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LAND-GRANT COLLEGE EDUCATION
1910 to 1920

PART III
AGRICULTURE

Edited by

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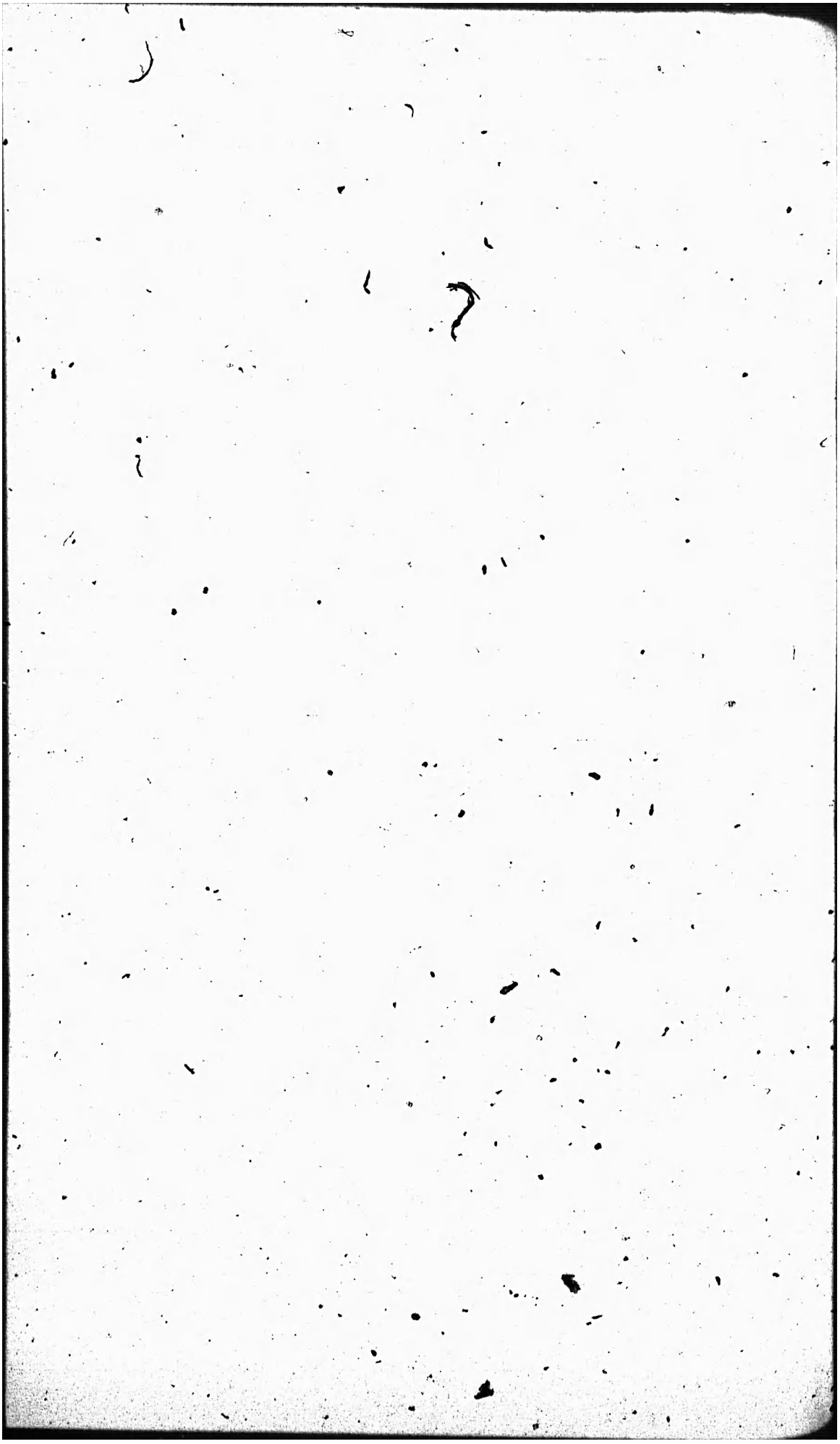

FOREWORD

For the sake of convenience this survey of land-grant college education is divided into five sections, published separately. This is Part III, which is devoted to "Agricultural Education in Land-Grant Colleges."

The other sections are as follows:

Part I. History and Educational Objectives of Land-Grant College Education.

Part II. The Liberal Arts and Sciences and Miscellaneous Subjects in Land-Grant Colleges.

Part IV. Engineering and Mechanic Arts in Land-Grant Colleges.

Part V. Home Economics in Land-Grant Colleges.

This section includes, among the various topics in agriculture, that of agricultural engineering, which for the present seems better classified under the general field of agriculture.

The editor desires to express his thanks to Dr. E. W. Allen, Chief of the Office of Experiment Stations, U. S. Department of Agriculture, and to Dr. C. B. Smith, Chief of the Office of Cooperative Extension Work, U. S. Department of Agriculture, for their cooperation in obtaining many of the illustrations used in this bulletin.

LAND-GRANT COLLEGE EDUCATION, 1910 TO 1920

PART III.—AGRICULTURE

Chapter I

A SURVEY OF AGRICULTURAL EDUCATION IN LAND-GRANT COLLEGES

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and

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Every State in the Union now has one or more agricultural colleges. During the last half century these colleges have grown from a group of weak and poorly equipped institutions to a commanding position in the field of education and they are now established on a sure foundation.

GENERAL ASPECTS OF GROWTH

Their progress and development during the decade from 1910 to 1920 have been especially noteworthy. For example, the white student enrollment in regular college courses in agriculture has increased during the decade (1910–11 to 1920–21) from 7,696 to 16,114. In the same period the number of degrees conferred in agricultural courses, not including institutions exclusively for colored students, increased from 886 to 2,561, while the advanced degrees increased in number from 83 to 195. Reports issued by the Bureau of Education show that the support, equipment, and building funds of the agricultural colleges have increased rapidly during the past 10 years. The more conspicuous appropriations in very recent years for new agricultural buildings are the following: Alabama Polytechnic Institute, $125,000; Connecticut Agricultural College, $226,455; Rutgers College of New Jersey, $75,000; New York State College of Agriculture, $44,000, and a $3,000,000 program extending over a number of years; South Dakota State College, $210,000; University

of Tennessee, $300,000; University of Wisconsin, $49,000. Again, the University of Illinois has recently paid $236,000 for 320 acres of land for a single department; the Kansas State Agricultural College has bought several farms near to or adjoining its original plant and has come into possession and effective use of 4,000 acres in one block, where only farming experiments and demonstrations are conducted; the Massachusetts Agricultural College is adding a tract of 735 acres to its holdings, to be used as a laboratory for teaching forestry; and the Iowa State College within the past few years has acquired nearly a section of choice land for the use of the agricultural division.

It is needless to multiply examples. The fact that Congress and State legislatures are willing to make liberal appropriations for agricutural education of college grade is adequate proof that the agricultural colleges of the country have justified their creation and merit confidence and support. These colleges, however, have had a long struggle for recognition. They have been compelled to fight on in the face of many and varied difficulties. They have had to train their teachers gradually; develop material suitable for their curricula; build up departments and courses of study; overcome the active opposition of a large number of farmers, and win the support of certain educators who looked upon the agricultural college as a menace to educational progress. But the colleges have achieved notable successes along all of these lines. Their future usefulness is now assured. If adequate funds are placed at their disposal, they will certainly grow in influence and in helpfulness, and will train an ever-increasing number of men and women for useful service to society and in the field of agriculture.

DEVELOPMENT IN INSTRUCTION

Within recent years an unusual interest has prevailed among agricultural faculties concerning the subject of improvement in methods of instruction. The Association of Land-Grant Colleges, at its annual meetings, has for a long time emphasized the importance and value of this subject. The general appreciation of the need for better instruction in agriculture has also been shown by the work which has been done in late years by several institutions in organizing for teachers, courses of instruction in methods of preparing subject matter, maintaining interest, etc. In many of these classes special emphasis has been placed on the value of the problem method in teaching agriculture. In one institution in the Middle West, many of the faculty members who have taken some of these teacher-training courses are greatly pleased with the helpful suggestions which have come to them, and are positive that their own teaching is now vastly more interesting and successful than formerly.

Many modifications in curricula have been made during the past decade in order to meet changes in agricultural, educational, economic, and social conditions. And the last of such modifications has not yet been recorded.

Some of the important changes may be listed as follows:

(1) The quantity of dependable agricultural information, both scientific and practical, included in curricula, has been greatly increased, and approximately as fast as the material could be put into teachable form.

The agricultural experiment stations have been responsible for the development of a vast fund of subject matter for agricultural courses. Much of this material has been of special value for class use because many instructors have also been members of station staffs, and have thus been in a position promptly and successfully to put experimental data in shape for the use of students. A large amount of valuable subject matter has also been provided in the very large number of excellent textbooks which have appeared within the decade under consideration.

(2) The development of the elective system, and a tendency toward a wide range of choice in the matter of specialization.

One of the most important advances of the past 10 years in the field of agriculture has come from specialization of the work. At the present time, in some colleges, the subdivision and specialization of subject matter have gone so far as to provide a great multiplicity of courses. As a natural result of this situation, students have been allowed to specialize to a considerable extent along rather narrow lines. Such specialization may of course go too far in undergraduate courses and become a defect, but it is doubtful if it is, at this time, a factor which tends to lessen the efficiency of the work in any first-class college. A four-year course of study in agricultural journalism may be looked upon by some educators as an extreme example of specialization. But it is a fact that in one college, where such a course of study has been established, the faculty has every reason to believe that the students enrolled in this course are getting an unusually well-balanced and valuable training for their professional work after graduation.

(3) The introduction of a goodly number of strong, well-organized courses in agricultural education, farm management, agricultural economics, agricultural journalism, and rural sociology.

During the past decade the conviction has steadily grown among agricultural college faculties that a well-balanced four-year course must include more work than formerly has been required in agricultural education, economics, sociology, and allied subjects. Therefore, there has been a tendency on the part of these institutions to

strengthen greatly their work along these lines. The general results from this change in curricula will undoubtedly be far-reaching and very satisfactory.

(4) New courses have been introduced to meet the requirements of students who are especially interested in certain technical agricultural subjects, such as soil surveying, plant breeding, sheep husbandry, fruit growing, marketing of farm products, dairy bacteriology, and many others which might be listed.

Most of the courses which may be included in this group have been outlined, and are offered in response to a student demand for special work which it is believed will prove especially helpful soon after graduation. For example, a student plans on taking up, at the end of his college course, soil surveying, the management of a farmers' elevator, cotton breeding, cheese making, teaching in a consolidated school, the work of county agent, or some other special line. It seems logical that such a student should be able to secure at least a limited number of courses which will be of special interest and help to him in preparation for his chosen line of work. This type of course, however, should not be multiplied to an extent which will prove burdensome to the faculty or too much of a drain on financial resources.

(5) In some colleges quite radical curricular changes have been made through the advancement of elementary courses from the freshman to later years; and in some cases science courses have been more generally made prerequisite to the agricultural courses.

DEVELOPMENT OF GRADUATE WORK

The graduate work in the agricultural colleges has developed with amazing rapidity during the past few years. The war brought this work practically to a standstill, but it is now in full swing in most of the larger colleges which have competent faculties and are equipped for this type of teaching. There are now 112 graduate students registered in the agricultural division of the Iowa State College; 30 of this number are taking their major work in a single department. Other colleges, such as the New York State College of Agriculture and the Wisconsin College of Agriculture, also have large groups of students in their graduate divisions.[1]

The chief purpose of these courses at the present time is to train teachers, investigators, and administrators of agricultural enterprises. The demand for well-trained men in these fields is now very great, and is growing stronger year by year as secondary agricultural education and research activities gain in strength and multiply the number of positions which are open to agricultural graduates with

[1] See data on graduate enrollments on page 1.

advanced degrees. On the whole, the graduate work in agriculture in the older and larger colleges has emerged from the realm of small beginnings and slow development. It is now firmly established on a solid footing and is regarded as one of the important divisions of the college work. In some colleges, however, graduate work is now seriously handicapped because of shortage of funds, overcrowded classrooms and laboratories, and overworked faculties. It is hoped that more adequate provision will soon be made in at least all of the larger agricultural colleges for the development of strong graduate courses which will meet satisfactorily the growing demands for work in this field.

IMPORTANT RESULTS

It is not difficult to point to definite, tangible evidence of achievement on the part of the agricultural colleges in the field of agricultural education. It is now generally admitted that their main purpose is the training of leaders. The most unfriendly critic of agricultural education must admit that a very large percentage of the graduates of American agricultural colleges have "made good," not only on the land but also in many and varied lines of work which have offered opportunities for leadership and unselfish service in the general field of agriculture. Some agricultural college graduates may have failed as farmers, but for every one in this group there are many men on the land who are looked upon by their neighbors as community leaders and are regarded as successful, money-making farmers. Moreover, it is almost impossible to go into any farming community in the leading agricultural States and not find there one or more men from the agricultural colleges who have helped to make their communities better places in which to live. This is a very significant fact because the churches, schools, and, in fact, nearly all of the organized activities of the open country need the helpful leadership which can be given only by those who have gained efficient training for service to society.

The agricultural colleges have also trained a large number of men and women who have contributed in a large way to the development and progress of agricultural education and research. Records show that a very large proportion of the most efficient county agents, teachers of agriculture in colleges and secondary schools, and experiment-station workers are from these institutions. The training of an ever-increasing number of men and women for these important lines of work has been one of the outstanding achievements of the agricultural colleges during the past decade.

These colleges, in cooperation with the agricultural experiment stations, have also had a far-reaching influence on agricultural pro-

duction. They have done much to improve methods of crop production and livestock management; to develop more profitable systems of soil management and fertilization; and to establish superior dairy and creamery practices. A complete record of the contributions which the agricultural colleges have made in the last 10 years to the development of American agriculture along production lines would prove that these institutions have not failed in this part of their program but have been among the most efficient of the agencies which have made possible increased crop yields, permanent systems of soil management, and more profitable methods of breeding and feeding livestock.

The agricultural colleges accomplished a noteworthy work in their relation to food production during the war period. With the advent of war, without a moment's delay, these institutions formulated a gigantic plan for an increased food supply. They secured the whole-hearted support of farmers everywhere in carrying out this very important part of the Nation's program for winning the war. As a result of their unqualified success in this venture, they further intrenched themselves in the confidence of Government officials and of the people of the whole country.

Another worth-while achievement of the agricultural colleges is the notable work which they have done in bringing about a change in the viewpoint and the attitude of large groups of both city and country people toward the farm and the problems of the farmer. For many decades the man in the city has been so completely wrapped up in his own affairs that he has given little more attention to agriculture than occasionally to express the hope that farm and garden products might continue to be plentiful and relatively cheap. In recent years agricultural college men have repeatedly shown the business leaders of the country that general business and agriculture are most intimately related. And it has been made clear that it is for this reason that when the latter is not prosperous there can not be real and abiding prosperity in the cities and towns.

The teaching of the agricultural colleges has also encouraged farmers to organize, to study their financial, transportation, and marketing problems, and to make an earnest endeavor to establish farming on a sounder economic basis.

THE FUTURE OF THE AGRICULTURAL COLLEGES

From the standpoint of agricultural education, it is generally conceded that the influence of the agricultural colleges during the last half century and especially during the last decade has been of such a character as to guarantee for the future increased efficiency in teaching, research, and extension work. In the first place, through the activities of these institutions, there has been developed a rich

fund of subject matter for use in all grades of agricultural schools from the college to the one-room rural school. Secondly, through the efforts of these colleges, large numbers of men and women have been trained for efficient service in agricultural teaching and research; practically every one of them is prepared to do something for the further development of agriculture. There is large promise for the future in this fact, for without doubt the outstanding handicap of college and station work in the past has been a shortage of competent teachers and investigators.

The future usefulness and progress of the agricultural colleges will be largely determined by the extent to which their physical and financial problems are solved. During the past decade these institutions have been confronted with some very perplexing problems. For example, they have been crowded with students. Their buildings, in many cases, have been outgrown; their equipment has been inadequate; and there has been a general shortage of funds. The lack of funds has made it impossible to provide many facilities, and placed a real handicap on much of the work. A modern agricultural college is an expensive plant. It requires large sums of money for (1) buildings and equipment, (2) salaries, (3) maintenance of laboratories, (4) herds and flocks, (5) land for demonstrations and experiments, (6) greenhouses, (7) special facilities for graduate work, and (8) staff and equipment for a state-wide extension program. Most of our agricultural colleges now have wise and competent leadership, and loyal, well-trained faculties; their needs in the future will center primarily on money, land, and equipment.

Excellent work has been done by many colleges in changing curricula to meet more nearly the modern requirements of agricultural education. But in some cases their work is still too largely restricted to methods of production. It is now generally agreed that well-balanced curricula should provide an adequate amount of instruction in transportation questions, credits for farmers, distribution of farm products, country-life problems, and allied subjects. They should also provide for better foundation work in the sciences related to agriculture and for a carefully selected and supervised list of electives.

Some agricultural educators believe that a five-year course should soon be offered by our agricultural colleges. The additional year provided by this arrangement would enable the student to take up certain subjects which have a special value in training for service to society and the performance of citizenship duties. There is a real challenge to our agricultural colleges in this enlarged program which should make it possible to train some men, perhaps a relatively small number, for a larger field of usefulness in the service of agriculture.

Chapter II

AGRONOMY

By ANDREW BOSS

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HISTORICAL

Education in agriculture has been marked by a rapidly increasing body of knowledge, and by frequent enlargement and division of fields of subject matter followed by repeated shifting and reorganization of courses of instruction. From a one-professor subject in 1870, through the group-subject period of 1895 to 1910, to highly and finely specialized fields of subject matter with many instructors, is the record of development. Out of this march of progress have come many new terms and definitions as well as new methods of instruction.

The Association of American Agricultural Colleges and Experiment Stations, through its committee on instruction in agriculture, has contributed to the colleges many valuable ideas and suggestions. It was through the work of this committee that the term "agronomy" was adopted, and interpreted to cover in a restricted sense that part of the general field of agriculture devoted to climate, soils, fertilizers, and farm crops.[1] Following the adoption of the term in 1896 there came a gradual reorganization of subject matter to meet the demand for more highly specialized courses of instruction. By 1910 the term had been quite generally accepted and college departments were so reorganized as to recognize agronomy as a specific instructional field. An examination of the bulletins and catalogues of the colleges of that date, however, reveals the fact that while the term "agronomy" had been accepted and recognized, there had been difficulty in many colleges in reducing the subject matter to the restricted field and that it still covered much more territory than had been prescribed by the committee. It is nevertheless true that much more clearly defined courses were being given than formerly and that there was a tendency toward the observance of the classification of subject matter suggested by the committee.

Rapidly shifting and frequently changing courses, offered prior to 1910, indicate that instruction in agronomy was in the formative state. The courses were general in nature, dealing largely with

[1] Proceedings of the tenth annual convention of the Association of American Agricultural Colleges and Experiment Stations.

botanical classifications and characters, with cropping plans, and with problems relating to the care of soil and crops in the general cultural practices.

DEVELOPMENT OF SUBJECT MATTER

State experiment stations, which have been developed coordinately with the agricultural colleges, have been a prolific source of subject matter for college courses. The fact that many of the instructors have been engaged also in experiment-station work and that many of the experiment-station investigators have been required to do some teaching has resulted in rapidly assimilating in the courses of instruction the new fragments of science that are constantly being discovered.

The administration by the Office of Experiment Stations of the United States Department of Agriculture of the Federal funds provided for experiment-station work has greatly stimulated interest in agricultural research. Following the passage of the Adams Act, in 1906, definite steps were taken to organize experiment-station work on the project basis. This has resulted in more clearly outlined investigations and in shifting investigations from short-time trials, tests, and observations on how to manage soils and grow crops, to the more fundamental and far-reaching problems of soil physics and chemistry, plant physiology, and plant genetics. This research has developed in several important phases. Among them are, specifically, (1) the classification of soil types and the development of a knowledge of crops and crop requirements on particular classes of soils; (2) an increased knowledge of the genetic relations of varieties and species of crop plants leading toward a more logical classification of crops; (3) the application of genetic laws and principles to plant breeding as a means of scientific crop improvement; (4) more fundamental knowledge of crop rotations in relation to soil fertility and permanent agriculture; and (5) improved technic in conducting field-plot tests resulting in more accurate interpretation of data on the behavior of crops and varieties. There has been a marked tendency during the decade to turn from the secretive, individualistic type of investigation of the early days toward the cooperative and correlated type in which a mass attack is made upon complicated and fundamental problems from the solution of which well-established principles or laws may be evolved. As a result of this development of scientific research, the subject matter now being included in course instruction is based upon collective data gathered from carefully guided and controlled research projects reflecting the combined knowledge and judgment of a number of workers.

DEVELOPMENT OF CURRICULA

A comparison of the curricula of 1910, in a number of the leading colleges, with those published since, shows no radical change at any one time. As technical material became available through research, however, there has been a gradual movement toward more highly specialized courses in crops and soils. This is quite in contrast to the array of general courses offered at the beginning of the decade. The specialization of subject matter has gone so far in some colleges as to lead to great multiplicity of courses and repetition in instruction. This is likely to lead to confusion in the minds of students. As an example of this high specialization it may be noted that one college now offers 36 courses in soils and 22 in crops. Many other colleges also have multiplied rapidly the courses open to undergraduate students.

Since the subject matter in many other fields of college instruction has also become highly specialized and subdivided, it is obviously impossible to require that all courses available be included in an undergraduate curriculum. There is, therefore, a decided tendency in curricula making at the present time toward the elective system, with certain restrictions in the choice and sequence of courses. Perhaps the most fundamental change may be noted in the attitude toward the position of the elementary or beginning courses. Formerly it was thought that these must be offered in the freshman year. A preference is now being shown for having the courses in botany, biology, chemistry, and physics precede the applied agricultural courses. This results in the elementary crops and soils courses being crowded forward into the sophomore year with the advanced courses carried into the junior and senior years. There are unquestionably advantages in following a curriculum of this nature. The inclusion in the most modern science courses of illustrative material from the economic plant groups and the more directly useful crops gives excellent preparation for the agronomy courses, and thus the instruction in the agronomy subjects can be more specific and more directly applied to the subject matter covered without the necessity of first giving instruction in the fundamental sciences. This procedure is, perhaps, further justified by the fact that secondary schools are now giving elementary courses in agronomy, and many of the students entering colleges have had the more general phases of the crops and soils courses.

The important changes made in the agronomy curriculum may be stated as (1) more highly specialized and dependable subject matter; (2) the development of the elective system, permitting group specialization; (3) the advancement of the elementary courses from the freshman to the sophomore year; and (4) insist-

ence that the science courses be made prerequisite to the agronomy courses.

IMPORTANT RESULTS

It is difficult always to find tangible evidence of achievement in education or to express in concrete terms the results of new forms or methods of teaching. It is quite certain, however, that the curricula of most agricultural colleges not only provide for but insure a more thorough grounding in the sciences than formerly. It is probable also that graduates of agricultural colleges have a more accurate knowledge of the specific soil and crop needs and of plant behavior under varying conditions than in the early days. As a consequence they are better prepared for teaching or for investigational work or farming. Unwittingly, perhaps, the curriculum has been lengthened, not in years of undergraduate work, but in the time required to gain a knowledge of the subject matter available and desirable. It is possible that too many highly specialized courses have been developed in the curriculum of the general student as a result of the rapid increase in the amount of information available. This may result in the student failing to get a broad viewpoint in the subject of agriculture because he can not crowd all of the agronomy courses into his curriculum without crowding out other equally important subjects.

It is too soon to judge accurately, but there seems at present to be a tendency to swing from the highly specialized courses to more comprehensive ones for the undergraduate years, leaving the intensely specialized courses for those who are fitting for special fields of teaching or investigation, or for those who desire to take graduate work. There can be no question about the stimulation of advanced study by the introduction of specialized courses and the opportunity for research work in the experiment stations. There has been a very rapid increase in the enrollment for graduate work at the colleges that are equipped and well prepared to give advanced work of high quality. The effect of more intensive and accurate teaching and greater opportunity for advanced study has been to give better preparation to those who go out as teachers. It is also reflected in the wiser management of crops and soils and better adaptation of crops to needs and environment by those who engage in farming.

RELATION TO THE ECONOMIC SITUATION

For many years the emphasis in agronomy instruction has been on phases related to large production. It is probable that production will always remain the most important factor in successful agriculture. Quite as important as quantity production, however, is ef-

ficient production. Instruction in agronomy will not be complete until it includes information on "what crops to grow" and "why" as well as "how" to grow them. In many colleges this is provided for by including in the curriculum courses in farm management and farm economics. Where not otherwise provided for crop economics should be included in the agronomy courses. The adjustment of production to the world's needs, the avoidance of so-called marginal crops of doubtful value, the selection of crops suited to local needs and environment, and the adaptation of crops to soil conditions must receive attention if crops are to be profitably raised. It may be truthfully said that this fact is now recognized and that the colleges are so shifting instruction as to teach wise as well as adequate production. Such instruction will eventually lead to the best economic methods of utilizing land for the production of necessary food supplies.

Instruction in agronomy by the colleges of agriculture has been a potent factor in securing the ample production which the world now enjoys. The colleges have furnished much of the leadership involved in the development of the better farming methods and practice. The training of farmers so to live that life is enjoyable and profitable for all engaged in farming is perhaps the greatest value of all agricultural teaching.

THE FUTURE

There is already available more subject matter than can be crowded into a four-year curriculum. Research workers in the experiment stations and in privately endowed institutions are constantly adding to the literature and subject material for college instruction. Broad knowledge, keen discernment, and sound judgment will be essential in curriculum making in the future. If students are to be so trained in a four-year college course as to meet understandingly the problems in education and practical agriculture, emphasis must be laid in the freshman and sophomore years upon the sciences related to agriculture. In the junior and senior years the courses should include subject matter related to the application of scientific principles to the problems of the farm. The teachers of such courses must be well grounded in scientific agronomy and able to generalize from the fields of specialized knowledge. It is only in this way that scientific training can be made useful in farming. The four-year curriculum should be so arranged and taught as to give the student scientific knowledge and a correct understanding of productive and practical agronomy. This is necessary whether he is to become a teacher or an investigator, or will practice the art of farming. This program implies that the highly specialized courses should be reserved for

upper classmen and for graduate students who are to enter special fields. The greatest need of the future will be for teachers well grounded in the sciences who know *what* and *how* to teach and who have a practical knowledge and understanding of the farm problems, with keen sympathy and interest in the business of farming.

Chapter III

POMOLOGY

By W. H. Chandler

Professor of Pomology, University of California

The subject of horticulture, of which pomology was generally the predominating interest, had practically from the beginning a separate existence in the agricultural colleges. Thus, while many of the departments now of large importance are of very recent development, this subject has been so long established that it would seem probable that it might more effectively have found the best division of subject matter with other departments, as well as the best method of approach to its problems. In the earliest organizations horticulture included not only pomology, vegetable culture, and ornamental horticulture, but also minor interests that did not seem to fit elsewhere, such as the growing of ginseng or goldenseal. In fact, one college dean expressed the view that any crop grown only in a small way belonged in horticulture. Generally the same man was compelled to give some attention to all of these lines. It was to be expected that as college staffs grew there would be such a division of labor that these separate subjects, certainly such as vegetable growing and ornamental horticulture, would be handled by different groups of men. In most colleges the departments of horticulture are still maintained, but in them are rather distinct divisions, so that a man working in pomology is generally no more interested in these other lines than he would be if pomology were a separate department. Even in the subject of pomology itself not all of the field that was claimed by the early workers has been effectively occupied. Thus, 12 to 15 years ago in departments of horticulture perhaps more attention was given to spraying than to any other phase of orchard management. It is probable that until the last five or six years, at least, more money was expended upon studies in spraying in departments of pomology than in departments of plant pathology or botany and departments of entomology combined. Yet it seems safe to say that the contribution has been insignificant as compared

with that from departments of plant pathology and entomology. The reason is easy to find. In disease and insect control, knowledge of the organism to be combated is of greater importance than knowledge of the responses of the tree or fruit. The subject of spraying is still taught in some pomology departments but it has much less emphasis.

Plant breeding also was early stressed in departments of horticulture, usually by men whose greatest interest was pomology. It has been found, however, that the pomologist has the poorest material with which to study the laws of heredity, and because he propagates vegetatively, perhaps the least interest in complete studies of the transmission of characters. The rapid development of genetics has been in other departments where better material is found.

Within the past few years there have been indications that the field of business management of orchards, particularly such problems as cost of producing various crops, marketing statistics, and the like may wisely be left to men in the departments of agricultural economics, whose training peculiarly fits them for such studies. The field of pomology seems to be narrowing to the study of the fruit plant and its environment and the study of the fruit.

One important phase of the subject that has been emphasized from the beginning is systematic pomology. This continues to find a place in the work of all important colleges, though at the present time there is possibly a little less emphasis placed upon it than there was 10 years ago. Many teachers find it a difficult subject in which to interest students. This is perhaps partly because they have generally interested themselves only in the fruits of the Temperate Zone climate, and the number of species is so small that not much time can be used to advantage in teaching students to identify them. And since no way has been found to identify varieties by means of keys, not enough order can generally be put into variety studies. Then, the teachers in this line have generally had their largest interest in problems with the culture of the fruit, that seem to offer a more promising field for research. Since not many commercial varieties are involved in the entire Temperate Zone fruit industry of America, it has seemed to most workers that the greatest service to the industry could be rendered by means of research in cultural problems. While this subject has not appeared to most students a promising field of endeavor a considerable amount of research has been done, and some outstanding work from the New York State Experiment Station at Geneva has been published during the last 15 years. The value of such research is coming to be realized in its connection with the breeding of fruit. Most of the fruit plants live so long and are grown in large numbers with

such great difficulty and expense that they are not satisfactory material with which to study principles of heredity, and the finer genetic principles are not readily applied. Except under peculiar local or temporary conditions, the search for new varieties is by far the most important work that can be done for the fruit growing industry, and so far the most important guide in fruit breeding is a broad and intimate knowledge of fruit species and varieties.

The other field that continues to be stressed in pomology is the response of the fruit plants to the various cultural treatments and to variations in natural environment, and responses of the fruit tissue to cultural and natural influences and various harvesting, transportation, and storage practices. Teaching the responses to culture and environment is not so easy with fruit plants as with annual or biennial plants. The student does not stay in college long enough to see the response to treatments that he may give in laboratory exercises. He must accept the teacher's statement that the method recommended is the correct one. This, of course, is not true of problems in fruit handling, since the student can see the fruit as it is put in storage and when it comes out at the end of the season, and thus readily learn for himself the influence of the various practices upon the keeping of the fruit. Earlier teachers were compelled to base their conclusions as to cultural practices upon indirect information. Apparently there was a considerable amount of faith in such conditions. Thus, up to about 1905, or a little later, a good deal of emphasis was placed upon analyses of fruits, leaves, and twigs as indicating the fertilizer need of the different fruits. The time when fruit bud formation begins in summer was also early stressed as suggestions for practices. We know now that such studies can be used only in connection with experiments with cultural practices.

During the past 10 or 15 years there have been appearing the results of field experiments with actual cultural practices. Among the most careful of these, as well as the most extensive, were those by Pickering, of the Woburn Experimental Farm, England. It is needless to say that the results from such experiments have been conflicting. This was to be expected because of the different soils and climates in which the work was done, and the very wide experimental error inevitably associated with experiments with trees. Possibly, however, the experimental error was found to be greater than might have been anticipated. Unquestionably with few, if any, of the experiments are conclusions justified when based upon differences no greater than 25 per cent. These results have been so discouraging that many of the best-trained workers are inclined to minimize the importance of such experiments and place greater value upon physiological studies. It should be emphasized, however, that these results

furnish us with much better information than we have been able to secure by any other method. Thus after long observation of orchard practice it was still taught that nitrogen must be used in the orchard very cautiously or it will throw the tree into excessive vegetative growth and reduce fruitfulness, yet we know from these experiments that in America, generally, nitrogen is the element most likely to be applied profitably. And even in very fertile soils there is little danger of reducing fruitfulness by the use of nitrogen. Even though the error in such experiments is great and it has not been possible to study responses smaller than 25 per cent, it is of value to bring the range of doubt to that margin. Resulting from such field experiments, we have fairly conclusive proof that in the American orchard potassium and phosphate phosphorus are so seldom present in the soil in insufficient quantities for high production of fruit trees that the problem as to these elements is a minor one, though at least one soil condition has been found where for peaches the application of potassium is of great value. On the other hand, while we formerly applied nitrogen with some fear that it might stimulate vegetative growth to an injurious extent and thus reduce fruitfulness, we have found that this very seldom happens, and as a matter of fact, nitrogen is the element that can most often be applied with profit. Further, we have learned that while the soil must be low in available nitrates before the apple, pear, blackberry, and probably the currant, when grown under the cultivation and cover-crop system, will show response to applications of nitrogen, the peach, cherry, plum, raspberry, and gooseberry are much more likely to show a response. By field experiments we have learned, not only the injurious effect of sod on trees, but that by the use of nitrogen that injurious effect can, with the apple at least, be largely overcome. We have further learned that nearly all orchardists have been pruning young trees too severely and thus delaying the time when they should be expected to bear profitable crops and that summer pruning does not stimulate fruitfulness, but probably the reverse. We have also learned, with reasonable certainty from experiments, that alternate bearing of fruit trees can not be prevented by thinning, and that thinning can be expected to be profitable only through the influence on the crop thinned, or through its effect on the growth of the tree. Such information is of the greatest value, since it concerns the most essential orchard practices.

Perhaps the greatest contribution of these field experiments is to teach workers the importance of certain refinements of methods by which unquestionably the range of experimental error will be reduced. Among these are greater replication of plots receiving the

same treatment; preliminary periods of about four years before treatments are varied, during which records are kept for all of the trees; and physiological studies of apparent responses. The pomologist has found his field, has learned many of its difficulties, and is in a position to make larger contributions. It must be admitted, however, that so far, his contribution to the fruit industry has not been so great as that of the entomologist and the pathologist.

In the future there will be a clearer recognization of the value of systematic pomology and of its field. It will not be looked upon as a mere incident in the work of a department to be taught by anyone who happens to have the time, but that men will be chosen particularly for this work. Such men should have, in addition to an intimate knowledge of orchard practice, an extensive training in plant taxonomy and ecology. No less attention will be given to study of varieties, but much more attention will be given to botanical relationships, distribution, economic importance, culture, and uses of all the fruits of the world, particularly those that may come into competition with the deciduous fruits. This work will have two main objects: To broaden the student's interest through a knowledge of his industry as practiced by people in various parts of the world; and to form a background for the greatest possible improvement in the fruit industry—the securing of better varieties.

Of course, men who are to stress cultural problems will generally have large training in physiology and chemistry. The general practice, both in teaching and research, will be to start with the industry as it is found, study the problems as they present themselves in the orchard, attempt their solution by variations in cultural practice, and, as the last step, study both the physiological and chemical responses to these variations in practices. In other words, the method will be to work backward from the problem, as it presents itself in practice, step by step, using superficial studies first, rather than attempt to secure an answer by reasoning from fundamental studies. The teacher will realize more and more that it is dangerous to give his students theories as to wise practices, based not upon trial of the practice but upon his conceptions of the nature of the tree. For his knowledge of the tree will for a long time be very incomplete. Deducing systems of practice from physiological principles, or what the teacher thinks are physiological principles, is a pleasing method of teaching, but it will be used largely only by teachers whose knowledge of the complicated responses of trees is very limited. More and more such speculation will be eliminated from courses in pomology, and physiological knowledge, though used more extensively, will be used more cautiously, primarily to supplement or explain results of actual trial of practices.

Chapter IV

VEGETABLE GARDENING

By PAUL WORK

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The vegetable gardening industry had its rise in the vicinity of our earliest cities at the time when home gardens were no longer able to supply the needs of the inhabitants. For decades the processes of production and marketing were carried to completion within the immediate environs of the city. Even when truck farming or production for shipment to distant markets began about 1855, it was in isolated districts. Thus it came about that the vegetable grower has been late in developing a group consciousness which would enable him to formulate his needs and to express his demands. Meanwhile, other branches of agriculture attracted the attention of the workers in the newly established colleges and experiment stations, either through calls for help against enemies which threatened disaster or through recognition of the relative importance of the industries as they then stood.

For these reasons those young men of the last quarter of the nineteenth century who looked to agriculture for a professional career were trained in animal husbandry, agronomy, or pomology. With their interests thus established they naturally continued in their fields and the development of interest in other branches was a slow process.

The vegetable business has enjoyed an unparalleled growth during the past two decades. The total value of products according to census figures has grown from 217 millions of dollars in 1899 to 417 millions in 1909 and 1,302 millions in 1919. Of course the latter figure was reached under conditions of war-time price inflation, but a figure comparable to that of the previous census would be not less than 700 millions. Further, the 1919 figure represents 8.8 per cent of the total value of agricultural crops for that year. In New Jersey this percentage amounts to 40 and in New York, with its vast acreages devoted to production of dairy feed and other general farm crops, it amounts to 25 per cent of the total.

Prior to 1908 the commercial vegetable industry was almost wholly unorganized and it possessed no journal of its own. Neither were there more than a few books on the subject, and most of these were amateur rather than professional or commercial in their bent. At that time there were not more than four or five vegetable specialists

in the colleges. The year 1908 saw the establishment of the Virginia Truck Experiment Station, the organization of the Vegetable Growers Association of America, the founding of the Market Growers Journal, and it found a few men such as Lloyd and Watts giving enthusiastic instruction in the subject in certain of the agricultural colleges. Most of the courses in vegetable gardening at this time were handled by men whose chief interest was in fruit. The point of view in most cases was that of the home garden rather than of the commercial industry.

From 1908 onward there has been a steady increase in interest in vegetable gardening in the colleges. The number of specialists, the number of courses offered, and the number of students have all shown marked progress. In 1912, five institutions offered for four-year students as many as three to five courses in vegetable gardening, 9 offered two courses and 21 offered single courses. A total of 57 courses was listed at that time. Thirty-five colleges offered general elementary courses, often emphasizing home production as much as commercial. Ten offered general advanced courses, mostly commercial in viewpoint, 6 offered courses in vegetable forcing, 3 in systematic vegetable crops, and 3 special courses in home gardening. Prof. H. W. Schneck presented corresponding data for 1922 at the Boston meeting of the American Society for Horticultural Science. He found vegetable courses in all the State colleges but one, 10 offering 5 or more, 8 listing 3 or 4, the others about equally divided between 1 and 2. He found 32 institutions giving general advanced courses, 18 courses in vegetable forcing, 12 in systematic vegetable crops, and 3 on potatoes, while home-garden courses, aside from the general elementary courses, had disappeared.

PERSONNEL

Since 1908 the number of vegetable specialists has increased greatly. It is impossible to draw lines sharply, but a perusal of the list of workers uncovers at least 80 names of men whose activities are wholly or almost wholly devoted to the vegetable crops. This does not include many part-time men. In 1910 Cornell supported a single vegetable worker. At present the department of vegetable gardening numbers a staff of 10.

Along with the increase in the number of specialists has come a marked increase in standards of training. Up to about 1920 not a man with a doctor's degree was to be found in the field. At present there are six or eight men with the degree of Ph. D., and many more approaching this standard. Still others have accepted the ideal of fundamental training and are acquiring the desired equipment in less formal ways. In other words, the majority of the workers have

set about the task of building their profession upon the foundation of the basic sciences.

Just as significant has been the development of interest in vegetable gardening undertakings on the part of workers in other departments. Ten years ago pathologists and entomologists gave scant attention to the enemies of vegetables. A glance through the Experiment Station Record reveals a very strong representation of vegetable titles. Plant breeders, soil specialists, rural economists, and physiologists are all turning to garden problems and are making welcome contributions to the field.

LITERATURE

The literature of vegetable gardening has advanced in marked degree, though naturally and properly enough hardly in proportion to the other evidences of growth. Bailey's Principles of Vegetable Gardening, appearing in 1901, was the first text intended for college students. It has been recently revised in such a way that it becomes the best authority on the systematic botany of vegetable crop plants. Works by Watts and Corbett appeared in 1912 and 1913, respectively, and, according to Professor Schneck's questionnaire, are still the most widely used. Texts by Lloyd and Boyle are also in use. Thompson has just published a work which goes further than any previous volume in assembling the research material that bears upon vegetable gardening and relating it to the practices of the industry, also in making use of available information from neighboring sciences.

A bulletin file on vegetable gardening contains hundreds of titles, including extension publications for home and commercial gardens, description and classification of varieties, reports of experimental work, and more recently a small but increasing number of excellent research papers.

The rapid growth of interest in vegetable gardening has brought with it many problems of organization and method. It may be assumed that the function of college work in this subject is to serve the vegetable-growing industry through research, and resident and extension teaching. At first, practically the whole emphasis was placed upon the teaching work. With the advent of the extension movement, vegetable gardening has shared in the activity, though in smaller degree than many other branches of agriculture.

TEACHING

Teaching in vegetable gardening seeks to train specialists who will engage in production or in institutional work. It also offers an insight into the field to larger numbers where primary interest lies

in some other direction. The increasing prevalence of commercial vegetable growing on the general farms of the country adds significance to this phase of the work. The general elementary courses serve this group and also afford a starting point for the specialists. In fact, the teacher usually regards this course as a recruiting ground from which he hopes to enlist a choice group for further training.

The vegetable specialist who is to serve the future must be possessed of a lively interest in the field. He must share the practical point of view of the grower and the inquiring mind of the scholar. In this dual outlook lies safety against developing either mere artisans or men whose bent is purely academic. He must gain experience in field operations by actual service on vegetable farms. In college he must acquire a broad foundation in underlying sciences as well as in his own subject.

The vegetable-gardening teaching, both in the classroom and in the field, has been largely empirical, being based chiefly upon the practice of successful growers. The experimental material is meager at best, and many courses have not taken sufficient account of the information actually in print. The growing realization of the need for a large body of research results, on which to found classroom and extension teaching, has been a potent stimulus for investigational activity. To-day the teachers are making fuller use of the literature and of the contributions from underlying sciences, such as botany, physiology, soils, genetics, and economics, with the result that the instruction is being placed on a much more scholarly plane.

Many methods are in use in vegetable-gardening teaching. Years ago the classroom work in too many cases consisted chiefly of recitations from a text supplemented by more or less random remarks gathered in field experience and visits. On the other hand, such men as Massey, Bailey, Watts, and Lloyd prepared lectures that were both enlightening and inspiring. These men laid the foundation upon which the whole fabric of institutional service to our industry is being constructed.

Present-day class work does not aim primarily to teach the student how to do things, but rather strives to equip him to make his own solutions of problems as they arise. In the classroom the student is encouraged not only to acquire information but also to digest it and to make applications. While the material of the sciences is extensively used, field practices are not allowed to pass out of view.

Early laboratory work frequently consisted in doing the things that needed to be done in the gardens on a given day. The introduction of individual gardens has made the laboratory work a means of raising questions and has given opportunity for demonstrational answers. Emphasis is well placed upon developing the student's

personal familiarity with the actual plant material. This is one of the great contributions of the courses in systematic vegetable crops in addition to teaching the taxonomy, types, and varieties of the vegetables.

Graduate teaching in vegetable gardening is making rapid gains. It is generally deemed best for a specialist in this field to take his minor or his major subjects or even both in underlying sciences in order that he may have as full use as possible of their equipment in dealing with gardening problems. Several men have done this, interest and point of view being the anchors which hold them in the field of vegetable gardening.

RESEARCH

Early experiment station work in vegetable gardening consisted chiefly of variety studies and of field and greenhouse experiments. Much of the systematic work consisted of mere descriptions, some neither orderly nor complete. Sturtevant and Goff, at Geneva, were pioneers in systematic studies. The former searched botanical literature to the depths, and the latter drew up keys and classifications in addition to conducting comparative trials and making descriptions.

The value of much of the investigational work, conducted prior to 1908, was undermined by attacking too many questions in one experiment and through the lack of checks and repetitions, as well as through the failure to adopt a critical attitude in interpretation. Nevertheless, a number of workers published material of lasting value, among them Bailey, Lloyd, Austin and White, Price and Starnes.

The first task in vegetable experimentation, of course, was to learn what happens under special treatments or conditions. The early tendency was to seek the best practice by routine methods. More recently the need for a broader foundation has been realized, and there is now a tendency toward the type of research which seeks to understand the principles lying beneath the observed outward manifestations, striving to discern the various links in the chain of causation which lie between the initial treatment and the final effect. Applying nitrate, the student is interested in its history in the soil, its entrance to the plant, its travel and transformations within the plant, and the ways in which it affects the processes of vegetation and fruition.

Physiology and chemistry have been used to a large extent in building knowledge in vegetable gardening. This is but natural and may be expected to continue. In the future it may be expected that further use will be made of such branches as histology, soil science, meteorology, and physics and others. The light of syste-

matic botany is being focused upon problems of types and varieties, and the principles of genetics are being widely employed in the improvement of vegetable forms.

While the laboratory and microscope are coming into wide use, field trials are not abandoned. It is realized that light from every possible angle is necessary before such extremely complex problems as crop nutrition, tillage and cultivation, rotation relations, and irrigation practices can be solved.

There are now at least five substations or branch research farms devoted primarily to vegetable studies. The growth of these outlying stations demonstrates the recognition of the importance of vegetable gardening and also of the necessity for securing suitable land.

EXTENSION

Extension teaching in vegetable gardening is recognized in most of the States. The worker formerly engaged chiefly in farm visits and lectures of the institute type. The demonstration method has now taken firm hold, and workers generally give it the leading emphasis. Meetings are usually concerned with a specific topic of interest to a given group or community, frequently being held in connection with a demonstration. Local schools of three to five days' duration afford opportunity for connected subject matter study. The extension worker is no longer satisfied to merely answer practical questions, but he seeks to build an understanding of principles as well. He prefers to help the grower answer his own questions rather than to deal in categorical statements and specific advice.

ORGANIZATION

There is wide variation in the organization of vegetable work in the various institutions. Vegetable gardening first appeared as a phase of horticulture but it was generally overshadowed by the great interest in pomology. More recently heads of horticultural departments have recognized the growing importance of the field and have sought specialists, and in many cases have established separate sections or divisions of vegetable gardening coordinate with pomology, landscape art, and floriculture. At Cornell and California vegetable gardening is organized as a separate department. There are still some colleges where the vegetable teaching is a side line for a man primarily interested elsewhere. The fact that almost every State possesses a sizable and growing vegetable industry is gradually bringing about the universal employment of vegetable specialists and the recognition of the field as a distinct

branch of horticulture. The chief obstacle at present lies in the shortage of adequately trained men.

Much could be written about the progress of vegetable gardening in extension and in the farm bureau, in junior club activities, in the secondary and vocational schools. Suffice to say that progress in these fields is no less marked than in the colleges, with the result that the industry is aided and interest is aroused which insures for the future a supply of well-trained men which will correct the existing shortage.

Chapter V

FORESTRY

By Henry S. Graves

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Educational institutions have played an important part in the development of forestry in this country. Thirty to forty years ago the practice of forestry was almost nonexistent. The Government had not yet undertaken to protect the forests on the public domain, practically no private owners were seriously endeavoring to practice forestry, and the destruction of our forests by fire and other agencies represented a direct loss of no less than $50,000,000 a year. A Division of Forestry had been established in the Department of Agriculture under the leadership of Dr. B. E. Fernow, who with a small group of foresters was conducting scientific investigations and carrying on a campaign of public education in regard to the importance of forestry. In addition to this group, there were a number of far-sighted men who were working to bring about a change in public sentiment regarding our forest resources. Most of these men were connected with educational institutions. Among these early leaders of forestry were Professors Sargent, of Harvard; Brewer, of Yale; Spaulding and Beal, of Michigan; Bessey, of Iowa; Rothrock, of the University of Pennsylvania; and numerous other educators. The majority of them were botanists and geographers whose field of work brought them into contact with the widespread destruction of the forests that characterized that period. The individual efforts of these men in their public addresses and publications and in their teaching at their respective institutions had an important influence in laying the early foundations of forestry.

EARLY INSTRUCTION IN FORESTRY

Thirty years ago there were no schools which undertook to give a full technical training in forestry. The subject was, however, touched upon to some extent in the curricula of a good many of the land-grant colleges. In 1897, no less than 22 agricultural colleges were represented as giving some instruction in forestry. These included the agricultural colleges of Alabama, Arkansas, Connecticut, Iowa, Idaho, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Texas, Vermont, Washington, and West Virginia. This work varied from a few lectures to courses of instruction extending over two terms. The subjects taught were primarily the general economic importance of forests, the identification of trees, and the methods of tree planting. In addition to the foregoing institutions, it is understood that forestry was touched on incidentally in the courses of botany and horticulture in the agricultural colleges of Virginia, North Carolina, Georgia, Mississippi, Colorado, Oklahoma, Indiana, and Maine.

This list of educational institutions which 25 or more years ago were giving some attention to forestry is somewhat surprising, and the question may be asked why these efforts did not lead to more direct results in the better handling of our forests. It will be recalled that the first efforts of forestry in this country were in the direction of planting trees either on areas where the forests had been entirely destroyed or on the prairie regions of the West. The early pioneers in the treeless regions were very much embarrassed on account of the lack of lumber for building material. Transportation had not yet been developed to make available the great pine forests of Michigan and the South. About the same time the accessible pine in the eastern forests was being rapidly cut out and the more distant supplies were not available because of the lack of transportation. The fear of a scarcity of timber became so prevalent that during the decade following 1867 no less than 16 States passed laws for the encouragement of tree planting, and the Federal Government enacted the timber culture act looking to the same end.

Instruction in forestry at the different educational institutions during the nineteenth century was largely confined to the problem of establishing forests on the farms in the treeless regions or the restoration of trees where the forest had been stripped off. Neither the educational work nor the legislation of the Federal and State Governments touched the vital problems of the proper protection, management, and perpetuation of existing stands of timber.

THE ESTABLISHMENT OF TECHNICAL FOREST SCHOOLS

A real beginning of an effective forestry movement in this country was made when the United States Government assumed the responsibility of protecting and administering the forests owned by the Nation. The authority for establishing Federal forest reserves was granted by Congress in 1891. It was not until 1897, however, that legislation was enacted providing for the administration of these properties. This legislation was passed only after a vigorous controversy which in itself had the effect of calling public attention to the importance of forestry. Since that time there has been a remarkable change of public attitude toward forestry and a great advance has been made in administering the public properties and in the enactment of legislation by the States. The success of the forestry movement so far achieved has been possible because of the work of the educational institutions in training a body of professional foresters.

In 1897 the United States Government embarked upon a new policy of public-land administration. It had the task of protecting and administering many millions of acres of forest land, and it had no profession of trained foresters to draw upon to handle this important work. A number of far-sighted institutions saw the necessity for a body of technically trained men, both for the new work on the public forest reservations and for the introduction of forestry practice elsewhere. The first institution to establish a high-grade school of forestry was Cornell University in 1898. This was organized as a separate college in the university and was supported by State funds. A tract of 30,000 acres in the Adirondack Mountains was also provided to serve as a practical training ground for the students and as demonstration of the methods of forestry. During the same year a private school of forestry was established at Biltmore, N. C., under the direction of the forester of the large estate of George W. Vanderbilt. This was not of collegiate grade. It has a historical importance, however, because a number of men who later became leaders in the country obtained their first training there. In 1900 Yale University organized a school of forestry which offered a course of two years for graduate students. Though the Cornell and Yale curricula differed in some respects, they both set a high educational standard which was of great importance in the history of forest education during the succeeding two decades. As a result of circumstances, which it is unnecessary to mention in this paper, the school of forestry at Cornell was discontinued after four years, but was reestablished under a different form in 1910. The Biltmore School was given up in 1912.

Between 1900 and 1910 there was a remarkable expansion of the Federal activities in forestry. The system of national forests was extended so that by 1910 they included a net area of about 170 million acres. Legislation was also secured which enabled the building up of a competent administrative organization for protection and for the handling of the business of the national forests. The Forest Service, established under its present name in 1905, with a new recognition and authority, called for a large number of technically trained men. For a time the demand of the Government was far greater than could possibly be met by the forest schools. A young man entering a forest school had a practical assurance that upon graduation he could secure a position with the Government, with a favorable opportunity for important work and advancement. In some years the Government appointed as many as 75 men of the highest technical grade and over 300 men of the ranger class.

This demand for trained foresters by the Government caused many young men to enter the profession, and it also led to the organization of courses for the training of technical foresters by a number of colleges and universities. During the decade following the establishment of the forest schools at Cornell and Yale, there were organized technical courses in forestry at Harvard, at the Universities of Michigan, Minnesota, Nebraska, Missouri, Washington, Idaho, Georgia, and Maine, at the State Colleges of Michigan, Iowa, Massachusetts, Pennsylvania, Colorado, Washington, and Oregon, and at Colorado College; and there was established the Pennsylvania Academy of Forestry for the training of students for State service. In 1910, Cornell University reestablished a full course in forestry as a branch of the college of agriculture; and very shortly there were organized courses for full technical training in forestry at Syracuse University, the University of California, and the University of Montana. More recently a department of forestry has been organized at Bates College, and special courses are now offered in a number of land-grant colleges.

The majority of these institutions offered a four-year undergraduate course leading to a special degree in forestry, and of the same general educational standard as the undergraduate courses in engineering, agriculture, or other special branches of study in the respective colleges or universities. Three forest schools, Yale, Harvard, and Michigan, offered a two-year postgraduate course requiring for admission an undergraduate degree from a collegiate institution of recognized standing. At the same time provision was made for undergraduates in these universities to anticipate certain courses

in forestry and to complete the graduate work in one year. Later on a number of the other schools offered postgraduate work, placing their courses in substantially the same class as Yale, Harvard, and Michigan.

OBJECTIVE OF TRAINING IN FORESTRY

At the beginning practically all the forest schools aimed to meet the demand for men in public service. The Federal civil-service examination largely governed the standards of training and the United States Forest Service absorbed most of the graduates. Thus in 1912, there were about 20 institutions, many of them supported by individual States, preparing men for the national service. About that time occurred a reaction that seemed to indicate an overdevelopment of forest education. This was due to the rather abrupt dropping off in the annual demand for technical men by the Forest Service. The first organization of the national forests had been completed. The need for a large number of new recruits each year had passed. From that time the requirements would be confined to replacements and to the handling of new work authorized by additional congressional appropriations. The idea became prevalent that already the profession of forestry was fully supplied. Many forest schools found their membership seriously diminished and faced the necessity for readjustments both in the objective and in the plan of instruction.

The idea that the profession of forestry had reached its limit was, of course, wholly fallacious. We had made only the first beginning in establishing forestry in this country, and our efforts were largely confined to the work of the Federal Government. The development of 20 institutions to recruit men for the Government service was ill-advised, and when the demand for men in that work was curtailed the forest schools had to adapt themselves to the new conditions.

One of the first results of the changed conditions was that several institutions entirely altered the character of their courses. Harvard University gave up its full course in forestry and substituted specialized graduate work in research and other lines. The universities of Nebraska and Missouri, the Massachusetts Agricultural College, and the State College of Washington confined their activities to courses specially suited to the needs of students of agriculture. Other institutions likewise modified their courses to meet special local needs for forestry training as well as for such demands as continued in the Federal service.

STANDARDIZATION OF FOREST EDUCATION

The rapid development of specialized training in forestry resulted in a diversity of educational standards in different institutions. While the scope of the instruction given at the various forest schools followed the general pattern originally set by Cornell and Yale, there was considerable of diversity in the character and scope of individual courses and in the methods of instruction. An important step was taken in December, 1909, when a conference was called by Gifford Pinchot, then Chief Forester of the United States, for consideration of the aims, scope, grade, and length of course of a technical training in forestry. A committee was appointed, of which the writer was chairman, to formulate a plan for the standardization of the requirements of education in forestry. The committee presented its report at a second conference held in December, 1911.[3] These conferences and the approved report resulted in clarifying the objectives of forest education and in setting certain broad standards in regard to the ground to be covered, the length of course, and the methods of instruction. A general agreement was secured regarding the scope of an undergraduate course in forestry. At the same time the limitations of such a course were recognized, and the need shown for a fifth or sixth year of specialized work for those who desired to secure the best technical training in forestry. The forest schools found themselves in the same position as the schools of engineering.

IMPROVEMENTS IN RECENT YEARS

The past decade has been characterized by various changes in courses of instruction shown by experience to be desirable, and by the strengthening of the institutions in personnel of the faculties and in improved equipment and facilities for teaching. Experience demonstrated certain weaknesses in the original plan of training. At the beginning, the courses of instruction centered chiefly about the problem of forest production, and special consideration was given in the foundation work to the biological and physical sciences. This was sound but the curriculum in most schools was deficient on the engineering side of forestry. A well-balanced course of study in forestry should comprise enough mathematics and engineering to enable the graduate to handle the problems of forest surveying, logging engineering, lumbering, and lumber manufacture, which nearly every practicing forester is bound to meet. The recognition of this has resulted in the development of two schools of thought.

[3] Forestry Quarterly, vol. 10, no. 3, 1912.

Some institutions place the chief emphasis on the productive branches of forestry as in the case of agriculture; others aim to make forestry more a science of engineering than of production. The western forest schools especially have inclined to give emphasis to training men in logging engineering and lumbering. There is a place for special training for those who wish to enter the lumber industry. The curriculum in such a course should be strong in mathematics and engineering, and there should, also, be instruction in special features of the lumber business. It would be unfortunate, however, to permit the instruction in lumbering in a forest school to overshadow the productive sciences to a degree that would lead to a lowering of the standards of forestry. Most schools are endeavoring to preserve a proper balance between the instruction in forest production and that in forest utilization. This is being done by offering elective courses that enable the student to specialize in forest engineering and lumbering, or in silviculture, or to obtain a broad training that includes a sound foundation in both branches.

A recent development has been the demand for men by the wood-using industries. The problems of seasoning wood, of chemical and other by-products, of paper manufacture, etc., are assuming increasing importance, and the manufacturers are looking for men with a knowledge of forestry and a special training in the technology of wood. The College of Forestry at Syracuse is making a special feature of work in forest products.

The measure of advance in forest education was shown at a conference of forest schools held in New Haven in December, 1920. An excellent report of the proceedings has been published by the Bureau of Education (Bul. No. 44, 1921), in which definite standards are set forth for undergraduate and graduate courses, for electives, for ranger courses, and for courses in vocational training. The schools have adjusted themselves to the needs of the country for foresters, and they are reaching out into specialized fields of training for the industries as well as for research, for teaching, and for the general practice of forestry.

This development has been possible only through the building up of a more competent personnel in the staff of instructors. The teachers are now more mature and have a richer fund of experience than formerly. The schools have also greater resources and are able to employ specialists in different branches of forestry. In only a few instances do we now find one instructor endeavoring to carry all the special teaching in forestry.

A second feature is the increasing number of excellent textbooks and other literature dealing with the conditions of the United States. In former days there was practically no American forest literature. The teacher was obliged to furnish a large part of the material for

class work through lectures. Still another great advance has been made in the facilities for teaching. Many of the forest schools now have their special buildings well equipped with laboratories, libraries, herbaria, and wood collections. Every school carries on a large amount of work in the forest, and most of them have either their own experimental and demonstration forests or have access to public or private forests for their practical field work in silviculture, mensuration, forest engineering, forest management, etc.

SPECIAL PROBLEMS OF THE LAND-GRANT COLLEGES

The land-grant college will play an important part in the development of forest education in the United States. This is inevitable because of the intimate relationship between forestry and agriculture. Moreover, many of the land-grant colleges are peculiarly well fitted to undertake work in forestry.

There are three problems in forestry which require consideration by the land-grant colleges: First, the training of professional foresters where conditions justify a full technical course; second, the instruction needed by all students of agriculture and especially those who may own woodland tracts; and third, the work connected with the advancement of forestry in the respective States.

It is not necessary or desirable that all land-grant colleges should provide a full training for professional foresters. Two considerations govern the wisdom of establishing a complete course in forestry. The first is the local demand for the services of trained men. The second is the responsibility of the State institutions to train leaders to forward the movement of forestry and to bring about its practice on the farm woodlands and elsewhere. In most places the demand for the services of foresters has followed the training of professional men by the forest schools. Forestry became a reality in this country because a few institutions had the courage and vision to encourage young men to enter the profession of forestry in advance of an established demand for their services. These institutions created the profession. The activities and leadership of the professional foresters have been developing the science, extending the practice of forestry, and stimulating new demands for trained men. Broadly speaking there are now enough high-grade forest schools, with one exception. There exists a real need for an additional forest school in the far South. We need more southern men in the profession who understand local conditions and who can take the lead in developing the movement of forestry in that section.

Every agricultural college should offer instruction adapted to the forest problems that will be met by its graduates. It is increasingly appreciated that in many regions forestry and agriculture must go

hand in hand. This is especially true where a portion of the land is not suited to cultivation and improved pasturage. In such sections the productive use of nonagricultural land for forest growth is essential to a prosperous agriculture. It is estimated that in the long run fully 60 per cent of the forests of the country will be owned by farmers or will be interspersed in relatively small holdings among farms. The agricultural interests can not fail to recognize that forests and the industries dependent upon them are an essential factor in building up a sound industrial structure in rural regions. The progress of forestry in many States will depend upon the participation of the agricultural colleges and experiment stations in the movement, upon their work in training men in the methods of handling woodlands, their research in establishing the principles of public policy and forestry practice, and their efforts in educating the public to the importance of forestry as an instrument to advance agriculture and build up rural prosperity.

There are 11 land-grant colleges which offer a full technical training in forestry. In all these cases it has been felt that there is sufficient demand for trained foresters to justify the undertaking. Some of these are well equipped with an adequate staff of instructors. Several institutions are handicapped by lack of funds and are endeavoring to accomplish more than is possible for one experienced teacher of the technical forestry subjects. Ordinarily an adequate training requires at least three experienced teachers, with such additional assistants as may be required by the number of students. If available funds are insufficient to employ a full staff, the wise course is to begin with the training needed for the agricultural students and to build up a forest school if conditions justify it.

The land-grant colleges offering a full course of study in forestry are as follows: University of California, Colorado Agricultural College, Cornell University, University of Georgia, University of Idaho, Iowa State College of Agriculture, University of Maine, Michigan Agricultural College, University of Minnesota, Pennsylvania State College, and Oregon Agricultural College. In addition several institutions offer excellent major courses in forestry—these are: Purdue University, Massachusetts Agricultural College, University of New Hampshire, and the State College of Washington. Twenty-three institutions give courses in forestry, chiefly in connection with the courses in horticulture, designed to aid the farmer in the handling of his wood lot. Of these Louisiana and Ohio give the most extended course, while Connecticut employs a trained forester specially qualified for technical instruction, and Texas and Vermont have the advantage of instruction by the State forester. Nine institutions give no work in forestry at all.

In the colleges which do not offer a course of study in forestry, the chief objective is to aid the farmer in handling his woodland property. The work of the different colleges varies in extent, in methods of instruction, in subject matter, and in efficiency. In several institutions the entire work is included in a single course of two hours for one term. In most cases the course or courses comprise three to six credit hours. The designation of the courses differs considerably, but in general the following ground is covered:

A. The identification of trees.

B. General forestry, designed to show the importance and scope of forestry with particular reference to the conditions in the State.

C. Farm forestry, designed to aid the farmer in handling his own woodland and comprising elementary work in forest protection, silviculture, mensuration, and marketing of woodland products.

Naturally the subject matter in the courses varies widely because of different local conditions. The amount of training in forestry which may be offered in a given institution is subject to the difficulties encountered in all branches where the curriculum is in danger of overcrowding by the addition of specialized subjects. The question of time must be measured by the increasing importance of forestry in a broad system of agricultural development.

A review of the local problems in many of the States and of the work now given at the land-grant colleges suggests the following comments:

1. *Dendrology.*—First of all the student must have a foundation of forest botany. This applies not only to the study of the species in common use but of those which are likely to be of value in the future, and those of less value which grow in association with the commercial kinds. The student should, further, have some training in plant physiology in its relation to the life history and behavior of trees and forests. This may be give in connection with dendrology, as a special course, or as an introduction to silviculture.

2. *Forest economics.*—A certain amount of instruction in forest economics is now given at most institutions in the general course of forestry. A thorough course in forest economics is of great importance and should be required of every student of agriculture. Whether it is given in connection with rural economics or as a separate course is not so important. It is essential, however, that every agricultural student should understand the place of the forest in the economy of the country and of the State, the service of the forest in building up and maintaining a prosperous agriculture, the problems of supplying the needs of farmers with wood materials at reasonable prices, the need of maintaining nonagricultural lands in a productive condition, the relation of forests to water resources and erosion, the relation of forestry to grazing, problems of taxa-

tion of woodlands, the economic basis for forest management, and similar matters.

3. *Forest protection.*—This subject is generally included in the course in farm forestry. Here again it is of little importance what the course is called provided the instruction in it is adequate. The farm forests of the country are not now being properly protected. Many farm woodlands are repeatedly burned over. In fact, in some States it is customary to burn over the woods every year. The student should understand the various adverse factors which are operating to injure our woodlands and how to prevent such injury. These include fire and also insects, disease, lightning, and other injuries. One of the features of the modern State forest policy is organized fire protection. Every farm forest is a unit in a State-wide system of protection. The methods of fire prevention and the methods of fire fighting are essential to every woodland owner.

4. *Forest management.*—The work of forest management is usually included in the course entitled farm forestry, estate forestry, or some other designation. It includes silviculture, forest mensuration, the appraisal of timber values, and forest administration. The extent of instruction depends entirely upon the time which can be devoted to it. Work is required not only in the classroom but also in the field. In this course the student is taught how to secure natural reproduction when he cuts his timber, how to increase the rate of growth of his forest by skillful thinnings, how to establish new stands by planting or seeding, how to appraise the value of the standing timber for sale, and how to organize and administer his woodland in a way to secure effective results.

5. *Forest utilization.*—This is a broad term covering the information required by the owner to make the best disposition of the products of the forest in the market. The farm owner should understand something of the possible uses of the different species which he grows, the sizes and grades of timber required by the market, and the values which he should place upon his products. Under this head may be included also instruction in the methods of handling and seasoning woodland products, and of preserving fence post and poles by the use of creosote or other materials.

Other subjects may be introduced where special conditions warrant it. Thus one institution gives a special course in ornamental and shade-tree forestry. In some States it may be desirable to give special work in the engineering phases of forestry, the methods of logging, problems of the small sawmill, etc. This is a question of fulfilling a local need that must be worked out in each institution.

The enumeration of the foregoing courses gives the impression of a rather extensive program in forestry education. No general rules

can be laid down regarding the time which should be devoted to forestry in an institution which is not offering a major course of study. A review of the local problems of forestry as related to the building up of agricultural and rural life convinces the present writer that the land-grant colleges have a responsibility to undertake a much larger program of forestry, both in the instruction to students and also in advancing the interests of forestry in the States. The time that should be given to the subject in the curriculum should be from 8 to 10 credit hours rather than from 3 to 4 hours as is now the case in most colleges.

One of the difficulties encountered at the present time relates to the effectiveness of the instruction. The importance of forestry in agriculture justifies the employment of an experienced forester by practically every land-grant college. His first duty should be to give such instruction in the college as conditions justify. He should also be available for the direction of forest research in the agricultural experiment station and for the organization of general educational work in the extension department. Usually where the college and the experiment station are located at the same point, one competent forester would be able to perform these functions at the beginning. The expansion of the work and a possible separation of the various functions later on would be a matter of growth.

OTHER EDUCATIONAL PROBLEMS

The scope of this paper does not permit the discussion of the development of education for rangers nor the introduction of appropriate teaching of forestry in the schools of various grades. In some instances the land-grant colleges have an opportunity and responsibility to organize such educational work. This will naturally follow where an institution undertakes its special task in forestry and is provided with an experienced forester who can study the large needs of the State and the methods of meeting them.

We are now passing out of the pioneer stage of forestry. Crude methods of practice are being replaced by a more efficient and scientific handling of the forests. The advance in forestry will come only through the leadership of technical men, just as was the case in engineering. In this the educational institutions will play an important part. It is their opportunity and responsibility to produce the leaders who have not only a knowledge of the technique of forestry but the broad point of view and vision to bring about a change of attitude on the part of land owners, to develop sound public policies, and to establish right standards of practice. The process of adapting our forestry education to the needs of the country

is by no means complete. This is fully realized by the institutions now teaching forestry. The fact that they are constantly studying possible ways to improve their work insures a sound and progressive development in the future.

Chapter VI

SOILS AND FERTILITY

By H. G. Patterson

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The teaching of soils, previous to 1895, at most institutions was of a very general, if not to say, in many instances, of a superficial character. This was due largely to the fact that the existing knowledge of soils had not been systematized and reduced to a pedagogical form. The teaching of fertilizers and factors relating to fertility was brought into a systematized form much earlier and may be said to date in America from the time of S. W. Johnson's books "How Crops Grow" and "How Crops Feed," published in 1867 and 1870, respectively. In this connection it may be of interest to note that there was a well-recognized need for more systematized knowledge on these subjects much earlier than the dates mentioned, as is evidenced by the passage of an act by the Maryland Legislature, in 1847, providing for the establishment of the first laboratory in the United States for the purpose of investigating and disseminating information on soils and fertilizers.

SOIL SURVEY

In 1890 Maryland recognized the importance of soils as fundamental for an agricultural college course and for agricultural research by establishing in the Maryland Agricultural College a chair of soil physics and in the experiment station a research department in the same subject.[4] This chair was filled by Dr. Milton Whitney, now chief of the United States Bureau of Soils in the United States Department of Agriculture. The research work at the Maryland Experiment Station was conducted in cooperation with the United States Weather Bureau and Johns Hopkins University. The development of this work and its recognition brought about, in 1892, the

[4] It must also be recognized, in this connection, that much earlier than this, Hilgard gave much consideration to the mechanical character of soils while making his chemical studies of the soils of Mississippi and California. King, of Wisconsin, and Wiley, of the U. S. Bureau of Chemistry, in the work they were doing at this same period, gave the mechanical analysis of soils an important place.

establishment of a division of soils, afterward a bureau in the United States Department of Agriculture. Doctor Whitney developed during the next few years the systematic soil survey work until now it covers a large part of the principal agricultural areas of the United States. The first maps and reports of this work were published in 1900, and though based largely upon the physical characteristics of the soil, yet they gave due recognition to the geological, chemical, and botanical factors. The information gained through these surveys and the coordinating of the physical, chemical, and botanical characters of the soils made it possible to develop and give some systematic and detailed instruction in soils and make up an inventory of its fertility and crop-producing resources and adaptability.

Another factor which caused a wide variation in the soil and fertility courses was due to the fact that the finances of the institutions, in but few instances, permitted men to specialize in these subjects, but conditions and circumstances made it necessary to allot these subjects to the department which could most conveniently perform the task. Hence the teaching of soils and fertility might be done either by the agriculturist, chemist, geologist, botanist, or physicist. The result, as might be expected, would be a wide variation in the manner of presentation, angle of approach, and length and thoroughness of the courses. The lack of suitable laboratory equipment also interfered with good teaching.

The teaching of soils and fertility, in common with the teaching of other subjects, changes from time to time so as to present not only the new information which has been acquired, but also in such a way as to develop the subject as as to meet the changing demands and environments.

The period from 1910 to 1920 witnessed marked changes and rapid developments in the teaching of soils and fertility in most of the institutions. These may be classified as follows:

1. The information which has been acquired by the research conducted by the experiment stations had been coordinated, organized, and reduced to a teachable form. In doing this task recognition was given to the fact that the productive power of the land is the first and most important fundamental consideration in farming. It was kept in mind that a full realization of the ideal productivity must combine the best teachings of science with the philosophy of farm practice. The interpretation of the results of research supported, explained, and developed the reasons for the methods followed by successful farmers.

2. This period was marked by the organization in most institutions of separate departments, with at least one man devoting his full time and energies to these subjects.

3. The equipment of special laboratories for these subjects has enabled the student by handling and seeing to become familiar with the appearance, the physical and chemical properties, and producing capacities of soils. This put life into the subject and incited the interest of the students. It also enabled the teachers to demonstrate principles in connection with specific cases and to some extent to give the students that training which enables them to think in terms of soils.

4. The development of the laboratory method reduces the teaching of soils to a great extent to an individual basis and enables the division of sections and project assignments to be made upon capacity of scholarship and experience rather than by the alphabet.

5. This period witnessed, in most institutions, the offering of a soils curriculum covering four years, and some institutions gave opportunities for graduate instruction leading to both master's and doctor's degrees. The extent of this work has been necessitated and made possible by the rapid growth and definiteness in the character of the knowledge of soils which has been acquired during the past 20 years. The advanced work offered in soils is usually well supported by good fundamental courses in geology, physics, and in general, physical and colloidal chemistry. The courses offered will fit students for following farming as an occupation or for becoming teachers, research workers, or extension specialists.

6. Marked advances were made in this period in teaching the fundamental principles as to the soils best suited to the most important crops, that is, "Fitting Crops to Soils"; ways of modifying soils to fit crops; and the ways to fertilize crops with reference to the nature of the soil and its previous treatment. These factors have also to a large extent been correlated with the climatic conditions.

Soil fertility is one of the most fundamental and important conservation problems which confronts the United States, and its solution will have great influence on economic conditions.

The Association of Soil Survey Workers and the American Society of Agronomy, in cooperation with the colleges and experiment stations, are doing much to develop methods and facilities for research and instructions in soils and fertilizers, with the indications that the results to be gained will enable every farmer to classify the soils on his farm; select the crops with reference to the soil type; adopt a system of rotation and management which will insure larger yields and lower cost of production; and establish permanent agriculture which will not be inconsistent with profitable farming.

The first great problem is for the research agencies to acquire the information. The next step will be its dissemination by the teachers

in the classroom and the extension workers' demonstrations in the field so as to make certain its application in every day practice.

This is a big and important educational program for the future.

Chapter VII

PLANT PATHOLOGY

By Donald Reddick[1]

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During the five years 1867 to 1872 there were associated in the faculty at Halle, two men who have been accorded the title of "Father of modern plant pathology." Julius Kühn, "the microscope farmer," had published a decade earlier his well-known book "Die Krankheiten der Kulturgewächse," and at the time, had under way experiments which extended well into the present century and which proved the most extensive ever undertaken in the control of plant disease. Anton De Bary, a medical school product, had established conclusively the fact of fungous parasitism through his epochal work on *Phytophthora infestans*, the potato blight fungus, and on *Puccinia graminis*, the wheat rust fungus. There is almost no evidence that these men at Halle found a great deal in common and from this it may be inferred that there was no particular conflict or overlapping of work and no recognition of any peculiar community of interests. The present overshadowing importance of fungi as the cause of disease in plants had yet to be developed. De Bary was interested in fungi whether they caused disease in plants or not; Kühn was interested in disease whether caused by fungi, nematodes, wet soil, or what not.

The condition existing at the very inception of modern plant pathology has persisted to a marked degree even to the beginning of the present decade, and, indeed, can not be said to have disappeared entirely even at the present time. No longer ago than 1910, one of the foremost plant pathologists in the United States felt impelled to justify the use of the word plant pathology, the organization of the American Phytopathological Society (which has increased from 200 to 500 in membership during the decade), the "starting of new courses, indeed of departments in the universities;

[1] This report is based upon replies to a questionnaire sent to pathologists in all the land-grant colleges. The writer is under obligations to the various persons who assisted in the compilation, but obviously he must accept responsibility for the interpretations presented here.

the publication of textbooks and of independent journals." "The reply is simple and we believe practically sufficient, *even though not quite satisfying scientifically.*" [The italics are mine.] "* * * The advance of plant pathology will be just in proportion to the clear recognition of the fact that its chief problems are biological rather than economic, that the primary concern must be with the uncovering of physiological relations and principles rather than the field trial of fungicides," etc.

The foregoing is from the man who has been the leader in phytopathological teaching during the decade, from the man whose previous work in the educational field helped very much to break down the ideas he has expressed in the quoted passages, and whose recent work has by no means conformed to the narrow limits prescribed in his remarks.

The most notable change in plant pathology, in general, in the United States during the decade has been the disappearance of that old distinction between pure science and applied science. The idea that when the so-called pure scientist had determined the life history of a parasite or had determined the proper balance of mineral food for best development the so-called applied scientist might be intrusted safely with performing the necessary field trials to develop a suitable means of control of a disease, has broken down almost completely. Rather it appears that in the science of plant production there is a convenient natural division, plant protection, which involves a proper fragment of all of the older subjects—general biology, botany, physiology, biochemistry, meteorology, agronomy, horticulture, etc., and which properly blended may be called plant pathology, a subject which of necessity is as "pure" as the purest, and as applied as the most practical. Indications are not lacking that the last remnant of "parlor botanists" came to a true realization of the problems of plant pathology when they offered their services in stimulating crop production in 1917, while the so-called practical men some years earlier recognized the particular contributions that the skilled scientists with their microscopes and test tubes could make to the solution of problems of greatest practical importance.

While it is true that indications of this general trend were not lacking prior to the decade just ended, the development of the past 10 years has been such as to indicate a rapid emergence of plant pathology as a definite unit in a department of botany or as a definite "department" in a college of agriculture, with the consequent disappearance of such courses in botany as "economic mycology," "parasitic fungi," "mycology and bacteriology," and in agronomy

and horticulture of such courses as "spraying," "seed treatment," and the like.

The blending of the so-called pure and applied in the development of plant pathology has been accomplished chiefly through the education of a new generation of workers, trained alike in the technique of the laboratory and of the field, intimately acquainted not only with the practical phases of the subject and the significance of them but equally alert to the most obstruse theoretical considerations.

An early blend which is fundamentally important seems to have been considerably diluted during the decades and only very recently has any attempt been made to improve the mixture. The basic importance of the facts established by Pasteur never have been overlooked, but the developments in animal pathology brought about by that vast progeny of Pasteur have not been utilized to the fullest extent. There is little question that this is to be attribtuted to lack of personal contacts. The overshadowing importance of human pathology has drawn the animal pathologist to the laboratories and hospitals of the large cities while the principal materials of the plant pathologist are in the open country. No long-established institutions have established work in plant pathology, although most of them maintain animal pathology in a highly developed medical school. Thus the two branches of a subject basically identical have become widely separated, a condition surely detrimental to the most rapid progress in plant pathology and doubtless somewhat detrimental to development in animal pathology as well.

GRADUATE TEACHING

Plant pathology is primarily and of necessity a graduate subject, in which research on the part of the professor and his students is the principal goal. "Of necessity," because the accumulated experience in this new field is not so great that many credit hours of undergraduate college work can be justified.

The instruction of professional students, for the most part is on a personal basis. The number of students in any given institution is very small and formal courses are uncommon. It is in only a few of the larger institutions that formal graduate courses in plant pathology are offered and in most of these the development of them has fallen within the decade. It is a curious fact that while every teacher of plant pathology recognizes that his teaching, whether graduate or undergraduate, is based on previous research and often very decidedly upon the researches done at his own institution, nevertheless, at half the land-grant colleges the teacher is not allotted any time for scholarly work and professional advancement. Re-

search is not clearly recognized as one of the functions of a teacher. The unfortunate effect of this condition upon the progress of teaching can not be doubted. It needs to be remembered, however, that many of the teachers are employed part time on experiment-station work. In this event they may have opportunity to undertake a research, although the numerous details connected with extensive field experimentation often consumes a great deal of time at the expense of real research.

UNDERGRADUATE TEACHING

Courses of study in plant pathology for undergraduates are now offered in most of the land-grant colleges. In less than half of the institutions plant pathology is a separately organized unit or department. In the others it is a recognized division of botany. In only a single case is it attached to another department than botany (or biology), namely, to agronomy. These courses of study have been organized within the past decade in more than half the institutions. The content of the courses is as yet extremely variable, due, no doubt, to the fact that teachers of pathology have never held a symposium on the subject and that no generally adopted textbook for college students has yet appeared. Almost without exception, however, teachers try to make the elementary course general or else more or less general with local adaptations. Beginning courses, taught primarily from the standpoint of important crops within the State, are rare; but in certain States, particularly those of widely diversified agriculture, special courses of this type are being developed to follow and supplement a general course. In a great many institutions some mention of important diseases of special crops, with discussion of control measures, is made in courses in horticulture, agronomy, and the like; but, almost without exception, the tendency is away from this practice. This statement represents the judgment of teachers of pathology, but it is borne out strongly by the fact that so many departments of pathology have been established in recent years, and by the number of "prescribed" four-year courses in which pathology is made a requirement for graduation.

The courses for undergraduates, without exception, are based on previous botanical courses, often including physiology and bacteriology, so that for the most part only senior and junior students may be admitted.

EXTENSION TEACHING

Very extensive development of teaching away from the colleges has come during the decade. The nature of the subject is such that most satisfying, clear-cut, and obvious results of demonstrations may

A. Class in Beekeeping, Department of Entomology

B. Class in Orchard Practice, Department of Horticulture

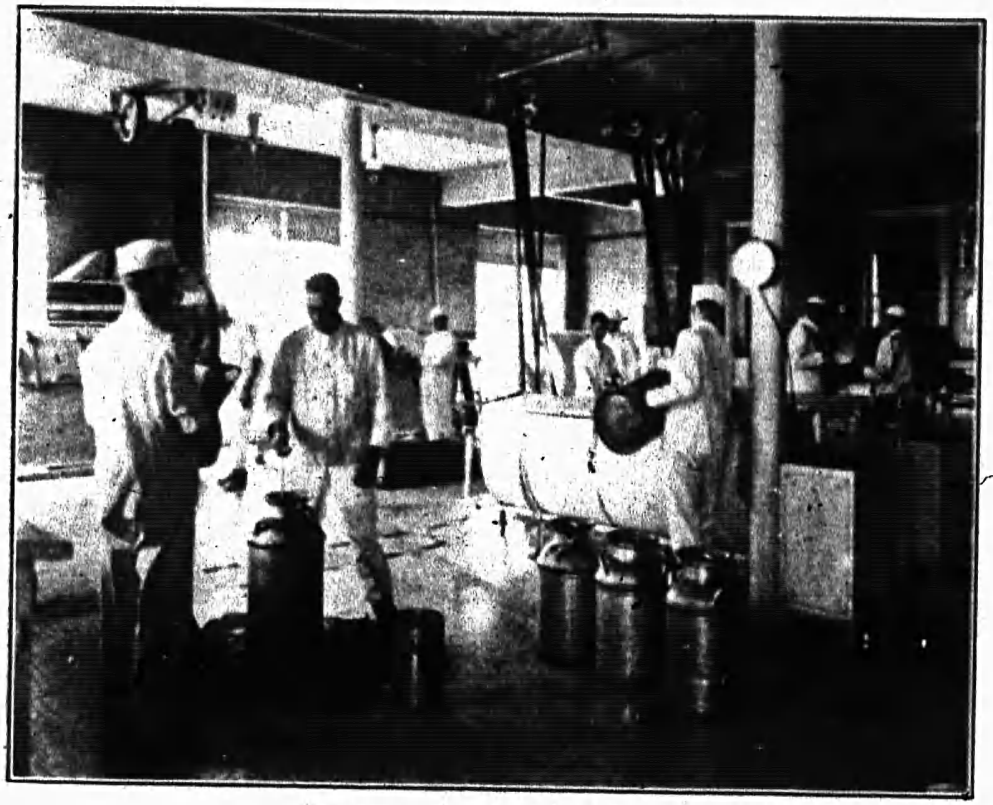
ALABAMA POLYTECHNIC INSTITUTE

A. Judging Dairy Cattle

B. Judging Sheep

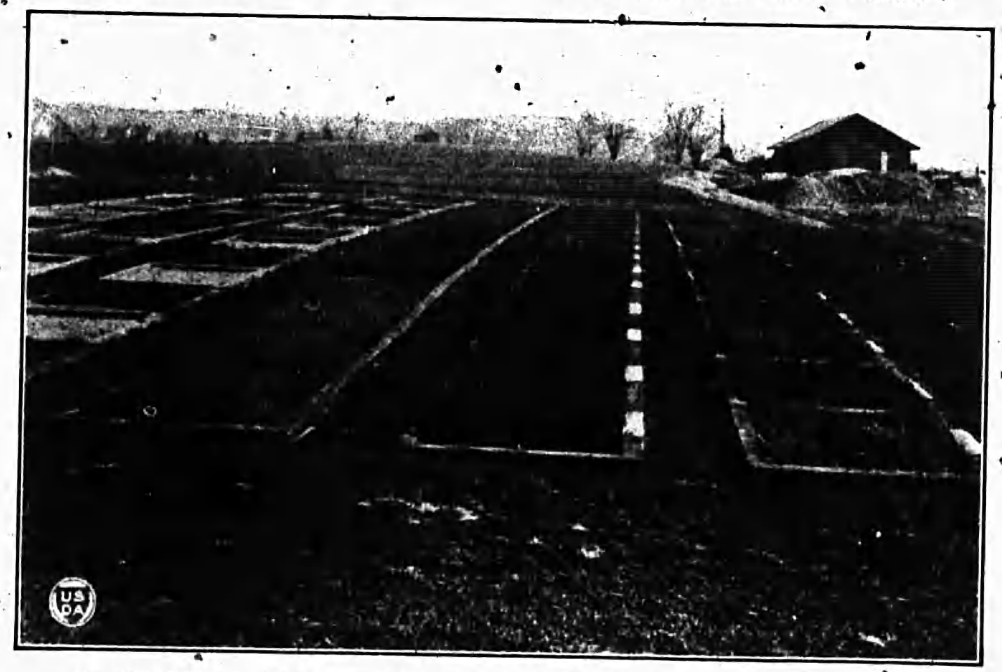
IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS

A. Cutting Meat, Animal Husbandry Department

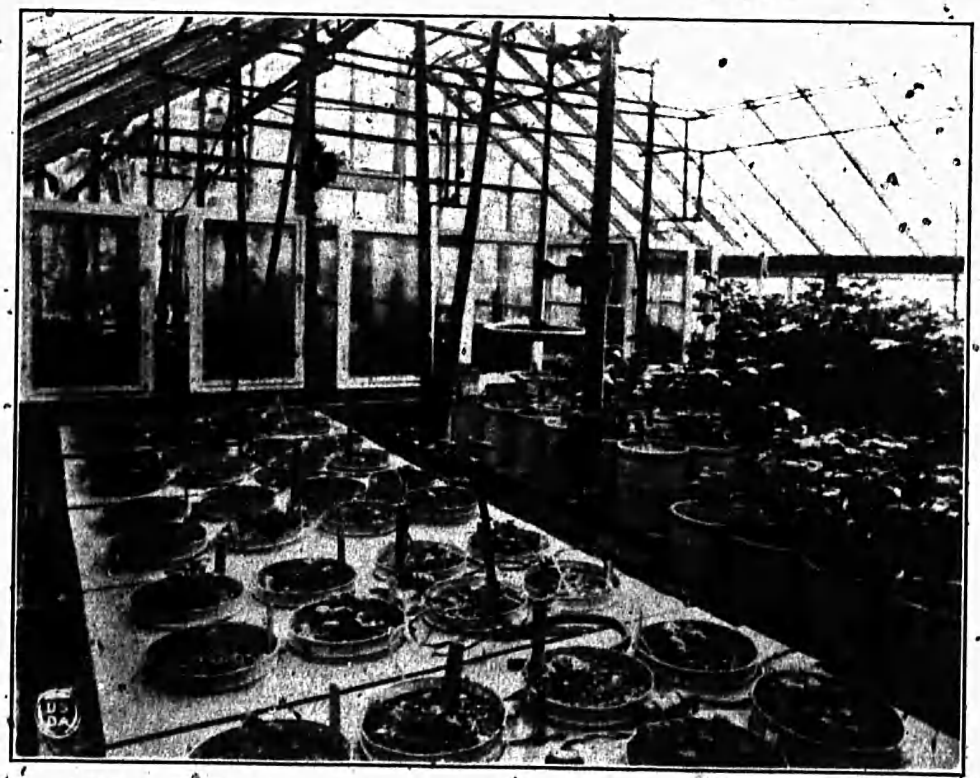


B. Class in Dairying in the Creamery

IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS



A. CONCRETE FRAMES FOR FIELD EXPERIMENTS. AGRICULTURAL EXPERIMENT STATION, CORNELL UNIVERSITY



B. PLANT PATHOLOGY GREENHOUSE, AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF NEBRASKA

be secured often in a single season. It is doubtful whether any other agricultural subject lends itself more readily to extension teaching than does plant pathology. Except for purposes of administration extension teaching is virtually attached to the subject matter department in most institutions. And in the same way the experiment-station pathologist, if indeed he be a different man, is just as intimately associated. In the case of the experiment-station men this intimate association has, without exception, proved advantageous to teaching; and for obvious reasons. In the case of extension, opinion at the present time is about equally divided between those who think that teaching has been helped by it and those who think that there has been no effect. Considering the recent development of plant pathology in many of the States, it seems likely that in the course of time all will agree that extension teaching will prove a benefit to resident teaching. A number of reasons are offered for the belief, chief among which are the following: The teacher is kept acquainted with the important problems in his community and can present his work with a touch of local color which always adds interest; students come to the courses with some appreciation of its practical importance and maintain interest or even enthusiasm from the beginning; the number of students is increased. This is not necessarily a benefit; but in most of the colleges the number of students in the course is not so large as to be a burden and in some it is so small that some increase is a real inspiration to the teacher.

SUMMARY

At least one course in plant pathology is now taught in practically every land-grant college. In more than half of the colleges the course has been established during the decade. This indicates general recognition of the fact that the body of knowledge about disease in plants and diseases of plants has reached a point where sufficient work of college grade may be offered to students to justify a certain amount of "credit" toward graduation. Research and investigation are logically preceding undergraduate teaching and extension teaching is logically following it.

Whether workers in the field of plant pathology will make more rapid progress in the development of their subject by the organization of separate divisions or departments is now being tested. Another decade should give some indication of this. The evident tendency to base class work on previous general training in fundamental subjects, as is indicated by the class of students to which the subject is offered, augurs well for the outcome.

Chapter VIII

ENTOMOLOGY

By JAMES S. NEEDHAM

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With the founding of the land-grant colleges entomology first gained a recognized place in the educational program. The subject was taught elsewhere and earlier, but in the agricultural colleges it became a regular and necessary part of a curriculum. This was because of the important relations insects bear to agriculture. They must be studied.

During the latter part of the nineteenth century the subject was introduced into all these colleges, one general course at least being offered by them all, and provision for investigation of insect pests being made by all. There were great teachers in some of these colleges, and they developed the pedagogical methods applicable in this field in both general and special courses.

Since that time there has been little change in fundamentals. There is usually given one general course to take care of the rank and file of agricultural college students. This course aims to give some knowledge of insect structures and transformations, some acquaintance with the character of the more important systematic group of insects, and some knowledge of the nature of insect injuries and of methods for their control.

Owing to pressure for room in the agricultural curriculum, this course is sometimes skimped for time, and, in consequence, is given in a way that is inadequate to serve either educational or practical ends. Sometimes it is demanded that the applications of entomology be taught before anything has been learned about the insects themselves. Applied entomology is demanded with little or no entomology at hand to apply. But it has come to be generally recognized that a full-year course of 365 hours' college credit is scant enough for the needs of the general student. For these things are true about insects, and are of pedagogic moment:

1. Insects are more numerous and diversified in kinds than any other group of animals.

2. They affect human interests in more ways than do any other animals.

3. There are more different methods for their control than with any other animals.

The general course is of real value about in proportion as it gives the student opportunity for acquiring first-hand knowledge of insect structures, transformations, habits, and control methods.

This course is commonly followed by other courses that are intended primarily for special students of entomology though some of them may serve well as a part of a general scientific education. Succeeding courses have, however, much less in common in the different colleges. They may be pure science courses in the morphology, embryology, physiology, taxonomy, or ecology of insects, designed to give breadth of training; such courses are most widespread. They may be courses providing technical training in subjects or in groups of particular difficulty, such as courses on scale insects, on aphid life histories, on insect parasitism, on bee diseases, etc. They may be purely economic, such as courses on sprays and spraying, on insecticides, on insectory methods, on biological control, etc. Local needs in each State have much to do with determining the nature of the more specialized applied courses; for such courses generally lead to research and to participation in the work of pest control.

The present day requires of the economic entomologist that he shall have studied all these things, and much that precedes or is fundamental to them. For example, work with insecticides demands some knowledge of both chemistry and physics. Work with the insects themselves involves every phase and aspect of general biology. Systematic entomology, which was somewhat discredited and out of fashion for a time (though ever justified by our need to know species and to be able to distinguish economic forms from the other harmless ones that are nearly allied), is called into special requisition when foreign pests, such as the Japanese beetle, the Mediterranean fruit fly, the Argentine ant, or the European cane borer, make their appearance on our shores. Even the need for detailed systematic study of all larval stages was manifest, when on the recent outbreak of the European cane borer in Massachusetts no one seemed to be equipped with a knowledge of larvæ sufficient for distinguishing this pest from nearly allied harmless native species.

Economic entomology is becoming more and more biological in its methods, and so is demanding increased biological experience on the part of those who come up from the colleges. Biological control is not new, but is having a new emphasis. Control of a harmful species by means of its parasites and predaceous enemies demands a knowledge of a vast array of biological factors; a knowledge of foods and feeding habits, of baits and repellants; a knowledge of sex and of breeding habits, of eggs and reproductive capacity; a knowledge of life cycles, times and seasons, in very great detail; a knowledge of parasitism in the large and in particular; and of general ecological relations. The biological method is nature's method. It is the method of the future, in all really difficult

cases, when the slapdash, temporary applications of poisons are not adequate. And so the entomological training of the future must provide increase of training in biological methods. The coming of entomology into its own by reason of valuable service rendered to agriculture has been accomplished by the development of more efficient and business-like methods in the application of control measures to crop saving. Extension teaching has made the latest knowledge generally available. Producers have systematized their control work. Insecticides have been standardized. Spray calendars and dosage tables have been devised. Machinery and equipment for large-scale operations have been evolved. All this has reacted upon the teaching of economic entomology. The use of these things must now be taught.

Hitherto our chief concern about insects has been to destroy the harmful sorts. We are beginning to employ parasites and predators to do this work for us. We are raising these useful forms, giving them care and protection, relieving them in part of the struggle for existence and securing their increase, and we are distributing them among our crops at the times and seasons when they can do the most good. But we have as yet given little attention to the raising of other useful forms. Aside from the honeybee there is hardly another species in this country that is commonly raised for its product. Recent ecological studies have shown, however, that certain herbivorous insects are worthy to rank with the ruminants and the rodents as nature's chief agents for the turnover of vegetation into animal flesh for the feeding of the carnivorous hosts of the earth. Recent trials have proven that the larvæ of mosquitoes and midges are efficient consumers of certain organic wastes, and may themselves be economically grown as food for black bass and other fishes. A number of progressive fish hatcheries have already introduced this practice as a regular part of their operations. Experiments are going on with quick-growing terrestrial herbivorous forms that bid fair to add a new chapter to the textbooks of entomology of the future, a chapter on the raising of insects as food for other animals.

Chapter IX

ANIMAL HUSBANDRY

By F. B. MUMFORD

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The most significant development of animal husbandry instruction in recent years has been in the direction of greater specialization. In the beginning the subject matter included under dairy husbandry and poultry husbandry was usually organized in the department of animal husbandry. At the present time there are a large number of institutions having separate departments of animal husbandry, dairy husbandry, and poultry husbandry. In those institutions having a department of animal husbandry as distinguished from dairy husbandry and poultry husbandry, there has developed a tendency to specialize still further by dividing the subject matter into a breeding phase, a nutrition phase, and a stock-farm management phase. In connection with the stock-farm management phase, many institutions now have specialists in horse production, in beef production, in sheep production, and in swine production.

This minute classification and specialization of subject matter has undoubtedly resulted in better teaching, although the criticism may be urged that extreme specialization in animal husbandry departments has a tendency to encourage extreme specialization in our livestock farming. It is true, however, that in a growing subject like animal husbandry the method of specialization which confines the activities of one specialist to one kind of animal does give him an opportunity to become an authority in his special subject.

The subject matter of animal husbandry has been greatly improved in the last decade. Through research in the agricultural experiment stations and interest in biological research in institutions not strictly agricultural, the content of animal-husbandry courses has been greatly enriched. These researches, also, have tended to make the instruction in animal husbandry far more fundamental. More and more emphasis is placed upon principles and less and less upon "rule of thumb" methods.

Animal husbandry instruction has also benefited through the elimination of irrelevant material which in the past has often cumbered the lectures of animal husbandry teachers.

The most obvious improvement in animal husbandry teaching during the decade has been the expansion and extension of equipment. Large investments have been made in buildings, shelters for livestock, and in the very best types of animals. The land-

holdings of all agricultural colleges have been increased, often primarily for the purpose of making it possible to keep larger numbers of animals, in order that the best possible animal husbandry instruction may be given to students.

It is also to be noted that the preparation of livestock, having in mind its educational use, has greatly improved. It is true that at all the leading colleges of agriculture one will find representatives of leading breeds of livestock. At one institution there are maintained 400 animals belonging to 20 distinct breeds. This has greatly increased the cost of animal husbandry instruction, but has made it possible to give thoroughly good training in every line of animal husbandry.

The preparation for college of students now working in animal husbandry has improved during the decade. The students are better prepared to do fundamental work in breeding and nutrition lines than ever before. It is therefore possible to strengthen the courses in all animal husbandry subjects.

It is to be observed that the curricula planned for the purpose of training men primarily for animal husbandry work are better organized and accomplish their purpose much more thoroughly than in the earlier years of agricultural teaching.

The teaching of animal husbandry has come to be very closely associated with the practice of livestock production. The instruction in animal husbandry is very practical. The students are taught the things they need to know in order to breed, feed, and properly develop livestock for every purpose. By reason of this fact, animal husbandry teachers have commended themselves and their work to practical livestock men, perhaps to a greater extent than have the teachers of some other subjects. This, however, may have been accompanied with too great emphasis upon the immediate practical applications of scientific principles and of tried methods, and a corresponding decline or lack of attention to the more fundamental subjects of physiological chemistry and of genetics. There is apparent a tendency on the part of institutions to regard the department of animal husbandry merely as a so-called practical department for the teaching of stock-farm management and to organize the work in genetics and animal nutrition in separate departments. It is, in the writer's opinion, an unfortunate tendency; particularly is it to be so considered from the standpoint of the development of the subject matter of animal husbandry.

The progress of the sciences concerned need not be less rapid by inclusion of the research upon which the subject depends within the departments of animal husbandry. It is certain that such inclusion will result in a more scholarly point of view on the part of the

instructors in animal husbandry and a higher appreciation of the fundamental importance of scientific research.

The departments of animal husbandry have also concerned themselves far more generally with the public phases of their subject. They have interested themselves in livestock shows, judging contests, sales of breeding animals, and have otherwise come to have a not unimportant relation to such public activities. Such activities are to be encouraged, provided they are not permitted to interfere with high standards of efficient teaching and fundamental research.

On the whole, the progress of animal husbandry teaching in the past decade has been very considerable. This is especially true in the content of the subject matter and in the methods of presentation. There have been very important additions to the science of animal husbandry through research in genetics, animal nutrition, and in stock-farm management. The subject has thoroughly established itself as one of university grade and of the greatest possible value to the industry of agriculture.

Chapter X

DAIRY HUSBANDRY

By H. A. Ruehe

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Those engaged in the educational side of dairying realize that there have been many changes, not only in the teaching of this subject but also in the subject matter taught. If one studies the catalogues of the various agricultural colleges, in most cases it will be noticed that there have been many new courses that have been added to the dairy curriculum. But the descriptions of these courses fall short in giving detailed information as to the real changes that have taken place. It is hoped that this brief résumé, although not complete, will set forth some of these changes in a way that will call attention to the fact that the teaching of dairy subjects has made rapid strides during the past 10 or 12 years.

The dairy industry, both the production and manufacturing phases, has changed a great deal during this period. Along the production side there has been an improvement in the breeding, feeding, and management of the herd. There has been an increase in dairying as a side line among farmers whose main activity is not dairying but some other system of farming. Economic factors have called attention to the fact that in many sections diversified farming is

more advantageous than specialization on one crop. This is true not only from the standpoint of cash returns to the farmer but from the standpoint of the fertility of the land and the permanency of agriculture as well. In the manufacturing of dairy products, there have been many changes since the year 1910, besides the development and growth of certain branches, such as ice cream, powdered milk, etc., and the great trend from farm to factory in the butter-making industry.

All of the changes in the commercial side of dairying have reflected somewhat on the educational side, so that it has been necessary to institute new courses and revise old courses, in order to meet the needs of the students. Furthermore, the commercial world has been on the lookout for men well trained in dairying and the fundamental sciences allied to it; and also those trained in the economic and business aspects of the industry. This demand is recognized by students and they have been preparing themselves for such positions. Furthermore, the great demand for research work both by commercial and educational institutions has made it plain that the dairy student must receive training in the fundamental sciences underlying dairying.

In answer to a questionnaire sent out to various dairy departments, one answer summed up the situation, as follows:

> Previous to 1910, the teaching of dairy subjects was dependent upon the practical experience of the instructor; that is, the interest developed in any course was dependent upon the practical experience of the instructor. This is still true to a certain extent. But this practical experience must now be supplemented by a good training in the fundamental sciences. The foregoing is true due to other development of our knowledge of chemistry and bacteriology as applied to dairy products, and to the development of genetics and animal nutrition as applied to the breeding of dairy cattle.
>
> In the development of our courses in dairy subjects, provision must be made and is being made to prepare our students with the foundation of fundamental knowledge in order that they can interpret the practical things that develop in their line of work. We can not go far into dairy subjects without being confronted with subjects pertaining to genetics, physiological chemistry, and bacteriology.

In short, as the foregoing quotation implies, previous to 1910, the courses were designed and planned to teach a student a trade—to be a butter maker, or herdsman—rather than the scientific phases of dairying, as they are now considered. Formerly emphasis was placed on *how* a thing was done; now stress is laid on *why* it is done.

The type of work covered by courses, as given in a number of our leading agricultural colleges in 1910, can be classified under the following headings:

> 1. Dairy production: (*a*) Judging; (*b*) feeding; (*c*) breeding (not Mendelian); (*d*) management of the herd.

2. Dairy manufactures: (*a*) Butter making—(1) Farm butter making; (2) creamery butter making. (*b*) Cheese making—(1) Various varieties of hard and soft cheeses. (*c*) Testing—(1) Babcock test for milk, skim milk, cream, butter, and cheese; (2) acidity testing; (3) lactometer readings and determining solids by formulæ; (4) butter analysis, rapid methods for moisture and salt. (*d*) City milk supply.

3. Bacteriology. But few institutions had courses in bacteriology, and such courses were of a more general nature than some now being taught in dairy bacteriology.

4. Graduate study. There were few courses offered in graduate work; relatively few institutions offered such courses, and then only from one to three courses were available.

Previous to the year 1910 most dairy departments were relatively small, having from 3 to 10 members. There were but one or two men with doctorates; a goodly number with masters' degrees; but by far the greatest number had only bachelors' degrees. There were, also, a few that had no collegiate degree. In general, there was but little encouragement for students to pursue graduate study beyond that required for a master's degree. In contrast to this, let us consider the dairy faculties of the year 1922. In the leading agricultural colleges the departments are composed of from 5 to 24 members. There are about equal numbers of men with advanced degrees and bachelors' degrees, and practically no members without collegiate degrees. There are a number of members with doctorates, some departments having as many as six with this degree. It would seem that it is self-evident that the dairy faculties of to-day are much better trained fundamentally than were the faculties previous to 1910. Furthermore, the development of courses for graduate study in some institutions is rather conspicuous, especially as regards to the subject matter offered and as to the number of graduate students in dairy husbandry.

Regarding dairy production, there is not a great deal of difference in the general subjects which are being taught. However, there has been a great deal of improvement in the subject matter taught due to the vase amount of information brought forth by research, and also due to the fact that many of those teaching these subjects are better trained in the fundamental sciences underlying the general subjects. The students in dairy production are electing more courses in zoology, physiological chemistry, animal nutrition, genetics, and economics now than was formerly the case. This is indicative of the fact that the subject matter taught in the dairy courses creates in the student a desire for further fundamental information, and, furthermore, he sees the necessity for such training. Some dairy departments have instituted advanced courses in applied genetics and dairy cattle nutrition.

In dairy manufactures a number of courses have been added. These include courses in ice-cream making, milk condensing, factory management, dairy mechanics, dairy bacteriology, and dairy chemistry.

In addition to these changes in the curriculums of dairy manufactures the students specializing in these subjects, as well as the students in dairy production, and also in general agriculture, are electing more of the fundamental courses especially along the line of economics, business organization and operation, chemistry, bacteriology, and other fundamental sciences. They are taking these courses not only from the standpoint of becoming more fundamentally trained, but also from the standpoint of preparing themselves for graduate work.

Just what sort of a dairy curriculum will best meet the demands of the commercial dairy industries can be shown by presenting the recommendations of a joint conference of the committee on agricultural colleges of the International Milk Dealers' Association and representatives of the dairy departments of 10 agricultural colleges. This conference was held in Minneapolis, October 8, 1922, for the purpose of discussing the problems of training men for milk-plant work, and the following recommendations were prepared:

It is the desire of the agricultural colleges to be of greatest service to the market milk industry. It is believed that this service lies along two general lines—that of solving industrial problems and that of training men.

We also feel that more attention should be given by the agricultural colleges to the problems of the milk dealers. In accomplishing these ends the agricultural colleges desire the closest cooperation with the milk dealers so that the problems of both may be mutually understood.

The present suggestions are concerned with the development of men prepared to grow into the broader responsibilities of the business rather than the training of routine workers.

The aim of this training is to lay a foundation of a thorough knowledge of the fundamental sciences, together with training in their application, to the market milk industry.

Such men should rapidly grasp the details of commercial problems and operations as they occur in milk plants.

It seems to us that it is the duty of the milk plants to develop these technically trained young men into real milk plant experts.

The course of study which will best fit men for responsible positions in milk plants should include a thorough training in the fundamental sciences coupled with as much applied work as the student's time will permit.

The fundamental sciences should include chemistry, physics, and bacteriology, each to be followed by courses making clear their application to the market milk industry.

The applied courses should include work in market milk, butter, cheese (including fancy cheeses), ice cream, condensed milk, powdered milk, dairy by-products, and dairy machinery.

The instruction in these courses should be directed toward showing the application of science to these subjects as well as to develop manual skill.

Special attention should be given to the subject of economics. The work in this field likewise should include training in both fundamentals and their application to dairy problems.

During the senior year there should be a course in milk-plant management which should bring together and coordinate the previous teaching in scientific and applied courses.

We feel that the milk companies can render valuable assistance in the better development of good men by making it possible for students to get experience in milk plants during the summer months.

As far as the writer is aware, the conference referred to above is the first attempt on the part of an industrial dairy association to meet with a group of college dairy department representatives for the purpose of assisting in formulating a dairy curriculum that would best train the student for commercial work. Other branches of the industry may attempt similar conferences. However, the above recommendations, with slight changes, should apply to all branches of the dairy manufacturing industry. A few of the leading dairy departments are practically meeting these recommendations, and other departments will also as rapidly as their circumstances will permit.

In spite of the fact that our courses in dairy manufactures have been improved a great deal during the last decade, it may be said that, in many instances, the teaching of dairy departments has not kept pace with the rapid development that has taken place in commercial dairy industries. A great deal of valuable research work in dairying has been done by commercial organizations. This has been made possible largely because commercial concerns have offered greater salaries and other inducements than those offered by educational institutions, and hence have secured the services of some of the leading investigators. Consequently, the colleges have been confronted with the task of continually training staff members, many of whom have left educational work at a time when they were just trained to the point of undertaking research work.

Perhaps something should also be said of the short course work that has been given during this period. Most departments have continued giving short courses in the dairy manufacturing subjects, especially butter making, and in some institutions cheese making. The demand for training in the manufacture of ice cream has developed among short-course students during the past decade, whereas previous to 1910 there was little of this work given. In many institutions there has been a decrease in the number of short-course students in butter making, although there is still a demand for such training. Some of the middle western institutions have given special courses of from one to four weeks, for creamery fieldmen. This has been especially true in those States where the commercial creameries

have developed the cream station method of purchasing cream. These fieldmen's courses have developed since 1917.

The short courses given in dairy production have continued to emphasize herd selection, breeding, and feeding. Special emphasis has been stressed on economic milk production, since the high price of feedstuffs has forced milk producers to take cognizance of the fact that they must select their economical producing cows and feed them properly with the most economical balanced ration. It has been pointed out to them that since they can not control the selling price of their product, the only alternative which they have toward increasing profits is to decrease cost of production. Good management will force down the cost of production and increase the net returns, whereas poor management will raise the cost of production and decrease the net returns.

What is the relation of the educational output of the dairy departments to the economic situation of the dairy industry in the United States? That is a fair question, and it should be answered both from the standpoint of quantity and quality of output. The dairy industry to-day, like other industries, realizes as never before the value of well-trained men. This is true with both the production and manufacturing phases. To be successful in either line, men must be able to think and reason, to find their problems and formulate the correct solution, and then work it out to a conclusion. This is true with the purely technical side of the business, and it is equally true with the strictly business side of the enterprise. It is impossible for any one to get ahead of the development of an industry by merely training along with it, he must devise some "short cut" so as to gain ground faster than the industry. It seems only logical that the "short cuts" are embodied in a thorough training in the sciences which are fundamental to the dairy industry. If our students are trained in these sciences and in addition are taught the application of these to the industry, together with the right kind of practical experience, then they will be meeting the requirements that the industry is setting forth. The men who lack the basic training are not the men who will be sought to serve in leading positions. The future of dairying like that of other industries will be a future of well-trained men.

As to the question of the quantity of output meeting the needs of the industry, this can probably be best answered by asking a question. "Are our best dairy students in want of positions?" This is not the case, but on the other hand, many positions have been referred to departments which they can not fill. Furthermore, many concerns are just beginning to realize the value of scientific training, so that there is little doubt but that the future will bring even a greater demand then now exists for well-trained men.

What does the future hold for the dairy departments? This question might well be supplemented with another. What should be the future purpose of dairy departments? It seems that the duties will be twofold, to train men for teaching and research work, and to train men to fill the demands of the commercial interests. In either case, the men, as indicated above, will have to be well trained not only in the applied subjects of dairying but in the sciences which are fundamental to it. Many of the students will not pursue graduate study but will enter commercial work immediately after completing their undergraduate studies. Therefore, they must get their scientific training during the time they are in college, and our curriculums should be built up accordingly.

The curriculum for the men who intend to follow teaching and research in dairying should be such that they can pursue graduate study without "going back" to make up the undergraduate work which is prerequisite for the line of graduate study which they intend to follow. However, care should be taken to see that this class of students receive proper training in the applied courses in dairying, and also that this is supplemented with adequate practical experience, so that they will have the vision which is necessary for research and for the training of future students.

All departments should cultivate a close contact with the dairy interests in the State. This relationship is extremely valuable. It keeps both students and faculty in touch with the progress of dairying in the State, and provides means for placing students where they can get the necessary practical experience during their summer vacations and permanent positions upon the completion of their college course.

Chapter XI

VETERINARY EDUCATION

By V. A. Moore

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Veterinary education began in the United States about 1857 in private schools. Their apparent purpose was the instruction of students in the available knowledge of animal diseases and in the treatment of sick and injured horses. They were not concerned with research. With the development of animal husbandry the losses from diseases among food-producing animals became a matter of much economic significance and the veterinarians were not prepared to treat successfully sick cattle, sheep, and swine. There was,

therefore, a very practical and pressing need for information on the nature of animal diseases and for schools that would prepare more adequately veterinary practitioners.

The opportunity for taking up such research came with the establishment of the land-grant colleges. In several of them a veterinarian of high attainment was secured to direct the study of animal diseases. Courses of instruction in comparative anatomy, physiology, animal parasites, and practical medicine and surgery were given for the benefit of the students in agriculture. Strong "departments of veterinary science" were developed in a number of these institutions. The work was so thorough that a veterinary degree was given to a few graduates. It is of interest to note that Dr. Daniel E. Salmon, who later was instrumental in the organization of the Bureau of Animal Industry in the United States Department of Agriculture, received in 1872 a veterinary degree from a land-grant university where, as a student, he specialized in veterinary subjects. A few others received a similar degree, but the practice was soon discontinued until separate veterinary faculties were organized.

The appearance in this country of such destructive diseases as contagious pleuropneumonia in cattle, epizootics of foot-and-mouth disease, and the steadily increasing annual losses from various maladies, especially among dairy cattle and swine, were convincing evidence that there should be veterinary schools with adequate equipment for teaching and research. The demand for practitioners in the rapidly growing cities likewise gave occasion for the opening of numerous proprietary schools. The animal husbandry of the country, however, required men trained in the diseases of food-producing animals. In the absence of endowments for this purpose, satisfactory schools could not be equipped and maintained from the fees the students alone could pay. In Europe veterinary education, from its beginning in 1762, had been a state responsibility. With this as a precedent, and a desire to meet the requirements, a few of the veterinary departments in the land-grant colleges organized separate faculties to teach veterinary medicine. The first of these was in the Iowa State College where, in 1879, a definite course was outlined and a veterinary degree provided. About 1888 the veterinary department in the Ohio State University had developed into a school of veterinary medicine under the management of the president of the university, the head of the veterinary department, and two others. In 1895 the school was made a college with a dean and separate faculty.

In a few States special acts of the legislature created State-supported veterinary colleges and placed their management with the

trustees of the land-grant institutions. The New York State Veterinary College at Cornell University was the first to be established in this way. In the land-grant institutions it was arranged that the existing departments, such as animal husbandry, botany, and chemistry, should teach veterinary students these subjects. By such cooperation it was possible to provide comprehensive courses of instruction in veterinary medicine at the minimum cost. From the passage of the Morrill Act, in 1862 to 1910, veterinary faculties or separate veterinary schools were organized in connection with eight of the land-grant colleges, and one under the auspices of an endowed university.[6]

Veterinary schools organized in connection with land-grant colleges prior to 1910

Land-grant college	Location	Name of school	Year
Iowa State College	Ames, Iowa	Division of Veterinary Medicine	1878
University of Pennsylvania	Philadelphia, Pa.	School of Veterinary Medicine	1884
Alabama Polytechnic Institute	Auburn, Ala.	do	1893
The Ohio State University	Columbus, Ohio	College of Veterinary Medicine	1895
Cornell University	Ithaca, N. Y.	New York State Veterinary College	1896
The State College of Washington	Pullman, Wash.	College of Veterinary Science	1898
Kansas State Agricultural College	Manhattan, Kans.	Division of Veterinary Medicine	1905
Colorado Agricultural College and Experiment Station.	Fort Collins, Colo.	Division of Veterinary Medicine (first 2 years only).	1907
North Dakota Agricultural College.	Agricultural College, N. Dak.	School of Veterinary Science (2 years only)	1909

In addition to the State veterinary schools, there were, in 1910, twelve privately owned institutions for teaching veterinary medicine. Much credit is due to the pioneer private schools. They undertook a very necessary work and several of them tried earnestly to build up institutions that would be a credit to veterinary education. The organization of the Federal meat inspection service in the United States Bureau of Animal Industry, in 1891, stimulated the opening of several private schools to provide veterinarians for the Federal Government as well as for practice.

There were in 1910 a total of 2,717 veterinary students in the United States, of whom 706 graduated in 1911.[7] Of these 219 were in State schools and the remaining 487 in proprietary institutions. There was a decided difference in the entrance requirements and the length of the course between the State and the proprietary schools in 1910. The State colleges required a preliminary high-school education or its academic equivalent for admission and a professional course of either three of four full academic years. The proprietary

[6] The veterinary college at the University of Pennsylvania is the only one of this class. It received State aid for the construction of its buildings, and it is supported in part from funds appropriated by the State legislature to the University of Pennsylvania, and in part from endowments.

[7] Professional Schools, Bureau of Education, 1911 and 1912.

schools had only grade school entrance requirements and the length of the course was two or three years of from five to seven months each.

Since 1910, three veterinary schools have been established at State agricultural colleges, as follows: The Division of Veterinary Medicine, organized in the Michigan Agricultural College, East Lansing, Mich., with a dean and separate faculty in 1911; a School of Veterinary Medicine, established in the Agricultural College of Texas, College Station, Tex., in 1916; and, in the same year, the Division of Veterinary Medicine, in the University of Georgia, Athens, Ga. Veterinary education received important aid during the World War. The War Department and the Bureau of Animal Industry in the United States Department of Agriculture required that all veterinary colleges whose graduates would be eligible to employment by those departments of the Government must have entrance requirements equal to graduation from a recognized high school and a professional course of four academic years. These requirements were in harmony with those of the State schools, but the privately owned ones could not satisfy these demands, and consequently eight of them closed.

There are at present 12 State[8] veterinary colleges, one of which gives but the first two years of the course and three privately owned schools. However, the entrance requirements and the length of the course are announced to be the same as those of the State schools. The equipment is inferior.

The total number of veterinary students in the United States decreased from 2,717 to 2,487 in 1914. There was, however, at this time a gradual increase in the number of students in the State colleges, which was in marked contrast with the tendency during the preceding decade when the number of veterinary students, largely in the proprietary schools, increased from 362 to 2,717. The growing demand for veterinarians in the country districts and the coming of the automobile, which reduced rapidly the number of horses in the cities, were the essential factors that turned the tide of student prosperity from the private schools and stimulated larger attendance in the State colleges.

In the period from 1910 to 1917 there was an earnest and persistent effort on the part of the State schools to raise the standard of veterinary education to a plane that would adequately prepare men for veterinary service. As the proprietary institutions had not required such educational preparation, the opinion became widespread that it was not necessary. It was a slow process, therefore, to convince the public that it was essential for practitioners to have

[8] This includes the School of Veterinary Medicine at the University of Pennsylvania.

a cultural education and a thorough technical training to prepare them to diagnose, treat, and control animal diseases. This made progress educationally difficult and often discouraging. However, the State schools were united on an educational policy when, during the World War, the action of the Government relative to veterinary education brought about the desired advances.

At the close of the war, a condition of affairs was precipitated that tended to react against the veterinary profession. This is reflected chiefly in the pronounced reduction in the number of students that have matriculated. The registration of veterinary students since 1919 is given by years in the appended table.

Date	Freshmen	Upperclassmen	Total
1919-20	234	488	722
1920-21	140	473	613
1921-22	150	401	551
1922-23	151	380	[1] 531

[1] This does not include the few students in the three remaining schools.

The foregoing table shows a registration of but 531 students at the present time and but 613 in 1920. This is nearly 400 per cent less than at the beginning of the World War in 1914, when the registration was 2,481. The effect on the animal husbandry of the country of this reduction in the number of veterinarians may be serious. The losses from sporadic diseases and injuries are heavy at best, but with restricted veterinary service they will be much greater. However, it is likely that as soon as the shortage is realized a sufficient number of men will be attracted to the work. The explanation for the great reduction in veterinary students may be found largely in three conditions.

The extensive use of motor cars has eliminated most of the equine practice from the cities. As a result a large number of veterinarians found themselves without sufficient clients and consequently they looked upon veterinary medicine as a profession that has outlived its usefulness. Their training had been for the most part in the treatment and care of horses, their homes had been in the cities, and they wished to stay there even if they were obliged to engage in other business. In these circumstances they did not encourage young men in the cities to study veterinary medicine as a profession.

The economic situation following the armistice has not made country practice especially attractive. The rapid drop in the price of livestock and dairy products and the slow decline in the cost of articles required by farmers tended to develop considerable indiffer-

ence on the part of livestock owners to veterinary service unless the sick animals were especially valuable. This condition was reflected in the reduced volume of work that came to practitioners, and many of them became dissatisfied with their calling. It is not to be expected that they would advise young men to take up veterinary medicine as a life work.

A third factor that discouraged temporarily many practitioners, even to the point of their leaving the profession, was the extension of the accredited herd plan of dealing with bovine tuberculosis from the purebred herds, for which it was adopted originally, to all cattle. As this plan provided free tuberculin testing, it took away in many instances a large percentage of the professional work that was being done by practitioners. Many veterinarians interpreted this invasion by the Government of their field of service as an indication that disease control and livestock sanitary work were to be carried out by public employees. This would leave, in many localities, too little professional work to support a practitioner. The veterinarians who were doing considerable testing, and many of them were, advised young men of the limited opportunities in this field. They felt keenly the discrimination that was made by Government and State officials against practitioners, especially those who had satisfied all the technical educational requirements and had gone into practice to render a real service.

Notwithstanding the disturbing influences, which are believed to be temporary, the outlook for the veterinary profession is brighter than at any previous time. The veterinary colleges are no longer schools to prepare men to diagnose and treat the ills of individual animals alone. They have become institutions where not only instruction in animal diseases and their treatment is developed highly but also where animal hygiene and sanitation, animal husbandry, dairy and meat inspection, and the relation of animal diseases to public health are given proper consideration. The veterinarian must cease to be merely a doctor, a "tinker" of sick and injured animals. He must become the leader in the animal husbandry of his community and the protector of the human family from the diseases of animals communicable to man. His services are needed constantly by the livestock owners to solve the problems in breeding and feeding to the end that the losses from disease may be lessened.

Now that veterinary education has come to be a State function, added responsibilities are placed on both the schools and the livestock sanitary authorities of the respective States. Further, it is clearly before the State authorities to provide these schools with adequate facilities for teaching and research. As the States have assumed, and properly so, the maintenance of veterinary education, it is important that the graduates be protected and utilized as much

as possible by the States in the suppression of animal diseases. Veterinarians who have secured a professional education, largely at the expense of the public, are under obligations to render efficient service in return, and usually they are very glad to do so. Those who fail to meet this obligation should be eliminated from the profession.

The problems in veterinary education, however, are not solved by providing material equipment. The schools must teach all the subjects necessary to qualify their graduates to do efficiently their professional tasks. The efforts of the practitioner are being judged by a public far better qualified to pass on the qulality of his work than it was before the advent of the land-grant colleges. The employers of veterinarians are often thorough students of breeding, feeding, hygiene, and the principles of preventive medicine. Therefore, they are intelligent judges of the character of the service rendered by the practitioner. In these circumstances the mapping out of a course of study, broad enough in its range of subjects and thorough enough in the details of each, to equip the student to meet the present-day demands, is a difficult task when the preparation is only a high-school training and the curriculum but four years. The next advance will be either lengthening the course or requiring better preparation in the basic sciences.

Another problem that confronts veterinary educators is the inability of practitioners to specialize beyond a limited extent; as a rule, veterinarians must do a general practice. To render service, they must deal with all the diseases of all species of animals in their community. Further, the veterinarian who serves a community must usually go to his patients, and there are not sufficient cases of a single disease in a restricted locality to support a specialist. As a rule, the dominating species of animals in a community determines the extent of specialization of the practitioner who serves it. The colleges, therefore, must furnish instruction adequate for all the so-called specialties and include it in the regular course.

A brief survey of the number of livestock in the United States their value, and of the losses that accrue to the industry as a result of various diseases, will place in somewhat bold relief the economic question with which the veterinary profession has to deal. In 1910 there were in the United States 207,691,207 animals, with an estimated value of $4,925,173,610. There were 11,552 veterinarians, or one for 17,978 animals, valued at $413,494. In 1920 there were 198,300,078[9] animals, valued at $8,013,324,808. According to the estimate made recently by Dean White there are 8,692 veterinarians in the United States, or one for 22,814 animals, valued at $912,560.

[9] The decrease is largely in sheep where there has been a reduction of over 17,000,000.

This does not include pet animals and poultry. There are 370,000,000 fowls, among which losses from disease are very heavy. Likewise, a considerable number of veterinarians are engaged in the treatment of pet animals. It is estimated conservatively that there is an annual loss of 3 per cent from disease and injury to animals, and that two-thirds of it is preventible. This means an annual loss of more than $250,000,000, of which $171,000,000 can be prevented when the country has an adequate number of properly trained veterinarians distributed throughout the livestock districts. The efficient control of the communicable diseases depends upon the extent of cooperation between the practitioners and the livestock sanitary authorities.

Another important fact that has been brought out during the past few years is the heavy losses caused by the so-called sporadic diseases. Attention has been called repeatedly to the destruction of animal life by infectious maladies and epizootics, but little has been said about the inroads of the more common ailments that, in the absence of competent veterinary service, would cause very heavy losses. A questionnaire sent to a number of practitioners in New York State revealed the fact that on the average about 80 per cent of the services of veterinarians in that State is required for sporadic diseases and injuries, and that the major portion of the deaths among animals are due to these causes. The conservation of animal life, therefore, depends to a large extent on the local practitioners.

There is not a standard curriculum for veterinary schools. It is not likely that it would be found desirable, because of local conditions and needs. There is a committee of the American Veterinary Medical Association, consisting of the deans of the State colleges, working on the course of study. It will determine how far uniformity may be had in subject matter. The rapid growth of knowledge of animal diseases and methods of sanitation has forced upon the veterinary colleges a problem of selecting subject matter for a curriculum that is most intricate and complex, in order to provide the instruction necessary to enable a graduate to function efficiently and to give him the proper relationship to animal husbandry and public sanitary measures.

In the future the ranks of the veterinary profession will be supplied with men who, from their general education and technical training, should render more efficient service. The nature of the work demands scientific training on the part of its artisans, and the regulations of the schools and requirements of the State licensing boards preclude the admission to legal practice of persons who have not had such preparation. This is a great victory educationally.

The faculties are made up of well-trained men who devote their entire time to teaching and research. Methods of instruction are being carefully studied and improved. The legislators have come to

recognize the importance of veterinary service, and appropriations for the schools are increasing annually. The teaching of the practical subjects has been enhanced by the establishment of ambulatory clinics, whereby senior students are enabled to study cases on the farms and under the conditions they will meet later as practitioners. Clinical laboratories are maintained; well-planned exercises in surgical operations are required; thorough instruction in physical examination is given; and laboratory facilities in the basic sciences are generally good. As the veterinary colleges of to-day are integral parts of State or other universities, and governed by the same authorities, veterinary education to-day is on a par with that of the other colleges in the land-grant institutions.

Chapter XII

POULTRY HUSBANDRY [10]

By WILLIAM A. LIPPINCOTT

Professor and Head of the Department of Poultry Husbandry, Kansas State Agricultural College

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It is just past 20 years since the first formal course in poultry husbandry was offered at a land-grant institution. In the spring of 1892 Prof. James E. Rice presented a course consisting of lectures and practice periods at Cornell University, where poultry instruction has since continued without interruption under his direction.

The Connecticut Agricultural College, then located at Mansfield, now at Storrs, included a course in poultry husbandry as a requirement in the sophomore year of the agricultural curriculum in 1896, and Utah Agricultural College offered a course of college credit the same year.

It is probable that the subject-matter taught in these pioneer courses would hardly be recognized as of collegiate grade at the present time. They were distinctly vocational in purpose, teaching how rather than why, and profit rather than training for thought was the goal. This was true in a large measure of most of the agricultural teaching at that time, and a true perspective in this regard has hardly yet been reached.

That these pioneer courses justified themselves in a large way, however, is shown by the fact that the work has been continued at these institutions, and that in 1922 the land-grant institutions of 45

[10] Free use has been made of the facts presented by Prof. Loyal F. Payne in an excellent paper entitled "Resident teaching of poultry husbandry in the United States," read before the thirteenth annual meeting of the American Association of Instructors and Investigators in Poultry Husbandry, New Brunswick, N. J., August, 1921.

States were offering courses in poultry husbandry. Though the courses have been multiplied, the emphasis has shifted, and a great deal of new material has been added. It is a tribute to the genius of Professor Rice as a teacher that not a widely used textbook on poultry husbandry has been written in this country and hardly a course has been offered which does not reflect the original course as he outlined it, not in content only, but in organization and illustration.

The great development in poultry instruction has come since the beginning of 1910. Prior to that year instruction in poultry husbandry was offered in 15 States. In addition to New York, Utah, and Connecticut, these were Rhode Island, Maine, Massachusetts, Minnesota, Pennsylvania, Montana, Kansas, Michigan, Indiana, Oregon, Iowa, and Wisconsin. Poultry investigational work was under way in West Virginia.

Formal poultry instruction began in New Jersey, California, Oklahoma, New Mexico, Georgia, and Maryland in 1910, since which time most of the States of the Union have established well-organized courses. In the majority of cases these courses are administered in separate departments of poultry husbandry, though in a considerable number of institutions a separate department has not been organized, and the courses are administered in one of the agricultural departments, usually by animal husbandry.

From necessity the subject matter finding its way into formal courses was at first the product of observation rather than experiment, and analogy rather than research. The lack of data pertaining to poultry sometimes led to the assumption of analogies between domestic birds and domestic mammals which more accurate observation and study have shown to be erroneous. As an example, in the early years the so-called wedge-shaped hen was put forth in the classroom as the proper egg type, an assumption apparently borrowed directly form the teachings of dairy husbandry regarding the proper type of milk cow. That there is less confidence now regarding a definite laying type—if by type is meant shape—beyond certain characteristics of vigor and capacity than there was then is a sign of healthy development. At the same time means of distinguishing the poor layers from the good have been worked out which are the basis of the nation-wide practice of culling farm flocks. Twenty years ago the actual numbers of eggs laid by individual hens were known in a comparatively few cases. Trapnesting, by means of which the production and progeny of each individual hen is made known, and now generally used in connection with experiments with poultry, was then in its infancy and few great producers had been intensively observed. And great producers according to present-day standards were then practically unknown. A

production of 300 eggs in a calendar year is hardly more rare now than a 200-egg production was 15 to 20 years ago.

The organization of egg-laying contests in many States, with accompanying studies of correlations between form and function, researches into the inheritance of egg production, and experiments dealing with feeding, housing, incubation, and other items of stock management, have furnished data which have supplemented and amplified the courses from year to year.

A conspicuous example of a subject hardly to be found in poultry courses five years ago is artificial lighting to increase the consumption of feed, and, in turn, the production of eggs during the winter months. Feeding by the use of artificial lights is also an example of a rather widely adopted practice taken up largely at the instance of the poultry departments of several land-grant institutions.

That the courses as now taught are not by any means wholly the product of the experimental breeding yard and feeding laboratory, however, is shown by the fact that the teaching in the various States is, as it should be, considerably colored by location. In some States, notably the extreme eastern and western, poultry production is taught from the point of view of specialized farms making poultry and eggs the main source of income. In many Central and Middle Western States the teaching is from the point of view of poultry production as an increasingly important phase of diversified farming.

With the amplification of the old courses has come an increasing tendency to multiply courses. Either the old general course is frankly broken up into specialized courses of more restricted scope, or it survives as a general and rather elementary course designed for all students in agriculture, and dealing with the common phases of poultry management, but is followed by more intensive and advanced courses in the several divisions of the general subject, such as breeding, feeding, incubating, marketing, business organization, disease control, and the like. The latter courses are intended for students specializing in poultry husbandry.

Insistent demand, and sometimes it is to be feared overenthusiastic efforts to "catch up" with longer established departments in their teaching, have at times led to the overmultiplication of courses, not because such courses are illogical or unnecessary for the well-rounded training of specialists, but because research has not yet had time to provide the below-the-surface view, which reveals why rather than how. They have been, sometimes, outline courses in the truest sense of the word, mostly outline. Such overmultiplication has, however, had the very wholesome and constructive effect of emphasizing to both instructors and students the urgent need of fundamental research, and the framework gradually is being covered.

The peculiar relation which poultry husbandry, in common with most of the agricultural subjects, bears to the farming public has had a marked influence upon the personnel of the teaching staffs. Personality rather than scholarship has been the criterion of selection. This fact is reflected by the tendency to keep the special courses as well as the general courses vocational in character, dealing in methods and practices rather than principles, and to evaluate material for the several courses on the basis of their immediate money-making value.

The teacher of the classics, it should be pointed out, has a comparatively simple educational problem. His aim, to be sure, ought to be at least threefold: (1) To impose mental discipline, (2) to make attractive a liberal culture, and (3) to develop character. The instructor in poultry husbandry, on the other hand, should share this threefold aim and in addition, at present, must teach a trade, train vocational teachers and county agents, carry on experiments varying from the more or less demonstrational to the fundamental, be able to stir around among people making friends and popularizing his work, and be an aggressive publicity agent, in the high hope that the public purse strings will be loosened and the appropriation for his particular line will be somewhere near adequate for its pressing needs and proper development. He must be at home in the classroom, in the experimental breeding or feeding yard, on the public platform, on the farm, and in the public press. He must maintain an office for the business administration of his department and the reception of visitors. (He ought to have a study and a chance to use it.) And from the exigencies of the situation down to the present time he must be money-minded. The students and the farming public are constantly and insistently demanding how to make money out of poultry. And he must constantly be searching for ways and means of getting money for the support and the development of his work.

It is small wonder that an increasing number of the most promising collegiates are turning aside from poultry educational and investigational work for the poultry business in one of its several phases. The getting of money has occupied a rather too prominent place.

The remedy for the situation is a reemphasis of the fact that poultry husbandry is worthy of a place in a collegiate curriculum only when it is a means to the ends of broadening the intellectual horizon, strengthening the mental muscles, and making for character, as well as of getting a living.

In the further development of special advanced courses in the several divisions of poultry husbandry, the threefold aim and prime purpose of education must be kept to the fore, with a full realization that an instructor does a student greater service when he acquaints

him with a principle rather than a practice, and a yet greater one when he persuades him to try thinking on his own account rather than advises him of certain facts. Happily there are signs of a reorientation in this regard, and "problem courses," whereby students must study out their own facts in order to solve certain problems, are increasing in number.

Unfortunately for the development of good teaching, talented teachers are rare and their successes largely unobserved. A good piece of experimental work easily gets before the public and comes to the notice of institutions searching for likely men. Word of a good piece of teaching, on the other hand, comparatively seldom gets beyond the walls of the classroom and still more seldom escapes the confines of the campus.

From the very beginning of formal instruction experimental work was undertaken. In most cases the work was at first more demonstrational than experimental, but served its purpose and led the way to more carefully planned and controlled work. This has aimed, for the most part, at immediately applicable and relatively superficial results, rather than at the truly fundamental. This situation persists at present and is likely to persist until agricultural teaching, using teaching in the broadest sense, finds itself as a medium of education rather than merely a means to a vocation. With a very few brilliant exceptions, the fundamental research that has been done with poultry has been carried on in other than poultry departments and by persons trained in one of the several sciences, rather than in poultry husbandry.

In investigation as in classroom instruction there should be somewhat of a redirection of aim. There always will be, as there should be, poultry experiments of an immediately practical nature in progress at most agricultural experiment stations. In the long run, however, practical applications are by-products of fundamental researches and the goal of poultry husbandry research should be the discovery of principles as well as the development of methods and practices.

Such a redirection of the aim of experimental work necessitates a better-trained personnel on the investigational staffs. The poultry investigator should have a training which brings expertness in at least one of the sciences underlying the practices of poultry husbandry without lessening his love of domestic birds, thus spoiling him as a poultryman, or so insulating him that he loses contact with people and everyday farm affairs. It should bring alertness to see possible relationships to poultry production of principles worked out with other organisms from mammals to protozoa, perhaps even the plants, and to point the way to their application.

The tendency of the next few years in investigation and also in classroom instruction will undoubtedly be toward specialization. If not carried too far it will be a hopeful sign.

It would be negligent not to point out that a proper development of poultry research necessitates a certain amount of protection of the researcher by his administrative superiors, from responsibilities which interfere with his best productiveness.

Most of the instructional and executive duties of staff members must be done at specified times, while those coming at irregular intervals press for immediate attention when they do come, and can not be put aside. Classes must be prepared for and met on schedule. Committee work should be ready at a designated time. Out-of-town lectures are set for definite dates, requests for information by mail must be answered with promptness and out-of-town visitors given the immediate attention they desire. Much of investigational work, on the other hand, can be done nearly as well at one time as another. It is one of the things that can wait and does wait. If the periods for taking records are definitely arranged for, opportunities for prolonged and intensive observation of the subjects experimented with, usually quite as important as the making of routine records, are likely to be crowded out. Nor is leisure for keeping abreast of the literature in all its ramifications provided.

A highly successful research program can not be carried forward under the situation as it usually exists, unless the investigator is assured of freedom from interruptions which will interfere with doing well such investigational work as he is allowed to undertake. And if fundamental research is to enlist and hold the interest of a fair share of the ablest men, means must be worked out by which a person giving a major part of his time to investigation may secure satisfactory recognition in rank and salary without being compelled to lay down his investigations for executive work.

Chapter XIII

AGRICULTURAL ENGINEERING

By J. B. Davidson

Professor Agricultural Engineering, Iowa State College

In the most comprehensive sense agricultural engineering includes all the various branches of civil, mechanical, electrical, and sanitary engineering, in so far as they are related to or identified with the industry of agriculture. In organization and analogy, agricultural

engineering is similar to mining engineering. Agricultural engineering treats of the following subjects: The mechanical equipment for the farm; the application of power to farm operations; the location, design, and construction of buildings and other farm structures; water supply and sewage disposal on the farm; the sanitation, heating, lighting, and ventilation of farm buildings; labor-saving equipment for the farm home; reclamation or improvement of land by the drainage of wet areas; the irrigation of land where needed, or by the removal of stumps or stones; road building, and certain phases of the manufacture of agricultural products, such as packing of fruit and the preparation of dairy products.

THE RELATION OF ENGINEERING TO AGRICULTURAL PROGRESS

The most significant feature of the progress of American agriculture during the past century has been the introduction of machine methods of production, not only on account of the greatly increased production of each farm worker, but also by reason of the income available from the increased production. It is only by making a comparison of production by hand implements and with modern machine methods that the change in the effectiveness of farm labor can be fully appreciated. A careful study of agricultural production would indicate that for the principal crops "the quantity of product is almost five times as great per unit of labor" as it was before the general introduction of machinery.[11] The effect on the farmer and the conditions which surround him are even of greater significance; much of the arduous toil of the farm is gone. The leisure time of the farmer is increased; his mental activity is stimulated; his home comforts are made possible and the desire for them developed.

The significance of agricultural-engineering subjects at the present time, and the rapid advancement made during the decennial period included in this report are indicated by data from the Fourteenth Census Report:

TABLE 1.—*Changes in machinery values, acreage, production, and personnel*

	1910	1920	Increase, per cent
Value of machinery and implements	$1,265,149,783	$3,595,317,028	184.2
Value of machinery and implements manufactured	146,329,000	536,945,000	267.0
Value of farm buildings	6,325,451,528	11,430,855,631	80.7
Land provided with drainage (acres)	----------	53,024,974	----------
Land irrigated (acres)	----------	19,191,716	33.0
Total persons, 10 years of age and over, engaged in agriculture, forestry, and animal husbandry	12,659,082	10,953,158	−13.5
Total production, 6 principal cereal crops (bushels)	4,482,264,450	4,482,656,812	----------

[11] Influence of Farm Machinery on Production and Labor, by H. W. Quaintance.

Even when allowance is made for the inflation of prices caused by the World War, it is clear from the above that there has been an advance in the use of farm equipment. Comparison with earlier census data indicates that this advance has been as rapid, if not more so, during the decade from 1910 to 1920 than at any other similar period in the history of the country. An increase in the production of the six cereal crops, with a reduction of the number of persons engaged in agriculture is also significant.

In addition to the large area of land now improved by drainage, it is estimated that an area of swamp land equal to the combined area of Indiana, Ohio, and Illinois may be reclaimed by drainage whenever the demand for more agricultural land makes its development financially and economically feasible. In like manner, the area of farm lands may be greatly increased by reclamation of arid land by irrigation, and of stump land by clearing.

EARLY DEVELOPMENT

Agricultural engineering has had a place in the agricultural college curricula since a very early period. An examination of the courses of study followed at Massachusetts Agricultural College, in 1867; at Cornell University, in 1868; and Iowa Agricultural College, in 1871, reveals that in each instance two or more agricultural-engineering subjects were included. At the Iowa Agricultural College, in the junior year of the course in agriculture published for the year 1871, "farm engineering," "road making," "water supply," "farm machinery," and "rural architecture" were listed. Agricultural engineering, however, did not develop so rapidly as its importance as part of the training of an agricultural student might warrant. All branches of agricultural instruction in the early period of agricultural colleges were committed to one man, and there was little opportunity for specialization. The development of agricultural engineering not only depended upon specialization on the part of the instructor, but also required a fundamental preparatory training of a different character than for the teaching of other agricultural branches. A period of rapid development began before 1910 when the larger colleges started to add agricultural-engineering specialists to the teaching staff, followed later by the organization of separate departments of instruction.

RAPID DEVELOPMENT OF SUBJECT FROM 1910 TO 1915

Owing to an increased interest, the most rapid development of agricultural engineering as a separate branch of agricultural instruction took place in the first half of the decennial period included in this report. A survey made in 1910 of the agricultural curricula

of the State agricultural colleges indicated that several among 48 of the State institutions placed little emphasis upon agricultural-engineering studies. It would not be fair to make a more definite statement, for, in many instances, the instruction was combined with that in other subjects, and therefore not easily recognized by an outside investigator. Five years later 48 institutions in as many States were offering definitely outlined special studies in agricultural engineering. In 44 institutions work amounting to an average of 7 semester credits was required, and in one instance as much as 23 semester credits. In addition, all institutions offered more or less elective work amounting to as much as 30 credit hours in one instance. Since that time there has been little expansion of the work but rather an improvement of the character of the work offered.

SELECTION OF NAME

Many terms have been given to the educational specialty here referred to as "agricultural engineering," and practice is not entirely uniform at present. Over three-fourths of the institutions having separate departmental organizations use the term "agricultural engineering." In several instances "farm mechanics" is used, and in a few "rural engineering." It is now quite general practice to apply the term "farm mechanics" to secondary-school instruction of the same character.

PRESENT SCOPE

The agricultural-engineering subjects or studies may be classified as follows: (1) Shop work; (2) drawing; (3) farm machinery; (4) farm motors; (5) farm structures; (6) farm sanitation (including water supply, sewage disposal, heating, lighting, and ventilation of buildings); (7) surveying; (8) drainage; (9) irrigation; and (10) miscellaneous subjects. The extent to which these subjects are required is indicated by the following table, prepared from data secured from the 1917–18 catalogues of the 50 State colleges by Chester D. Jarvis.[12]

TABLE 2.—*Agricultural-engineering subjects required for graduation in 50 agricultural colleges*

Subjects	Number of institutions requiring for graduation	Maximum number of credit hours required[a]	Minimum number of credit hours required	Median number of credit hours required
Shop work	28	13½	6	8¼
Drawing	17	5	1	3
Farm machinery and farm motors	29	7		3
Structures and farm sanitation	7	4½	1	2½
Surveying	21	5	1	3
Drainage and irrigation	15	6½	1½	3
General course	10	7		3½

[a] One credit hour = 1 recitation per week for 18 weeks or the equivalent.

[12] Bur. of Educ. Bul., 1918, No. 29.

It is to be noted that in 10 institutions the practice prevails of requiring a general study covering several subjects. In these institutions this general study is usually the only one required for graduation.

DEVELOPMENT OF A PROFESSIONAL COURSE

From the educational point of view two rather distinct developments of the subjects have taken place, guided and directed by the objectives sought. The first is that of agricultural engineering as a part of the training of the student preparing for agricultural production, and would include the application of engineering practice and methods to farm operations and construction. The other phase is that of specialization in agricultural engineering for professional service.

ADMINISTRATION

The administration of agricultural engineering has been something of a problem, owing to the general practice of separate colleges or divisions for agriculture and engineering instruction, with an opportunity for the difference of opinion as to how agricultural engineering should be classified. No doubt this problem of classification has been a retarding influence upon the development of the specialty. At the present time agricultural engineering is administered in the majority of instances as agricultural instruction, in a few instances as engineering instruction, and in five of the larger institutions a joint plan of administration is followed and seems to be gaining favor. It is evident that with any plan of administration, in order to secure development and efficiency of instruction, an inviting field of endeavor must be provided for the capable specialist with initiative and leadership.

OBJECTIVES OF INSTRUCTION FOR AGRICULTURAL STUDENTS

The question may well be raised as to the objectives sought in the instruction of agricultural students, for it is clearly recognized that every farmer can not become a trained engineer in addition to his general preparation for farming. On the other hand, a study of agricultural development, of the production of agricultural crops at the present time, and of the conditions which make for the well-being of the farmer indicates clearly that the execution of modern farm operations requires for economic production the application of engineering principles and methods. In many respects, the modern farm is not unlike a factory. It is obvious that the instruction in agricultural-engineering subjects should furnish such training and experience as will make for capacity and resourcefulness in the use

of mechanical equipment in carrying out farm operations, in the reclamation and improvement of land, in the construction of better housing for livestock, and in the building of more comfortable homes.

PROFESSIONAL AGRICULTURAL ENGINEERING

In addition to the general knowledge of engineering practice, which every farmer should have, there has been recognized an important need for a specially trained engineer prepared to render a special service in connection with the larger engineering problems connected with the development of the industry. Such an engineer should not only have a fundamental training in engineering science and art, together with a special knowledge of the special engineering problems of agriculture, but also a general knowledge of agricultural science, methods, and conditions.

Iowa State College, in 1910, offered a four-year curriculum leading to the degree of bachelor of science in agricultural engineering. Several institutions soon offered similar courses of study, until in 1920 at least six other institutions had such courses, viz, University of Nebraska, Kansas State Agricultural College, University of Missouri, Utah Agricultural College, Texas Agricultural and Mechanical College, and Virginia Polytechnic Institute.

These courses were made up of from 30 to 64 per cent of studies usually designated as engineering subjects, with a median of 47 per cent, and from 18 to 45 per cent of agricultural subjects, with a median of 29 per cent.

Over 200 students are now pursuing the professional agricultural-engineering courses offered by the foregoing institutions.

At several institutions where the plan of a general agricultural course, with an opportunity for a major in some department of instruction, is in practice, the privilege is offered to students to major in agricultural engineering.

It has been demonstrated that the graduates from the professional course in agricultural engineering have an unusual opportunity for service and find quite a wide range of employment. In the agricultural-engineering equipment industry they are employed as designers, or sales and advertising specialists; other graduates design and build farm structures as specialists for associations of commercial firms interested in the sale of building materials or as contractors. Many graduates become reclamation engineers in drainage, irrigation, or land clearing. In addition, there has been a continued demand for specially trained men for educational and experiment-station work.

The development of the professional phases of agricultural engineering is well indicated by the growth of the American Society of

Agricultural Engineers, a national professional society organized in 1910, and now having a membership of over 700.

SHORT COURSES

Many agricultural-engineering subjects lend themselves to special short-term courses of instruction. The rapid introduction of equipment, due to the shortage of labor during the decennial period of this report, occasioned an unusual demand for such instruction. Short courses in tractor operation were particularly in demand. Nearly every State institution is now called upon to offer one or more such courses during the year. The enrollment in these courses is large.

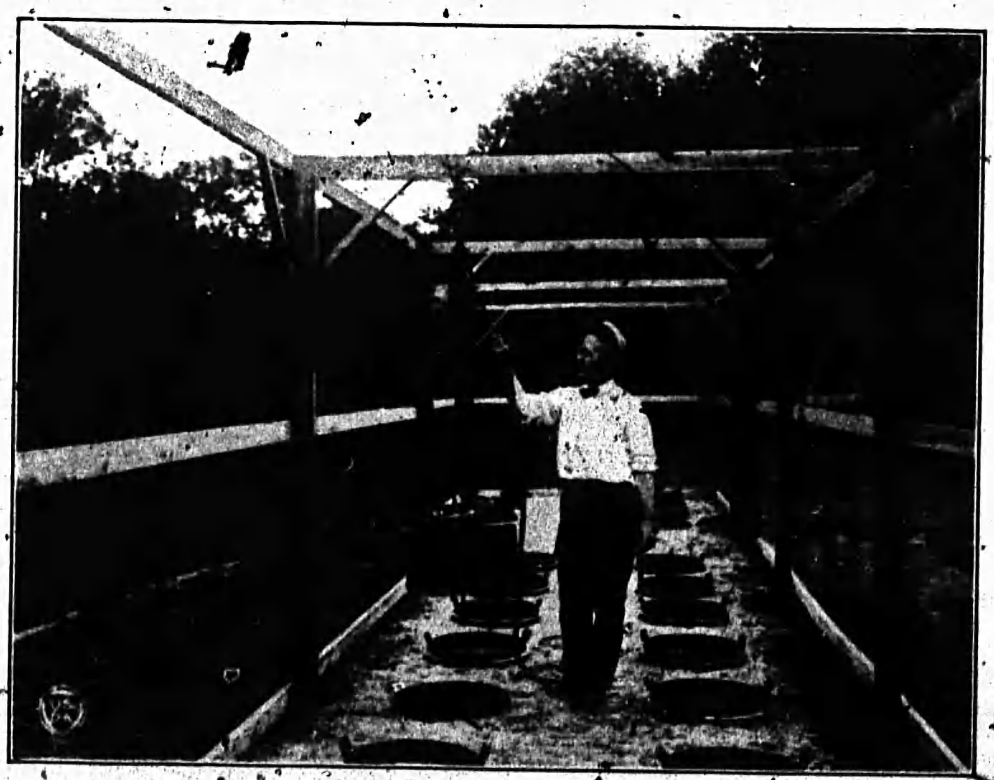
EXTENSION SERVICE

At the beginning of the decennium there was little effort upon the part of State colleges to furnish extension instruction in agricultural-engineering subjects, but there has been a marked development in this respect. Some institutions employ as many as three specialists in agricultural engineering, and, in some instances, the extension work has developed to the point of being of greater importance and magnitude than the resident work. The methods used consist in short courses, lectures, and demonstrations. The subjects that are stressed more strongly in extension instruction vary widely with the States and are governed by the conditions existing in the States. The following, however, are common: Farm machinery, tractors, farm structures, soil erosion, land clearing, drainage, irrigation, sanitation, etc.

RESEARCH AND EXPERIMENT STATION WORK

It is to be regretted that the development of research and experiment station work in agricultural engineering has not kept pace with the development of instruction. With the development of more complicated equipment and the greater demand for efficiency, the uncertain rules of procedure or rule-of-thumb methods can not be used. It is true there is a great fund of well-established general engineering principles and information which may be applied to the agricultural industry; but, on the other hand, many, if not most, of the engineering problems of agriculture are of a special character and require special study and investigation for their solution. It is now realized that machines must operate with greater precision, that there shall be little lost energy, and that economy demands greater durability of construction. Buildings for livestock and storage must be erected with consideration for warmth, light, ventilation, and sanitation, as well as strength and durability. The same statement will apply to other subjects in a like manner.

A. CEREAL BREEDING NURSERIES. MINNESOTA AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF MINNESOTA



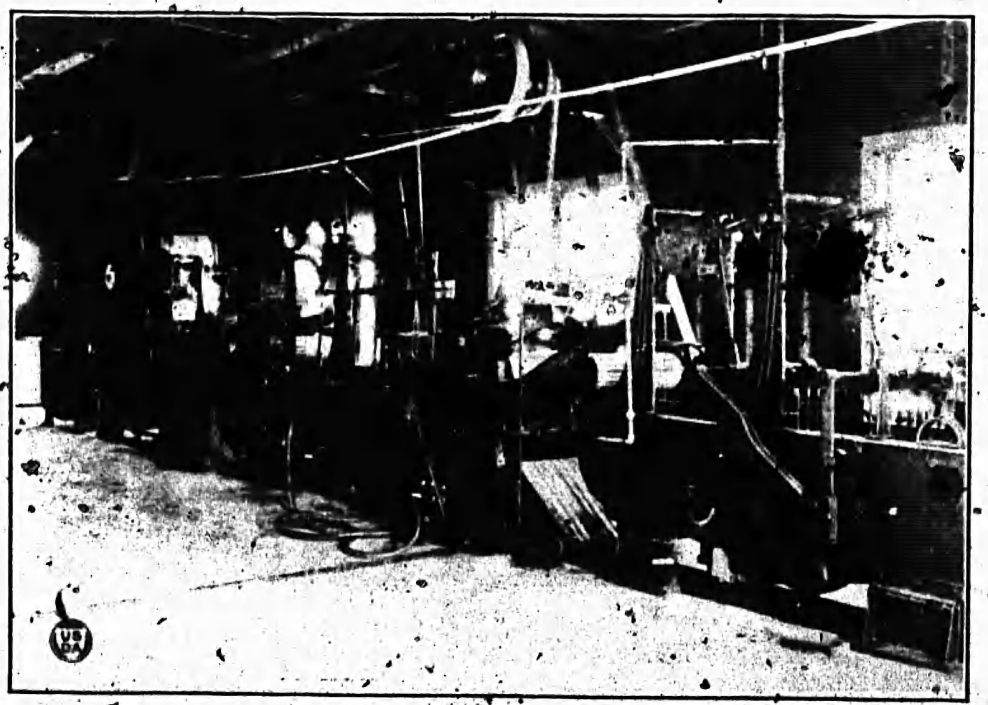
B. MEASURING IN-COME AND OUT-GO OF SOIL. AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF TENNESSEE

A. Metabolism Experiment with Steer

B. Study of Respiratory Products

COLLEGE OF AGRICULTURE, UNIVERSITY OF NEW HAMPSHIRE

A. AGRICULTURAL EXTENSION WORKER PREPARING COMMUNITY PROGRAM WITH REPRESENTATIVE FARMERS



B. TESTING WOOL AND MOHAIR SHRINKAGES. TEXAS AGRICULTURAL EXPERIMENT STATION

A. COUNTY AGENT DEMONSTRATING IMPROVED FEEDING METHODS

B. ADULTS OBSERVING BOYS' CLUB PROJECT

It is to be noted that one agricultural experiment station now employs two special investigators in agricultural engineering, in addition to provision for research by graduate students, but in the majority of the State institutions little attention is given to research. The development of research is the most urgent need of the specialty.

THE FUTURE

If agricultural production in the future is to be adequate, if the decrease of agricultural workers is to be compensated for, and if the standards of rural living are to be inviting to the intelligent young men and women now on the farms, the application of engineering principles and methods must be extended. It is reasonable to expect even greater interest among the State agricultural colleges in the development of agricultural-engineering instruction and research during the next decade than ever before.

Chapter XIV

SHORT COURSES IN AGRICULTURE

By JOHN PHELAN

Director of Short Courses in Massachusetts Agricultural College

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A study of the development of short courses in agriculture in the land-grant colleges presents at this time peculiar difficulties. The work of rehabilitation carried on by the Federal Board for Vocational Education and later by the Veterans' Bureau has affected the number, character, and attendance in these courses. There may, out of this experience in the rehabilitation of these World War veterans, be developed in the several States a program for rehabilitation of men and women injured in industry. Such a program does not come within the scope of this discussion.

Short courses have been affected by World War conditions in other ways both favorably and unfavorably. Some students who served for a year or two in the military or naval forces of the United States may have felt that they were too old to undertake a four-year college course of study, and decided instead upon one of the shorter courses. On the other hand, general industrial conditions that have prevailed since the war have tended to reduce attendance. Whereas the price of farm products has returned to the pre-war level, the wage paid urban labor is high. The result has been that many who would have entered agricultural schools and

colleges for short or long courses have gone into industry. It is impossible to measure fully the effects of these conditions on short-course work. Therefore, the history of the past five years can not be taken as an indication either of the demand, the service, or the policy of administration of these courses.

The material for this discussion was gained from a study made through a period of years of the bulletins and catalogues of agricultural colleges, of historical articles treating of short-course work, and from correspondence and administrators in the land-grant colleges.

The Ohio State University at Columbus made an effort, in the winter of 1877–78, to interest farmers in a course of lectures. The scheme proposed four lectures a day for 10 weeks. No entrance examinations were required. The scheme was widely advertised, but there was no adequate response. The following winter, 1878–79, a more ambitious effort was made at Ohio of four weeks' duration, and it met with success. This was not so much a short course as a lecture course for farmers. The short course in agriculture at the University of Wisconsin opened the 1st of January, 1886, and continued 12 weeks, with an attendance of 19 students. These courses indicate tendencies in the early history of short-course policy. The courses were concerned with production and were intended for farmers. At that time, and for many years thereafter, there were few other agencies. Since then agricultural courses have been established in high schools, county schools of agriculture have been created, a great extension service has been built up, and county farm bureaus have been organized, so that the question may fairly be asked, What is now the function of the short course? Will the four-year college course function so effectively, not only in the training of experts, but also in the training of farmers, that short courses will be unnecessary?

No one would question the statement that men and women trained in a four-year college course are needed on the farms and in the rural communities—men and women who can participate in the economic, social, and political life of the community. But it is very problematical if these men and women can ever be supplied by the four-year college course. The demand for teachers, county agents, extension-service workers, entomologists, chemists, botanists, and research investigators in economic and social problems is increasing year by year. We are not approaching a time when more of our four-year college graduates will go to the farm. The reverse is the case. A survey made some years ago of a college of agriculture in a large western university—a college that has rendered distinguished service to agriculture—showed that only 39 of the 324 graduates of

the long course since 1878 are now farming in that State, whereas 354 of the 446 short-course students are actively engaged in farming. It would seem from these figures, and the facts are not uncommon, that if the agricultural colleges are to send men directly to the farms the need for short courses will increase.

In this connection it should be borne in mind that only a very small part of the total farm population can be influenced by resident teaching. The agricultural colleges can afford to lose neither the institutional prestige, the clientage and public confidence of the farming population, nor the first-hand contact with the real problems of the farm that comes from participation in this type of work.

The real value of these courses is probably best summed up in a statement made by W. A. Henry, of Wisconsin, in which he said:

> I wish to say after 20 years' experience, observing results during all that time, that I am more than ever a believer in this line of effort, as one worthy of attention by our agricultural colleges. That great factor, time, has now developed young men of earlier years in the short course until they are rapidly becoming the leading farmers of our State, the best stock raisers, the owners of the best herds and flocks, good, useful citizens all around. This year they are getting into the legislature and are showing up as some of the best lawmakers, and they made their way there because of their fitness and because their neighbors insisted on them as their representatives.

The scope of the short course will expand as the definition of agriculture becomes more inclusive. The earlier definition limited the efforts of agricultural instruction practically to the field of production. In recent years there has come a realization of the economic problems of the farm, and still more recently the human factors have had consideration. But the definition must be broader. It must include the whole question of the food supply, production, storage, distribution, and consumption if the farmer is to be considered in his true relation. Thus the agricultural college will become an institution recognized as safeguarding the interests not only of the producer but also of the consumer; and the field of short-course work, as well as that of the four-year and graduate courses, will be greatly increased.

The problem of culture must also be taken into consideration in the development of these courses, since it has an important bearing not only on the student's personal life but also on the life of the community in which he lives. With the idea that culture is limited to certain subjects and that there can be no culture in a short course in dairying, animal husbandry, etc., the writer has no sympathy. Culture is lived, not studied, and the farmer, the plumber, the surgeon, and the lawyer must all see the relation of their work to the unity of life, appreciate to the full the social value of the things they do, and in that realization there is culture. No course

in the long run can succeed that does not have in it the culture element. No persistent group in society is ever without it. The European peasant has a culture, though sometimes we do not recognize it as such. The recognition of rural types of culture is one of the fundamental problems of rural social advance.

Several types of short courses have been developed in the United States:

1. The special separate agricultural school intended for boys and girls who have not had a high-school education. The curriculum of these special schools includes not only technical but academic subjects. In some cases they are preparatory to the four-year college course; in others, the completion of the course of the agricultural school is an end in itself.

2. The short course for farmers who are able to leave the farm for a few weeks only, and then at a time when there is the least to do. These courses are the most common, and, perhaps, the most popular offered by the agricultural college.

3. Short schools for specialists in which practically the whole day is devoted to one line of work, as, for example, dairying, cotton culture, ice-cream manufacture, etc.

4. Special vocational courses varying from three months to one year in some phases of agriculture, as, for example, poultry or dairying. In general, these courses are confined to the consideration of one interest, though the tendency is in the direction of including allied subjects.

5. One, two, and three-year courses in agriculture and horticulture. These courses are intended for young men and women who wish to make farming a life work.

6. There are, in addition to the above, special student groups in several of the institutions. The tendency is to limit the special student group either (*a*) to those who have the equivalent of college entrance requirements, or (*b*) to those who have already gained experience in the field in which they wish to study.

7. Summer schools are growing in popularity. The practice is becoming more and more common to offer regular college courses for credit in these schools. Hence they can not be properly classed as short courses. In addition to these regular college courses, special schools dealing with the economic, social, and spiritual problems of the farm are being established in the summer sessions.

In the development of short-course work numerous problems have arisen. These might be classified under the following heads: (1) Organization, (2) administration (3) financial support, (4) the teaching staff, (5) the course of study, (6) student relationships, (7) farm experience, and (8) the relation of the graduates to the college.

ORGANIZATION

A question that frequently comes up in short-course administration is: Shall these courses be organized in a special school of agriculture separate from the four-year college, with its own administration and teaching staff? In some instances this has been done, though these are exceptions rather than the rule. In general, short courses are organized as part of the resident teaching. The advantage of the special school of agriculture is in unity and, perhaps, in efficiency. The disadvantage lies in the fact that the school of agriculture will gain popular support at the expense of the general college. There is also the danger that in the mind of the student the four-year college course will not be considered as one of the avenues to the farm.

ADMINISTRATION

The practice is growing in favor of placing the administration of short courses in charge of a dean or director whose official position ranks with other deans or directors in the institution. This director is held responsible for the organization, administration, and development of short courses. It is his duty to study the needs of the State in agriculture and to organize courses that will meet these needs. The value of this method of administration needs no comment. It has already been demonstrated in the extension services and experiment stations.

FINANCIAL SUPPORT

The practice varies in the financial support of short courses. In some institutions the expense of these courses is borne by general departmental funds; in others there is a special short-course budget for both instruction and maintenance. Though the practice in general is to defray the expense of short courses from the general college fund, there is much to be said in favor of a special short-course budget for instruction and maintenance. A separate budget makes it possible to develop short-course work without having these courses a charge on the general college, and without in any way detracting from the opportunities offered the four-year college student. There is a real danger that the four-year student may feel that he is being exploited for the benefit of the short-course student. The separate budget makes it possible for the administrative official in charge of short-course work to develop new policies and plans.

THE TEACHING STAFF

The instruction in short courses in most institutions is given by the regular faculty assisted by special temporary instructors. The

tendency does not seem to lie in the direction of the organization of special short-course staffs. The reason for this condition is found in the fact that the short-course student is just as much of a specialist as the 4-year college man; sometimes even more so. The teacher of short-course students must be well trained, reasonably mature, and, though a specialist, he must see agriculture as a whole. Practical farm experience is of inestimable value in dealing with this group of students. Even though the short-course instructor be paid from special funds, it seems to be the better professional policy to have him a member of the regular teaching staff, thus making greater specialization possible, and providing an opportunity for professional growth and advancement.

THE COURSE OF STUDY

There are at least two marked tendencies in the organization of the course of study. One is in the direction of specialization, the other toward the general course. These tendencies represent sectional differences. The specialized courses have developed in areas of specialized farming. The general course is found in the general farming areas. Whether the courses be general or special, there is a marked tendency toward including the social and economic problems of the farm. The consensus of opinion of administrators would undoubtedly favor a larger consideration of these problems than is now given them.

STUDENT RELATIONSHIPS

The relation of the long and short course student groups is one that calls for careful administration. The presence of short-course students on the campus should in no way deprive the 4-year student of the advantages of college life that he has previously enjoyed. It should be recognized, however, that athletic, social, recreational, and religious activities are a vital part of the development of the individual student. They are also a vital part, perhaps the most vital part, of rural community life. There is no good reason why short-course students should not have their athletic teams, dramatic clubs, and social organizations in a democratic American college. This does not imply, however, that it is necessary for short-course students to play on the varsity team or join the varsity fraternities. If a satisfying athletic, social, and religious life can not be built up within the short-course student group, there is something radically wrong with the method of administration.

FARM EXPERIENCE

Whether or not students who have not already had some practical experience on the farm should be admitted to the short courses is a point often discussed. The chief argument in favor of farm experience is that it makes the teaching more effective. If the farm experience previous to the taking of the short course might be had on a selected farm with a good farmer, the value could not be questioned. But, if it is to be a requirement for haphazard experience gained with the misfit farmer or the pessimist, the student might better come to the college without farm experience. Farm experience should be required of all students in the one, two, and three year short courses before the course is finished. It can not very well be required in shorter courses, and, indeed, is not necessary. This farm experience should be at least five months in duration, with an allowance of some time for a vacation, if the student is to return for a second or third year. Some institutions, especially agricultural schools, are fortunate in being able to provide sufficient farm experience on the school farm. A program of study and work is arranged in such schools. These schools are comparatively few in number. The agricultural colleges in general use the college farm for laboratory and teaching purposes, and have to depend upon commercial farms for the farm practice of their students. This farm practice must, however, be as carefully organized and as carefully supervised as is the work in the classroom. Students should not be placed with every farmer who writes in requesting help. It is an educational not a labor project. The student should be expected to earn and receive a reasonable wage. The employer should be required to take a reasonable interest in varying the farm experience of the student as much as possible. This farm placement training, or, as it might better be called, vocational placement training, is the key to the situation. The plan immediately commends itself to the farmers of the State. It disabuses the mind of the farmer of the idea that the colleges are not training farmers. It is the best form of general information in regard to the work of the college.

RELATION OF GRADUATES TO THE COLLEGE

One of the undeveloped sources of power for the land-grant college lies in the relation of the short-course graduate to the college. Though great effort has been made to organize the alumni of the four-year course, but little seems to have been done for the short-course graduate. From the standpoint of the graduate this relationship is very vital. There is no time when the student needs the help of the college more than when he is making a start in the farming business. The United States Veterans' Bureau, in establishing super-

visors of agricultural projects for disabled Federal trainees, has inaugurated on a large scale a plan for the guidance, direction, and assistance of the man who is making a start. From the standpoint of the college, no institution can afford to do without the wholehearted support of the people actively engaged in the business. It is both good sense and good policy for the college to keep in touch with the achievements of its short-course graduates.

Chapter XV

AGRICULTURAL EDUCATION

By GEORGE A. WORKS

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One of the most marked developments in the activities of the land-grant colleges during the past decade has been the increase in number and size of the departments concerned with professional training of teachers of agriculture. These departments are variously designated as departments of agricultural education, vocational education, rural education, and rural life, the terminology being affected by the type of organization and the range of activities. The first of these names is the one most commonly used and for this reason will be used in this discussion.

At present, each land-grant college has a department of agricultural education, and, according to the 1921 report of the Federal Board for Vocational Education, there were, in the academic year 1920–21, 278 persons engaged in giving professional training to prospective teachers of vocational agriculture. In addition, there were persons engaged in other educational work in these departments. Such activities as the preparation of material designed to encourage the study of agriculture and nature study in the rural school, and to assist rural communities with their educational problems are included in their work.

The department of agricultural education made its appearance in the land-grant college that was a part of a State university about 1910. The universities of the States of California, Illinois, and Wisconsin were pioneers in this field. Departments of education had been established previously in several of the separate colleges of agriculture. Of the departments in institutions of this class the first one to be established that has had an uninterrupted existence is the one in South Dakota. It was established prior to the passage of the Nelson amendment. In the five-year period immediately fol-

lowing the passage of this amendment, seven more were established. In the next five years 12 more were added, so that by the time the Federal Vocational Education Act was passed, in 1917, there were 20 departments of agricultural education in operation in the land-grant colleges. It was natural that this development should have come first in the separate college of agriculture rather than in those that were parts of universities, because in the latter the early needs for work in education were met by departments, schools, or colleges of education that were commonly a part of the university.

By the passage of the Federal vocational educational law, in 1917, funds were made available to the States, under certain conditions, for the training of teachers as well as for the stimulation of the development of instruction in vocational agriculture. The growth of vocational agriculture during the last five years has been rapid. Not all this development, however, should be attributed to the foregoing Federal legislation. As has been indicated, departments of agricultural education had been established in nearly half of the land-grant colleges prior to the passage of the act. In the interval between the time of establishment of the first department and the passage of the Federal act, departments were organized in other land-grant colleges and most of them had a steady growth.

Under the provisions of the Federal vocational education act, $500,000 was made available to the States from Federal funds for the fiscal year beginning July 1, 1917, for the training of teachers of agriculture, home economics, and trade and industrial subjects. This was increased during the succeeding years until $1,000,000 became available for this purpose. It was stipulated in the law that not more than 60 per cent should be expended on the training of teachers for any one of these lines. The law further provided that a minimum of 20 per cent must be reserved for each one of the phases of teacher training. These funds were made available to the States only on condition that an equal sum from State sources was made available for the work.

The following table contains data taken from the 1921 report of the Federal Board for Vocational Education, showing the status at that time of teacher-training work in departments of agriculture for the years ending June 30, 1918, 1919, 1920, and 1921:

Teacher-training work of departments of agriculture

Years	Institutions	Teachers	Students	Expenditures
1918	40	116	1,534	$121,244.10
1919	60	222	1,334	306,895.47
1920	64	293	2,310	553,580.32
1921 [1]	61	278	2,936	651,722.28

[1] Data from Pennsylvania were lacking.

Following the passage of the act the growth of the work was so rapid that it was difficult for the land-grant colleges to secure adequately prepared instructors for service in this field. The experience of the States in this matter leaves little doubt that it would have been better if the portions of the act making provisions for the training of teachers had become effective at least two or three years prior to the other phases of the legislation.

The range of courses offered under the name of agricultural education varies greatly with different institutions. In some land-grant colleges that are a part of a university the correlation of work between the department of agricultural education and the department, school, or college of education is so close that the work in agricultural education is limited to two or three special courses. Those generally deal with the problems peculiar to the teaching of agriculture and with supervised teaching. In other instances, and especially where it is a separate land-grant college, a considerable range of courses is given. In addition to such work as has been mentioned courses are given in psychology, educational psychology, measurement, principles of teaching, vocational education, secondary education, and educational administration. Besides the professional courses designed to meet the needs of undergraduates several institutions are giving graduate work designed to meet the needs of those preparing for State supervision of vocational agriculture and for teacher training.

In a few institutions the work in agricultural education has been organized as a department in the school or college of education, with cooperative relations with the college of agriculture. There can be but little doubt that this type of organization will give close correlation between the work in agricultural education and the general phases of education. This is an end to be sought. In attaining it, however, it is important not to lose sight of certain weaknesses that are likely to result from a complete separation of the work in agricultural education from the college of agriculture. It is important that those concerned with training of teachers of agriculture should have a voice in curriculum and course of study problems in the agricultural college. A strong department of agricultural education is in a position to materially influence the selection of teaching content and the methods of instruction in a college of agriculture when it is a part of that institution.

One of the most difficult problems that has been presented to the departments of agricultural education is that of furnishing facilities, so that the prospective teacher may secure supervised teaching experience. A demonstration school on the campus is used by some institutions. It is more difficult to provide proper conditions for supervised teaching in vocational agriculture by this means than

in case of academic subjects, because it is frequently impossible to give the students in training an opportunity to work with a group of students that have a genuine interest in farming. This is due to the fact that in case the college of agriculture is located in a city it is difficult, if not impossible, to secure any considerable number of boys desiring to prepare for the farming vocations. If the college is situated in a small place the conditions are not greatly improved, because the number of boys available is not sufficient to furnish adequate teaching experience to any considerable number of students. To meet this problem various means are being tried by the departments of agricultural education. In some cases the work is done with the short course or special students who are in attendance at the college of agriculture. At best this is not very satisfactory because the conditions as to student body and courses of study are very different from those that obtain in the departments of vocational agriculture in the high schools. There is a further and more serious difficulty in the fact that it is impossible under these conditions to provide an opportunity for the prospective teacher to have responsibility for guiding the supervised practical work of the vocational pupils. This omission is unfortunate as this phase has come to be regarded as an important part of the training of the vocational pupil in agriculture. The local high school is used in some instances. In case the college of agriculture is located in a city it is very difficult, if not out of the question, to secure a group of boys who have a genuine interest in farming. In addition, the whole setting is very different from that obtaining in most communities in which instruction in vocational agriculture is being developed. In case the location is in a small place the number of boys available for instruction in vocational agriculture is so small that it is impossible to furnish teaching experience for any considerable number of students. The difficulties presented by these two situations have been at least partially met in some institutions by providing demonstration practice departments of vocational agriculture in rural high schools that are reasonably accessible from the college campus. This particular plan has been developed more completely in Ohio than in any other State. In some States the students are given an opportunity to serve as "apprentices" to the regular teachers in high-school departments of vocational agriculture. The periods of apprenticeship vary from a few weeks to a semester.

The weaknesses that exist in the pre-service training are partially remedied in many States, at least, by a period of in-service professional training. Under this plan arrangements are made by which some member or members of the department of agricultural education are charged with the duty of guiding the professional

growth of the teacher for the first year or two after he enters upon his teaching. This plan adequately developed provides an excellent opportunity for those in charge of the teacher training to study the needs of the teachers and to so organize the work as to meet these needs.

That the land-grant colleges recognize the importance of the supervised teaching and the in-service training is shown by the following recommendations taken from the report for 1919 of the committee on instruction in agriculture, home economics, and mechanic arts of the Association of American Agricultural Colleges and Experiment Stations:

> That more attention be given to developing facilities for, and methods of, conducting supervised teaching under conditions similar to those in the high schools where the teacher training candidates will be expected later to work.
>
> That as rapidly as possible provision be made for itinerant instructors whose function will be to keep in touch with and assist vocational teachers in the field, particularly during the first year or two of their work.

Further problems that face departments of agricultural education, in their efforts to provide the right kind of teachers for the work in vocational agriculture, are: Selections of persons possessing the qualities that make for success in teaching; securing candidates with an adequate background of vocational experience, a phase that has been too generally neglected; the organization on a functional basis of the professional work; assistance in strengthening the instructional work of the colleges of agriculture; and securing a proper coordination of the work in teacher training and the work of the State supervisory staff in vocational agriculture.

In many institutions the work of the departments of agricultural education is not limited to the training of teachers of vocational agriculture. Other lines of work that come within the range of their activities are: Professional training for teachers of home economics, extension activities with rural schools, issuing of publications designed to stimulate the study of agriculture and nature study in the elementary schools, junior extension, or boys' and girls' club work, and professional courses designed to meet the needs of extension workers.

In this last phase of agricultural education some of the colleges that have taken a leading part are Arkansas, California, Iowa, Minnesota, New York, and Wisconsin. The early efforts in this field were directed largely toward familiarizing extension workers with administrative features. More recently attention has been given to a consideration of the principles underlying methods of instruction. This is shown by the announcement of courses in visual instruction and methods of extension teaching. There is, however,

a large opportunity for study of the problems involved in putting extension instruction on a more scientific basis.

In very few of the States has the boys' and girls' club work been placed in the department of agricultural education. If this were more generally true there can be but little doubt that it would be a means of materially reducing the conflict that exists in some States between the work in vocational agriculture and boys' and girls' club work. It should also have a tendency to emphasize the educational aspects of this work, a phase that is quite likely to be neglected where the work is handled by the extension department of the agricultural colleges more or less independently of the school system. It is very unfortunate that provision was not made originally for the organization of this work through the educational system of the country.

There is evidence that the development of departments of agricultural education in the colleges of agriculture has stimulated an interest in the teaching work of these institutions. In its early stage, in most instances, this took on the form of informal conferences between instructors in agricultural education and members of other department of the colleges. Gradually the scope of activities was extended to include more formal work, such as group discussions, attendance by members of the staff on courses in education, and the securing of outside speakers to address the faculty on teaching problems. Recently there has developed a demand for courses in education designed to meet the needs of college instructors. The following recommendations, which were adopted by the Land-Grant College Association at its meeting in Washington, on November 22, 1922, are an index of this trend:

That the Land-Grant College Association declare this year in favor of professional training for college teachers.

That beginning this year the land-grant colleges make particular efforts to improve their methods of teaching by some special means best suited to their respective facilities.

That a number of colleges having strong departments of education offer immediately professional courses for graduate students preparing for college teaching, including the development of graduate work, with special emphasis on its application to the technical fields of agriculture, home economics, and engineering.

That until such time as courses in methods of college teaching can be made readily available to teachers of technical subjects, these teachers be permitted and encouraged to avail themselves of such courses in educational psychology and the principles of teaching as are readily accessible, even though these courses are not designed primarily to meet the needs of college teachers.

That the institutions with well-established departments of education make an effort to offer strong summer courses, so that members of the teacher-training staffs in other colleges may be given opportunity to pursue special work in these colleges.

We believe and urge further—

That greater use should be made of departments of education, and that these departments should become service departments in connection with the instructional work of land-grant colleges as well as training departments for teachers.

That the land-grant colleges make definite and liberal arrangements for professional training of teachers in service, and urge such teachers to take professional courses at summer schools or elsewhere for at least two successive years.

That instructors in the technical departments be urged to pursue graduate work in education with particular emphasis on research in some problem of teaching in their technical fields.

That frequent conferences should be held of teachers handling the same or related subjects. These conferences should aid in developing esprit de corps among the instructors, in improving teaching methods, in considering textbooks, in revising schedules of assignment, in scrutinizing teaching content.

That much attention should be given by the heads of departments to guiding younger teachers. Under careful supervision beginners in teaching should be given opportunity to teach a variety of subjects, thus broadening the horizon of their interest.

That experienced and successful teachers should have charge of, and take part in, teaching introductory and basic courses.

That beginning with 1925 candidates for teaching positions in land-grant colleges be required to have at least six semester hours of professional training, including courses in educational psychology and methods of teaching. As soon as practicable this requirement should be increased.

The passage of the Federal vocational education act has resulted in a marked emphasis by the departments of agricultural education on the training of teachers. That other activities of the nature of those mentioned will increase in relative importance there can be but little doubt. It is desirable that they should, because in most States the colleges of agriculture are in the best position of any educational institution to render such service to the schools.

Chapter XVI

THE TRAINING OF TEACHERS OF VOCATIONAL AGRICULTURE

By C. H. Lane

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Previous to the passage of the Federal vocational education act in 1917, the States had established and maintained, partly through Federal aid, institutions of college grade equipped to prepare practical farmers and specialists in agricultural science. These institutions had not, however, except in a very few instances, established training departments for teachers of vocational agriculture nor was

such training offered in other vocational institutions except in an incomplete, inadequate way. Since the passage of the Federal vocational education act, every State has, through its State board for vocational education, set up plans for the training of these teachers and has designated the land-grant colleges as the institutions where the work is to be carried on.

The importance of this advance is evident. The quality of the teaching is the pivotal fact in any system of schooling. High quality in teaching can be secured only through careful preparation and training. This is especially true with regard to agricultural teaching because of the wide scope and special demands of such work.

The success of the training of teachers of agriculture is largely dependent upon the meeting of the following conditions in so far as the character of the institution which is to do the training is concerned:—

1. The institution should be in touch with the latest developments in the field of scientific agriculture, in so far as these developments relate directly to the agriculture of the State. This means that the institution should have the facilities for, and be engaged in, the teaching of agriculture as a vocation.

2. The institution should give the instruction in classes in technical agriculture from the standpoint of the use of the results of this instruction in the field of practical agriculture. The institution would, therefore, require farms, farm animals, farm buildings, and farm equipments, as well as practical school laboratories.

3. The institution should be in touch with the farmers of the State, in order that there may be direct contact with the conditions and development of agriculture in the State. The institution should be the center of agricultural activities of the State in so far as they relate to the best principles and practices of agriculture.

4. The institution should be the best equipped in the State in so far as the instructors, laboratories, farm machinery, farm animals, and the other equipment, material, and supplies needed for instruction in the subject matter of agriculture are concerned.

5. The institution should give instruction in rural-life subjects, such as rural sociology and rural economics, etc. This means that the institution should be in touch with the rural life of the State, including rural organizations and societies.

It was owing to the fact that the foregoing conditions obtained in a very large way in each of the land-grant colleges that the State board for vocational education designated this institution to prepare teachers of vocational agriculture.

The designation of the land-grant colleges to train agricultural teachers by State boards placed before these institutions a new oppor-

tunity for service. Each institution that had not already done so immediately set up machinery designed to train teachers of vocational agriculture. While the work of such departments was more or less crude in the beginning, yet a beginning was made with the distinct aim and view of bringing forward into the public school system an adequate supply of properly trained teachers.

ORGANIZATION

The outstanding development in teacher-training work for secondary schools during the past five years has been in the separate agricultural and mechanical colleges. Scarcely any two teacher-training departments in these institutions are alike as to details of organization and procedure.

There has been much difference of opinion as to the organization of the vocational teacher-training work. The department of agricultural education in the division or college of agriculture has been most favorably considered by those directly engaged in the training of agricultural teachers. This is probably due, in the first place, to the fact that such an organization makes the work a part of that technical subject matter division from which must be drawn the substance of all that is to be taught by the vocational teacher; and, being in that department, the head of the teacher-training is almost assured the cooperation of the faculty of the division or college. Thus are made available for training the strongest and most likely prospects before entering the institution. Furthermore, materials and equipment for the various phases of instruction in agriculture are made available to the department in a way that does not seem to exist in an organization where the teacher-training work is a part of the college of education independent of the college of agriculture. Theoretically, however, it is held that the division or college of education is the place to prepare teachers of vocational agriculture, for the main reason that it is the whole duty of this division to prepare teachers, while other divisions are mainly engaged in the work of developing lines of technical subject matter. It may be said, at the present time, that where the teacher-training work is in the hands of individuals who are capable of developing a cooperative spirit on the part of fellow workers, a successful piece of work is being done in the training of vocational teachers.

COURSES OF STUDY

At the outset of the program of vocational education in agriculture the Federal Board for Vocational Education set up in bulletin form, as a suggestion to institutions organizing teacher-training

work for the first time, the general scope of a teacher-training course for teachers of agriculture. No hard and fast lines of classification were used. The course suggested was simply an attempt to indicate what ought to be the general content of a two or four year course for teachers of agriculture. Those institutions which had no department of education before the year 1917 set up all of the professional courses with the idea that they were to prepare vocational teachers and vocational teachers only. On the other hand, those institutions which were preparing general teachers proceeded to use the Federal money available for teacher training and the money which offset it on the special courses in vocational education, including principles and methods of teaching agriculture and practice teaching. The separate agricultural and mechanical colleges followed quite closely the recommendations of the Federal board in setting up their teacher-training programs by dividing the program about as follows: Agricultural subjects, including field and forage crops, animal husbandry, dairying, farm mangement, horticulture, etc., 40 per cent; science subjects, such as chemistry, physics, plant pathology, bacteriology, etc., 30 per cent; humanistic subjects, such as English, history, and government, rural economics, rural sociology, etc., 20 per cent; and professional subjects, such as educational psychology, special methods (in agriculture), practice teaching, principles of teaching, etc., 10 per cent.

SUPERVISED OBSERVATION AND DIRECTED TEACHING

The land-grant colleges as teacher-training institutions had practically no experience up to 1917 in giving supervised observation and directed teaching. This is admittedly one of the most difficult features in the whole scheme of preparing vocational teachers. It is also admitted as one of the most, if not the most, important feature. It may also be said that herein lies the greatest variation in organization. This necessarily follows from the difference in the environment in teacher-training institutions. It is also due in a very large measure to the fact that those responsible for the development of this phase of the training program were not in the beginning fully cognizant of either the absolute need of, nor the possibilities for, organizing on an adequate basis.

One of the outstanding features of the teacher-training program is the fact that every State has made arrangement for supervised observation and practice teaching on the part of trainees, the idea of which is: Practice under conditions as nearly as possible like those they will face when assuming charge of classes as regularly employed teachers. In the beginning there were, however, many

makeshifts. The "moot class," and instruction in collegiate classes has practically disappeared as a principal means of giving practice in teaching. In a few places the campus school, known variously as the preparatory department, departments of elementary science, university high school, and the like, still persists and in at least one case classes of vocational rehabilitation men are used, for the major part, for practice teaching.

The great majority of practice teaching throughout the country may be grouped under two heads:

1. That wherein a vocational department is organized in the local town or village high school under more or less complete control or direction of the teacher-training department of the institution.

2. The development of one or more rural vocational departments located fairly convenient to the teacher-training institution, the departments, for the most part, being under fairly complete control of the teacher-training department. In many cases, the instructor or instructors in these departments are members of the teacher-training staff and serve as critic teachers as well as teachers of agriculture in the local department.

TRAINING IN SERVICE

Professional improvement of teachers in service has become an important feature of the teacher-training program. During the first year in service of any teacher it has been found desirable that a representative of the teacher-training institution should visit the man as frequently as possible and should be given such authority as is needed to correct any teaching faults detected. As a rule, the college instructor of special methods classes is assigned the responsibility of following the new teacher throughout his first year of probation. This practice has its influence for good upon college teachers of special methods, in that it makes teachers responsible for these courses more practical in their teaching when there are frequent contacts with the men in service, and especially when they have some responsibility for improved service in the State.

The working arrangement for training in service with the State board for vocational education has worked out about as follows:

1. The State supervisor of agriculture sends a letter at the beginning of the year to the principal of each school in which there is a teacher receiving training, informing him of the fact that this teacher will be subject to professional visits by a member of the teacher-training staff.

2. During such visits the representative confines his work to the improvement of the teacher's technique of instruction as represented by his work with pupils in the field, laboratory, classroom, and

directed or supervised practice in agriculture at home. The visits are of such duration that it is possible to accomplish this result. If there are changes of an administrative nature that would result in improving the quality of instruction, these are brought to the attention of the State supervisor of agriculture, who may take them up with the local authorities if he deems it wise to do so. Under no circumstances does the member of the teacher-training staff assume any responsibility for their correction.

3. Since the State supervisor of agriculture also endeavors to improve the instruction of his teachers, he deals with the teachers who are receiving training in service from the teacher-training institution. For this reason, it has been found essential that the supervisor and those who are training teachers come to an agreement upon the fundamental principles that are to be observed in developing the work in vocational agriculture. When such an agreement is reached there has been found but little or no danger of great disparity in the advice that comes from the two sources.

4. A definite period of time (for example, one year) is usually set for this systematic instruction in service. Whether this instruction is continued over a longer period with certain teachers is determined entirely by the State supervisor of agriculture.

GRADUATION REQUIREMENTS

The certification of teachers of vocational agriculture by State departments of public instruction has emphasized certain graduation requirements, such as farm experience. The minimum amount of farm experience that has been set by the colleges during the last five years is at least two years of practical experience for entrance to the institution plus an additional amount of farm practice in the college course. This practice takes on the nature of (1) practice or experience in the fundamental farm operations; (2) practice in the handicraft of the operations which make up a part of the usual laboratory courses of a standard college; and (3) practice in carrying on a farm business or some special line of agriculture, such as poultry raising or fruit growing.

HANDICAPS IN DEVELOPING THE TEACHER-TRAINING PROGRAM

Conditions attendant upon the World War seriously interfered not only with the program of training teachers but with all of the college activities. Very few teachers were prepared through the regular courses during the war. Many of the States, however, put into operation short, intensive, emergency courses. Through these courses men experienced in farming, trained in science, and with experience in teaching were given instruction in technical agricul-

ture. These courses have now been discontinued, except in some cases where those who have already had summer instruction are being given an opportunity to complete a course of instruction already begun.

Upon demobilization of the military forces and the return of men to college, teacher-training departments got under way and have turned out each year larger groups of trained men until, for the fiscal year 1922, the number of men trained apparently caught up with the demand for such men. During that year throughout the country there were enrolled 2,452 white men in the classes of the regular college session and 1,310 in the summer session of the previous year, which made a grand total of 3,762 men enrolled in teacher-training in the white institutions. These same institutions graduated 991 men quite fully trained to undertake this important work. In addition to these, the colored teacher-training institutions turned out 344 men prepared to teach. Roughly, this number approximates the number of new departments of vocational agriculture organized and the estimated turnover in the old departments. So that it may be said for the first time since 1917 that it is possible in the current year to supply practically all departments with men properly trained for their work.

STANDARDS

This condition makes possible the raising of standards for teachers of vocational agriculture. Practically all States now require that vocational teachers shall be graduated from a four-year course in agriculture, with special attention to the diverse needs of a teaching position, and, in addition, shall have pursued a definite course in teacher-training, which calls for from 9 to 20 or more hours of professional work. In a few cases, States are stipulating that after a given time the teachers shall not only have this preparation but shall, in addition, have done at least a year of graduate work along agricultural educational lines.

Apparently, as a result of the program in teacher-training, it is noteworthy that many college faculties are paying much attention to methods of instruction. Some institutions have employed specialists to instruct members of the agricultural faculty. In some, the teacher-training departments are being called upon for such service, while in others, conference groups within the college of agriculture itself have been organized for improvement of instruction.

The standing committee on instruction in agriculture, home economics, and mechanic arts of the Association of Land-Grant Colleges made, in 1920, significant recommendations to the association

affecting the training of teachers of vocational agriculture. They are:

1. That the colleges encourage students who hope to become college teachers to take courses in education.
2. That they insist upon graduate study, including courses in education, for appointment to any position higher than that of instructor.
3. That college instructors doing graduate work to prepare for teaching be urged to take work in education designed for college teachers, including methods of teaching, college organization, and supervised teaching.
4. That the colleges provide for the improvement of college teachers in service by bringing in outside lecturers, and arrange for conferences or seminars among teachers to discuss methods of teaching.

In conclusion, it may be said that the future of the teacher-training portion of the program for vocational education in agriculture is very bright. Problems involved are receiving the attention of the most able men in the country, and adjustments, refinements, and improvements are being made in the methods of training throughout the country. As a result, it may confidently be expected that, within a few years, agricultural teachers throughout the country will be among the best-trained teachers in the secondary school system.

Chapter XVII

DEVELOPMENT AND PRESENT STATUS OF THE AGRICULTURAL EXPERIMENT STATIONS AND EXTENSION SERVICES

By A. C. True

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The establishment of agricultural experiment stations as distinct organizations, maintained with public funds, began in the United States in 1875. During the next 12 years stations were established in 17 States. Most of these were connected with the agricultural colleges but a few of them were separate State institutions. They had very limited funds and their field of operation was quite narrow. A large share of their work consisted of chemical analyses and studies of fertiliers and economic plants, and simple field experiments with fertilizers, varieties, and methods of cultivation. They were, however, sufficiently successful in getting the support of farmers and others interested in agriculture to make it possible for the land-grant colleges and the independent stations, with the aid of Commissioner Colman, of the Department of Agriculture, to secure the passage by Congress of the Hatch Act of 1887, which

granted $15,000 annually to each State for an agricultural experiment station as a department of a land-grant college, except as the legislature might decide to give this Federal fund to an independent station established prior to the passage of the act. This act enumerated a considerable number of broad lines of work for the stations, and in addition empowered them to carry on "such researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Territories."

They were also "to conduct original researches or verify experiments." Under this act stations were soon established in all the States and undertook a great variety of work in many lines of agricultural science and practice.

During the next 20 years the stations accumulated a large body of tested knowledge in both the science and practice of agriculture. A considerable amount of their work dealt with fundamental principles but a large share of it was of a more immediately practical character. The results of their work caused many important changes in agricultural practice throughout the country and furnished a sound scientific basis for many old and new practices. Their influence among the farmers steadily increased, and the States granted them additional funds which greatly broadened and strengthened their operations.

Aside from their practical influence, very important educational results followed the organization and work of the stations under the Hatch Act:

(1) It established research as an organic part of the work of the agricultural colleges. This was soon recognized as so desirable that nearly all the separate stations were united with the colleges.

(2) It immediately gave the colleges an opportunity to broaden greatly and to specialize their agricultural faculties by employing men who divided their time between teaching and research. This has had some unfortunate results, since it brought the temptation to impose too much teaching, often of an elementary character, on the station force. The problem of part-time investigators and teachers still remains a serious one in our agricultural colleges. There is now, however, a considerable body of station workers who are wholly engaged in research or give a small part of their time to teaching advanced students.

(3) It caused the steady accumulation of knowledge which made possible sound and substantial agricultural education. Until the stations had obtained a goodly amount of this knowledge college courses in agriculture were very weak and attracted few students.

(4) The work of the stations greatly improved the character and increased the volume of agricultural literature, including the agricultural press.

(5) The wide dissemination of the results of station work through publications and addresses at farmers' meetings greatly broadened and modified the mental outlook of a great body of farming people and liberalized their attitude toward science and education.

The pressure for immediate practical results grew with the success in attaining such results and endangered the station enterprises by too much limitation of the more fundamental research. There arose among thoughtful agricultural leaders a movement to secure a more permanent basis for the higher work of the stations. This resulted in the passage of the Adams Act, in 1906, which gave an additional grant of Federal funds to the stations but limited the use of these funds to the maintenance of "original" research.

During the decade succeeding the passage of this act the stations had great prosperity, with large increases in State funds, personnel, and equipment. A large number of more thorough basic investigations were undertaken, and at the same time their more practical work was broadened and strengthened. The establishment, with State funds, of numerous substations and outlying experiments, enabled them to meet more fully the requirements of different agricultural regions and brought them closer to the farming people on a large scale.

This movement was seriously checked by the entrance of the United States into the European war. Some of the station officers went into the military service, some engaged in researches or other work made necessary by the military requirements, others undertook extension work to stimulate agricultural production. The great rise in living expenses and in the price of equipment and supplies needed for agricultural research stopped or hindered important lines of the station work, especially since the funds available for research were not materially increased. A diminished supply of well-trained agricultural teachers and investigators increased once more the number of workers who divided their time between research and teaching or extension work. These and other difficulties caused by the war have not yet passed away. The rapid expansion of the extension work of the agricultural colleges after the passage of the Smith-Lever extension act in 1914, and the great popularity of this enterprise caused relatively large amounts of public funds to flow in this direction, and temporarily obscured the importance of the station work.

Recently a movement has arisen to increase the financial support of the stations and some of the States have materially added to

their income during the past year. There is also pending before Congress a bill (the Purnell bill) for increased Federal appropriations for this purpose.

Until quite recently the stations dealt mainly with the problems of agricultural production. Their economic studies were chiefly confined to comparatively simple investigations of the relative cost of production of various crops and livestock. There is now an urgent demand for more thorough and comprehensive research in the field of agricultural economics. These can not be made by the stations without material increase of their funds.

There is, moreover, great need of research in home economics in order that this subject, which, in its broadest aspects, has such vital relations to many interests of our rural and urban life, and which is increasingly taught in our schools and colleges, may have the same kind of scientific basis which the researches of the stations and kindred institutions have given and are giving to agriculture. The Purnell bill takes into account both agricultural economics and home economics and makes provision for research in these fields by the stations.

Besides their experimental work the stations have done under State laws a large amount of analytical and other routine work connected with the control of fertilizers, feeding stuffs, foods, seeds, insecticides, fungicides, etc., and with soil surveys, etc. The complex organization of the agricultural colleges and stations has also led to much use of station funds for farm operations which do not contribute to research. The expenses of the operations outside their experimental work have in recent years absorbed so much of the gross income of the stations that the amount left for research has not materially increased. This should be taken into account in considering the following general statements regarding the funds and equipment of the stations.

Increase in funds and equipment.—During the decade 1911 to 1921 the Federal funds remained the same, the Adams fund reaching maturity in 1911. Each of the 48 States now receives annually from the Federal Treasury $15,000 under the Hatch Act and $15,000 under the Adams Act. The total appropriation under these acts is $1,440,000.

The State appropriations have increased from $1,246,470 in 1911 to $3,696,997 in 1921, with a total for the period of $26,618,308, as compared with a total from the Federal Government of $15,790,688.

The sales funds have increased from $202,687 in 1911 to $1,167,856 in 1921, with a total of $7,563,794. This with fees and miscellaneous sources of income, which for 1911 amounted to $692,783 and in 1921 to $731,387, with a total for the period of $10,294,233, gives a total

income from all sources of $3,655,319 in 1911, and $7,570,368 in 1921, making a grand total for the period of $62,577,427.

The value of the additions to the buildings of the experiment stations from 1911 to 1921, inclusive, was $5,518,766. Additions to the station libraries for this period totaled $322,175; additions to scientific apparatus were valued at $796,172; the value of additional farm implements, etc., was $969,881; and the increase in value of livestock was $1,732,948. Other miscellaneous increases amounted to $1,865,028, giving a total amount for equipment of all kinds of $10,267,076.

Personnel.—In 1911 the total number of persons on the staffs of the stations was 1,564, and in 1921 it was 1,965. The number on the staffs who were also engaged in teaching was 573 in 1911, and 1,023 in 1921. The number on the staffs who were also engaged in extension work was 485 in 1911, and 434 in 1921. The total number of publications issued by the stations in 1911 was 566 with 20,699 pages, and in 1921 was 830 with 20,148 pages. The total number on the mailing list was 1,012,520 in 1921, and 899,079 in 1911. The results of station work are now discussed in a large way through the extension service.

Projects.—During this decade the project has become the recognized unit in investigation, and gradually all the stations have organized their work on the project basis, with definite outlines indicating the object, method (in general), and general character of each project. The latter is also the basis in large degree for assignment of funds. The stations now are engaged in investigations of a total number of 4,750 projects, over one-third of these (2,190) being in agronomy, including both soils and crops. Botany and horticulture included nearly 1,000, and animal husbandry subjects, including dairy, about 720. Comparisons can not be made with 10 years ago as few stations then had all their work so outlined.

Station results.—Among some of the more outstanding results of the work of the experiment stations, during the past decade, may be mentioned the fundamental studies on animal nutrition, especially in connection with the vitamins, which are exerting a profound influence on the whole subject of feeding, the results being equally applicable to human nutrition. A number of the stations have participated in the work on these problems and have contributed largely to our knowledge of the subject.

Important studies have also been made in entomology, among which may be mentioned especially the discovery of a leaf hopper as the cause of curly leaf of sugar beets, a disease that was seriously affecting an immense industry in the West, and also the discovery of a severe disease of the potato, tip burn, which was likewise caused by another species of leaf hopper. The early disclosure of the rav-

ages of the European corn borer in this country was also of great importance, and no less so the discovery of the cotton-boll weevil and the Mexican bean beetle, the latter insect having recently gained a foothold in the Southern States, where it does not limit its attacks to the field and garden bean crops but extends its ravages to velvet beans and cowpeas.

Much progress has been made in soil studies which is giving the foundation of a more rational system of soil treatment and management. This is noticeable in the contributions made to the subject of soil reaction and liming in the conservation of nitrogen; the use of legumes in the maintenance of soil fertility; and to the important rôle that is played by the soil flora on the availability of plant food. Investigations in the utilization of water by plants has extended the possibilities of dry farming as well as led to a more rational practice of irrigation.

Many improved strains of various crops have been developed and introduced by the stations which are being widely planted. These include many with valuable characters, such as high yield, disease resistance, and hardiness. Among many others may be mentioned rust resistant Kanred wheat, Rosenrye, Connecticut round-tip tobacco, Hubam sweet clove, and a number of improved strains of corn.

The control of hog cholera and contagious abortion has made rapid strides as a result of numerous investigations on these subjects. Valuable contributions have also been made on the subject of poisonous range plants, the losses from which were rapidly increasing.

The introduction of sunflowers as a silage crop, especially for the Northwestern States where corn will not mature well, and the utilization of some of the native plants of the Southwest for carrying the cattle over the winter have been largely the results of the work of the stations.

AGRICULTURAL EXTENSION WORK

From their beginning the agricultural colleges and the United States Department of Agriculture have done extension work by having members of their staffs attend farmers' meetings in order to make addresses on agricultural subjects; prepare articles for the press and popular publications for free distribution, etc. Since the establishment of the experiment stations great numbers of publications regarding their work have been distributed to farmers and others throughout the country. The farmers' bulletins and other publications of the Department of Agriculture have also been very widely distributed.

The farmers' institutes grew out of the early extension work of these colleges, whose lecturers have had a prominent place in the

institutes, though in many States these meetings have been under the administrative control of the State departments of agriculture. In 1911 about 6,000 institutes were held at which 1,100 lecturers and many voluntary speakers addressed over 3,600,000 people.

At this time there was great interest in educational trains run by the railroads in cooperation with the extension agencies. In 1911 71 such trains were run in 28 States, and the meetings where those trains stopped were attended by about 1,000,000 people.

Beginning early in the nineteenth century, agricultural exhibits at fairs became increasingly important, and were in many cases supplemented by farmers' meetings held at the fairs. Though the fairs were controlled by a great variety of public and private agencies, the agricultural colleges came to have an important share in their enterprises. In 1909 an attendance of 15,791,000 people was reported from the county fairs alone.

As the extension work of agricultural colleges grew in extent and variety it was necessary to organize it more systematically. Forty-three colleges in 1911 reported the assignment of an officer to have charge of this work in the State and 35 colleges had 345 men giving the whole or part of their time in a regular way to such service.

Meanwhile another system of extension work had achieved great success in the Southern States. When the ravages of the boll weevil began to make a serious inroad on cotton growing, the Department of Agriculture, aided by the General Education Board, undertook to offset this through farm demonstrations of improved methods of agriculture. This system was devised by Dr. Seaman A. Knapp, and for a considerable period was not connected with the agricultural colleges. In 1904 agents were appointed to conduct this work in districts, which by 1907 began to be restricted to a single county. At first men only were employed but soon the interests of the farm home were included and women agents were added to the force. Boys' and girls' clubs were also inaugurated.

In 1911, in 12 States 583 demonstration agents were employed, and in 1913 this force had grown to 878 men and women. The movement began to spread to the North in 1911, and in 1913 there were about 100 county agents in the Northern and Western States.

Through the combination of Department, agricultural college, and other forces interested in agricultural extension work, Congress was led to pass the cooperative agricultural extension act of May 8, 1914 (Smith-Lever Act). This act was broadly drawn to include in the extension system both the demonstrations and other features which the experience of the department and the colleges had shown to be permanently useful. It put the work on a permanent national basis by providing funds for its gradual and complete development.

This act, which provides for extension work in agriculture and home economics by the land-grant colleges in cooperation with the United States Department of Agriculture, declares that:

> The cooperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities, and in imparting to such persons information on said subjects through field demonstrations, publications, and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State agricultural college or colleges receiving the benefits of this act.

There was permanently appropriated out of money in the Treasury of the United States, a sum of $480,000 per annum. Ten thousand dollars of this sum was paid to each State, for the fiscal year 1914–15, each State having assented by action of its legislature to the provisions of the act. There was also appropriated an additional sum of $600,000, for the fiscal year following the passage of the act; and for each year thereafter, for seven years, a sum exceeding by $500,000 the sum appropriated for the preceding year. For each year after the seven years there was permanently appropriated a sum of $4,100,000, in addition to the original appropriation of $480,000.

Before the fund becomes available to any college for any fiscal year, the plans of work to be carried on under this act must be approved by the Secretary of Agriculture. The money is allotted annually to each State by the Secretary of Agriculture, in the proportion which the rural population of the State bears to the total rural population of all of the States as determined by the Federal census. No money, beyond $10,000, is paid to any State in any year until an equal sum has been appropriated for that year by the legislature of such State, or provided by State, county, local authority or individual contributions from within the State for the maintenance of the cooperative agricultural extension work provided for in this act.

In order to provide a comprehensive basis for the cooperative agricultural extension work in the several States a general memorandum of understanding between the department and the colleges was drawn up. This memorandum provides that each college shall organize and maintain a definite administrative division for the management and conduct of extension work in agriculture and home economics, in charge of a responsible director selected by the institution and acceptable to the United States Department of Agriculture; that each college shall administer through the extension division thus organized any and all funds received for such work from appropriations made by Congress or the State legislature, by allot-

ment from the board of trustees of the college, or from any other source; and that each institution shall cooperate with the department in all extension work in agriculture and home economics which the department is authorized by Congress to conduct in the States.

The States Relations Service, through its Office of Extension Work, represents the Department of Agriculture in the administration and general supervision of all its cooperative extension work in agriculture and home economics. This involves relations with the State agricultural colleges, and the different bureaus of the department.

In the States the extension organization, under the director, includes county agricultural agents; county home demonstration agents; county club agents dealing with boys and girls; extension specialists in various phases of agriculture and home economics, located at the State agricultural colleges but spending a large share of their time in the counties; and State and district leaders of the county workers.

In 1922 there were agricultural agents in about 2,100 counties; home demonstration agents in 750 counties; and club agents in 200 counties, together with about 750 extension specialists and 420 State and district leaders. In addition, there were 155 negro agricultural agents and 91 negro home demonstration agents.

Since the passage of the Smith-Lever Act Congress has made annual appropriations supplementary to the regular Smith-Lever funds, and also provided the States Relations Service of the Department of Agriculture with funds to be used in cooperation with the colleges and counties in extension work. The States and counties have more than met their obligations under the Federal legislation.

In the year beginning July 1, 1921, the extension work in the States was maintained with $18,500,000, divided as follows:

Federal Government:	
States Relations Service	$1,050,754
Other bureaus of Department of Agriculture	100,205
Federal Smith-Lever funds:	
Regular	4,080,000
Supplementary	1,500,000
Total	6,730,959
From sources within the State:	
To offset Federal Smith-Lever funds:	
Regular	3,600,000
Supplementary	1,500,000
Additional funds from States, counties, and other sources	6,666,401
Total	11,766,401
Grand total	18,497,360

During the three years following the passage of the Smith-Lever Act much emphasis was laid on strengthening and broadening the extension organization. More intimate contacts were made with the farming people in the way of demonstrations on their farms and in their homes, etc. With the entrance of the United States into the European war the extension organization was used by the Government as a very important agency for stimulating food production and conservation, for informing the farming people regarding the plans for winning the war and enlisting their cooperation in making these plans most successful. For this purpose Congress made supplementary appropriations of several million dollars for two years. Under this stimulus the extension force was greatly expanded. County agricultural agents were located in over 2,400 counties, home demonstration agents in 1,700 counties and in 200 cities. Great numbers of children were enrolled in clubs. Thousands of gardens were successfully grown in urban and country communities, and great stores of food were canned and otherwise preserved. People were taught how to use foods to which they had not been accustomed and to make their food supplies go much farther toward their sufficient nourishment than they had previously thought possible. But the largest contribution of the extension forces was in heartening and aiding the patriotic farm men, women, and children in their wonderfully successful task of speeding up agricultural production in spite of the withdrawal into military service of millions of the most vigorous farm workers.

Up to the time of the European war agricultural extension work had dealt chiefly with the problems of agricultural production, though the demonstration work had emphasized the importance of good agricultural practice as a means of increasing the income from the farm. In recent years economic problems have become increasingly prominent in the work of the extension agents and this has been particularly true during the severe economic depression of agriculture in the past two years. The agents have dealt with a great variety of matters connected with the cost of production, standardization, storing, transportation, and marketing of agricultural products, the purchase of farm supplies, the farmer's labor income, keeping of farm and home accounts, organization and conduct of cooperative associations, etc.

In a broad way the extension system has greatly contributed to the nation-wide spread and great importance of the movement for the organization of the farming people to promote their economic and social interests. When it became apparent that the extension agents in the counties could not do their best work except as they had the support and assistance of groups of farming people, various organizations were formed for this purpose. In the Northern States

this brought about the organization of the county farm bureau as a nonsecret and nonpartisan organization open to any farmer and having as its object the promotion of the extension work. The extension agents actively helped the farmers to form farm bureaus, particularly during the war. The movement spread rapidly through the Northern and Western States and contributed in a large way to the success of the war measures for food production and conservation.

As the economic problems of the farm became more urgent the farm bureaus enlarged their functions to include marketing and other work outside the extension work. They then formed State and national federations, which undertook in a large way to promote the economic and legislative interests of the farmers, and carried on active propaganda to increase membership and organize farm bureaus throughout the country. The result has been the organization of over 1,500 farm bureaus in 47 States, with about 1,000,000 members. While the county farm bureaus have continued to cooperate with the extension forces, and in 20 States are recognized by law as agencies for this purpose, it has been necessary to have an understanding that the extension agents receiving any part of their support from public funds should confine their work to "the giving of instruction and practical demonstration in agriculture and home economics," leaving to the farmers and their organizations the conduct of business matters and the promotion of legislation in the interest of agriculture and country life. With this policy well established throughout the country, the extension work will be a permanent system of practical education for farming people, supplementary to their systematic education in schools and colleges.

In 1920 the extension workers directly aided the improvement of farm and home practices of 1,200,000 farmers, 400,000 farm women, and 445,000 farm boys and girls. Thousands of these children were stimulated to continue education in the schools, and a considerable number undertook courses in the agricultural colleges. That year all the extension work cost [illegible] cents for each $1,000 of gross returns from agricultural production in the United States.

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