5 ; percent	0	7	15	19

PHOSPHORUS FROM FIELD A. Mean of 3 years (1939-1941)

Mean yield of phosphorus; lbs/acre
Percent P_2O_5 in Fertilizer

Limestone; lbs/acre	None	16	24	32
None	2.31	3.62	3.79	4.33
1000	3.70	4.45	4.71	5.15
2000	3.69	4.85	5.44	5.50
4000	3.82	4.95	5.04	5.39

Mean increase over no treatment; lbs/acre

None	0	1.31	1.48	2.12
1000	1.39	2.14	2.40	2.84
2000	1.38	2.54	3.13	3.19
4000	1.51	2.64	2.76	3.08

Mean increase as percent of no treatment yield

None	0	57	64	92
1000	60	93	104	123
2000	60	110	136	138
4000	65	114	120	134

Response to phosphate (average of all limestone levels)

Total yield; lbs/acre	3.38	4.47	4.76	5.16
Increase over no P_2O_5 ; lbs/acre	0	1.09	1.39	1.79
Increase over no P_2O_5 ; percent	0	32	41	53

Response to limestone (average of all phosphate levels)

Limestone; lbs/acre	None	1000	2000	4000
Total yields; lbs/acre	3.78	4.66	5.16	5.01
Increase over no lime; lbs/acre	0	0.88	1.38	1.23
Increase over no lime; percent	0	23	37	33

Response to phosphate carrier (average of all P_2O_5 and Lime levels)

	None	Triple-Super	Ca meta	Fused
Total yields; lbs/acre	3.38	4.74	5.01	4.64
Increase over no P_2O_5 ; lbs/acre	0	1.36	1.63	1.26
Increase over no P_2O_5 ; percent	0	40	48	37

Copy to W. W. Woodhouse 9/2/41

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1941*

North Carolina

Agricultural Experiment Station

1. Project title, number, and fund: Use of T. V. A. Phosphates and Limestone on Pastures.-- Bankhead Jones No. 1.

2. Departments and cooperating agencies: Agronomy, Animal Nutrition, and Tennessee Valley Authority.

3. Personnel: W. W. Woodhouse, Jr., J. O. Halverson, and George Rommel.

4. Nature and extent of work done this year: Field pasture plots, Experiments A and B, in the mountain section were triplicated and duplicated, respectively, 120 and 32 composited dry samples of the season's clippings. Chemical analysis of composited monthly clippings and statistical analysis by variance of the data have been made. These consisted of total absolute solids, nitrogen, ash, calcium and phosphorus. The data was analyzed both on the total absolute dry yield and on the percentage basis.

Likewise chemical analysis of the 1940 crop is nearing completion and in a preliminary way the statistical interpretation of the carotene content of the August clipping is being completed.

5. Major results, and any practical applications or public benefits achieved or in prospect (preliminary or confidential information should be marked as such): Total Yields (Carrying Capacity). On this basis in Field A the application of limestone has produced marked increases in the total yields of dry matter, of nitrogen (protein), of ash and calcium and, to a less extent, of phosphorus. One ton per acre of limestone gave maximum yields.

The phosphate applications had only a small effect upon the total yields of dry matter or of nitrogen but a somewhat greater effect on the yields of calcium and was marked in the case of ash and of total phosphorus.

On Percentage Basis of Dry Matter (Quality). The addition of limestone definitely increased the percent of nitrogen but had no observable effect on the percents of ash, calcium and phosphorus in the crop. Rates of phosphate in the fertilizer mixture up to 32% tended to increase the percentage of nitrogen, ash, calcium and phosphorus. Phosphate effected the percent of nitrogen somewhat more than it did the percent of calcium (which was very slight), but less than the percentage of ash and phosphorus, increases of which were highly marked at all levels up to 24 percent.

Effect of Sources of Phosphate. The effect on percentage of the three phosphate carriers, calcium metaphosphate, triple superphosphate and fused phosphate varied some what.

Experiment B

The results of Field B where limestone was applied to all plots were not effected by the addition of potash. Total yields were not increased by the application of nitrogen. In general total yields of the mineral constituents were not effected but there were some responses on the percentage basis.

6. No publications issued.

Director

*Two copies to be given to the O. E. S.

Number of Project: T. V. A. 20 (Supplement)

Name of Project: T. V. A. Phosphate-Lime Pasture Experiment

Leaders: W. W. Woodhouse, Jr.

Cooperators: Department of Agronomy of the N. C. Agricultural Experiment Station and the Tennessee Valley Authority.

Location: A privately owned farm in either Haywood or Jackson Counties.

Soil type: Halewood loam

Date begun: Spring, 1938

Object: To determine the relative efficiency of triple superphosphate, calcium metaphosphate and fused rock phosphate at different P_2O_5 levels in combination with different amounts of dolomitic limestone in the production of pasture grasses on one of the dominant upland pasture soils of the mountain area; and to determine the efficiency of triple superphosphate and limestone when used with or without nitrogen and with or without potash at different P_2O_5 levels in the production of pasture grasses on this same soil.

Method of Procedure: A suitable uniform area of the Halewood loam soil type of moderate and uniform slope is to be selected and prepared in the spring of 1938. If possible, a field now in bluegrass sod will be used and this sod will be disturbed as little as possible in the smoothing of the surface. In addition it will be given a heavy seeding of Kentucky bluegrass and white clover in order to secure a uniform thick sod. The fertilizer and lime treatments will be made and the sod be allowed to grow and become thoroughly established. Yields will be taken for the first time in 1939.

To secure yields, the grass will be cut with a power mower with pan attachment. These clippings will be made at intervals during the grazing season as often as the grass reaches about 4 inches in height. The entire plat will be harvested with the exception of buffer spaces. After each clipping, all buffer spaces will be clipped with the same machine and discarded.

Green weights will be taken in the field and samples will be secured for determinations of dry weight and for chemical analysis.

Size of plats: 1/200 acre

Sources of nitrogen: 75% from sulphate of ammonia
25% from nitrate of soda

Source of potash: Muriate of potash

Source of limestone: Finely ground dolomitic limestone

Plan of Experiment

Basis of all fertilizer treatments is 400 lbs. per acre

Field A

The applications of both fertilizer and lime are to be made on this field once every 3 years. Wherever fertilizer and limestone are to be used on the field, the fertilizer is to be mixed with 1000 pounds per acre of limestone; that is, if the plat is to receive 1000 pounds per acre of limestone, the limestone will be mixed with the fertilizer. If the plat is to receive 4000 pounds per acre of limestone, 1000 pounds of it will be mixed with the fertilizer and the remaining 3000 pounds of limestone will be applied separately.

Treatments

<u>Plat No.</u>	<u>Analysis</u>	<u>Source of phosphate</u>	<u>Dolomitic limestone</u>
1	0-0-0	No phosphate	None
2	0-0-0	"	1000 lbs.
3	0-0-0	"	2000 "
4	0-0-0	"	4000 "
5	0-16-0	Triple superphosphate	None
6	0-16-0	"	1000 lbs.
7	0-16-0	"	2000 "
8	0-16-0	"	4000 "
9	0-16-0	Calcium metaphosphate	None
10	0-16-0	"	1000 "
11	0-16-0	"	2000 "
12	0-16-0	"	4000 "
13	0-16-0	Fused phosphate	None
14	0-16-0	"	1000 "
15	0-16-0	"	2000 "
16	0-16-0	"	4000 "
17	0-24-0	Triple superphosphate	None
18	0-24-0	"	1000 "
19	0-24-0	"	2000 "
20	0-24-0	"	4000 "
21	0-24-0	Calcium metaphosphate	None
22	0-24-0	"	1000 lbs.
23	0-24-0	"	2000 "
24	0-24-0	"	4000 "
25	0-24-0	Fused phosphate	None
26	0-24-0	"	1000 lbs.
27	0-24-0	"	2000 lbs.
28	0-24-0	"	4000 lbs.
29	0-32-0	Triple superphosphate	None
30	0-32-0	"	1000 lbs.
31	0-32-0	"	2000 lbs.
32	0-32-0	"	4000 "
33	0-32-0	Calcium metaphosphate	None
34	0-32-0	"	1000 lbs.
35	0-32-0	"	2000 "
36	0-32-0	"	4000 "

These treatments will be replicated 3 times at random.

(continued)

<u>Plat No.</u>	<u>Analysis</u>	<u>Source of phosphate</u>	<u>Dolomitic limestone</u>
37	0-32-0	Fused phosphate	None
38	0-32-0	"	1000 lbs.
39	0-32-0	"	2000 "
40	0-32-0	"	4000 "

Field B

Ground dolomitic limestone is to be mixed with the fertilizer at the rate of 500 pounds per ton of mixture. This entire field will receive an initial treatment of 1500 pounds per acre of ground dolomitic limestone.

Treatments

<u>Plat No.</u>	<u>Analysis</u>	<u>Source of phosphate</u>
1	0-0-0	Triple superphosphate
2	0-0-4	" "
3	4-0-0	" "
4	4-0-4	" "
5	0-8-0	" "
6	0-8-4	" "
7	4-8-0	" "
8	4-8-4	" "
9	0-12-0	" "
10	0-12-4	" "
11	4-12-0	" "
12	4-12-4	" "
13	0-16-0	" "
14	0-16-4	" "
15	4-16-0	" "
16	4-16-4	" "

These treatments to be replicated 2 times at random.
The above applications are to be made annually.

3

Shaw

ANNUAL PROGRESS REPORT, FEDERAL-GRANT PROJECTS, 1942.
(Two copies to be given to the O. E. S. examiner)

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

Bankhead-Jones B724-A12.

PROJECT TITLE, NUMBER, AND FUND: **Carotene and mineral content of dried grass from TVA phosphate lime pasture fertilization plots of W. W. Woodhouse, Jr.**
DEPARTMENTS AND COOPERATING AGENCIES: **Animal Nutrition.**

PERSONNEL: **W. W. Woodhouse, Jr., J. O. Halverson, and George Rommel**

NATURE AND EXTENT OF WORK DONE THIS YEAR: **Chemical analyses made of 152 composited samples of 6 clippings for total solids, nitrogen ash, calcium and phosphorus on Fields A and B consisting of respectively 120 and 32 randomized plots each triplicated and duplicated for the year 1940. The analytical work for 1941 is in progress.**

Both total yield and percentage in herbage have been determined and statistically evaluated for the season 1940.

Carotene in the green grass of 120 samples of the August clipping of Field A have been made and evaluated for 1940; and 48 samples for the effect of triple superphosphate compared with no treatment for 1941, has been completed.

MAJOR RESULTS (confidential information should be so marked):

EFFECT OF PASTURE FERTILIZATION ON CAROTENE - Field A
Summary for Year 1940 (40 Plots in Triplicate)

Limestone and 3 types of phosphate fertilizer applied to mountain pasture land of Halewood loam produced both an increased content of carotene in the grass as well as an increased yield per acre.

Phosphate fertilizers applied alone significantly increased the carotene about 15% (17) while limestone alone produced larger increases of 35% (37). The application of both phosphates and limestone produced the largest increase, 40 - 45% with an increased yield of 90% (92) per acre.

~~Carotene~~ Continued on separate page.

PRACTICAL APPLICATIONS OF RESULTS OR PUBLIC BENEFITS:

See separate page.

PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

Annual Report for the N. C. Agricultural Experiment Station.

DIRECTOR

CAROTENE - SECOND YEAR - 1941

The application of limestone compared with no treatment gave a 16% (15.7) increase in the carotene content of the herbage. Triple superphosphate alone did not give a significant increase (2.6%) in carotene.

Total yield of carotene - Triple superphosphate produced a 16% increase; limestone alone produced a 78% increase while both fertilizers produced an increase of 66%.

This in general confirms the results of last year, showing that there is an increase in the plant content of carotene of $1/6$ and that the total yield is increased two-thirds.

FIELD A.Results of Two Years' Fertilization

<u>On Yields</u>	<u>Yield</u>	<u>Nitrogen</u>	<u>Ash</u>	<u>Ca.</u>	<u>Phos.</u>
Phosphates alone	31.3	37.7	39.2	62.9	111.7
Limestone alone	54.3	72.6	56.2	67.8	74.8
Both alone	<u>72.1</u>	<u>107.4</u>	<u>82.2</u>	<u>91.6</u>	<u>145.0</u>

On Percentage in Herbage

Phosphates alone	<u>9.0</u>	6.1	4.2	<u>26.9</u>
Limestone alone	<u>15.3</u>	4.7	4.3	1.9
Both alone	<u>18.8</u>	3.3	6.1	<u>28.9</u>

The application of limestone and phosphate increased yields of dry solids 72.1%, also other constituents with 145% increase for the phosphates. Yields for the other constituents were intermediate, being 107.5% nitrogen.

The increase in percentage in the herbage was greatest for nitrogen being 18.8 due to application of both limestone and phosphates and an increase of 28.9% for the phosphate content due to the use of phosphates.

FIELD B.Results of Two Years (Limestone Applied to All Plots)

Where limestone was applied to 32 plots, the use of a complete fertilizer produced an increased yield of phosphates and also content in the herbage. The application of nitrates depressed the yield. Other results were not significant.

PRACTICAL APPLICATIONS OF RESULTS OR PUBLIC BENEFITS:

Pasture fertilization is of importance to the farmer because:

Yields are increased at least 72% upon the application of limestone and phosphates.

In the herbage itself the nitrogen was increased one-fifth (18.8%) and the phosphates between one-third and one-fourth.

The total yield of carotene was increased three-fourths for two years and the content in the plant itself about one-third. Thus the important feed nutrients respond appreciably to fertilization of the principal pasture soil in the mountain area.

concept of good Beef animal

9108
AUGUST 13, 1941

ANIMAL NUTRITION

TVA - 5

GENERAL SUMMARY ON PERCENTAGE BASIS OF DRY MATTER

Statistical Analysis on Percent Basis of Nitrogen, Ash, Calcium and Phosphorus

Composited Samples from Series A - 1940

L = inc
Percent Nitrogen: Each increment of limestone up to 2000 pounds per acre, produced marked increases in the %N in the yields. The maximum percent of N was reached with the 2000 pound application. Four thousand pounds per acre gave essentially the same results.

P = inc
Phosphate application, at any level, resulted in a higher % N in the yield as compared with the no phosphate plots. There are no marked differences between the 16, 24, and 32% phosphate levels although there is a tendency for the 32% phosphate to produce a slightly larger percentage of N in the yields. 18

Fused P > TSP
Fused phosphate was slightly superior to triple^{super} phosphate in increasing the % N. Calcium metaphosphate was intermediate and not significantly different from either of the other phosphate carriers.

L = 0
Percent Ash: The addition of limestone to the plots without phosphate has no demonstrable effect upon % ash in the clippings. The application of limestone to plots receiving phosphatic fertilizer tends to decrease the % ash. The decreases, due to the successive increments of limestone, are small and not significant, especially after the first 1000 pounds of limestone per acre, but in the aggregate they become marked.

P = inc
The mean % ash in the yields from the plots getting 16% phosphate was somewhat greater than that from the no-phosphate controls. As the % phosphate

Pmc = Ash etc
 increased, the % ash in the yields decreased rather markedly so that the % ash in the clippings from the 32% phosphate plots was slightly less than that in yield from the controls.

The highly significant interaction L"P" as the data in Table 4 (not given) show that the mean % ash in the crops from the 24% phosphate treatments is slightly greater than that from the 15% phosphate application, when no limestone is used. However, the decrease in ash content with increasing limestone, is more marked with this amount/^{phosphate} (24%) than with other levels, so that the smallest mean % ash recorded (Table 4, omitted) was obtained from those plots receiving 24% phosphate and 4000 pounds limestone per acre.

There is no demonstrable difference in the overall mean effect of the three types of phosphate carriers or the ash content of the clippings, but in detail, they act differently.

The triple superphosphate plots yielded a larger % ash than those receiving fused phosphate; calcium metaphosphate being intermediate. Calcium metaphosphate produced a greater % ash in the yield than triple superphosphate with fused phosphate in an intermediate position when 16% phosphate is supplied. With 24% phosphate applied at the 32% phosphatic level, the order was again changed with fused phosphate superior to triple superphosphate in stimulating the accumulation of ash in the clippings.

Percent Calcium: The analysis of variance shows that some of the treatments have had an appreciable effect on the % calcium in the clippings. Some trends, or tendencies, are indicated by the data (Tables 4, 5, and 6, not given). These are suggestive only and cannot be considered as demonstrated even though some of the more extreme contrasts reach the level of statistical significance.

There is a tendency for the clippings from the plots receiving limestone (any level) to contain more calcium than those from the unlimed plots.

With no limestone or with 1000 pounds per acre, there is a tendency for percent calcium to increase with the amount of phosphate applied but with 4000 pounds limestone per acre this tendency is reversed and the % calcium decreases with increasing amounts of phosphate.

The crop from plots fertilized with fused phosphate tended to contain more calcium than those from the triple superphosphate plots.

Percent Phosphorus: The application of 1000 pounds limestone per acre had no effect on the percent phosphorus in the plant. Larger applications of limestone tended to decrease the percent phosphorus but the amount of the decreases were not marked.

Each successive increment in the amount of phosphate applied definitely and markedly increased the percent phosphorus in the harvested clippings.

There was practically no difference between triple superphosphate and calcium metaphosphate as sources of phosphate, but the fused phosphate was definitely inferior to either of these two in increasing the percent of phosphorus.

Carotene -

Phosphate fertilizers applied alone significantly increased the Carotene about 15% (17) while limestone alone produced larger increases of 35% (37). The application of both phosphates to limestone produced the largest increase 40-45% with an increased yield of Carotene 90% (90) per acre.

AGRONOMY. ANIMAL NUTRITION AND T. V. A. - PASTURE

EXPERIMENT. SERIES A - 1940 - II

SERIES A - Results of A Statistical Analysis of The Yields of
Dry Solids, Nitrogen, Ash, Calcium and Phosphorus in Composited Samples
in Plots in The Pasture Experiment.

General Summary on Total Yield

GENERAL SUMMARY OF TOTAL YIELD

As in the preceding year limestone is the outstanding factor in increasing the yield of total dry matter, of nitrogen, of ^{oil} oil, of calcium and, ^{as} is a net result of increased yields which offsets the lower percentage of phosphorus, there is a very marked increase in the yield of total phosphorus due to liming. The maximum yields have been obtained when limestone was applied at the rate of one ton per acre. Two tons per acre have not given any greater yields.

There is a definite although not marked, increase in the yields of dry matter with increasing amounts of phosphorus in the fertilizer and a more definite response for total nitrogen.

The application of 16% phosphate increased the total yield of ash without any further increase for the other increments. All increments of phosphate increased slightly the yield of total ash and more definitely for 24 to 32 percent phosphate.

All increments of phosphate resulted in definite increases in yield of total phosphorus with maximum returns not yet reached with 32% phosphate in the fertilizer which results are more definite than previously obtained.

None of the types of phosphate carriers produced any significant difference in yield of dry solids. Fused phosphate was definitely superior to triple super-phosphate for yields of total nitrogen and of calcium and only slightly so for dry yields. Calcium metaphosphate was slightly superior for total yield of phosphorus.

In general the difference in total phosphorus due to the type of phosphate carrier used was not great. Calcium metaphosphate was slightly superior to either triple superphosphate or fused phosphate. In yields none of the types of phosphate produced any significantly greater amount.

Total Nitrogen: Limestone was highly effective in increasing the total amount of nitrogen harvested, confirming the results of last year. Two thousand pounds per acre was definitely superior to 1,000 pounds per acre in this respect, but 4,000 pounds did not increase the yield of nitrogen over that from 2,000 pounds.

All phosphate applications markedly increased the yield of nitrogen over the no phosphate plots and 32 per cent phosphate was better than 16 per cent in increasing the yield.

Fused phosphate, in contrast of ^{Ca}metaphosphate last year, produced larger yields of nitrogen than triple-superphosphate. Calcium metaphosphate was intermediate and not significantly different from either of the other two phosphate carriers.

Yield of Total Ash: The present results obtained confirm those of last year. The application of 1000 pounds limestone per acre increased the mean total ash markedly over that from the unlimed plots. Two thousand pounds per acre still further increased the total ash. The yield of ash from the plots receiving 4000 pounds limestone per acre was not greater than that from the 2,000 pounds per acre plots.

The application of phosphatic fertilizers increased the total yield of ash in the crop. Sixteen percent phosphate, in contrast to the results of last year, was sufficient to secure this increase and no appreciably different yields were secured from the 24 or 32 percent treatments.

There was no demonstrable difference in ash for the three types of phosphate carriers used.

Yield of Total Calcium:

The application of 1,000 to 2,000 pounds of limestone per acre gave marked increases in the total yield of calcium. Four thousand pounds of limestone did not result in any additional increase.

The increasing increments of phosphate applied from none to 32% gave small non-significant increases in total calcium except for the increment of 24 to 32% where increased yield was significant. This practically confirms previous results.

Fused phosphate proved to be definitely superior to triple phosphate in increasing the yield of calcium compared to the significantly greater effect of calcium metaphosphate last year in the yield of calcium.

Yield of Total Phosphorus:

Previous results have shown that limestone increased the yield of dry matter and decreased the percentage phosphorus in the crop. Present results show that the increased yield offsets the lower percentage of phosphorus, so that the net result is a very marked increase in the total phosphorus due to liming. The greatest increase per acre over the unlimed plots resulted from the application of 1,000 pounds of limestone. The 2,000 pound application gave a smaller but highly significant increase over the 1000 pound treatment. There was practically no difference between the results from the 2000 and 4000 pound applications.

Each succeeding increment of phosphate resulted in a marked increase in total phosphorus. The greatest increase was due to the application of 16% phosphate over the untreated plots. The successive increases due to 16, 24 and 32% phosphate were linear, showing that, so far as total phosphorus is concerned, the point of maximum return was not reached with 32% phosphate in the fertilizer.

The differences in total phosphorus due to the type of phosphate carrier used were not great, calcium metaphosphate being slightly superior in this respect, thus confirming previous results.

Caroline —

Pl5 - A14

Corn is more extensively grown in this State than any other crop. Because yields per acre are rather low, it is a rather expensive crop. Salvaging the soybeans not harvested, with weaned pigs of 40 to 45 pounds in weight until they weigh about 80 to 100 lbs. (before they are placed on the fattening ration of tankage, fish meal, or cottonseed meal ration), saves about 150 lbs. of corn per pig which would be necessary in making the 40 to 55 pounds gain on soybeans. Soybeans are quite adapted to the eastern part of the State and yields are good.

Pl6 - A15

It has been definitely shown that pellagra is not only due to a deficiency of nicotinic acid, but is frequently caused by multiple deficiencies of which riboflavin is one of the most important. It is, therefore, important that comprehensive studies be made of typical North Carolina foods and feeds. Before this can be done existing methods of assay must be improved in the light of our increased knowledge of vitamins since the original methods were devised.

1. The work and data obtained to date form the basis for a critical rat assay (growth) method for the estimation of a growth promoting constituent (riboflavin) in cowpeas and soybeans, also for the occurrence in other food stuffs.
2. The acquisition of a basic rat growth method adds an improved tool in the hands of investigators for checking the present chemical methods.
3. Chemical and physical-chemical methods will ultimately replace the biological assay method but for a long time to come the chemical methods must be checked by the rat method.
4. Most of the current biological methods were developed when little was known about other factors which influence growth.
5. In recent years, for example, vitamin B₆ (peridoxine) and pantothenic acid have been shown to be important rat growth factors. In view of this a critical rat growth method is necessary.
6. Knowledge of riboflavin in foods is necessary in balancing diets. The determination and distribution of this constituent in foods must supply this knowledge. An improved tool is being elaborated for the purpose of increasing the knowledge of this vitamin.
7. The animal organism of the rat is used to measure the distribution of this nutrient (vitamin) in food stuffs but its presence is necessary in promoting growth and well-being in farm animals. In fact, all recent knowledge and advances in this field emphasize the importance of this vitamin for all bodily functions. Indeed, much of the pellagra observed in the South is complicated by riboflavin deficiency.

BJ24 - A12

The fertilization of Halewood mountain soil, pasture land, with various amounts of limestone and three types of TVA phosphates, triple superphosphate, fused phosphate and calcium metaphosphate, produced the following increased yield per acre of pasture for two years: 757 pounds of dry solids (exclusive of water), 164 pounds of protein, 7.5 pounds of calcium, 4 pounds of phosphorus and 0.567 gram per acre carotene. This increased carotene per acre will carry a 1000 lb. steer 6 weeks on a fully adequate carotene intake without any other source.*

There was also an increase in feeding nutrients in the herbage due to fertilization. The pounds increase in per ton of hay are: 5.5 pounds protein, 1 pound calcium, 1.5 pounds phosphorus and 72000 micrograms of carotene which will carry a 1000 lb. steer 5 days without any other source of carotene.*

Considering that Halewood and a similar loam (Haysville) constitute 75% of the pasture and meadow mountain land, the above results show what the farmer can accomplish by proper practices. He can increase the protein, lime and phosphorus as well as the carotene content of his pasture grasses and meadow hay for his livestock by the application of limestone and concentrated phosphate fertilizer.

Thus his livestock will not be impoverished by lack of these minerals and this necessary vitamin in which fertilized grasses are so rich. It will not be so necessary to feed mineral mixtures.

*This result is for the dry summer of 1941. For the preceding year the increased carotene was two and one-half times as great, that is, a 1000 pound steer would be carried 15 weeks on an acre of pasture grass or almost two weeks on a ton of hay.

Shaw

J. O. Halverson

Comparison of 1939 and 1940⁰ Results
Pasture Fertilization Experiment

with TVA and W.W. Woodhouse Jr.

Field A

	General	Mean	Std.	Dev*	Coeff	Vav.
Total yield dry matter	1939	1940	1939	1940	1939	1940
% N. in dry matter	755	1135	120	130	15.9	11.5
Total yield N	2.63	2.68	0.17	0.14	6.4	5.4
% P in dry matter	20.0	30.8	3.9	4.4	19.4	14.4
Total yield P	0.32	0.33	0.02	0.012	7.3	3.7
% Ash in dry matter	2.43	3.75	0.46	0.46	18.8	12.3
Total yield ash	6.14	7.81	0.22	0.35	3.6	4.5
% Ca in dry matter	46.4	88.3	9.0	10.3	19.4	11.6
Total yield Ca	0.87	0.85	0.08	0.08	8.8	10.1
	6.6	9.6	1.2	1.3	18.7	13.8

Field B

Total yield dry matter	874	1262	108	215	12.3	17.0
% N. in dry matter	2.67	2.78	0.13	0.07	5.0	2.5
Total yield N	23.3	35.2	2.8	6.3	11.9	18.0
% P in dry matter	0.34	0.37	0.04	0.02	12.1	5.1
Total yield P	2.95	4.73	0.23	0.83	7.8	17.9
% Ash in dry matter	6.29	7.66	0.40	0.25	6.4	3.3
Total yield ash	54.8	96.7	5.3	14.9	9.6	15.4
% Ca in dry matter	0.86	0.78	0.05	0.04	6.4	4.5
Total yield Ca	7.5	9.9	1.5	1.8	19.7	17.7

* Sum of squares for replication were not subtracted from error sum of squares in 1939 results, but were in the 1940 results.

ANIMAL INDUSTRY - NUTRITION

EFFECT OF FERTILIZATION AND MANAGEMENT ON THE COMPOSITION AND NUTRITIVE

VALUE OF PLANTS COMMONLY USED FOR LIVESTOCK FEED.

JULY 31, 1954
JUNE 30, 1955

	FED.- BANK- HEAD JONES	STATE	FEDERAL	STATE
	BJ24-A12	552-A119	*	*
	3,412	22,720	3,412	22,720
		75		60
		75		75
	130	500	360	700
	230	742		1,057
		500		
	<u>3,772</u>	<u>24,612</u>	<u>3,772</u>	<u>24,612</u>
EDWARD HAYWOOD		2,257		2,257
FRANK LANE	470 (A)		476	
G. MATRONE		7,452		7,452
MRS. T. J. PETERS		1,862		1,862
F. H. SMITH	620	6,436	620	6,436
S. B. TOVE	822		822	
G. H. WISE		4,713		4,713
	1,500		1,494	
	<u>3,412</u>	<u>22,720</u>	<u>3,412</u>	<u>22,720</u>

(A) SALARY CHANGED FROM FEDERAL TO T.V.A. AFTER JULY 1, 1953

ANIMAL INDUSTRY - NUTRITION

BIOCHEMICAL FACTORS THAT AFFECT THE APPARENT NUTRITIONAL QUALITIES OF
FORAGE PLANTS

JULY 1, 1954
JUNE 30, 1955

MISC. GIFTS
T.V.A.
N. C. - 709
T.V.-13434 A

*

MISC. GIFTS
TVA

*

4,000.

4,000.

4,000.

4,000.

FRANK LANE

2,775 (A)

CHUAN-TAO YU (GRAD. ASST.)

1,800

1,225
4,000

2,200
4,000 (B)

A. SALARY CHANGED FROM FEDERAL TO T.V.A. AFTER JULY 1, 1953
B. ASSUMING THAT T.V.A. GRANT WILL BE RENEWED FOR 1954-55

Separate project

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
BUDGET REQUEST

*FILE _____

PERIOD FROM July 1, 1954
TO June 30, 1955

DEPARTMENT of Animal Industry (Animal Nutrition Section)

PROJECT TITLE *Effect of fertilization and management on the*
~~Factors affecting the~~ composition and nutritive value of
plants commonly used for livestock feed.

** Biochemical factors that affect
the apparent nutritional qualities of
forage plants.*

FUND	Budget 1953-54			Budget 1954-55		
	<i>Carroll County</i> Federal	State	Misc. Gifts W.O. - 709 TV-13134 A	Federal *	State *	Misc. Gifts W.O. - 709* TV-13134 A
PROJECT NO.	B124 - A12	S52 - A119	TV-13134 A	B124 - A12	S52 - A119	TV-13134 A
1. Salaries and wages	3412 ✓	22,720 ✓	4000	3412	22,720	4000
2. Travel	--	--	--	--	--	--
3. Transportation of Things	--	75 ✓	--	--	60	--
4. Communication Service	--	--	--	--	--	--
5. Rents and Utility Services	--	--	--	--	--	--
6. Printing and Binding	--	75 ✓	--	--	75	--
7. Other Contractual Services	--	500 ✓	--	--	700	--
8. Supplies and Materials	130 ✓	742 ✓	--	360	1057	--
9. Equipment	230 ✓	500 ✓	--	--	--	--
10. Land and Structures	--	--	--	--	--	--
Total for Project	3772 ✓	24,612	4000	3772 ✓	24,612 ✓	4000
SALARIES:						
Edward Haywood	✓	2257	✓	✓	2257	✓
Frank Lane	1470 ^{a/}	✓	2775 ^{b/}	1476	✓	✓
G. Matrone	✓	7452	✓	✓	7452	✓
Mrs. T. J. Peters	✓	1862	✓	✓	1862	✓
F. H. Smith	620 ✓	6436	✓	620	6436	✓
S. B. Teve	822 ✓	✓	✓	822	✓	✓
G. H. Wise	✓	4713	✓	✓	4713	✓
Chuan-Tao Yu (Grad. Assistant)	✓	✓	✓	✓	✓	1800
LABOR	1500	✓	1225	1494	✓	2200
TOTAL SALARIES & WAGES	3412	22,720	4000	3412	22,720	4000

*Do not fill in this space
N.B. Please use 4th, 6th, and 8th columns as needed for your budget proposals from various funds to support the project in 1954-55.
The 5th, 7th, and 9th columns should be left blank for adjustments necessary in the Director's office.

^{a/} Salary changed from Federal to T.V.A. after July 1, 1953.
^{b/} Assuming that the T.V.A. grant will be renewed for 1954-55.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
1953 ANNUAL PROGRESS REPORT, NON-FEDERAL PROJECTS
(Four copies to be sent to Director's Office)

1. PROJECT: (Fund, number, and title): State - S52 - A119 -- Study of the effect of phosphorus fertilization on the nutritive quality of forage.
2. Departments and Cooperating Agencies:
Agronomy Department
State Department of Agriculture
U. S. Plant, Soils and Nutrition Laboratory, Ithaca, New York
3. Personnel: G. Matrone, Virginia Weldon, W. W. O. Smart, Jr., F. H. Smith
P. W. Sherwood, G. H. Wise, Zeta Peters, and W. W. Woodhouse, Jr.
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

Studies on the 1950 differentially phosphate-fertilized soybean hay crop indicated that when the phosphorus content of the diets was equalized, rabbits fed the non-phosphorus fertilized hay gained more than those on the phosphate-fertilized hay. Data on the total digestible nutrients of the test diets and nitrogen, sulfur and phosphorus balance of the test animals offered no explanation for observed differences.

Studies on the 1951 soybean hay crops, which were grown on plots fertilized at three different levels of P_2O_5 (0 lbs., 40 lbs., and 280 lbs./acre), indicated that the level of phosphate fertilization beyond that needed for plant growth might have reduced the availability of the phosphorus in the plant for rabbits. No differences in the availability of the phosphorus in the test forages were indicated for lambs in a feeding trial.

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified):

More data needed before generalizations can be made.

6. WORK PLANNED FOR NEXT YEAR:

Further work will be done on characterizing utilization of nutrients and identification of factors associated with nutritional differences.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

Bulletin entitled, "Effect of Phosphate Fertilization on the Nutritive Value of Certain Forages for Sheep and Rabbits," in press

8. Prepared by _____ Approved _____
(Director)

Date _____ Date _____

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
1951 ANNUAL PROGRESS REPORT, NON-FEDERAL PROJECTS
(Four copies to be sent to Director's office)

1. PROJECT: (Fund, number and title): State, S52 - A119 - Study of the Effect of Fertilization on the Nutritional Quality of Feed Crops.
2. Departments and Cooperating Agencies: Animal Industry and Agronomy Departments, N. C. State College, U. S. Plant, Soil and Nutrition Laboratory, U. S. Department of Agriculture, North Carolina Department of Agriculture.
3. Personnel: G. Matrone, F. H. Smith, F. W. Sherwood, W. W. G. Smart, Jr., Hartlee M. Baxley, Virginia Weldon, E. U. Dillard, W. W. Woodhouse, Jr., J. L. Rea, Jr. and G. H. Wise.
4. NATURE OF RESEARCH AND PRINCIPAL RESULTS OF THE YEAR (Confidential information should be so marked):

Part A. - A study of the effect of phosphate fertilization on the nutritive value of soybean forage, as determined by chemical analyses and by dietary responses of sheep and rabbits, has been in progress five years.

Concentrations of phosphorus and of calcium were consistently higher in the plants from phosphated soils than in those from non-phosphated. With the exception of the year 1948 when the variety of soybeans was the Roanoke instead of the Ogden, the protein levels were higher in the plants from phosphated soils than in those from the unphosphated. The effects of phosphate fertilization on yield were at least twenty-fold greater than on chemical composition.

Gains in weights of lambs and of rabbits were greater from the consumption of phosphate-fertilized hays than from the non-phosphated only in the 1947 crop. The nutritive difference in lambs was ascribable primarily to the relative concentrations of phosphorus, as evidenced by the responses of lambs receiving the non-phosphated hay to supplements of this element. The studies with rabbits indicated that neither amount of phosphorus nor quality of protein was involved in the difference. Studies of the 1948 crop in which controlled paired feeding of rabbits as well as ad lib. techniques were employed, and of the 1950 crop, using only the ad lib. procedure, revealed no difference in the nutritive characteristics of the hays. Digestion and balance trials, in which either sheep or rabbits or both species were employed, revealed no differences in the availability and the utilization of the nutrients from the various differentially-fertilized hay crops produced in 1945, 1946 and 1947. (Hays of the 1948 and the 1950 crops have been subjected to digestibility and to balance trials, but the chemical analyses have not been completed.)

The comparative effects of feed crops grown on soils receiving different levels of phosphorus on the health and the reproductive efficiency of sheep have been observed since 1947. The results thus far have not revealed any conclusive differences.

Part B. - Two series of pilot trials with cured clipped forages, produced in 1948 and in 1949, were conducted to ascertain the effects of species, fertilization and geographical location on the nutritive value of the plants for rabbits. Gains in weight indicated that trefoil, either alone or in mixtures, was less nutritious than either ladino clover, alfalfa or a combination of ladino and a grass. The limited evidence also suggested that phosphate fertilization improved the nutritive value of the forage; the most striking differences were manifested in hays produced at the Tidewater Station. Location, which involved many different factors, apparently played a role in the effects of the hays on growth. Alfalfa grown on a red clay soil at N. C. State College was superior to alfalfa grown on sandy soil (Sanders Farm) in the Coastal area.

5. APPLICATION OF FINDINGS (expressed in terms of measurable public benefits if and when justified):

Although the qualitative characteristics of forages apparently are affected by the kind and the amounts of elements available in the soil, the effects of phosphorus fertilization on the nutritive value of soybeans are relatively small in relation to the effects on yields. The foregoing observations, though inconclusive, emphasize the need for more specific information on the interrelationship of soil and soil treatment, feed crops and their nutritive value for farm animals.

6. WORK PLANNED FOR NEXT YEAR:

Further studies of effects of soil treatments on soybean forages will include not only different levels of phosphate applications but also additions of nitrogen fertilizers and of lime. Since the only inconsistent results in the relative levels in protein occurred the year that Roanoke soybeans were planted instead of Ogden, the difference in the response of these two varieties will be investigated. The life-cycle studies of the breeding flock of sheep will continue according to past procedures.

7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:

Matrone, G., Smith, F. H., Weybrew, J. A., Weldon, V. B., Peterson, W. J. and Woodhouse, W. W., Jr. Effects of Phosphate Fertilization on the Nutritive Value of the Soybean Plant. Jour. Animal Sci. 2(4):675. 1950 (Abstract)

8. Prepared by Gennard Matrone Approved R. W. Cummings
(Director)

Date 4/11/51 Date 5/1/51

ANNUAL PROGRESS REPORT, STATE PROJECT, 1950

1. PROJECT: State, S52 - A119; - STUDY OF THE EFFECT OF FERTILIZATION ON THE NUTRITIONAL QUALITY OF FORAGE
2. DEPARTMENTS AND COOPERATING AGENCIES:
Animal Industry and Agronomy
U. S. Plant, Soil and Nutrition Laboratory
North Carolina Department of Agriculture
3. PERSONNEL: G. Matrone, F. H. Smith, F. W. Sherwood, W. W. G. Smart, Jr.,
Hartlee M. Baxley, Virginia Waldon, E. U. Dillard, W. W. Wood-
house, J. L. Rea, Jr. and G. H. Wise
4. NATURE OF WORK AND PRINCIPAL RESULTS OF THE YEAR:

The work of this project has been concerned with the effect of phosphorus on the nutritive value of forages as measured by plant composition and by the productivity and growth of farm and laboratory animals. During the first two years of work, no clear-cut evidence was obtained that phosphate fertilization influenced either the chemical composition or the nutritive value of soybean plants. In the third year (1947 crop) the phosphate-fertilized forage had a significantly higher concentration of crude protein, phosphorus, calcium and magnesium and lower N-free extract than did the non-phosphated forage. In the 1948 crop the protein was higher in the non-phosphated hay but the phosphorus was higher in the phosphated hays. These differences were manifested not only in the plant as a whole but also in the leaves and the stems.

In the 1947 hay crop, phosphate-fertilized soybeans had a higher nutritive value for lambs and rabbits than did the non-phosphated hay. This difference in the case of the sheep appears to be due to the extra phosphorus in the fertilized hay. Inasmuch as the protein and the phosphorus factors were eliminated in the rabbit studies, the factors responsible for the nutritional difference were not discovered. No evidence of differences in the availability of either the phosphorus or the protein of the soybean hay fed to rabbits and to lambs was detected.

Another phase of this study was designed to determine if the practice of adding phosphorus to a soil deficient in this element would improve the health and productivity of successive generations of sheep subsisting solely on crops grown in this soil. This investigation was initiated in 1947, but results thus far are inconclusive.

5. BENEFITS:

In past years the principal criterion of effects of fertilizers on forages was yields in terms of dry-matter per acre. More recently, increased emphasis has been placed on returns in terms of animal products. An understanding of the relationship of soil treatment to its effect on the composition of field crops and on the nutritive value of these crops for farm animals should lead ultimately to more profitable livestock production.

6. WORK PLANNED FOR NEXT YEAR:

The levels of phosphate application in the soybean forage study will be increased from two to three. During the spring of 1950 a calcium or liming study was initiated, employing Kobe lespedeza as a test crop. It is planned, also, to start a study next fall on the effect of lime and phosphate fertilization on the nutritive value of the oat plant. As a supplemental study, a stage of maturity investigation of the differentially-fertilized forage plants of this project will be conducted.

7. PUBLICATIONS:

Matrone, G., Lovvorn, R. L., Peterson, W. J., Smith, F. H. and Weybrew, J. A. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of Certain Forages for Sheep. Jour. Animal Science, 8: 41-51 (1949).

8. APPROVED:

George H. Wise
Project Leader

Director

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
PROJECT OUTLINE

Project No. S52--A119.....
Date
Submitted
Approved
Revised

1. Title Study of the Effect of Fertilization on the Nutritional Quality of Forage
2. Objective(s)
- (1) To determine the effect on the health and well-being of animals of applications of certain fertilizers on forages grown in areas known to be associated with nutritional deficiencies.
 - (2) To produce forages which may be used in the study of trace element deficiencies in livestock.
 - (3) To study possible harmful effects of intensive fertilization on the nutritive value of the plant.

3. Reasons for undertaking Investigations*

There are large areas of land in eastern North Carolina which at the present time return little or no revenue, but do produce natural grass and reeds in abundance. In these areas, beef cattle have been shown to be especially efficient in converting native growth into products available for human consumption, providing proper supplemental minerals were fed. Little is known about the possibilities of improving the use of these lands for livestock grazing, especially in relation to use of tame pastures and for the production of other sources of feed.

Indications are that forages grown on these soils are deficient in one or more mineral elements and possible other factors of nutritional importance.

*Including economic justification

4. Previous work and present status of investigations in the field of this project:

The introduction of better plant species and increased yields has been the objective of most fertilizer programs in forage improvement work. The effect of such programs on the nutritional quality of the forage produced is not ordinarily considered. There are certain initial considerations that are evident from many field observations by persons working with grazing animals in different parts of the country. These include (1) the occurrence of troubles which are apparently deficiencies caused by certain "minor" elements; (2) the occurrence of troubles particularly ascribed to phosphorus deficiencies in soils; and (3) the occurrence of troubles associated with intensive pasture and forage fertilization. It is proposed to study initially the effects of phosphorus deficiencies.

During the past several years, many observations have been made of breeding difficulties in beef cattle, sheep and swine on the North Carolina Coastal Plain. In these areas clinical observations and chemical analyses of forages have shown that phosphorus, cobalt and manganese are abnormally low and that copper, iron and other trace elements may also be involved in the nutritional difficulties observed.

5. Outline of Procedure:

Location: The new Tidewater Farm located near Plymouth has been chosen since its soils have been shown by analysis to be definitely deficient in phosphorus. Nutritional difficulties of livestock have been observed in this area.

Animals: Two groups of 25 lambs each with their dams will be placed on pasture in the spring--one group on pasture fertilized with superphosphate, the other group on pasture not given an application of superphosphate. All pastures will have an application of lime and potash.

Feeds: Since fertilization of a permanent pasture would probably modify the species distribution and thus complicate the experiment, no permanent pasture will be used. Grazing will be provided by winter oats and a succession of soybean plantings during the summer. Oats will supply pasture, grain and bedding. Soybeans will provide pasture, hay and soybean oil meal. Inasmuch as there will be an interval of perhaps five to six weeks between the close of the oats grazing season and the time that soybean grazing would be available, a temporary pasture of Italian rye grass will be furnished. Since this will be reseeded each year, the likelihood of species modification due to fertilization would be slight. Feeds will be grown with and without phosphate fertilization. It is the intention that this shall provide a continued supply of feed throughout the year for each group of animals. No imported feeds except a high-grade salt will be used throughout the experiment.

5. Outline of Procedure: - Continued

Estimate of feed required. About thirty (30) acres of unphosphated soybean pasture and fifteen (15) acres of phosphated soybean pasture will be provided. Successive plantings will be made so that grazing will be available during the entire normal grazing season. About five (5) tons of soybean hay will be required from each treatment—two and one-half (2-1/2) tons for paired feeding and digestion trials, and three (3) tons to carry ewe lambs through a winter of five months. The hay will be cut at an immature stage. Provision will be made for producing at least five hundred (500) pounds of soybean oil meal from both fertilized and unfertilized crops. One (1) ton of oat grain will be required from each treatment. Oat pasture for winter grazing will also be required.

Feeding studies to be conducted. As the soybean hay differentially fertilized with superphosphate is harvested, 10 pairs of wether lambs will be selected for a paired-feeding trial, leaving the remaining lambs on pasture. Weekly weights will be obtained during the feeding trial of 100 days. Digestion and nitrogen-balance trials with the soybean hay will be conducted following this time with 6 or more pairs of these lambs if facilities permit. At the end of this time, it will be decided whether it is desirable to make carcass evaluations and/or blood and tissue analyses. Throughout this entire study, blood analysis of no less than 10 representative animals in each group will be made at monthly intervals. If time and facilities permit, blood analyses of all animals is recommended at these intervals.

Of the remaining 30 lambs, the ewe lambs will be bred in the fall and carried through reproduction. During the winter months, groups will be fed soybean hay-oats-soybean oil meal diet differentially fertilized with superphosphate. The lambs from these ewes may be carried through another year of feeding forage and grain differentially fertilized with superphosphate.

All practical measures will be taken to avoid parasitic infestation of the animals. Fecal samples will be taken and counts made at desirable intervals during the course of the experiment.

Future work.

Future work would include studies of intensive nitrogen fertilization and the effects of liming on the nutritive value of pasture and hay. As an immediate step toward this, small plots could be set out to test the effect of these treatments on composition.

SUPPLEMENT

Title: A Survey of the Mineral Deficiencies in the Coastal Plain of North Carolina

A. Farm animal studies.

1. Detailed description of symptoms observed in livestock.
2. Such studies of length of oestrus cycle as are feasible will be carried out. Frequent observations may not be possible since almost constant attention of an experienced worker would be required.
3. Hemoglobin levels and Ca, P, Mn, Co, Fe, Cu, protein, and phosphatase contents of the blood will be ascertained. The determination of hemoglobin, protein, phosphorus, and phosphatase and the preparation of filtrates or ashes will be done at North Carolina State College.
4. Slaughter of affected animals and post-mortem examination for gross lesions, especially parasites. Organs and bones will be shipped to Ithaca for chemical and histological examination. Animals for slaughter could probably be obtained from farmers in the vicinity. The mineral mixture being fed the herd in the Hoffman Forest keeps them in reasonably good condition.

B. Seasonal analyses of reed forage in the Hoffman Forest and Wenona.

Samples will be sent to Ithaca for trace element analysis.

C. Survey of forage crops in the Coastal Plain.

Samples of native and cultivated forage plants will be collected in close relationship to the occurrence of troubles in animals. The data will be plotted on maps, and working closely with the Agronomy Department, the data will be used to map as accurately as possible the mineral-deficient areas of the Coastal Plain section of the state. Protein, fat, fiber, nitrogen-free extract, ash, and lignin will be determined at the North Carolina Station. Mineral constituents will be determined at Ithaca.

D. Digestion trials.

Since dried forage may be unpalatable, digestion trials on native forages, such as reeds, will probably have to be conducted with cattle grazing fenced areas, using the lignin ratio technique. The lignin ratio technique should be compared with the standard techniques, but since such a large quantity of reed forage would be required for steers, sheep would probably be a better test animal for this purpose.

E. Energy requirements.

If it becomes evident that lack of energy or any other factor is responsible for the deficiency symptoms observed, the effect of appropriate supplements will be studied.

G. Small animal studies.

Small animal work, possibly with rabbits, will be initiated at North Carolina State College to supplement the chemical work on forages.

6. Probable Duration of Project: 3 years

7. Date of Initiation: July 1, 1945

8. Personnel: (July 1, 1949)

Name	Department	Relation to Project
G. H. Wise	Animal Industry (Nutrition)	Leader
G. Matrone	U. S. Plant, Soil & Nutrition Lab.	Co-leader
F. H. Smith	Animal Industry (Nutrition)	Co-leader
F. W. Sherwood	Animal Industry (Nutrition)	Co-leader
W. W. G. Smart, Jr.	Animal Industry (Nutrition)	Assistant
Hartlee M. Baxley	Animal Industry (Nutrition)	Assistant
Virginia Weldon	Animal Industry (Nutrition)	Assistant
E. H. Hostetler	Animal Industry (Animal Husbandry)	Cooperator
R. L. Lovvorn	Agronomy	Cooperator
W. W. Woodhouse, Jr.	Agronomy	Cooperator
J. L. Rea, Jr.	N. C. Dept. of Agriculture	Cooperator
D. W. Colvard	Animal Industry	Adviser
K. C. Beeson	U. S. Plant, Soil & Nutrition Lab.	Adviser
H. L. Lucas	Experimental Statistics	Adviser
W. J. Peterson	Agric. and Biol. Chemistry	Adviser

9. Coöperation:

a. Interdepartmental

Animal Industry Department
Agronomy Department

b. Other Agencies

U. S. Plant, Soil and Nutrition Lab.
North Carolina Department of Agriculture

10. Financial Support:

a. Proposed Budget..7/1/49... to .6/30/50..

ITEMS	ALLOCATION OF FUNDS					
	Bankhead-Jones	Purnell	Adams	State	Other	Total
1. Salaries						
F. H. Smith				4,272		
G. H. Wise				3,510		
Hartlee M. Baxley				1,392		
E. G. Haywood				1,232		
2. Labor				1,334		
3. Travel				200		
4. Equipment & Supplies				1,481		
5. All Other				725		
Total				\$14,146		

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income
1950-1951	\$ 11,740	\$ 14,146	
1951-1952	11,740	14,146	
1952-1953	11,740	14,146	

11. General Remarks:

This project was initiated under the leadership of Dr. W. J. Peterson, who formerly was head of the Animal Nutrition Section. The outline herein is as originally presented.

SIGNATURES OF APPROVAL

1. Approval of Project Leaders

Date Oct. 11, 1949

George H. Ullal

Title Professor Animal Industry (Nutrition)

Date Oct. 12, 1949

Genuard Matrone

Title U. S. D. A. Chemist

Date Oct 12, 1949

F. W. Sherwood

Title ^{Research} Assoc. Prof. Animal Industry (Nutrition)

Date Oct. 12, 1949

Title ^{Assoc. Prof. Animal Industry} Associate Research Prof. Animal Industry (Nutrition)

2. Approval of Heads of Departments or Coöperating Agencies

Date 10/28/49

W. E. Coe

Head, Animal Industry

Date 10/15/49

W. E. Coe

Head, Agronomy

Date

Head,

3. Approval of Committee on Experiment Station Projects

Date

Chairman of Committee

4. Approval of Director

Date Jan 6, 1950

R. W. Trammings

Director, North Carolina Agricultural Experiment Station

5. Approval of U. S. D. A.

Date

Chief, Office of Experiment Stations

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
1949 ANNUAL PROGRESS REPORT, NON-FEDERAL PROJECTS

- (STATE - GENERAL
COASTAL PLAIN MINERALS - 852 - 4119
1. PROJECT: (Fund, number, and title):
 2. DEPARTMENTS AND COOPERATING AGENCIES: Animal Industry, Agronomy, and U. S. Plant, Soil and Nutrition Laboratory, Ithaca, N. Y.
 3. PERSONNEL: G. Matrone, J. A. Weybrew, W. J. Peterson, R. L. Lovvorn, E. H. Koztletler, and Virginia Welden.
 4. NATURE OF WORK AND PRINCIPAL RESULTS OF THE YEAR (confidential information should be so marked): During the first two years of work, no clear-cut evidence was obtained that phosphate fertilization influenced either the chemical composition or nutritive value of soybean forages. In the third year (1947 crop), the hays produced on phosphate-fertilized plots contained more protein, more phosphorus, and more calcium than did the hays from the unfertilized plots. These hays were compared in feeding trials with rabbits and sheep. In diets where the hays were supplemented with corn sugar, the animals of both species made significantly greater gains in favor of the phosphate fertilization. When the hays were supplemented with corn, a difference in favor of the phosphate fertilization was demonstrated only with the rabbits.
 5. BENEFITS realized by farmers or the public through application of findings, stated in dollars, bushels, or other values, where possible:
 6. WORK PLANNED FOR NEXT YEAR: Additional rabbit and lamb experiments are designed to evaluate the factors causing differences in nutritive value.
 7. PUBLICATIONS ISSUED OR MANUSCRIPTS PREPARED DURING THE YEAR:
Matrone, G., Lovvorn, R. L., Peterson, W. J., P. H. Smith and J. A. Weybrew. Studies of the Effect of Phosphate Fertilization on the Composition and Nutritive Value of certain Forages for Sheep. *J. Animal Science*, 9, 41 - 51, 1949.
 8. APPROVED: G. Matrone

Project leader

Associate Director