

**An Early History of the Penn State University
Agronomy Department**

Editor

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CHAPTER 1

Introduction

by

Edward J. Ciolkosz

During the 1980's a distinctive feeling came over the United States. This was a desire to have a better awareness of our past history (our roots). This instigated a publication of a history of Penn State University (Bezilla, 1985) and a history of Penn State's College of Agriculture (Bezilla, 1987). This trend did not trickle down to the Penn State Agronomy Department level. Although this was the case, an earlier attempt was made by Professor Charles D. Jefferies of the Agronomy Department in November 1954. Jefferies' manuscript was never published; and as we all know, unpublished material is lost to the future. Because of this reason this publication is being generated in order that Jefferies' information is not lost. His manuscript is Chapter 2 of this publication. It is also hoped that this publication will stimulate someone to pick-up the challenge and update Jefferies' history to the present day.

In addition to Jefferies' manuscript, a collection of papers (Cunningham et al., 1986) by members of the National Cooperative Soil Survey gives historical information on the Agronomy Department's involvement in Soil Survey activities. This compilation of information also needs to be updated.

References

- Bezilla, M. 1985. Penn State: An illustrated history. Pennsylvania State University Press, University Park, PA. 415 pp.
- Bezilla, M. 1987. The college of agriculture at Penn State. Pennsylvania State University, University Park, PA.

Cunningham, R. L., G. H. Lipscomb, E. J. Ciolkosz, H. W. Higbee, A. H. Paschall, and R. S. Long. 1986. A collection of papers describing and documenting the soil survey of Pennsylvania. Pennsylvania State University Agronomy Series No. 90. University Park, PA. 41 pp.

CHAPTER 2

A History of the Penn State Agronomy Department as of November 1954

by

Charles D. Jefferies¹

The Agronomy Department was organized as a unit of the School of Agriculture in 1907 under the direction of Dr. Thomas Hunt. The first administrative head was Professor J. W. Gilmore, who served in that capacity for one year.

Professor Gilmore set forth in the college catalogue of 1907-08 and in the Annual Report of 1907 the following concerning instruction and research. "The course in Agronomy is designed to acquaint the student with the fundamental principles in the production of crops, the utilization of crops, and in the management of soil. It offers practical training in these modern fields of knowledge and fits men for farm management and for educational and research work. It seeks to supply the great demand for trained scientists who understand soils, crops, and animals. The first two years of the course are given largely to the usual scientific and cultural subjects of a college course while the last two years are devoted chiefly to the technical subjects whose mastery equip the student for his life's work."

In 1907, the staff of the Department of Agronomy consisted of a mix of full-time members. The course leading to the degree of Bachelor of Science in Agronomy consisted of two years of general freshman and sophomore courses and junior and senior years in which more attention was paid to strictly agronomic subjects. The first two years, that is, the freshman and sophomore years, were designed to give the student a general training in languages and sciences, including botany, chemistry, geology, physics, and zoology. The junior and senior years, however, indicated more specialization in agronomic fields. The following outline of these four years of prescribed study shows what was considered then as adequate training for a professional agronomist.

¹Former Professor of Soil Technology, Agronomy Department, The Pennsylvania State University, University Park, PA 16802. See page 13.

Freshman Year

First Semester

Botany
Drawing
English
French or German
Mathematics
Military Tactics

Summer School: Surveying 100 hours

Second Semester

Botany
Chemistry
English
French or German
Shopwork

Sophomore Year

First Semester

Chemistry
English
French or German
Geology
Physics
Zoology

Summer School: Agricultural Chemistry 100 hours, or
Topographical Surveying 75 hours and Botany 25 hours

Second Semester

Agricultural Chemistry
Agronomy
Animal Husbandry or Forestry
Chemistry or Horticulture
English
French or German

Junior Year

First Semester

Agricultural Chemistry
2 Agronomy courses
Bacteriology
English
Horticulture

Summer School: Agronomy 100 hours

Second Semester

2 Agronomy courses
Animal Nutrition
English
Zoology
Elective

Senior Year

First Semester

2 Agronomy courses
Animal Husbandry
Dairy Husbandry
Political Science

Second Semester

2 Agronomy courses
Animal Husbandry or Forestry
Political Science
Elective

At that time the Agronomy Department offered 12 courses, two of which had to do with engineering on the farm. Engineering in those days was a part of the Agronomy Department but has since been separated and has been re-organized as the Department of Agricultural Engineering. So there were at that time, strictly speaking, only 10 courses in Agronomy, one of which included the summer school or summer practicum work.

The first graduating class in the Department of Agronomy consisted of six members. Since the organization of the Department there have been graduated 442, the average graduating class of the last five years consisting of about 25 persons. A comparison of the number of members on the staff at the present time with those in 1907 shows that the staff has increased from six to sixteen, and there are three part-time as well as three of Emeritus rank. The training offered is designed to fit the student for a career as a crops major or as a soils major; and with this in mind, the freshman years are not the same. There are now offered 17 undergraduate courses and 16 graduate courses.

One of the developments over the years has been the organization of a Graduate School at the Pennsylvania State University, which was established in 1922. Since that time, graduate study has been greatly emphasized. Previous to 1922, with no definitely organized Graduate School, the activity in this direction was not particularly emphasized. There are at present enrolled in the Agronomy Department 30 graduate students who are working towards either the M.S. or Ph.D. in crops or soils. During the last 5 years 25 Ph.D. degrees have been earned under the direction of the staff. With this increase in growth of the Graduate School there have been definite increases as far as facilities are concerned, and at present this department compares favorably with departments in other institutions of similar caliber. Graduate students have been admitted to this department from many other institutions in the United States, Canada, and other countries.

Besides the scholastic training which the students in Agronomy receives there are also other activities which are available to encourage other contacts. One of these is the Clover Club, which is a student branch of the American Society of Agronomy. This organization is operated entirely by students aided by a faculty adviser and has for its purpose the cultivation of social

activities between the faculty and students as well as giving them an opportunity to engage as a group in the student affairs of the College of Agriculture.

Students teams have competed in the various grain judging activities since 1927 and the National and International field crops judging contests since about 1930. These activities present the chance for students to become expert in these particular lines.

The principle motive running through the lines of investigation in the Department of Agronomy is that of improving our cereal and forage crops. This involves investigation in the lines of soil management, cultural methods, and crop physiology. The specific lines of work now underway may be briefly mentioned as follows:

1. A study of the effects of different fertilizers, lime, and plaster and definite amounts of these on the production of corn, oats, wheat, and mixtures of clover and timothy in a rotation.
2. A study of the effects of these treatments of the soil solution with a view of increasing our knowledge of crop nutrition and physiology.
3. A study of the influence of lime on both crops and soil with specific reference to its form, fineness and division, and quantity in relation to acidity and humus content.
4. An inquiry into the more practical methods of successful alfalfa culture on Hagerstown clay loam.
5. A study of varieties of potatoes with a view of improving those best adapted to Pennsylvania conditions.
6. A study of various cultural methods of potatoes on Hagerstown clay loam.
7. A study of varieties of oats with a view of their improvement.
8. A study of the varieties of wheat and a view of improving them.
9. A study of methods of selecting and keeping seed corn in relation to its productivity.
10. Studies on the production and variations in individual timothy plants.
11. Study on the production and variations in individual clover plants.
12. Study on the kinds and amounts of soil in crops for a stable fed herd.

13. The testing of winter oats in various parts of the state with a view of finding or adapting one variety or more that will be suitable for Pennsylvania.

In the report of 1908 are listed 17 research projects designed to take care of the previous mentioned objects. Twelve were specifically concerned with crop studies and five with soil investigations.

Professor Gilmore resigned in 1908 and was succeeded by F. D. Gardner, a man of wide experience in agronomic affairs and an exceptionally well-trained scientist who served as department head until 1937. Under Professor Gilmore the first reconnaissance Soil Survey of Pennsylvania was started. The details of this work were handled by Professors Shaw and Mooney. He also instigated the first studies concerning the use of lime. Under him, Professor J. W. White commenced fertility studies in three regions of Pennsylvania. The first was in 1915 at Snow Shoe on Dekalb soil, followed by similar experiments started in 1918 in Bradford County on Volusia soil and in Washington County on Westmoreland soil.

Shortly after this in 1922, the tobacco experimental work in Lancaster County, which, up to this time, had been conducted by William Frear, was transferred to Agronomy where it is still maintained in cooperation with the Department of Agricultural and Biological Chemistry and the U.S. Department of Agriculture.

In 1930, in cooperation with the USDA, an extensive pasture program was organized to study the maintenance of pastures under practical conditions. This experiment attracted much attention and ultimately led to the establishment of the United States Regional Pasture Research Laboratory at State College to serve the Northeast section of the United States.

In 1922, the Jordan Fertility Plots, which had been established in 1881, had been under the direction of Dr. William Frear, were taken over by the Agronomy Department and have been a part of the department activities since that time. The work on these plots is now under the direction of Dr. A. C. Richer.

While Professor Gardner was head of the Agronomy Department, Dr. C. F. Noll, a plant breeder, had contributed materially in this field by his studies concerning the breeding of small

grains, particularly oats and wheat. His Nittany 44 wheat and Patterson and Keystone oats and a smut-resistant oat, Pennsylvania Beaver (90-A-27), were generally recognized as outstanding contributions in this line of work.

In 1929, Professor H. B. Musser instigated studies on turf and fine grasses as related to golf courses, recreation areas, etc. which has attracted wide attention.

In 1932, the study of the minerals in soils was undertaken by Professors Jefferies and White and this work has attracted considerable interest in soils.

In 1934, Professor J. S. Cobb, along with Professor Noll, instigated extensive experiments on potatoes, particularly as to the improvement of them and their quality.

Soil structure studies were commenced in 1936 by Dr. F. G. Merkle and these studies have contributed much to our understanding of the means of maintaining this important character in soils.

The Soil Survey, which was previously mentioned, in Pennsylvania was started in the Lancaster area in the summer of 1900 by Professor C. W. Darby. The Lebanon area was finished in 1902 and the Lock Haven area surveyed in 1903. All of these area surveys were made in response to demands for soil information related to the growing of fruit and tobacco.

The Pennsylvania Soil Survey program was further developed by F. D. Gardner and the late Charles F. Shaw between 1906 and 1916. During this period and under the leadership of Professor Shaw a reconnaissance Soil Survey was completed for the entire state of Pennsylvania. The results of this survey were published in the form of maps and reports for five regional areas and the summarization of the work was published as Pennsylvania Agricultural Experiment Station Bulletin 132, entitled, "The Soils of Pennsylvania," by Charles F. Shaw, October 1914. Since this early work the progress of the Soil Survey in Pennsylvania can be observed by a study of Figure 1 which sets forth in detail the various surveys which have been made, the type of survey, and the dates when such work was done (Editor's note: The location of Figure 1 is unknown). Since the beginning of the Soil Survey there have been published in Pennsylvania 56 reports having to do with the Soil Survey activities. The Soil Survey has been temporarily

suspended twice--once during World War I (1918-1920) and during World War II (1944-1947). The Soil Survey of Pennsylvania is now being conducted under the leadership of Professor Howard Wm. Higbee.

In 1934, the Soil Erosion Service of the U.S. Department of the Interior established a research station in State College, in cooperation with the Agricultural Experiment Station. Dr. Austin L. Patrick of the Agronomy Department was in charge of the installation of the station. Dr. Nolan F. Farris was placed in charge of research facilities. Dr. R. B. Alderfer joined the staff of the station and it became known as the Soil Conservation Research Station. In 1946, the Soil Conservation Service terminated its financial support of the research program but the facilities have continued to be operated under the Agricultural Experiment Station with some member of the Agronomy Department acting as collaborator with the Soil Conservation Service. Dr. Louis T. Kardos of the Department of Agronomy now serves in this capacity.

In 1930, following fundamental soil studies involving base exchange, Markle undertook an inquiry into the development and the use of rapid tests as a means of determining the status of soils. This work led eventually to the development of the State Soil Testing Laboratory in 1951 which has been of a decided benefit to the farmers of the state.

Professor Gardner retired in 1937 and was followed by Dr. C. F. Noll, who served in this capacity from 1937 until his retirement in 1945. Dr. Noll was an outstanding plant breeder and, as has been previously mentioned, had contributed materially to the development of outstanding varieties of wheat and oats. He had also been very much interested in the study of the quality of potatoes as well as corn. In 1942, Professor L. L. Huber came to Pennsylvania with the responsibility of developing the hybrid corn studies in this state. This work has resulted in very outstanding contributions to increases in the yield, quality, and the management practices in the production of corn.

Dr. Noll had to maintain the organization of the department through the trying years of the second world war when many of the efforts of the department had to be curtailed because of the war effort, and he retired in 1945 shortly before the end of the war because of ill health.

Dr. Harold K. Wilson took Dr. Noll's place in 1945 and continued until 1947. During this time the facilities of the department were expanded materially, particularly in the acquisition of new quarters in what is now the Plant Industries Building. This building is divided between the Horticulture and the Agronomy Departments. The facilities of the department have been greatly expanded and the staff has increased accordingly.

Dr. Wilson was followed by Dr. H. R. Albrecht who served as department head from 1947 till 1953. Three of the outstanding developments which occurred during this time were the completion of the building and the acquisition and installation of new equipment and a re-organization of the department.

In 1949, many of the practical problems of grassland renovation and management were studied and the investigations commenced in many areas of the stated under Dr. Washko. The intensive study of various herbicides was instigated under Dr. S. W. Raleigh in 1947. In 1951, the state Soil Testing Laboratory was established which is now in operation by the extension service in cooperation with the department. Many of the methods and procedures which were studied earlier by Merkle and others are used in the conduct of this Soil Testing Laboratory.

In 1953, Dr. Albrecht resigned to become Director of Extension of the University and was replaced by Dr. Howard B. Sprague, formerly of the Texas Research Foundation, Renner, Texas. Dr. Sprague had wide experience both in soils and crops studies; and under his direction, it is felt that the affairs of the department will be adequately handled and that the various research programs will be expanded and amplified.

As of 1954, there are at present 49 active projects having to do with the various aspects of agronomic problems. There are 36 projects having to do directly with a study of crops and 13 with soils. In the 47 years that the department has been organized there have been published 56 bulletins, 26 having to do with crop studies as such and 30 with various phases of soils. There have been published 76 articles in the Journal series of the Pennsylvania Agricultural Experiment Station, 18 having to do with crops and 58 with soils. The list of active research projects is attached in the appendix. These projects are supported by Federal, State, and private funds.

Outstanding events which have occurred in the College of Agriculture which have been sponsored largely by the department are mentioned. One of these was the 50th anniversary of the establishment of the Jordan Fertility Plots in 1931. This attracted the attention of soil scientists from all over the world and indicated the interest which was shown in the studies which have been conducted on these plots. The Jordan Fertility Plots are now the oldest plots in the United States from a standpoint of continuous operation. Consequently, the work is extremely well known and has attracted much interest wherever soils are studied intensively.

In 1951, the National Meetings of the American Society of Agronomy and the Soil Science Society of America were held in State College. This occasion attracted approximately 1,800 people from all over the United States and foreign countries. In 1952, the International Grassland Congress met here, at which time there were delegates from practically every country in the world. The primary reasons for these organizations meeting here were because of the activities of the staff of the Agronomy Department. The attendance and the character of the meetings indicated the favor with which these organizations looked upon the activities of this department.

The whole staff of the Agronomy Department is actively engaged in the activities of the American Society of Agronomy, The Soil Science Society of America, and, in some instances, the International Society of Soil Science, as well as being very active in the affairs of the Northeast Section of the American Society of Agronomy.

The efforts of several of the members have been rewarded over the years by recognition by the Society by being elected as Fellows in the organization. The men who have been so recognized are as follows:

F. D. Gardner	A. L. Patrick
H. B. Sprague	H. K. Wilson
C. D. Jefferies	V. G. Sprague
H. R. Albrecht	R. J. Garber

In addition to this, many members of the department have served in various capacities in the Society and have contributed materially to its success.

This staff consists of men who have been trained in many parts of the country. Their experiences are pooled towards the idea of improving the training of undergraduate and graduate students as well as carrying out extensive research projects, all of which are designed primarily to increase the well-being of the farming interests of the state of Pennsylvania. The results of the various studies made here are well and favorably known throughout the United States and the world. At the present time, there are enrolled 71 undergraduate students majoring in Agronomy and 30 graduate students who are working for advanced degrees.

Many of the graduates of this department hold positions of great responsibility. Their work has been recognized as outstanding, and it is a pleasure to realize that they received their preliminary training in this department.

In addition to the instructional and research activities the department sponsors many special conferences and field days relative to the interests of Agriculture. Among those which might be mentioned are the Fertilizer and Lime Salesmen's Conference, Seed Growers and Dealers Conference, Forage Crop Field Days, Turf Conference and summer field meeting, and Small Grains and Corn field days. These contacts with industry and the farmer have proved of extreme value to the department, not only from a standpoint of indicating the results of research as carried out in the department but also to having problems and difficulties presented to the department for which answers are not available. Cooperation of this sort is highly desirable and is looked upon as one of the major responsibilities of the department.

The staff of the Agronomy Department, at present, consists of the following:

Howard B. Sprague, B.S. M.S., Ph.D.	Professor of Agronomy, Head of Department
Frank D. Gardner, B.S.	Professor Emeritus of Agronomy
Jonathan W. White, B.S., M.S.	Professor Emeritus of Soil Technology
Frederick G. Merkle, B.S. M.S., Ph.D.	Professor of Soil Technology
H. Burton Musser, B.A., B.S.	Professor of Agronomy
Lawrence L. Huber, B.S. M.S., Ph.D.	Professor of Agronomy
Charles D. Jefferies, B.S. M.S., Ph.D.	Professor of Soil Technology
Harold K. Wilson, B.S. M.S., Ph.D.	Professor of Agronomy
*Vance G. Sprague	Professor of Agronomy
*Ralph J. Garber, B.S. M.S., Ph.D.	Professor of Agronomy
*Robert R. Robinson, B.S. M.S., Ph.D.	Professor of Soil Technology
A. Chester Richer, B.S. M.S., Ph.D.	Professor of Soil Technology
John B. Washko, B.S. M.S., Ph.D.	Professor of Agronomy
Stephen M. Raleigh, B.S., Ph.D.	Professor of Agronomy
Howard Wm. Higbee, B.S., M.S.	Professor of Soil Technology
Louis T. Kardos, B.S. M.S., Ph.D.	Professor of Soil Technology
J. Stanley Cobb, B.S., M.S.	Associate Professor of Agronomy
Henry R. Fortmann, B.S. M.S., Ph.D.	Associate Professor of Agronomy
*Howard L. Carnahan, B.S. M.S., Ph.D.	Assistant Professor of Agronomy
Roy P. Pennington, B.S.A., Ph.D.	Assistant Professor of Soil Technology
Donald P. Satchell, B.S. M.S., Ph.D.	Assistant Professor of Soil Technology
Richard W. Cleveland, B.S., Ph.D.	Assistant Professor of Agronomy
Clarence S. Bryner, B.S.	Instructor in Agronomy

*Members of the staff of U.S. Regional Pasture Research Laboratory who also hold appointments in the Department of Agronomy, Penn State University.

Department of Agronomy
Active Research Projects, July 1954

1. The Jordan Soil Fertility Plots: Their Maintenance and Comparison with Improved Lime and Fertilizer Practices. A. C. Richer, R. P. Pennington, and D. P. Satchell.
2. Soybean Varieties for Grain and Forage. J. B. Washko.
3. Short Duration Fertilizing Experiments Involving a Coordinated Study of the Amount and Kind of Fertilizers, and the Time and Method of Application Best Suited to Pennsylvania Crops, Soils, and Conditions. F. G. Merkle.
4. The Soil Survey of Pennsylvania. H. W. Higbee.
5. Evaluation of Existing and New Types and Varieties of Kentucky Bluegrass, Fescue, and Bentgrasses for Special Purpose Turf. H. B. Musser.
6. Disease Control Investigations on Kentucky Bluegrass, Red Fescue, and Bentgrasses. In cooperation with the Department of Botany and Plant Pathology. W. S. Beach and H. B. Musser.
7. Grass Mixtures for Special Purpose Turf. H. B. Musser.
8. Breeding Superior Varieties of Kentucky Bluegrass, Red Fescue, and Creeping Bentgrass. H. B. Musser.
9. The Role of Potassium in the Establishment and Maintenance of Special Purpose Turf. C. D. Jefferies and H. B. Musser.
10. Maintenance Practices of Fairway Turf. H. B. Musser.
11. Urea Formaldehyde as a Source of Nitrogen for Special Purpose Turf. H. B. Musser and A. C. Richer.
12. Breeding Cigar Leaf Tobacco for Disease Resistance and Quality. In cooperation with the Department of Agricultural and Biological Chemistry and Botany and Plant Pathology, and the U.S.D.A. H. B. Engle, W. S. Beach, and C. O. Jensen.
13. Improvement of Yield and Quality of Pennsylvania Tobacco. In cooperation with the Departments of Agricultural and Biological Chemistry and Bacteriology, and the U.S.D.A. H. B. Engle, H. B. Sprague, C. O. Jensen, J. J. Reid, and A. L. Haskins.
14. Soil and Water Conservation on Hagerstown Soil. L. T. Kardos and F. G. Merkle.

15. A Determination of the Major Production Factors Influencing the Cooking and Chipping Quality of White Potatoes. J. S. Cobb.
16. Montmorency Sour Cherry Fertilizer and Soil Management Study. In cooperation with the Department of Horticulture. H. K. Fleming, L. T. Kardos, C. B. Smith, and D. G. White.
17. Cover Crops for Sour Cherry Orchards. In cooperation with the Department of Horticulture. F. N. Hewetson, L. T. Kardos, and D. G. White.
18. The Relationship Between Sweet Cherries on Different Rootstocks Under Two Different Cultural Systems. In cooperation with the Department of Horticulture. H. K. Fleming, L. T. Kardos, C. B. Smith, and D. G. White.
19. Corn Breeding. L. L. Huber.
20. Disease Resistance in Corn. In cooperation with the Department of Botany and Plant Pathology. C. C. Wernham, L. L. Huber, and D. F. Satchell.
21. Effectiveness of Protective Plantings of Locust Trees Upon Nutrient, Moisture, and Temperature Conditions of Thin Pasture Soils. In cooperation with the Department of Dairy Science. F. G. Merkle, D. V. Josephson, and P. D. Jones.
22. Development of New Chemicals for Use as Insecticides, Fungicides, Bactericides, and Herbicides. In cooperation with the Departments of Agricultural and Biological Chemistry, Zoology and Entomology, and Bacteriology. D. E. H. Frear, L. E. Dills, C. E. Heist, and S. M. Raleigh.
23. The Nutritive Value of Grass Silage as Affected by Species and Stage of Maturity. In cooperation with the Department of Animal Nutrition. J. B. Washko, R. W. Swift, J. W. Bratzler, and R. L. Cowan.
24. The Nutritive Value of Hay as Affected by the Method of Curing. In cooperation with the Departments of Animal Nutrition and Agricultural Engineering. R. W. Swift, J. W. Bratzler, R. L. Cowan, A. W. Clyde, and J. B. Washko.
25. Influence of Soils and Fertilizers on the Composition and Nutritive Values of Foods and Feeds. In cooperation with the Departments of Animal Nutrition, Dairy Science, and Horticulture. R. W. Swift, C. E. French, G. P. Barron, R. L. Cowan, E. W. Hartsock, E. Keck, R. P. Pennington, E. M. Kesler, C. B. Smith, and C. A. Taylor.
26. Evaluation of Grasses and Legumes for Hay, Grass Silage, and Pasture for Dairy Cows. In cooperation with the Departments of Dairy Science, Agricultural and Biological Chemistry, the Regional Pasture Research Laboratory, and USDA. P. S. Williams, E. M. Kesler, J. B. Washko, and A. L. Haskins.

27. Renovation of Unproductive Pastures. In cooperation with the Departments of Agricultural Engineering and Agricultural Economics and Rural Sociology. J. B. Washko, A. W. Clyde, W. L. Kjelgaard, and J. K. Pasto.
28. Soil Management in the Concord Grape Vineyard. In cooperation with the Department of Horticulture. H. K. Fleming, D. G. White, L. T. Kardos, C. B. Smith, and G. A. Taylor.
29. Improvement of Wheat, Oats, and Barley. C. S. Bryner.
30. Influence of Seeding Rates of Certain Grass and Legume Combinations of Ultimate Establishment of Satisfactory Protective Cover on Cut and Fill Slopes of Highways. In cooperation with the Pennsylvania Department of Highways. H. B. Musser.
31. Safe and Efficient Limits of Application of New Insecticides for Tobacco Insect Control. In cooperation with the Department of Zoology and Entomology. B. F. Coon and H. B. Engle.
32. Renovation in Old Concord Vineyards. In cooperation with the Department of Horticulture. H. K. Fleming, L. T. Kardos, and D. G. White.
33. Weed Control in Corn by Pre-emergence and Post-emergence Herbicidal Treatments and Cultivation. In cooperation with the Departments of Agricultural Engineering and Botany and Plant Pathology. S. M. Raleigh, P. M. Anderson, A. W. Clyde, and A. R. Grove.
34. The Control of Quack Grass, Wild Onion, Canada Thistle, and Other Herbaceous Plants with Isopropyl N. Phenyl Carbamate, 2,4-Dichloro-Phenoxy-Acetic Acid, and Other Herbicides. S. M. Raleigh.
35. Control of Broad Leaf Plants in Forage Plantings with Herbicides. S. M. Raleigh.
36. Control of Weeds in Potatoes by Pre-emergence and Post-emergence Treatments and Oil Spray. J. S. Cobb.
37. Chemical Control of Crabgrass and Chickweed in Special Purpose Turf. H. B. Musser.
38. The Influence of Various Fertilization Practices on Crop Yields and Crop Quality in Rotations. D. P. Satchell, C. S. Bryner, and R. P. Pennington.
39. The Genetics and Improvement of Forage Grasses. H. R. Fortmann and R. W. Cleveland.
40. The Genetics and Improvement of Red Clover. H. R. Fortmann and R. W. Cleveland.
41. Forage and Grain Production of Winter Small Grains as Influenced by Fertilization and Management Practices. In cooperation with the Department of Agricultural and Biological Chemistry. J. B. Washko and A. L. Haskins.

42. The Genetics and Improvement of Birdsfoot Trefoil (Lotus corniculatus L.). H. R. Fortmann and R. W. Cleveland.
43. Establishment and Maintenance of High Quality Pasture Mixtures on Unproductive Lands. R. P. Pennington.
44. Harvesting and Processing Equipment for Seeds of Certain Grasses and Legumes. In cooperation with the Department of Agricultural Engineering. E. A. Myers, H. B. Musser, and J. E. Nicholas.
45. Irrigation of Forage Crops for Hay and Pasture. In cooperation with the Department of Agricultural Engineering. L. T. Kardos, J. B. Washko, and E. A. Myers.
46. Soil Structure Problems in Pennsylvania Agriculture. L. T. Kardos and F. G. Merkle.
47. The Genetics and Improvement of Alfalfa (Medicago sativa L.). H. R. Fortmann and R. W. Cleveland.
48. The Relationships of the Mineral Composition of the Soils of Pennsylvania to Their Agricultural Value. C. D. Jefferies and H. W. Higbee.
49. Seeding and Establishment of Grasslands. J. B. Washko.