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ABSTRACT

The proceedings of a conference which reviewed the content of undergraduate animal science curricula, content of courses in the animal sciences, and methods and materials used in undergraduate teaching in the animal sciences are presented in this bulletin. These individual papers are included: Trends in Animal Agriculture and the Future of Undergraduate Training in the Animal Sciences; Curriculum Development for Animal Science; Curriculum Development Projects for Technician Training Programs in Agriculture; Sourcebooks for College Teaching in Plant Pathology and Mycology; Sourcebooks for College Teaching in Crop Science and Soil Science; Animal Science in Basically Negro Colleges; and Remarks on the Land-Grant Colleges. Reports from working groups present recommendations in these areas: curriculum content, course content, instructional methods and materials, teaching in animal genetics, animal physiology, animal nutrition, and animal production. (PR)

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Undergraduate Teaching in the Animal Sciences

PROCEEDINGS OF A CONFERENCE

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National Academy of Sciences National Research Council

SE 012 159

UNDERGRADUATE TEACHING IN THE ANIMAL SCIENCES

PROCEEDINGS OF A CONFERENCE
MAY 20 and 21, 1966
WASHINGTON, D.C.

COMMISSION ON EDUCATION IN AGRICULTURE AND NATURAL RESOURCES
AGRICULTURAL BOARD
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Preface

The Conference on Undergraduate Teaching in the Animal Sciences was sponsored by the Commission on Education in Agriculture and Natural Resources, which is a unit of the National Research Council.

Background information about the conference—purposes, organization, and scope—is contained in a resource paper prepared by the Commission. See Appendix A of this report (p. 63).

Because it was felt that a small group could work with greatest efficiency, the conference was limited to about 40 persons. Participants were selected on the basis of recognized competence, geographic distribution, type of institution, and type of disciplinary background. They represented 4-year land-grant, non-land-grant, basically Negro, and 2-year colleges. Observers were selected from disciplinary and occupational areas closely related to animal science. Participants and observers are listed in Appendix B (p. 69).

Sponsoring conferences of this type is in harmony with the Commission's major purposes, which are to review trends in undergraduate teaching in agriculture and natural resources; to stimulate discussion, re-evaluation, and improvement of courses and curricula; and to make recommendations for the future development of academic programs.

The Commission is pleased with the results of the Conference on Undergraduate Teaching in the Animal Sciences and hopes that publication of the proceedings will stimulate worthwhile action. It does not necessarily endorse the conclusions and recommendations that appear in these proceedings.

The Commission expresses its appreciation to those who attended

the conference, and particularly to those who presented talks and those who served as chairmen of plenary sessions or as chairmen or recorders of the working groups.

R. E. LARSON, Chairman
Commission on Education in Agriculture
and Natural Resources

Summary

The following is a summary of the conclusions reached, and recommendations made, during the Conference on Undergraduate Teaching in the Animal Sciences.

STATUS OF TEACHING

A number of conferees expressed satisfaction with present-day teaching in the animal sciences and with efforts being made by a number of animal science departments to improve courses and curricula. Pride in the accomplishments of animal science graduates was evident.

However, several conferees noted an urgent need for accelerated improvement. A clear indication of their point of view is the large number of recommendations for specific action.

The concept of developing courses and curricula on an interspecies basis (integrating the study of meat animals, dairy animals, and poultry) was generally endorsed. However, most conferees believe that the upper-division production and management courses should remain on a separate-species basis.

The conferees reported an imbalance in the emphasis given to species areas. Several stressed the desirability of including fish, wildlife, light horses, and laboratory animals in management courses. The working group on teaching in animal genetics concluded that an imbalance with respect to quantitative or physiological genetics often exists.

In some departments, many animal science courses do not reflect knowledge derived from contemporary research.

The conferees agreed that many teachers do not make sufficient use of the knowledge gained by students in their prerequisite courses. Several working groups suggested that the number of prerequisites be held to a minimum. A related suggestion was that students entering a course with prerequisites be given a test to determine their competence in the prerequisite areas.

Courses in livestock judging, or selection, were given considerable attention. The conferees were divided on the question of whether such courses should be required, or even offered, by animal science departments. However, there was fairly general agreement that if such courses are offered, they should be developed as "selection" or "evaluation" courses—they should not take the traditional "on the hoof" judging approach.

RECOMMENDATIONS FOR ACTION

In the last plenary session, E. W. Glazener of North Carolina State University summarized the conference's recommendations for action. Dr. Glazener's statement follows:

"Conference discussions have focused on the following recommendations for action:

"1. Develop more resource material. This recommendation has come from each discussion group. Emphasis has been placed on laboratory manuals, guidebooks, and sourcebooks, although a shortage of adequate, up-to-date textbooks was recognized. There was general agreement that the most effective sourcebooks would adapt the methodology and results of recent research in the animal science field.

"2. Explore new directions for old functions, such as judging. Involve new technical approaches and more genetics in the selection and evaluation courses.

"3. Establish minimum course requirements in biology, mathematics, chemistry, and physics essential for animal science students. Work for improved communications to secure better teaching examples in the biological and physical sciences for majors in agriculture and biology.

"4. Develop minimum animal science subject areas—physiology, nutrition, breeding, animal products, management, selection, and disease control—essential for a major in animal science.

"5. Plan for course offerings, such as a course in light horses, for nonagricultural majors.

"6. Improve methods and procedures in a more organized fashion for training better teachers in animal science. This could include workshops on a regional and national basis.

"7. Strengthen faculty - student relationships in the learning process. An example is student seminars held in the homes of faculty members.

"8. Investigate the possibility of developing a laboratory animal curriculum.

"9. Organize management and production courses at the upper-division level, and involve the basic disciplines.

"Several additional suggestions for implementation of the conference recommendations were presented:

"First, the role of the Commission on Education in Agriculture and Natural Resources in implementation was described; it was pointed out that the Commission is primarily a catalytic agent; it is not an action group; also, Commission funds for the action programs that were recommended are limited.

"Next, the possibility of giving agricultural groups access to science teaching centers, such as the one designated for Florida State University, was proposed.

"It was agreed that the societies (for animal, dairy, and poultry science) have a responsibility in implementing the recommendations. The activities of the American Society of Agronomy and the American Phytopathological Society were cited as examples. It was pointed out that the agronomy group supported the preparation of two laboratory manuals and exercises were submitted by leading researchers. Attention was called to the fact that the American Institute of Biological Sciences and the American Association for the Advancement of Science should be contacted as possible supporting agents.

"Finally, there were suggestions that support for resource materials be sought from scientific societies and from private and public foundations."

In the discussion that followed Dr. Glazener's statement, there was a suggestion that an "American Society for Education in the Animal Sciences" should be formed to obtain funds and conduct projects.

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INDIVIDUAL PRESENTATIONS

W. A. COWAN

Department of Animal Industries
University of Connecticut

Trends in Animal Agriculture and the Future of Undergraduate Training in the Animal Sciences

It is not necessary to burden this knowledgeable group with details about current trends in animal agriculture. But it may help to review briefly, and in a general way, what is happening in this field in our rapidly changing world.

I will mention some trends, all of which are familiar to you; undoubtedly you could add others. Consideration of these trends may help those of us who are in university work to establish curricula that, for the next 30 years, will be the best that students of animal science could have.

POPULATION

We can be certain of a rapid increase in the number of consumers of animal foods and of other animal products. Most population experts predict that the world population will double by the year 2000. To meet the demand created by the "population explosion" in the United States, we will need material improvement in production efficiency or more livestock, or both—probably both.

We can be certain that the population of the future will tend to be less knowledgeable about, and less appreciative of, agriculture than is today's population. Our curricula should take this challenge into account.

DIET

We can expect that the affluent societies of the world will need fewer calories per person and will have a greater awareness of the hazards of excess weight and lack of exercise. For these reasons, and for economic reasons, the trend will be toward less fat in livestock products.

The controversy over fats and cardiovascular health continues, with few if any clear-cut, uncomplicated answers.

Whatever the outcome of the antifat trend, we, as animal scientists, must be sure to keep taste and nutritiousness in these products, or build them in. If the products do not taste good, they will not have a market.

Research on animal fats has the eventual objective of modifying—through breeding, feeding, or processing—the makeup of the fat to whatever ratio of saturation and unsaturation is considered desirable. This research should be increased, and should have strong support.

SUBSTITUTES FOR MILK, MEAT, AND EGGS

In the years ahead we can expect an increase in research, development, and marketing activities having to do with synthetic milk, meat, and eggs. The great challenge will be for animal agriculture to meet this competition by making the natural products more satisfying and less expensive while retaining the opportunity for profit.

We may find it necessary to utilize our cereal crops more efficiently by decreasing the proportions that go into livestock feed, thus increasing the proportions available for human consumption. We can expect that more nonprotein nitrogen will be used in ruminant nutrition—and more cellulose materials, such as cornstalks, silage, corn cobs, hulls, by-products, and even sawdust.

Increased competition may force continuation of the trend toward slaughter at lighter weights and younger ages—to obtain maximum production from limited feed supplies.

FEWER BUT LARGER FARMS AND RANCHES

You are familiar with the decline in number of commercial farms, feedlots, and ranches over the country. They are fewer but larger and more productive. To an ever-increasing degree, they are operated in accordance with scientific and business principles.

Because we have fewer farms and ranches, it appears to many that we do not have as great a need for educating prospective farmers at colleges. I cannot agree. It takes more know-how and "know-why" to manage a large agricultural enterprise than it does to manage a small one. Therefore, the need for college-educated farmers is greater than it has ever been. As the trend toward larger, more productive enterprises continues, the need for professional farmers with more than a high school education will increase.

PROCESSING, DISTRIBUTION, AND MARKETING

Not too long ago, most producers of milk, eggs, and meat did their own processing, distributing, and marketing. This situation has changed greatly. Processing, distribution, and marketing are now, for the most part, highly specialized functions that are not performed by producers.

The number of processors and purveyors is declining. As a result of improved efficiency, those who remain in the business are handling larger volumes. We can expect this trend to continue. Here, too, the need for training beyond high school will be greater than ever before.

AGRICULTURAL BUSINESS AND INDUSTRY

Automation, data processing, direct buying, and specification purchase of livestock carcasses and livestock products—all these will increase in the years ahead. There will be a demand for specialists to service the agricultural business and industrial complex.

In the feed industry, we can expect more satellite mills, higher-capacity plants, more "beeline" delivery, and at the same time more feed formulation at the larger feedlots and farms. We can expect also some increase in the use of complete rations.

GOVERNMENT PROGRAMS AND POLICIES

Programs and policies of agencies of the federal government have considerable impact on agricultural production, processing, and distribution. They have to be considered in curriculum development. The impact is likely to increase.

Some high-cost, low-enrollment curricula are appraised now on the basis of cost per student, whereas they should be measured in terms of value to society.

RESEARCH

We can look forward to greater utilization of genetic merit through increased use of artificial insemination, estrus synchronization, and possibly even sex control. Crossbreeding and rotational sire-use systems will become more prevalent. Genetic merit will be more precisely determined by objective and subjective approaches and by progeny evaluation work. We will also achieve increased efficiency in some phases of livestock production through mechanization, automation, environmental control, improved life-cycle nutrition programs, and disease-control programs.

JOB

Agricultural colleges are not producing graduates fast enough to meet the demands of the job market. Job opportunities abound, regionally, nationally, and throughout the world. I expect opportunities to increase in the future if colleges of agriculture meet the challenge of developing young men and women who can do the job as well as or better than graduates from other schools and colleges in the university.

NEW AREAS

Up to this point I have spoken of animal science in relation to food products—milk, meat, and eggs. There are at least two other developments in animal science that we should recognize as we plan curricula.

The first is the raising of light horses, an enterprise that is expanding rapidly. Horses add to the pleasure in life for many. College courses concerned with light horses are just as appropriate as courses in, for example, floriculture, landscape architecture, music, or painting. For some, such courses are a means of adding pleasure and beauty to life; for others, they have a vocational purpose.

Our courses in horse science at the University of Connecticut are very popular with students. Many employers, including feed companies, agricultural extension services, and some agricultural supply organizations, want employees who know something about managing horses. Often there is a request for someone qualified to be the manager of a horse farm.

The second development is the demand for persons qualified to be managers, supervisors, and technicians with laboratory animal projects.

With relatively little curriculum change, and with flexibility in program development, we could educate some of our students for this kind of work.

A number of openings have been brought to our attention in the last few years. Recently a large, private university asked whether we could suggest someone qualified for the job of supervisor in one of their species units. The starting salary was \$7,500. This institution has 40,000 head of "livestock," including rats, mice, monkeys, chickens, pigs, and sheep.

TRENDS IN EDUCATION

So much for some of the trends in the industry. Now, what about trends in education, and the challenges that must be met?

I have been directed not to include dairy manufacturing, poultry processing, and meats programs, although these are important areas for animal science students.

How are states organizing to provide facilities and instruction for the increasing numbers of qualified college applicants? Many state universities have established, or are planning to establish, branches that will provide the first 2 years of a broad and liberal education; these will be at several locations in a state. This trend probably will continue. It means that to an increasing degree the major work will have to be included in the last 2 years on the main campus.

One of our great challenges is to provide curricula that will enable students to become specialists and at the same time include a liberal education to develop proper appreciation of our biologic, economic, and social world. How can the knowledge explosion be sorted, digested, and included in a 4-year program? Should we have a program extending beyond 4 years?

At some universities there is a tendency for the most competent senior staff members to be engaged solely in research and graduate teaching. This is a problem because it means that some undergraduate major courses are taught by graduate students, many of whom lack the ability and experience to stimulate a thirst for knowledge among those who need it the most.

Another problem is the inability of some teachers to keep up with the knowledge developing in their fields. How can a teacher stay up to date when he is carrying 10 to 20 contact class hours weekly, serving on committees, counseling, and taking responsibility for commodity-day and livestock-management duties? What can be done to keep him

informed and perhaps enable him to write some papers of his own? The papers might help him be a better teacher and move him up the promotion ladder.

Great teaching is rare and good teaching is scarce on most campuses. How do we motivate teachers to greater effort?

At some institutions, more sophisticated titles are being given to animal science courses. A new title is meaningless to the students if the course content does not improve accordingly.

In some departments, usually outside colleges of agriculture, a problem is created by using freshman courses to screen prospective majors for those departments. As a result, courses that should provide broad education for nonmajors fail to do so. Departments at some schools need to be aware that service courses are for the entire school, not for departmental majors only. How should administration handle such problems?

Some feel that students' opinions on curricula and courses should not be taken too seriously. Yet, I have been surprised by the objectivity and seriousness with which students in animal science seminars have appraised courses and programs. When students avoid some elective course that we think they should have, the trouble is usually poor teaching, not that the course involves too much work.

Teachers' lack of appreciation for the whole field of animal science is another problem, one that is common among young specialists. Some went from high school directly into the B.S., M.S., Ph.D. sequence and may have had little, if any, breadth of experience. Some want every student they counsel to follow their own paths, failing to consider differences in ability, interest, and career objectives. That kind of counseling is not desirable.

How do we motivate our freshmen to have greater interest in the science courses closely allied with animal science? Some argue that freshmen should be interested in these courses spontaneously. The fact is that a great many are not. Would improved teaching of those science service courses be the answer? It undoubtedly would help, but many of our students do not understand why they are required to take those courses.

Suppose you have an introductory course in animal science that deals with types and breeds of livestock. Would such a course stimulate interest in chemistry, physics, or botany? It is doubtful.

But suppose you have an introductory course that orients animal agriculture to our changing world (showing the scientific, social, and political implications) and explains the role of animal science in the development of an efficient agriculture. In demonstration or laboratory

periods, such a course would give students a chance to see examples of research in nutrition, physiology, genetics, and management. Would this light a fire? It might. And it might be just what the nonagricultural student needs to help him appreciate agriculture.

Or what about an introductory course in animal and plant breeding that would deal with reproduction, genetics, and selection? Would such a course bring about recognition of the need for strength in the sciences? Would a course in animal physiology be an asset in helping us kindle an interest in chemistry, physics, and zoology?

Some animal science curricula are criticized because they include judging courses. Some critics never had such a course and do not know what is included in these courses today. The term "judging" should not describe most of these courses. Lining up animals and placing them might be called livestock judging, but "selection" or "appraisal" or "evaluation" is a better description of the content with which today's courses should be concerned. Such courses should include both "eyeball" appraisal and objective measurements. They should include carcass and cut-out value; and they should consider probes, biopsies, ultrasonics, and K40. If a course includes these things and, in addition, focuses on how "eyeball" appraisal can be made more valuable, it can be one of the most stimulating courses in the curriculum.

Some would have us omit the applied, or practice, aspects from animal science courses. The greatest stimulation of interest comes from a blend of the theoretical and the applied in course work. Few criticize courses in chemistry, medicine, communications, or the fine arts for including the "how." If we do not relate the "how" and the "why," we lose one of the most important requisites in education—the interest of the students. Moreover, some of the techniques that we teach become useful immediately after graduation—on the farm or ranch, in agricultural business, in agricultural education, or in foreign assignments.

An example may help to make the point. An instructor can lecture on the importance of proper teasing of bulls prior to semen collection. He can lecture until he runs out of words and still not get the message across. Another approach is to collect a bull without any teasing and run a methylene blue reduction test on the semen. Then collect him again after considerable teasing and run the same test. If all goes as it should, the second collection should be appreciably better. The instructor has thus demonstrated the "how," or the applied, and has raised a big question in the students' minds—"why?" He now has fertile ground to sow with theories and variations of "why?" Moreover, the students will never forget this lesson. The textbook theories will have more

meaning because interest and curiosity have been stimulated. Some of the students may even delve into the matter further. If this happens, the instructor has been the catalyst to real learning experience—not just a lecturer calling for regurgitation of hastily memorized facts when examination time comes around.

Flexibility in program planning must play an important role in training students for the increasingly specialized positions in the field—positions calling for specialization in production, science, business, service, education, or communications. A core of courses for all may be desirable, but students differ in their abilities, interests, and objectives, and should have considerable freedom to vary their programs of study.

The undergraduate curriculum for a student planning to go on for the Ph.D. should include as much science as two semesters of general chemistry, two of organic chemistry, possibly two of biochemistry, two of physics, two or three of mathematics, and one of statistics. In addition, it should include courses in physiology and zoology and the student's own major courses.

For the student interested in the business aspects of animal science, courses in advertising, salesmanship, personnel relations, psychology, marketing, credit, and public speaking may be highly desirable. Another student may have to take 15 to 24 credits in education to meet his particular goals. The student going into production should have supporting courses in agricultural economics, farm management, agronomy, range management, agricultural engineering, and animal diseases.

I cannot overemphasize the importance of electives and individual counseling. Without them, we revert to the days when the program of a student majoring in animal husbandry was completely planned for him, throughout his college career.

There is an alternative. We could have a fixed program for those wanting to emphasize business, science, production, or education—a program similar to many engineering programs in which students are trained for a given specialization in engineering. I am convinced that such a program in animal science is less desirable than a flexible program with electives.

When we look at outstanding examples of successful enterprises on poultry, hog, horse, and dairy farms, and on livestock ranches, we see that success is usually the result of the application of scientific principles in a businesslike manner by dedicated, hard-working men and women. We need both science and business in our animal science courses, and in the elective courses as well. Do not omit the livestock from the animal science curricula. Instead, insist that they be included. If you

leave them out, you may find that your enrollment is dropping and that many of the residents of your state are majoring in animal science at some other school. Our teaching should include principles that can be applied from the arctic to the equator; it should include methods and practices proved best by research and experience.

I have tried to indicate some of the challenges, problems, and questions facing those who plan 4-year courses of study in animal science. I would be remiss if I did not indicate that I strongly believe that we should have other programs, 1 and 2 years in duration, to train technologists for production and associated industry jobs that require more than high school education. I believe that the opportunities for increasing enrollment in the 2-year associate degree programs in animal science are fully as great as in the B.S. programs. We do not fulfill our obligation if we do not develop such programs.

Finally, it is obvious that we will need more animal scientists, trained beyond the B.S. degree, to teach and do research and thus lay the foundation for an improved animal science in the next century.

J. E. OLDFIELD

Oregon State University

Curriculum Development for Animal Science*

Prior to assembling curricular programs for the animal sciences, the Biological Science Action Committee on Animal Science tried to develop some points of basic philosophy that would serve as guidelines in future deliberations. I should like to comment on some of these points. I believe that they will explain some of our recommendations.

THE NEED FOR CHANGE

One may well ask why there should be such emphasis on curricular change at this particular time. Certainly, curricular development is a dynamic thing and should proceed continuously. There is evidence, however, that we are living in an especially exciting period of scientific development and that our branch of agricultural technology, the animal sciences, is changing at an accelerated rate.

The purpose of change is to bring about improvement. We hope that our suggestions will be viewed as attempts to advance in step with an advancing technology. They were not motivated by a desire to criticize present conditions and those of the recent past. In its discussions of

*This talk is based on a preliminary report from the Biological Science Action Committee on Animal Science, one of seven action committees formed jointly by the Commission on Education in Agriculture and Natural Resources (CEANAR) and the Commission on Undergraduate Education in the Biological Sciences (CUEBS) to recommend desirable education in the biological sciences (and secondarily in the physical sciences and mathematics) for undergraduates in agriculture and natural resources.

existing animal science curricula, the Committee recognized many excellent features.

The Committee's recommendations in any area represent a desirable basis from which to work, and are not intended to provide all-inclusive coverage of the area.

ANIMAL SCIENCE AND AGRICULTURE IN THE FUTURE

So much has been said and written in the last few years about the so-called image of agriculture that it needs no description here. However, one can hardly deal with curricula in the various disciplines of agriculture without contemplating how they will affect, or be affected by, this popular image.

It is generally taken for granted that agriculture owes much in its development to findings in the basic sciences. It is not so well recognized that the more basic branches of science—both physical and biological, but particularly the latter—can benefit greatly by application of their principles through the medium of agricultural involvement. It's a two-way street. If we can keep that fact in mind throughout our deliberations on curricular development, mutual enrichment should follow.

Some feel there is a question concerning the survival of animal science and other agricultural disciplines as distinct entities. Our Committee, understandably, feels that animal science has so much to offer that its continued existence is not open to question, provided that it advances with developments in allied fields.

THE OBJECT OF ANIMAL SCIENCE TRAINING

The Committee has wrestled with the problem of identifying the needs of the animal science graduate of the future. It is not easy to anticipate the needs of the future in any field of education, but some trends seem to be established well enough to be recognized.

Broadening the Frame of Reference

Most modern university animal science programs have broadened their objectives from the narrowly defined field of "animal production." The employment experience of graduates shows the desirability of the trend

toward broader programs concerned with the use of animals by mankind.*

What form does the trend take? The one most commonly seen is the development of optional areas of specialization within the animal science curriculum. Areas of specialization accepted throughout the country are business, science, and technology. The Committee does not wish to change away from such successful diversification. Rather, it has sought to identify, within such subdisciplines, a common ground of course preparation that may be desirable for all areas of animal science application. It seems likely that tomorrow's animal science major will have interests of two kinds—research-oriented and practice-oriented—and future curricula should serve these two areas.

Diversity of National Needs

It is important to recognize the diversity that exists in animal science programs around the country today, and in opportunities for career development in animal-oriented industries. We hope that we have recognized this diversity adequately by restricting the list of courses we consider essential, thus allowing some flexibility in developing programs to suit particular sets of conditions.

Improved Preuniversity Preparation

This point needs little discussion. Those of you who have youngsters exposed to the "new math" (as I have) need no further evidence that great changes are taking place in grade school and high school education. It seems fair to expect that these changes will give us better-trained university students. If these expectations are fulfilled, we should be able to eliminate some of the material we have covered at the university level in the past. Our task is to determine where the transition point will be.

The Action Committee on Animal Science has sought to compile a list of courses in physical and biological sciences that will be appropriate for animal science majors entering college in the future. (See Table 1.)

*Only about 15 to 20 percent of agricultural graduates in 1963-1964 were placed directly in farming careers, according to a survey conducted by the National Association of State Universities and Land-Grant Colleges with assistance by the Commission on Education in Agriculture and Natural Resources.

TABLE 1 Proposed College Courses in Physical and Biological Sciences for Animal Science Majors (by term)

Year	Courses	Fall Term	Winter Term	Spring Term
Freshman ^a	Mathematics through calculus ^b	X	X	X
	Preliminary chemistry	X	X	X
	Preliminary physics ^c	X	X	X
Sophomore ^a	Cellular biochemistry	X	X	X
	Functional biology	X	X	X
	Genetics			X
Junior	Vertebrate physiology	X		
	Comparative nutrition		X	
	Ecology			X
	Specialized courses in animal science	X	X	X
Senior	Specialized courses in animal science	X	X	X

^aThe Committee recommends courses in communications and economics in the freshman and sophomore years, but has not specified their content.

^bThe area of mathematics to be covered is thus delineated; however, specific course titles are withheld pending developments in structuring mathematics courses. (See A General Curriculum in Mathematics for Colleges, a report by the Committee on the Undergraduate Program in Mathematics, P.O. Box 1024, Berkeley, California 94701.)

^cSome of the topics to be covered in the preliminary physics course have been identified, but the specific course titles and the term time to be devoted to them have not been shown.

In the Committee's opinion, these courses will challenge and stimulate students who have had the kind of pretraining I have mentioned, and they will form a strong foundation from which students can embark on study programs designed to serve their various specific career needs.

ACTION COMMITTEE RECOMMENDATIONS

The most difficult part of the curriculum to define is the preliminary part, taken in the freshman and sophomore years. Defining it is difficult because, as I have indicated, we do not know precisely how much training students will have when they come to us. No doubt there will be considerable variation, as there is now. Also, defining the preliminary

part is difficult because of its importance; it must serve as a firm foundation and must make possible the diversity of development that we seek.

The Committee's recommendations for the physical and biological sciences are discussed below.

Physical Sciences and Mathematics

The Committee agreed that three extremely important basal areas are mathematics, physics, and chemistry. Important modernizing trends are taking place in all three. The "labels" that we are accustomed to applying to divisions of subject matter within these fields may not be appropriate in the future. For example, in mathematics, our Committee felt that we should require training through calculus (differential and integral) and probability theory. In the recommendations of the Committee on the Undergraduate Program in Mathematics, these areas are identified as Mathematics 1, Introductory Calculus (3 semester hours), and Mathematics 2P, Probability (also 3 semester hours), which would approximate the three-term sequence in mathematics listed in Table 1.

Similar realignments are taking place in physics, but since recommendations are not quite so far advanced, no specific course designations have been included. We hope that the physics basis will be oriented toward the needs of the rapidly developing field of biophysics and will include units and measurements, mechanics, energy, sound, light, and introductory material on atomic structure and radioactivity. Arrangement and coverage of this work will depend to a considerable extent on the beginning level of student training. Although physics is listed in Table 1 as a freshman-year offering, it may well be that it should be moved, in whole or in part, to the sophomore year.

Chemistry is an area of special concern to the animal science curriculum because of its very close identification with many phases of animal science study, including cytogenetics, nutrition, and physiology. The Committee recommends a year's sequence in preliminary chemistry, in the hope that this would build on an improved base of high school chemistry and would carry the student through introductory organic chemistry to an outline (and outline only) of biochemistry.

This suggestion is not original with our Committee. A number of brave attempts to streamline chemistry for agricultural students have been made, including some at my own school; certainly not all have been successful.



I have received mixed reactions to this suggestion. Some chemists feel that the principle of such a course is attractive, but that, as a practical matter, such a course would cause serious difficulties. We should like the course to be a satisfactory prerequisite for excursions into various areas of chemistry; we definitely are not interested in a watered-down terminal course.

I think there are two prime requisites for success with respect to chemistry. First, students at the college entrance level must be better trained than they have been in the past. They should not be "starting from scratch" in chemistry. The second requisite has to do with the nature of the instruction, and while it is pertinent here, it applies equally to other fields. I include several things in the phrase "nature of the instruction"—organization of the subject matter, clarity and enthusiasm with which the subject matter is presented, and identification of principles with areas of application, where appropriate. We do not suggest that this course be taught by animal science departments, or that it be taught in a section restricted to animal science students, but we hope that it can be taught in a way that will demonstrate an awareness of the involvement of chemistry in animal science.

This preliminary chemistry course would be followed by a course in cellular biochemistry, which would continue the involvement between chemistry and animal science by relating the chemical nature and physiological mechanisms of the reactions of the cell.

Biological Sciences

As in the physical sciences discussed, changes are taking place in the traditional arrangement of subject matter in the biological sciences—changes to relate undergraduate teaching to rapidly advancing knowledge.

The Committee has recommended, with the intention of providing a base that integrates various subdisciplines of biology, a three-term (or 1-year) sequence called functional biology. This would begin with an introduction to modern biology and the scientific method and would proceed through discussions of cell structures and functions, specialization in animal and plant organisms, mechanisms of heredity, and theories of evolution. This course would be offered concurrently with cellular biochemistry, and it is hoped that there would be considerable liaison between the two.

After this introduction, detail would be added through courses in genetics, vertebrate physiology, comparative nutrition, and ecology. We have attempted to identify at least some of the subject matter

involved in these courses. Throughout the series we would hope to integrate the entire field of biology as it applies to the animal sciences. First, the basic principles upon which biological reactions depend would be presented; then these principles would be related to the higher animal organism.

How to divide the subject matter was discussed at some length. We feel that the divisions chosen lend themselves well to the integration of biology as it applies to the animal sciences; they divide the various factors that influence animal life into inherent biology (represented by genetics and physiology) and environmental biology (nutrition and ecology).

The student would then branch out into the specialized areas most appropriate to his interests and his professional career. The opportunities to branch out have been indicated as occurring in the junior and senior years. Principles would be tied together in production - management courses for the technology-oriented students, in agri-business applications for the business-minded, and perhaps in growth and reproduction courses for those students interested in specific applications of scientific principles to the large animal species.

The omission of other important basic areas from these recommendations deserves comment. It is generally agreed that courses in communications, humanities, and social sciences are desirable and should be required. Their omission reflects the nature of the charge to the Committee.

H. N. HUNSICKER

U.S. Office of Education

Curriculum Development Projects for Technician Training Programs in Agriculture

There is definitely a trend toward post-high school vocational - technical education. Completion of 2 years of post-high school training probably will become as traditional, within two decades, as high school graduation is today.

In 1965, vocational education programs were established in 43 junior colleges, of which 36 were new institutions. The expansion is considerably greater in 1966, with approximately 50 new colleges being established.

In addition, 144 new vocational - technical schools were established in 1965. A total of 208 construction projects for vocational - technical education were approved.

The expansion in vocational education is due chiefly to funds made available by the Vocational Education Act of 1963.

Establishment of new institutions in vocational - technical education does not assure that instruction in agriculture will be included. In fact, it is doubtful that agriculture will be included unless agricultural organizations become interested and unite to persuade those responsible that there is a need for such curricula.

Vocational agriculture's roles at the post-high school level are those of leadership and promotion in behalf of the agricultural industry. The actual number of courses taught may be few compared with non-agricultural subjects, the number depending upon the curriculum.

Eventually, a junior college, or other post-high school institution offering vocational - technical curricula, will be easily accessible to every person.

Technician training in agriculture may be established in junior colleges, community colleges, technical institutes, and in connection

with existing colleges of agriculture. Programs may include grades 13 and 14, extensions of comprehensive high schools, or area schools.

Curriculum guides for technician training in agriculture are in process of development. These are brought about through cooperative effort of the U.S. Office of Education, colleges, trade organizations, and other groups. In the near future, guides pertaining to the following technological fields will be available:

- Ornamental horticulture technology. To be prepared by Farmingdale Agricultural and Technical College, New York.
- Food processing technology. To be prepared by Morrisville Agricultural and Technical College, New York.
- Agricultural mechanics technology. To be prepared by Cobleskill Agricultural and Technical College, New York.
- Grain, seed, and farm supply technology. To be prepared by Grain and Feed Dealers National Association.
- Crop production technology. To be prepared by Mount San Antonio College, California.
- Operating and managing a farm business (being negotiated).
- Animal science (proposed).
- Plant science (proposed).

A summer institute on technician training in agriculture will be held August 1-5, 1966, at the Cobleskill Agricultural and Technical College, Cobleskill, New York.

Constructive suggestions for further developing and improving technician training in agriculture are invited.

R. B. STEVENS

National Academy of Sciences
National Research Council

Sourcebooks for College Teaching in Plant Pathology and Mycology

Although I am here as a representative of the Division of Biology and Agriculture, NAS-NRC, I am speaking about sourcebooks for college teaching in plant pathology and mycology on behalf of the two appropriate societies.

Our Division first became involved in the preparation of sourcebooks in biology nearly 10 years ago when it produced, through the old Committee on Educational Policies, a sourcebook of laboratory and field exercises for secondary school biology. (The Committee's work on sourcebooks was a forerunner of work done by the American Institute of Biological Sciences through the Biological Sciences Curriculum Study.) This sourcebook was later published commercially.

Then the Division attempted to prepare sourcebooks for college biology, with some two dozen specialties represented. This effort proved largely a failure for the reason that material simply was not forthcoming from a general solicitation of college teachers.

At my urging, however, the American Phytopathological Society investigated what could be done in its specialty, with the assistance of a small grant from the National Science Foundation. Two approaches were used: solicitation of exercises in use by teachers of plant pathology and search of some representative professional literature, especially the journal Phytopathology, for published research that looked as though it could be successfully converted into laboratory exercises.

The first approach produced almost nothing of value.

The second approach was rewarding. The scientists who had performed the research reported in the literature were asked to produce exercises from it; they were asked to simplify where necessary, under-

score the touchy spots, and so on. The response was most gratifying even though many of these scientists had never been involved in teaching situations. The result of this effort totaled more than 200 exercises, which will be published as a book by W. H. Freeman & Co. in San Francisco. It will be a sourcebook from which an instructor can build his own manual or assembly of exercises.

In the mycology project, which is only about half completed, we are preparing what we call a "guidebook," rather than a "sourcebook." It is designed to tell the teacher of mycology: (1) where and how he may obtain specimens of the fungi in a particular group, including especially the tricks of the trade by which the specialist manages to come back from a field trip with a well-filled container; (2) the best way to store or maintain the specimens in the laboratory until the time they will be used; and (3) in what way these fungi can be demonstrated best in the laboratory, including any particularly dramatic or instructive experiment that can be done with them. An ancillary item, when appropriate, will be information on how a given fungus can be used to illustrate some fundamental of biology, such as genetics, photoresponse, or nutrient uptake.

It is not the purpose of the guidebook to divert the introductory course from its present emphasis, but to improve it within accepted objectives and to make it possible for the mycologist who is unfamiliar with certain groups to include these successfully in his general course. This operation, too, is supported by the National Science Foundation. It has one costly feature not present in the earlier project on plant diseases—that is, funds for three graduate students to try out the experiments under conditions similar to those of an average teaching situation. Thus we hope to get some indication of what changes in the material are needed before it goes into final manuscript form. With luck, the mycology guidebook will be completed in about 2 more years.

HYDE S. JACOBS

Kansas State University

Sourcebooks for College Teaching in Crop Science and Soil Science

My assignment is to tell you about the sourcebooks for college teaching recognized by the American Society of Agronomy (ASA).

The Society publishes two series of hard-cover books—the Agronomy Monograph series and the Advances in Agronomy series. Books in both series are designed to review research progress and agronomic practice. Each book in the Agronomy Monograph series is on a single topic. Each book in the Advances in Agronomy series consists of articles on a number of topics of current interest.

In addition, the Society publishes, for use by college teachers, Laboratory Manual for Crop Production and Soils Laboratory Exercise Source Book. I wish to spend most of the time discussing these two books. First, I will refer briefly to books in the two series.

The Agronomy Monograph series was started in 1949. Nine volumes have been published. Five are in preparation; they cover nitrogen, irrigation, soil acidity and liming, wheat, and population and food.

The Society's policy is to develop monographs to meet needs that are not being met through other publication channels. The procedures are simple. Any Society member may suggest topics for monographs. The Committee on Monographs and Advances investigates the need and probable reception. If a favorable report is made, the ASA president appoints an editor and an editorial committee. Preparation of the manuscript is strictly a "labor of love," for there are no royalties or expense accounts. The Society expects the editors to meet their increased expenses by making use of means regularly available to them. This policy was adopted because the Society considers that these editorial activities are of a professional nature and are part of a scientist's duties.

The Advances in Agronomy series has been published by Academic Press since 1949; one volume is issued each year. Editorial responsibility rests with a Society member who is retained by the publisher but is advised by the ASA Committee on Monographs and Advances.

Agronomic education activities of the Society are centered in its Resident Education Division. This division organizes annual educational symposia, sponsors a student activities subdivision, appoints committees in educational fields, and provides a forum for the presentation of professional papers related to agronomic education. The Society provides for the publication of the papers on agronomic education, maintaining an editor whose chief duty is to process them for publication in the Agronomy Journal.

I should like to comment on the work of the Teaching Improvement Committee of the Resident Education Division. First, the following background:

Instructors in introductory crops and soils laboratories prefer to use manuals that originate in their own universities. Varied crops, soils, and facilities make it difficult to write manuals that are widely acceptable. Most of the manuals in crops and soils laboratories are printed or processed locally and are not copyrighted. Such manuals have the advantage of being readily adaptable when it is desired to include new ideas. They have the disadvantage of tending to be provincial in the sense of concentrating on local aspects of a problem without giving sufficient attention to national aspects. Because they are "in-house" publications, they may not represent the best efforts of those who prepare them, and the instructor may choose to give key explanations and instructions verbally instead of including them in the exercise.

It was against this background that the Teaching Improvement Committee of the Resident Education Division collected outstanding laboratory exercises in beginning crops and soils courses in 1959 and 1960. Instructors were asked to submit their two most successful exercises. Dr. A. R. Hilst, now a member of the Commission on Education in Agriculture and Natural Resources, was then chairman of the Teaching Improvement Committee and served as editor of the laboratory manual for crop production. This effort was not designed to present a new approach to agronomic education or to provide an authoritative answer to the question of what ought to be done in introductory crops and soils courses. Rather, it was an attempt to bring together successful laboratory exercises so they would be readily available for use by crops and soils teachers.

The exercises were the basis of a crops laboratory manual and a soils laboratory manual sourcebook. These have been published by the

Society. The crops manual contains no copyrighted material. The soils sourcebook contains parts of five copyrighted exercises, included with the permission of the copyright holders. Permission was given with the understanding that the book was for the use of teachers only. The Society's executive secretary believes that we could have sold hundreds of books if they had been designed for student use.

I believe that instructors in many institutions would welcome a laboratory manual published under the auspices of a professional society. This would be especially true in the junior colleges and in departments too small to develop their own manuals. There may be relevance in the fact that the soils sourcebook has been translated into Turkish, and 5,000 copies have been published in that language—more than have been published in English. Evidently the book is being used by students in Turkey. We should remember, though, that a laboratory manual sourcebook has more versatility than a laboratory manual. An instructor may choose exercises and ideas from a sourcebook, whereas he usually is limited to a single exercise on a given subject once he adopts a laboratory manual.

After the exercises were collected, one of the first problems encountered was duplication in content. The crops manual editors approached the problem in one way, the soils manual editors in another.

The crops manual was completed first. It contains only one exercise in a given subject matter area, but all instructors who submitted exercises are listed as contributors.

The editors of the soils laboratory manual sourcebook chose not to publish any of the exercises intact. Almost every exercise included distinctive ideas that would have been lost if only selected exercises had been published. The editors divided the book into 17 divisions and included a general discussion and a variety of experiments in each division. Original exercises were added to some divisions to round out the presentation.

These manuals appeared at an opportune time. In the past few years, consolidation of courses in the animal and plant sciences has been widespread. Where consolidation has occurred, texts, laboratory manuals, and courses have been changed in a single stroke. The sourcebooks have been most helpful in organizing new laboratories and updating ongoing programs.

It is difficult to assess in detail the effectiveness of the Society's two laboratory volumes, but the crops laboratory manual is in its third printing and the second printing of the soils laboratory manual sourcebook is almost exhausted. One instructor wrote: "Of the 16 exercises which we present in our beginning crops courses, 12 are

from the sourcebook . . . so, if our selections have been made wisely, it should indicate that we replaced 12 of our exercises with 12 exercises from other institutions which we thought were better than the ones we were previously using."

Both books received the minimum in effort, cost, and time. If one starts with ideas that have already been put into exercise form, it does not take long to compile a sourcebook. Over 90 percent of the departments contacted responded to the request for exercises. Initial publication costs were underwritten by the Society but have been recovered through sales.

Crops and soils laboratory manuals now in general use can be improved. The need for improvement is greatest in these areas:

1. The discussions and explanations at the beginning of many of the exercises are too brief, in my opinion. To make the exercises meaningful, the instructor often has to supply the preliminary material orally. If key explanations are given orally, an important part of the laboratory manual goes with the instructor when he leaves the class. The students have only a few hastily made notes.

2. More illustrations are needed, and many of the illustrations used are substandard. This deficiency is especially noticeable in mimeographed exercises, and is more evident in the soils than in the crops collection.

3. The exercises were generally designed to illustrate rather than to investigate principles. Many of the high school curriculum projects, including CHEM Study, Biological Sciences Curriculum Study (BSCS), and the Earth Science Curriculum Project, have given particular attention to the investigative aspects of laboratory practice. Perhaps we, in the colleges and universities, should take the hint. Looking back, I believe that our Teaching Improvement Committee should have sponsored a symposium on laboratory teaching methods and ideas before publishing the manuals. The original exercise collections would have served admirably as the focal point for discussing teaching methods, subject matter, teacher-centered versus student-centered exercises, and the investigative rather than the illustrative approach.

DISCUSSION

Question: How many sourcebooks are being used?

Answer: Three hundred soils book have been published, and an additional three hundred are to be published.

R. L. BAILEY

Grambling College

Animal Science in Basically Negro Colleges

This study was concerned with the status of animal science programs in basically Negro colleges. Consideration was given to (1) curriculum offerings and requirements for completion, (2) instructional personnel (training, teacher load, and other responsibilities), and (3) laboratory equipment and facilities for instruction.

The following institutions were included in the study:

Alabama A & M College, Huntsville, Alabama
Alcorn A & M College, Lorman, Mississippi
Arkansas A M & N College, Pine Bluff, Arkansas
Delaware State College, Dover, Delaware
Florida A & M University, Tallahassee, Florida
Fort Valley State College, Fort Valley, Georgia
Grambling College, Grambling, Louisiana
Hampton Institute, Hampton, Virginia
Kentucky State College, Frankfort, Kentucky
Langston University, Langston, Oklahoma
Lincoln University, Jefferson City, Missouri
Maryland State College, Princess Anne, Maryland
North Carolina A & T College, Greensboro, North Carolina
Prairie View College, Prairie View, Texas
South Carolina State College, Orangeburg, South Carolina
Southern University, Baton Rouge, Louisiana
Tennessee State University, Nashville, Tennessee
Tuskegee Institute, Tuskegee, Alabama
Virginia State College, Petersburg, Virginia
West Virginia State College, Institute, West Virginia

TABLE 1 Semester-Hour Requirements for a B.S. Degree with a Major in Animal Science, by Courses^a

Institution	Animal Science	Other Agriculture	Chemistry	Biological Science	English and Communication	Mathematics and Physics	Social Science and Economics	Others	Total
Alabama A & M College	33	22	12	9	14	6	8	30	134
Alcorn A & M College	33	23	16	12	12	3	12	29	140
Arkansas A M & N College	30	33	12	12	6	3	3	31	130
Florida A & M University	39	15	17	11	12	6	9	27	136
Fort Valley State College	34	20	12	22	8	22	6	14	138
Grambling College	51	18	12	16	15	6	13	19	130
Langston University	23	3	4	25	10	6	8	45	124
North Carolina A & T College	43	15	13	12	8	15	9	20	135
Prairie View College	42	19	12	19	12	6	15	34	159
South Carolina State College	40	18	10	23	12	6	12	12	133
Tuskegee Institute	22	15	21	14	12	16	6	23	129
Virginia State College	21	20	15	12	9	7	6	46	136

^aThirteen of the institutions studied grant a B.S. degree with a major in animal science. Tennessee State University is omitted from the table because no catalog was received from that institution.

METHODS

Each institution included in the study was asked to furnish a copy of its latest catalog.

Two questionnaires were sent to each department of animal science. One requested information on laboratory facilities; the other was on training, teacher load, and other responsibilities of teachers.

Six of the institutions (Langston, Arkansas A M & N, Alcorn, Grambling, Prairie View, and Southern University) were visited for observation of facilities and interviews with personnel.

RESULTS

All but one institution sent a catalog and 12 returned the questionnaires.

The catalogs from Hampton Institute, Kentucky State College, and West Virginia State College indicated that these institutions had discontinued teaching agriculture. The offering closest to animal science at Maryland State College was a 2-year program in dairy manufacturing and food processing. Omission of these 4 institutions from the study left 16 departments for further consideration.

Delaware State College and Lincoln University did not have majors in animal science but did offer courses in that area in support of other programs. All other institutions reported a major in animal science. Usually the major was in general animal science, and a student could take additional courses in a special area according to his interest. Four of the institutions offered definite majors in poultry, dairy, or animal production.

CURRICULA

The semester-hour requirements for a B.S. degree with a major in animal science in the various institutions are given in Table 1, p. 28. Fort Valley State College was the only institution that operated on the quarter system; these hours were converted to semester hours for uniformity.

The requirements were grouped into (1) animal science, (2) courses in agriculture other than animal science, (3) chemistry, (4) biological science, (5) English and communication, (6) mathematics and physics, (7) social science and economics, and (8) other areas. The total hours

required ranged from 129 at Tuskegee Institute to 159 at Prairie View; the average was 136. The average number of hours required in animal science was 18.8; the average total hours in agriculture, 55.5.

All but three of the institutions followed some type of general core program during the freshman and sophomore years. In 11 of the institutions the program applied to all students in the department or in the school of agriculture. At one institution (Grambling College) the general curriculum was collegewide; this reduced to a minimum the flexibility of the program.

TEACHERS

Training

The following shows the degrees held by the 38 instructors teaching animal science in the 12 institutions offering courses in animal science: Ph.D., 10 (26 percent); M.S., 25 (66 percent); D.V.M., 2 (5 percent); B.S., 1 (2.6 percent). Most of the instructors indicated regular attendance at professional meetings and workshops.

Teacher Load

On the average, each instructor taught 8 semester hours and had 44 students. The student credit hours ranged from 9 to 416, with an average of 352.

Other Responsibilities

In addition to teaching, each instructor supervised one or more livestock enterprises. On the average, each instructor served on one to seven committees. Only the personnel at Prairie View, Tennessee State, and Tuskegee were actively engaged in research. In three institutions, an instructor in the animal science area also served as head of the department of agriculture.

LABORATORY FACILITIES

All departments reported possession of a college farm. The number of acres ranged from 200 to 1,300. All departments needed additional buildings and equipment.

The average dairy herd consisted of 74 animals; beef, 42; and swine, 64. The average poultry flock consisted of 1,700 birds. Only two institutions, Alcorn and Arkansas A M & N, reported raising sheep. Little is being done in the horse-raising area.

One institution visited was feeding the milk from the dairy herd to the swine; another was pouring it out, because of lack of processing facilities. None of the institutions reported small animal laboratories. All indicated that facilities for chemical and biological analysis and for comparative studies needed considerable improvement or did not exist.

CONCLUSION

From these studies the writer concluded that improvement of instructors through workshops and short courses is needed in these institutions, but the greatest need is for additional laboratory facilities, equipment, and teaching aids.

J. H. MEYER

University of California

Remarks on the Land-Grant Colleges*

Land-grant colleges of agriculture have gone through one era, with two stages, in their development, and are now entering a second era.

The first stage began in 1862 with the passage of the Land-Grant College Act. It became apparent that research was needed to produce new ideas and information; as a result, the Hatch Experiment Station Act was passed in 1887. Additional funds were provided for research in the experiment stations and for establishment of the Extension Service (1914) to extend research information immediately rather than through the process of student education. This first era encompassed the initiation of teaching, research, and extension in the land-grant colleges.

The second stage saw the development of the pattern that we know today. It lasted from about 1910 to about 1960. During this era, the United States changed from a rural to an urban society. The change placed the teaching and research functions of the colleges of agriculture in a new setting—an industrial and urban society.

We are now in the second era. The land-grant colleges of agriculture and the agricultural experiment stations are going through another stage of development. The formation of the Commission on Education in Agriculture and Natural Resources and its sponsorship of meetings such as this one give weight to this statement.

There appears to be a certain conflict between society needs and faculty interest. Most members of the faculties of colleges of agriculture today were selected from those who received degrees in one or another of the science disciplines, for example, genetics, physiology, or biochemistry. Making selections on this basis gives momentum to con-

*Introductory remarks at plenary session, evening of May 20.

tinuing interest in, and effort in behalf of, the individual disciplines. Yet response to student interest and to the demands of society requires an interdisciplinary effort in both instruction and research, for example, an effort involving several disciplines in animal science or in plant science. This means that faculty members trained within a discipline must develop curricula on an interdisciplinary basis. Hence the conflict.

One point of view is that the administrative organization for research within a university need not be identical with that for providing undergraduate instruction. Many research problems need attention—for example, in poultry husbandry and agronomy—and some research organization is needed. But a student's major may not be in poultry husbandry or agronomy; it may be in animal sciences or plant sciences.

Agriculture is integrated biology. The animal sciences integrate the disciplines of biology, such as animal physiology, nutrition, genetics, and biochemistry, into a curriculum. It is important to recognize not only that the disciplines of biology need to be integrated for the benefit of animal science students going into management but also that development of a program integrated with the social sciences, especially economics, needs attention. A curriculum planned only by animal scientists for students going into management will not result in the best program. Similarly, a program in management planned only by agricultural economists will not be completely satisfactory. It appears, therefore, that this session of animal scientists concerned with problems of curriculum development may be lacking an integral factor—namely, economists to aid in developing curricula for management in the animal science field.

Educators in the animal sciences, the plant sciences, and similar areas need to take stock and anticipate the future. Industry has changed, and more people are involved in food production off the farm than on the farm; the population explosion will have dramatic influences; and the changes ahead in biology will influence both teaching and research. I hope that all those in leadership positions in the animal sciences will not be defensive and use "old guard" techniques, but will bring in the rebels and really look ahead.

ROBERT F. HUTTON

Executive Secretary
American Fisheries Society

Statement on Fisheries Management*

The purposes of the Conference on Undergraduate Teaching in the Animal Sciences were stated as follows: (1) to assess the status of undergraduate teaching in the animal sciences; (2) to recommend action, if any, that should be taken to improve undergraduate teaching in the animal sciences; and (3) to suggest mechanisms for implementation of recommended action.

The scope of the conference covers "animal sciences," which are defined as "the sciences concerned with the management of animals for economic purposes, including meat animals, dairy animals, and poultry."

The inclusion of the words "for economic purposes" in the definition makes the scope of the project seem broad. However, only meat animals, dairy animals, and poultry are included. Two important aspects of the management of animals for economic purposes are omitted: commercial fisheries and recreational fisheries.

It has been estimated that the annual retail value of all commercial fishery products in the United States is about \$2 billion. The investment in vessels and fishing gear is about \$500 million, and directly related processing industries represent a greater investment. Over 600,000 persons are employed in the fishing industry or in directly related industries.

The recreational importance of sport fishing in the United States is amazing. We have more than 30 million anglers. They devote over 600 million days a year to sport fishing.

*Prepared by Dr. Hutton and Dr. Virgil Norton, Chief, Supply and Research Use Section, Branch of Economic Research, Bureau of Commercial Fisheries, Department of the Interior. Presented to the Working Group on Teaching of Animal Production.

FISHERIES MANAGEMENT

Two types of management of fish populations are used in commercial fisheries. The first and better known type is the management of what might be considered "wild" fish stocks. The goal is to obtain the maximum sustainable economic yield over the long run. To accomplish this, one needs to know a good deal about each species, such as growth rate, physiology of reproduction, and nutritional requirements. These, of course, are aspects of animal science.

The second type of fishery management, called fish farming, is not as well known as the first, although the management principles are similar to those that we apply to the production of beef cattle, sheep, poultry, etc.

Commercial fish farming has been successfully conducted in various parts of the world for hundreds of years. However, in terms of scientific management of fishery stocks, fish farming is new. The industry has been developed through a process of trial and error. Thus, the need for the development of scientific management principles is great.

Scientific fish farming involves management of fish stocks living in a restricted body of water, control of the environment in which the fish live, and controlled feeding of the stocks. Operations include:

- Building a pond that includes means of controlling water movement.
- Controlling the chemical composition of the water.
- Managing the plant and animal life in the pond by developing the optimum combination of the two.
 - Determining the required nutrients and providing these through feed of the proper type, quantity, and quality.
 - Supplying reproduction stock.
 - Preventing and controlling diseases.

Production in the fish farms of the south central United States has reached a rate of more than 1,000 pounds per acre per year. Continued research to guide the development and application of management principles should increase this yield substantially.

Each year many reservoirs and special fishing lakes are constructed to meet our increasing demands for fresh water. These also provide habitats for fish and space for more fishing. There are now more than 12 million acres of reservoirs in the United States, equal to the combined areas of Delaware, Rhode Island, Massachusetts, and New Jersey. In addition, more than one million farm ponds are managed for fish production and angling; most of them are in the southern states. Finally,

there are thousands of natural streams and lakes ranging in size from the Mississippi River and the Great Lakes to small trout streams and ponds; they total more than 100 million acres. Many fishery biologists will be needed to manage these water areas if they are to yield their full potential in recreation and food.

FISH PRODUCTION AND CONSUMPTION

United States domestic commercial production of fish for human food is over 2.5 billion pounds annually, and the annual domestic production of fish for industrial purposes (nonhuman or indirect human consumption) is 2.2 billion pounds. It is important to consider industrial production because more than 90 percent of the fish produced for industrial use is converted into fish meal, which is consumed indirectly by humans in the form of chicken. Most broiler rations contain a certain amount of fish meal as a protein supplement. The consumption of fish meal per broiler ranges from 0.1 to 1 pound. If we convert consumption of fish meal to consumption of fish (liveweight basis), we find that the consumption of fish per broiler ranges from 1 to 5 pounds. In comparison with the 5 billion pounds of fish produced annually, about 9 billion pounds of chicken (liveweight) is produced annually in the United States.

A good way to assess the importance of the fishing industry of the United States is to compare consumption of fish and chicken.

Per capita consumption of commercial fishery products is estimated at 11 pounds annually; per capita consumption of chicken is slightly over 30 pounds. It is important to note that fish consumption is reported on an edible-weight basis, while poultry consumption is reported on a ready-to-cook basis. If chicken consumption were reported on an edible-weight basis, the consumption figures would be much closer.

Per capita consumption of domestically produced fish on a liveweight basis (direct and indirect human consumption) is about 24 pounds annually in the United States. When imported fish are included, per capita consumption of fish on a liveweight basis is about 50 pounds annually.

Per capita consumption of broilers on a liveweight basis is about 45 pounds annually in the United States. Further, almost half of the fish consumed is consumed indirectly in the form of chicken.

CAREERS IN FISHERIES SCIENCE

Mainly because of recent legislation, job opportunities in fisheries science are expected to double or even triple in the next several years. The following acts are expected to have a significant impact on the demand for fisheries scientists: Public Law 88-309 (Commerical Fisheries Research and Development Act of 1964), Public Law 89-304 (National Anadromous Fishery Act of 1965), and Public Law 89-234 (Water Quality Act of 1965).

CONSIDERATIONS

1. Should meetings such as the Conference on Undergraduate Teaching in the Animal Sciences consider fisheries as an integral part of the animal sciences?
2. Should there be a broadening approach in the animal sciences to include undergraduate teaching of certain fisheries and fisheries-related courses?

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REPORTS OF WORKING GROUPS

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Curriculum Content*

NOTE This group recommended a minimum core of courses for undergraduate majors in the animal sciences. The group favored consolidation of certain courses in the animal sciences (livestock, dairy, and poultry) as contrasted with completely separate courses in nutrition, physiology, and genetics for each species.

Sound curriculum planning is based on studying the students—their qualifications, abilities, potentials, objectives, and ultimate employment.

A well-planned curriculum is not the only criterion for successful undergraduate teaching in animal science. The curriculum is highly dependent on the content of courses and on teachers who can motivate and stimulate students.

This working group soon recognized that it would be impossible to prepare a detailed curriculum that would apply to all animal science students at all universities. Broad approaches were discussed and some general guidelines resulted from the discussion.

EVALUATION OF PRESENTATION BY DR. OLDFIELD, "CURRICULUM DEVELOPMENT FOR ANIMAL SCIENCE"

"Mathematics through calculus" would be unrealistic as a freshman-year requirement in view of the way mathematics is now being taught in many universities. However, the 1965 report of the Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America points out that their suggested mathematics series

*T. H. Blosser, chairman of working group; R. E. Taylor, recorder.

would be feasible for the student who has completed 3 years of high school mathematics. This no doubt assumes a better mathematics background in high school than is now being obtained. Some of the working group members suggested that the future animal science graduate will need more mathematics; in particular, he will need it to understand linear programming.

Making teaching methods and courses stimulating to students enrolled in mathematics and physical science courses is a problem not only with respect to animal science students but also with respect to students in the biological sciences per se, in home economics, and in biologically oriented preprofessional programs. Biologically oriented departments need to unite in their approach to the mathematics and physical science departments so that courses in these areas can be more stimulating and palatable.

THE ANIMAL SCIENCE CURRICULUM

Employment opportunities for animal science graduates have expanded tremendously in the past few years, and continued expansion is expected. Industry and graduate school seem to be the major outlets for our graduates.

Our research scientists are insisting that undergraduates need more science courses. Comments from industry indicate that they need more communications, economics, and business courses.

Many universities have a core requirement but give students considerable opportunity to broaden their educational experience or to specialize, or both.

The working group suggests the following core of animal science courses:

Course	Suggested Semester Credits
Introductory	3
Nutrition	6
Genetics	3
Physiology	3
Animal products	2
Selection	2
Production and management	6

Course Content*

NOTE This group recommended that each animal science department have a committee to review course content. In-service institutes for college teachers are desirable.

TEACHING ON INTERSPECIES BASIS

Should teaching on an interspecies basis be increased? During discussion of this question, the following points were made:

1. Because of the increasing emphasis on 2-year colleges in most states, the freshman - sophomore animal science courses are being reviewed. Some attempts are being made to teach these courses in cooperation with (or with consultation from) the university. In a few schools, these courses are being moved into the junior and senior years.

2. A committee should aid in developing interspecies courses. It may even be desirable to have faculty outside the animal sciences help in developing such courses and to coordinate the new courses with courses taught in other departments.

BEGINNING COURSE

This group recommended that the following concepts be included in the beginning course: product characteristics, homeostasis, productive life cycles, growth, reproductive characteristics, behavior, milk

*Duane C. Acker, chairman of working group; Howard H. Olson, recorder.

CONSOLIDATED CURRICULA (Animal, Dairy, and Poultry Science)

The working group was highly in favor of consolidated curricula and consolidated courses; it was particularly in favor of consolidation of the introductory course and courses in genetics, nutrition, and physiology. However, production courses for the various species are undoubtedly necessary at the junior and senior levels.

It cannot be overemphasized that outstanding instruction will be necessary if the consolidated courses are to be successful.

SERVICE COURSES

Animal science departments depend on other departments for service courses and expect these departments to provide good courses. It follows, therefore, that animal science departments should give serious consideration to requests for service courses and should provide outstanding instructors for this purpose. Service courses in nutrition, breeding, and production will probably be necessary.

DISCUSSION OF REPORT IN PLENARY SESSION

Question: If the recommendations were made with the purpose of reaching certain goals, what are the goals?

Answer: Not specified.

Question: Are the recommended animal science courses excessive?

Comment: Further integration of courses—for example, integration of feeds and feeding (3 hours of nutrition) with management—may be desirable. However, the size of the animal industry indicates a need for a substantial number of hours in animal science in the curriculum.

secretion, heritability, embryology, nutrition (monogastric-polygastric), improvement rate by selection, animals' relation to society, international importance, and animal energetics.

Some members of the working group expressed concern about acceptance of this course by other departments as an elective course, or by other institutions to which students might transfer; the question of acceptance by other institutions would arise if those institutions taught similar subject matter in some other course organization. The group felt that such a course should help the student understand the need for chemistry, physics, zoology, etc., in his curriculum. It should also be designed to motivate study of the animal sciences. Prerequisites would not be necessary.

JUDGING

The merits of teaching judging in animal science courses were thoroughly discussed. There was a fairly strong opinion that judging courses should be made available but should not be required. It was felt that a properly taught course in "appraisal" of animals would be an aid to students, particularly in the case of beef and swine. The course should incorporate the latest methods of measuring the value of the animals. More emphasis should be placed on the relation between the visual score of the animal and carcass value. It was suggested that animal geneticists teach appraisal or selection of breeding stock to ensure that principles of selection, priorities of traits to be emphasized, and the concept of progress to be achieved by selection shall be consistent with principles of population genetics. (On many campuses this is not accomplished, partly because all selection or appraisal work is taught by faculty trained in animal nutrition or management.)

It was recognized that the livestock industry still uses visual examination as a major means of evaluation. It was suggested that colleges take a more forceful lead in encouraging use of more accurate means of evaluation.

PRODUCTION COURSES

Production courses should be offered in the senior year. They are of great value in bringing together pertinent pieces of information from all the other courses. These courses should be designed to apply genetics, physiology, nutrition, and the other subjects to management of specific animals.

There was some debate on the number of such courses that should be offered.

PREREQUISITE COURSES

There is a tendency in animal science courses not to utilize subject matter from the listed prerequisite courses. The group urged that only those courses that are really needed be required. When courses are listed as prerequisites, the student should be expected to know the subject matter of the prerequisite courses. An examination covering prerequisite material might be given, or a list of essential concepts that should have been mastered might be distributed at the start of the course. This would impress on the student his obligation to be familiar with the prerequisite material.

COMMITTEE ON COURSE CONTENT

A departmental committee on course content should exist. Such a committee would examine course content to prevent duplication of material and ensure that important subject matter is not omitted. Administrators carry responsibility for preventing unneeded duplication and for ensuring adequate coverage of topics among courses, but they can be aided considerably by a faculty committee on course content. Faculty members from other departments could be invited to serve as guest members of the committee.

A committee on course content could encourage an orderly presentation of course material.

POSSIBLE ACTION

The group agreed that the preparation of sourcebooks and other guidelines would be a great aid in teaching in the animal sciences. The need is especially great in the introductory courses, because of the great increase in the number of institutions (including junior colleges and non-land-grant schools) offering animal science courses. The group favored developing these materials by following the same pattern that was followed in developing materials for plant pathology and mycology.

Summer workshops were suggested as a means of helping teachers,

both the new and the experienced, keep abreast of new developments in teaching the biological and animal sciences.

DISCUSSION OF REPORT IN PLENARY SESSION

Question: Should there be "state board" examinations or accreditations for animal science?

Answer: This could stifle innovation.

Question: Should there be other moves toward professional identification of animal science graduates, such as certification of professional status or membership in a professional society?

Answer: This is done in Canada, and may have possibilities.

Instructional Methods and Materials*

NOTE This group recommended the development of sourcebooks, especially for the introductory course in animal science. New visual aids should be prepared for use in the introductory course; existing visual aids should be collected and exchanged. "Telelectures," lectures by telephone, should be used to a limited extent. Live animals are needed for use in undergraduate teaching in the animal sciences. Paperback books authored by animal scientists would be useful references for introductory biology courses.

INTRODUCTORY COURSE

The initial discussion was directed toward the teaching of introductory courses in the animal sciences (animal agriculture and animal food production). Several schools have followed a pattern in which two or more courses from different departments have been combined into one. Some courses stress principles and others practice: but generally both principles and practices are considered. Usually, different instructors teach one of these courses, each being responsible for a section that corresponds to his field of special interest. At times the committee approach encounters difficulties because of a clash of personalities, but this does not appear to be a serious problem. In general, students seem to like the combined-course approach. If such a course is fundamental enough, some students from the arts and sciences colleges take it. This should help improve the image of agriculture.

*J. L. Albright, chairman of working group; John Foster Lasley, recorder.

REFERENCE BOOKS FOR BIOLOGY COURSES

It was suggested that agricultural examples could be included in basic biology courses. Possibly this could be done if animal scientists were to write paperback books for use in biology courses. Publishers appear to be hesitant to print such books.

LIVESTOCK HERDS

Maintenance of livestock herds for teaching purposes is justified and encouraged. It was agreed that students should have the opportunity to work with live animals. Local farm herds could be used, but this approach is not convenient or satisfactory.

RECOMMENDATIONS

The group recommends that a laboratory manual and a sourcebook be developed for the introductory animal science course, and that visual aids (slides and movies) be prepared or collected for this course. These materials should be considered as supplementary to lectures. It was suggested that the American Society of Animal Science might act as a clearing agency for assembling slides and movies and supplying them to animal science departments and college libraries for use by individual instructors. It was also suggested that instructors could exchange slides and thus build up complete sets.

The use of telelectures was mentioned. Some advantages and disadvantages were pointed out. It was suggested that telelectures should be used primarily for current, motivating material and should be attempted once or twice each semester.

Seminars in the homes of faculty members appear to be popular among students and may be useful.

The group expressed its desire for representatives of the Commission on Education in Agriculture and Natural Resources to provide assistance to animal scientists who wish to undertake projects for developing visual aids, laboratory manuals, and sourcebooks. It was suggested that certain animal scientists could be asked to prepare project proposals and undertake the projects on sabbatical leave.

DISCUSSION OF REPORT IN PLENARY SESSION

Question: Could the audio-tutorial system of teaching (such as that developed by Dr. S. N. Postlethwait at Purdue for plant science) be adapted for animal science teaching?

Answer: Yes. For widespread adaptation, the number of animal science courses might need to be reduced in order to increase classes to a size suitable for the audio-tutorial method. (Most colleges probably have too many animal science courses anyway.)

General Comments: A strictly tutorial approach may be most appropriate for classes with small enrollment. More student involvement, perhaps through discussion groups, is desirable. Instructional materials that are developed should be derived from the results of recent research.

Teaching in Animal Genetics*

NOTE This group recommended that illustrative and problem-solving materials be prepared for use in laboratory or lecture. A programmed approach for teaching parts of the animal genetics course should be investigated.

A poll of the working group revealed a wide variation from one institution to another in the number and content of animal breeding courses offered. Comments were made concerning:

- The varying backgrounds students bring to the study of basic genetics.
- The need to overcome student apprehension about studying genetics.
- The question of how well agricultural students perform in basic genetics courses in comparison with other students.
- The question of how well, and in what departments, basic genetics is taught throughout the country.
- The general trend toward consolidating animal breeding courses.

REACTIONS TO QUESTIONS

The following reactions resulted from consideration of a series of questions:

1. Adequate teaching methods and sufficient instructional materials have not yet been devised for teaching animal genetics.
2. Opinion varies as to whether courses in animal genetics make sufficient use of prerequisite courses.

*H. H. Stonaker, chairman of working group; Kenneth Goodwin, recorder.

3. There is a shift of emphasis in research and practice in animal genetics—a shift toward the quantitative. Courses require change as new areas are explored, as material becomes obsolete, and as the pressure of time becomes a factor.

4. Meat animals, dairy animals, and poultry (all three groups) should be considered in the beginning animal genetics course. Other species, such as selected wildlife species and man, should be included where they are useful as illustrative material.

5. In some institutions there is a lack of balance between quantitative and physiological genetics. Interests of the instructor usually determine where emphasis is placed. The working group would not minimize either approach to teaching genetics. Sometimes there is too much emphasis on individual species.

6. Laboratory work is included in some animal genetics courses but not in others. Some kind of illustrative, problem-solving material is needed to enhance instruction.

7. The selection course recommended by the curriculum-content group should be directed toward an animal breeding approach in which emphasis is placed on appraising and objectively measuring live animals.

RECOMMENDATIONS

It is desirable that the animal breeding course be preceded by (1) at least 3 hours of basic genetics, (2) a course in statistics, and (3) a course in organic chemistry, or biochemistry, or both.

The group recommends investigation of a programmed approach for at least parts of an animal breeding course.

The group discussed the question: How and by whom can specific action be taken to develop useful materials and teaching aids for animal genetics? Two approaches were considered:

1. Endorsement and support of the various scientific societies might be sought. It is possible that such a procedure would forfeit support from many persons who are unable to participate actively in the affairs of a society.

2. Institutions might be interested in supporting such a project. Among possible sources of support are the National Science Foundation, the U.S. Office of Education, and private foundations.

The group recommends that each of these approaches be considered further.

Teaching in Animal Physiology*

NOTE This group recommended that a course outline and a sourcebook be developed. Workshops should be held for both experienced and inexperienced teachers.

The group reviewed the offerings of the various colleges represented and noted differences in the number of courses, content, prerequisites, and department which offers the courses. Most colleges offered the first course in animal physiology during the junior or senior year. Biology or zoology was generally prerequisite.

INTERSPECIES TEACHING

It is difficult to obtain adequate textbooks, laboratory manuals, and other materials and facilities for teaching animal physiology on an interspecies basis. Specialists in particular areas of animal physiology may know their own areas very well but it is difficult for them to make a more generalized presentation.

Some agricultural colleges include such departments as wildlife management and zoology. It is necessary that we consider needs peculiar to those institutions and also the needs of nonagricultural students. This re-emphasizes the need for broader approaches in teaching animal physiology.

*W. J. Mellen, chairman of working group; Floyd Hixson, recorder.

RECOMMENDATIONS

There is a definite need to compile material that would be useful in teaching specialized as well as interspecies courses. This material could be standardized into a course outline and sourcebook and be made available to all animal physiologists.

Teacher workshops in animal physiology should be developed and expanded to assist teachers without previous experience and to disseminate new ideas and approaches to those now teaching.

DISCUSSION OF REPORT IN PLENARY SESSION

Comment: There is general dissatisfaction with courses prerequisite to animal physiology.

Response: Efforts of the Biological Science Action Committee on Animal Science and the other action committees should be helpful. Other efforts are being made to work with those who teach the prerequisite courses.

Teaching in Animal Nutrition*

NOTE This group recommended preparation of sourcebooks for laboratories that would accompany two courses: "Principles of Nutrition" and "Nutrition Technology."

COURSE OFFERINGS

Nutrition courses should be offered at the junior and senior levels, with 12 semester hours of chemistry (including organic) as a prerequisite. A course, or several courses, in biochemistry would be desirable. For students electing a science option, two courses in biochemistry would be appropriate. The group did not favor a survey course in biochemistry specifically designed for animal science majors.

It was recommended that a survey course for nonmajors, combining principles of nutrition and their application to feeding practices, should be offered on campuses where the demand would justify such an offering. Such a course would be appropriate for students in the crop and soil sciences, agricultural education, agricultural economics, and the like.

The animal science student should pursue two courses in nutrition; the first, titled "Principles of Nutrition," would be followed by "Nutrition Technology." Both courses would be taught on a comparative-species basis.

*L. S. Pope, chairman of working group; Hal B. Barker, recorder.

COURSE IN PRINCIPLES OF NUTRITION

The content of the course in principles of nutrition could be very similar to that suggested by the Biological Science Action Committee on Animal Science. The major topics for consideration would be history of nutrition, interrelationship of nutrients, energy supply, provision of body substance, regulation of metabolic processes, nutrition and productive processes, and methodology of animal nutrition research and practice.

The group expressed a need for a nutrition textbook with the approach described here. Relating nutrients to physiological functions and deficiencies was considered necessary to bring the study alive.

It was considered most desirable that laboratory work accompany the lectures in the principles course. A sourcebook consisting of laboratory exercises should be developed. Many of the exercises could involve laboratory animals as experimental subjects.

COURSE IN NUTRITION TECHNOLOGY

The course in nutrition technology would embrace such subjects as identification of feed ingredients, physical and chemical characteristics of feeds, processing methods (pelleting, rolling, flaking), techniques of quality control, contaminants and feed additives, and ration formulation.

Laboratory work should also supplement the lectures in this course. Again there was an expression of need for a sourcebook containing laboratory exercises that might be adapted to meet specific needs on different campuses.

ARTICULATION WITH PRODUCTION COURSES

The importance of including nutrition in production courses was recognized. Where nutrition is involved, the courses in principles of nutrition and nutrition technology should be coordinated with the production courses.

LABORATORY ANIMALS

It is possible that more attention should be given—now and in the future—to the training of students who expect to be involved in the care and

management of laboratory animals. Many animal science majors have opportunities for employment in this area.

DISCUSSION OF REPORT IN PLENARY SESSION

Question: What procedure would be used in developing the sourcebooks?

Answer: Go to the researcher for the exercises.

Comment: Each teacher has developed his own "guidebook," but generally does not distribute it.

Teaching in Animal Production*

NOTE This group recommended the holding of regional workshops and teacher clinics (summer institutes) as means of improving production courses. Source-books are needed. Fish, wildlife, laboratory animals, and light horses should be considered in management courses.

This group discussed several questions.

1. What should be included in a production course in animal science?

Whenever consideration is given to course content, a wide variety of subjects will be mentioned. Many feel that this variety is necessary to meet particular area needs. Hoping to meet the need for variety, this working group listed two sets of suggestions, or guides, for establishing a production course.

The first is as follows: organization and operation of enterprises, including breeding, genetics, environmental control, mechanization, disease control, marketing, and economic considerations.

The second consists of the following topics:

- Historical aspects, trends, and changes
- Analysis and measurement of management
- Production costs and business policy
- Product composition and marketing
- Recordkeeping
- Housing facilities and environmental control
- Sanitation and disease control
- Feeding, breeding, and culling efficiency
- Care and management during special periods

*J. A. Hoefler, chairman of working group; Hilbert Kahl, recorder.

Mechanization and labor-saving devices
Animal waste management
Feed additives and residues

2. How much emphasis should be placed on prerequisites for production courses?

Most good students should be able to pass a standard production course without many prerequisites. In many cases, prerequisites might prevent students in other areas of study from taking this course. However, certain courses should be highly recommended as prerequisites.

It was recommended that classes in production be limited to students of junior or senior standing and that students have good backgrounds in farm management and animal nutrition and breeding.

Production courses should be taught on a highly integrated basis. This should include not only integration of the various disciplines (biological, physical, and social) that form the foundation for a good production course but also integration of production of the several species. Some of the material currently taught should be deleted, and the course should be taught at a higher technical level.

3. How important are other animals, such as laboratory animals, in teaching production courses?

Laboratory animals have a definite place in the teaching of laboratory practices. In some situations, consideration should be given to including studies of other animals that are economically important, such as horses, dogs, and fish. (Dr. Hutton, in his talk on fisheries management, suggested that fish production on small farms be included in production courses.)

4. Should practicum instruction be included?

Practicum instruction could be added to give students necessary skills in many areas of production. The students would be required to do the work on their own time during their 4-year course of study, either on or off campus but under supervision. The group did not agree on the question of whether academic credit should be given for this.

RECOMMENDATIONS

General

1. This report should be discussed in the summer meetings of the various societies.

2. University presidents and deans of agriculture should be given an opportunity to read the conference proceedings.

Special

1. Four regional meetings of those responsible for establishing and teaching the recommended production course should be held to disseminate information and improve communications. Those teaching related courses should be invited to participate in, or to observe, these meetings. Regional meetings, rather than a single national meeting, are recommended because it is believed that more persons would attend. Furthermore, the regional meetings would be smaller than a national meeting, and more could be accomplished.

2. Summer clinics and workshops are recommended for those who are teaching the course, to keep them abreast of recent developments in production.

3. Exchange programs between schools are recommended. These would involve both instructors and students on either a one-term or yearly basis.

4. Workbooks are also recommended, as well as references to sourcebooks which have been developed in other areas of study.

DISCUSSION OF REPORT IN PLENARY SESSION

Question: Did the group give attention to management courses developed on an interspecies basis?

Comment: Several institutions have implemented such courses, integrating either (a) dairy and meat animals or (b) dairy cattle, meat animals, and poultry.

Question: How can practical experience best be obtained?

Comment: Summer placement is a possibility. However, industry may "skim off" top graduates with this approach.

APPENDIXES

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Resource Paper for the Conference

The purposes of the conference are to:

- Assess the status of undergraduate teaching in the animal sciences.
- Recommend action, if any, that should be taken to improve undergraduate teaching in the animal sciences.
- Suggest mechanisms for implementation of recommended action.

Stimulus for this conference came from a proposal for course development that originated with the 1964-1965 Teaching Committee of the American Society for Animal Science.

SCOPE

For purposes of the conference, "animal sciences" are defined as "the sciences concerned with the management of animals for economic purposes." Meat animals, dairy animals, and poultry are included in the definition.

The conference will focus on the content of undergraduate animal science curricula, content of courses in the animal sciences, and methods and materials used in undergraduate teaching in the animal sciences.

BACKGROUND

There is evidence that undergraduate teaching in the animal sciences has progressed markedly in recent years, especially through increasing

emphasis on science rather than husbandry and on principles rather than practices. Nevertheless, more changes may be indicated by current trends, which include:

1. Advances from research in the biological sciences, especially the developments in molecular and cellular biology.
2. Resulting ferment and change in the teaching of biology at both secondary and collegiate levels.
3. Accelerating changes in the scientific, economic, institutional, and other characteristics of all of agriculture, and especially developments in research and practice in the animal sciences.
4. Changes in courses and curricula in agriculture, including a reduction in the number of hours devoted to agricultural courses in the undergraduate curricula, and especially the trend toward consolidation of courses and curricula in the animal sciences. Also, increasing questioning of the need for courses in several areas, including the introductory course, judging, breeds of livestock, and management courses, at least as they are now taught.
5. Criticism of excessive overlapping in content of courses in the animal sciences and in the basic biological sciences, and complaint of failure to take advantage of knowledge the student has gained in prerequisite courses.
6. The prospects of extensive development in the near future of post-high school, 1- or 2-year programs in the animal sciences, which will train technicians. Animal science departments will, therefore, be relieved of the temptation to design baccalaureate degree programs to train technicians.
7. Possible need for increased "renewable natural resources" and "international" orientation in undergraduate courses and curricula in the animal sciences.
8. The intense competition for educational resources, which demands the best possible teaching in the animal sciences as well as in all other subjects.
9. Nationwide population shifts, resulting in an increasingly high percentage of the population that is poorly informed about animal sciences and other areas of agriculture. This is especially important for key teachers, such as biology teachers. Thus, more instruction in the animal sciences that is better suited for nonagricultural majors may be needed.
10. Increasing need for changes in animal science offerings to better serve students who are majoring in other areas of agriculture.

It is increasingly difficult for many professors and even many animal science departments to keep aware of all that might be taught and of new instructional materials, to select the most appropriate subject matter, and to adopt the most effective teaching methods. Lack of time and funds often limits the availability of visual aids and other teaching resources. Furthermore, local traditions and pressures sometimes result in obsolete and otherwise inappropriate course content and array of courses.

Projects that might be initiated as a result of this conference could make possible the pooling of knowledge from a number of persons and from the resources of a number of institutions. Ideas could be expressed and discussed without the encumbrance of local restrictions.

While materials that might be produced by projects stimulated by this conference should be useful to all colleges teaching animal science, they would be especially valuable to the younger teachers and to those who are not involved in, or close to, research; to those institutions planning new or revised animal science teaching programs; to those institutions with relatively limited resources; and, perhaps, to educational institutions in emerging countries.

It is not intended, however, that such materials should be rigid and prescriptive; rather, they should serve as catalysts for making desirable changes and should be adapted to meet individual needs and desires.

POSSIBLE ACTION

The following list of possible projects is offered for consideration by the conferees. It is not intended to be all-inclusive.

1. Preparation of instructional materials.

a. Sourcebooks of laboratory exercises, experiments, and lecture materials on specific topics. These could be developed by identifying, and adapting for undergraduate instruction purposes, pertinent features of outstanding research projects. The rationale for this approach lies in the belief that undergraduate teaching often lags behind the forefront of research, and time and pooling of talent may be needed to adapt research results for effective presentation in undergraduate teaching. Similar sourcebooks have been prepared in plant pathology, soil science, crop science, and perhaps other areas.

b. Films, television tapes, and other materials that would make possible more effective teaching.

2. Compilation of a selected bibliography of suitable materials currently available for use in teaching, including texts, laboratory manuals, pamphlets, magazine and journal articles, films, and other visual aids.

3. Compilation of selected animal science curriculum outlines and course syllabi currently available.

4. Initiation of course and curriculum development projects. These could include:

a. A project to consider and recommend desirable courses for undergraduate majors in animal science. This could be limited to courses in the animal sciences or could encompass courses in all natural and social sciences and mathematics.

b. A project, or several projects, to produce listings of concepts that may be

- Organized into lectures and laboratory exercises, or into detailed syllabi for courses in the animal sciences, or both; and
- Organized for traditional course patterns (e.g., animal genetics, nutrition, physiology) or for new course patterns.

c. A more comprehensive project that combines a and b.

The nature of a project determines whether it should be sponsored by the Commission on Education in Agriculture and Natural Resources, a society, or an institution; whether it should be supported financially by a granting agency, a society, or an institution; and whether it should be conducted by a society, an institution, or an individual.

Projects selected might require separate funding, and it might be necessary to include funds that would make it possible to release teachers from their regular duties for periods ranging from several months to a year or more.

NATURE OF THE PROJECTS

It is hoped that projects undertaken would be innovative, or at least representative of a selection of the best material available. Traditional patterns should be disregarded if more effective approaches can be devised. For example, the traditional course array—which usually includes an introductory course followed by such courses as nutrition, feeds and feeding, types and market classes, physiology, breeding, and production (management)—might be ignored. Also, typical prerequisites and the sequence and year-level of animal science subjects might be reconsidered. New adaptations of technological innovations—e.g., automatic data processing, television, and teaching machines—should be considered.

We must focus on the future, considering the characteristics and trends of the animal industry as well as the changing demands upon the scientists and professionals in this field.

Numerous national as well as local projects to upgrade undergraduate teaching in various areas of science, mathematics, and engineering are underway. Thus, any projects undertaken would be part of a nationwide effort to advance teaching in a number of disciplines.

QUESTIONS

Following are some questions to which answers, or partial answers, may be suggested during the conference:

1. What will be the pattern of undergraduate instruction in the animal sciences 15 to 20 years from now?

2. Should projects undertaken encompass all three species groups—meat animals, dairy animals, and poultry? Or should they be considered separately? Should other species areas be included?

3. Four disciplines, or areas, have been selected for consideration—genetics, physiology, nutrition, and management. Should others (for example, behavior, pathology, meats, judging, breeds of livestock, the introductory course) be included?

4. As we undertake projects, should we consider only the needs of the student majoring in animal sciences? Should we consider also the needs of the agricultural student majoring in another area? Those of the nonagricultural major?

5. Should attention be given to animal science instruction in 1- or 2-year post-high school terminal programs?

6. Are there matters directly related to teaching that need attention besides course and curriculum content and teaching materials and methods? For example, should we consider teacher preparation?

7. To whom should the projects be directed? (See item 9 in the "Background" section, p. 64.)

FUTURE ACTION

Action that follows the conference will depend, of course, upon decisions and recommendations made, and upon ideas expressed, during the conference. After reviewing the report of the conference, the Commission will consider whether it should sponsor, support, or undertake any recommended project. The report will be distributed to animal scientists and others in agriculture and biology if the Commission approves doing so.

Conference Participants and Observers

The numbers after the entries indicate the working groups to which participants and observers were assigned. Numbers are keyed to working groups as follows:

1. Curriculum content
2. Course content
3. Instructional methods and materials
4. Teaching in animal genetics
5. Teaching in animal physiology
6. Teaching in animal nutrition
7. Teaching in animal production

PARTICIPANTS

- DUANE C. ACKER, Dean, College of Agriculture and Biological Sciences, South Dakota State University, Brookings, South Dakota—2, chairman; 5.
- J. L. ALBRIGHT, Associate Professor, Department of Animal Sciences, Purdue University, Lafayette, Indiana—3, chairman; 7.
- R. L. BAILEY, Professor of Agriculture, Grambling College, Grambling, Louisiana—3 and 7.
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- FLOYD HIXSON, Professor of Poultry Science, Fresno State College, Fresno, California—2; 5, recorder.
- J. A. HOEFER, Professor, Department of Animal Industry, Michigan State University, East Lansing, Michigan—2; 7, chairman.
- HYDE S. JACOBS, Professor, Department of Agronomy, Kansas State University, Manhattan, Kansas—3 and 6.
- HILBERT KAHL, Director, Department of Agriculture, Northeastern Junior College, Sterling, Colorado—3; 7, recorder.
- JOHN FOSTER LASLEY, Professor, Department of Animal Husbandry, University of Missouri, Columbia, Missouri—3, recorder; 4.
- W. J. MELLEN, Professor, Department of Veterinary and Animal Sciences, University of Massachusetts, Amherst, Massachusetts—1; 5, chairman.
- J. H. MEYER, Dean, College of Agriculture, University of California at Davis, Davis, California—1.
- J. E. OLDFIELD, Department of Animal Sciences, College of Agriculture, Oregon State University, Corvallis, Oregon—1 and 6.
- HOWARD H. OLSON, Associate Professor, Department of Animal Industries, Southern Illinois University, Carbondale, Illinois—2, recorder; 5.
- L. S. POPE, Head, Department of Animal Science, Oklahoma State University, Stillwater, Oklahoma—2; 6, chairman.
- H. H. STONAKER, Professor, Department of Animal Science, Colorado State University, Fort Collins, Colorado—3; 4, chairman.
- M. L. SUNDE, Professor, Department of Poultry Science, University of Wisconsin, Madison, Wisconsin—2 and 6.
- ROBERT E. TAYLOR, Associate Professor, Department of Animal Science and Dairy Science, Iowa State University, Ames, Iowa—1, recorder; 4.
- E. P. YOUNG, Professor, Department of Animal Science, University of Maryland, College Park, Maryland—3 and 6.

OBSERVERS

- J. FRANCES ALLEN (Chairman, Committee on Professional Standards, American Fisheries Society), Division of Biological and Medical Sciences, National Science Foundation, Washington, D.C.—2 and 5.
- EDWARD G. BUSS (Member, Panel on Preprofessional Training in the Agricultural Sciences, CUEBS), Department of Poultry Science, Pennsylvania State University, University Park, Pennsylvania—2 and 4.
- ROGER D. ESTEP (President, National Capital Area Branch, Animal Care Panel), College of Medicine, Howard University, Washington, D.C.—2 and 5.

- FRED G. EVENDEN, Executive Secretary, The Wildlife Society, Washington, D.C.—1.
- H. N. HUNSICKER, Division of Vocational and Technical Education, U.S. Office of Education, Department of Health, Education and Welfare, Washington, D.C.—1 and 7.
- ROBERT F. HUTTON, Executive Secretary, American Fisheries Society, Washington, D.C.—1 and 6.
- ELTON JOHNSON, International Rural Development Office, National Association of State Universities and Land-Grant Colleges, Washington, D.C.—3 and 6.
- ROY M. KOTTMAN, member, CEANAR; Dean, College of Agriculture and Home Economics, The Ohio State University; Director, Ohio Agricultural Research and Development Center; and Director, Ohio Cooperative Extension Service, Columbus, Ohio—1 and 7.
- N. C. MERWINE, Dean, College of Agriculture, Mississippi State University, State College, Mississippi—3 and 4.
- P. R. POFFENBERGER (Chairman, Resident Instruction Section, Division of Agriculture, National Association of State Universities and Land-Grant Colleges), Assistant Dean of Instruction, University of Maryland, College Park, Maryland—1 and 7.
- MARTIN W. SCHEIN, Director, Commission on Undergraduate Education in the Biological Sciences (CUEBS), Washington, D.C.
- R. B. STEVENS, Executive Secretary, Division of Biology and Agriculture, NAS-NRC, Washington, D.C.
- FRANK A. TODD, Washington Representative, American Veterinary Medical Association, Washington, D.C.—1 and 6.
- L. N. WISE, Vice President for Agriculture, Mississippi State University, State College, Mississippi—2 and 7.
- LEE E. YEAGER, Head, Cooperative Wildlife Research Units, Bureau of Sports Fisheries and Wildlife, U.S. Department of the Interior, Washington, D.C.—3 and 7.
- ROY A. YOUNG (Chairman, Panel on Preprofessional Training in the Agricultural Sciences, CUEBS), Dean of Research, Oregon State University, Corvallis, Oregon—2.

Conference Program

Conference on Undergraduate Teaching in the Animal Sciences

May 20 and 21, 1966

NATIONAL ACADEMY OF SCIENCES NATIONAL RESEARCH COUNCIL

2101 Constitution Avenue Washington, D. C.

Friday, May 20

Morning

Registration

PLENARY SESSION

Roy M. Kottman, member, Commission on Education in Agriculture and
Natural Resources (CEANAR), presiding

CEANAR History, Philosophy, and Activities

Roy M. Kottman

Trends in Animal Agriculture and the Future of Undergraduate Training in the
Animal Sciences

W. A. Cowan

Curriculum Development for Animal Science

J. E. Oldfield

Curriculum Development Projects for Technician Training Programs in Agriculture

H. N. Hunsicker

Sourcebooks for College Teaching in Plant Pathology and Mycology

R. B. Stevens

Sourcebooks for College Teaching in Crop Science and Soil Science

Hyde S. Jacobs

Discussion

Afternoon

Meetings of the following working groups:

Curriculum content

Course content

Instructional methods and materials

Evening

PLENARY SESSION

J. H. Meyer, University of California at Davis, presiding

Remarks on the Land-Grant Colleges

J. H. Meyer

Reports of working groups

Discussion

Saturday, May 21

Morning

PLENARY SESSION

Animal Science in Basically Negro Colleges

R. L. Bailey

Meetings of the following working groups:

Teaching in animal genetics

Teaching in animal physiology

Teaching in animal nutrition
Teaching in animal production

Afternoon

PLENARY SESSION

Franklin Eldridge, University of Nebraska, presiding

Reports of working groups

Discussion

Summary of Recommendations for Action

E. W. Glazener

Adjournment

Commission on Education in Agriculture and Natural Resources

The Commission was formed in 1960 as the Committee on Educational Policy in Agriculture by the Agricultural Board, a unit of the Division of Biology and Agriculture, National Research Council. The Committee became the Commission on Education in Agriculture and Natural Resources on July 1, 1965.

Members of the Commission are:

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