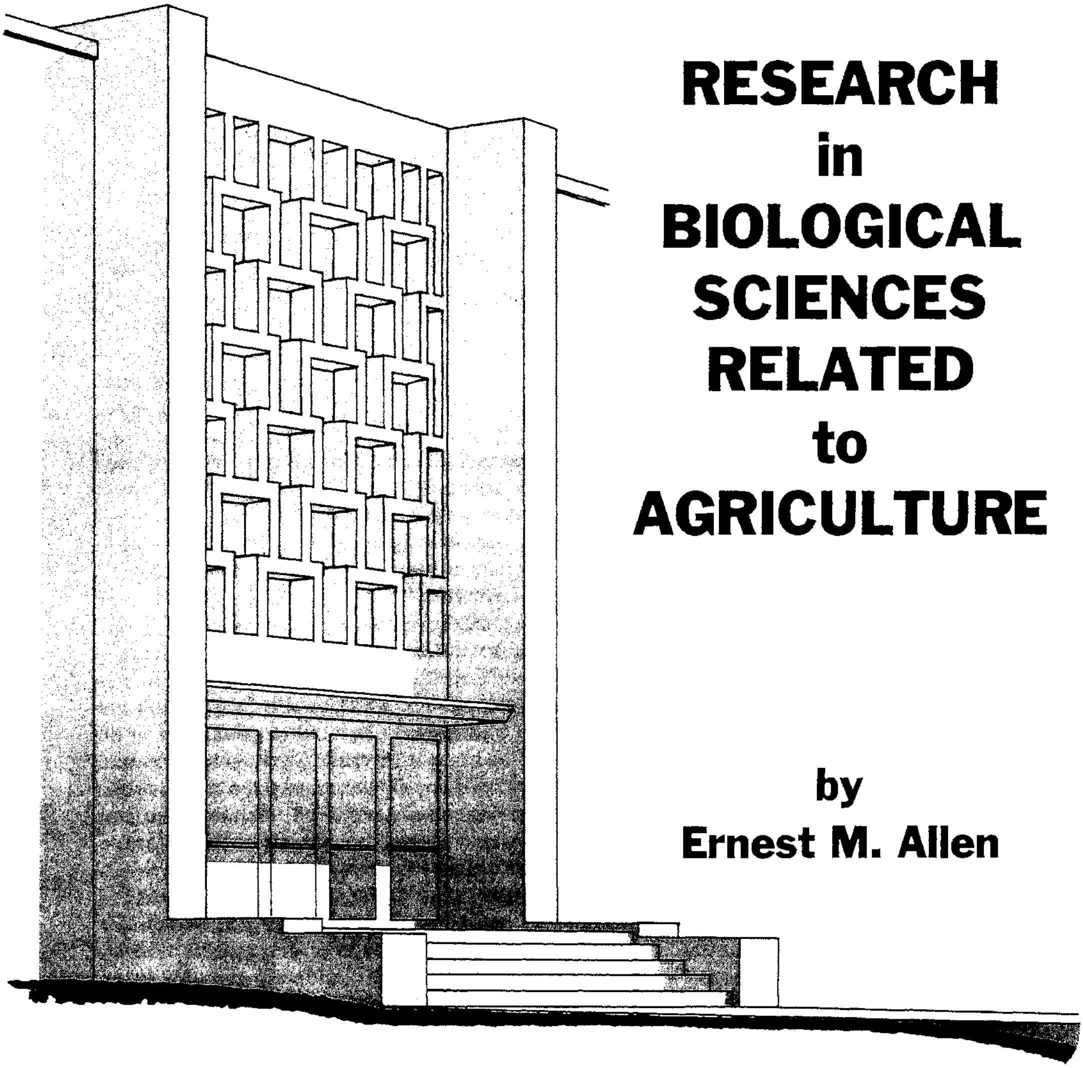

RESEARCH in BIOLOGICAL SCIENCES RELATED to AGRICULTURE

by
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AGRICULTURAL EXPERIMENT STATION

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RESEARCH IN BIOLOGICAL SCIENCES RELATED TO AGRICULTURE

by
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It is a privilege to join you today in the dedication of the new agriculture building at the University of Missouri. The event marks an important step in the advance of agriculture and of biological science; for while men and money are essential ingredients in any kind of scientific endeavor, there must also be adequate facilities. I join you in your pride in this new building; it will help the University retain its important place in the research and educational structure of our country.

In inviting me to address you on this occasion, you are giving recognition to the kinship between our two great domains - agriculture and public health. I am tempted to say we are close cousins, but the analogy does not give adequate expression to the closeness. Our kinship lies in the unity in life itself. Its galaxy of variegated forms constitutes one vast chemical laboratory, which houses an infinity of interrelated chemical processes. Kinship between us lies also in our recognition that all forms have a common dependence upon the factors in the environment and that each form is related to some other, be it for good or ill.

With such unity of research interest between us, we in public health can look with admiration at your own tradition of research in agriculture. In this country agricultural research goes back for at least a century, and agricultural colleges and their associated experiment stations have been among the most successful research institutions. While their researches have been initiated primarily toward solution of agricultural problems, they have nevertheless served far wider interests than those of the agricultural sciences alone. Agricultural research has contributed to practically the whole range of the biological sciences, including medicine. The development of streptomycin, for example, grew out of agricultural experiment station research. The same is true of dicumarol, which first came to notice in investigation of hemorrhagic illness in cattle and only later was found to be useful as an anti-clotting agent in the treatment of coronary disease in man. In the same way medical research has given much of value to agriculture, in contributions ranging from many of the antibiotics to studies of maximum permissible workloads on the farm.

Jointly we have built a truly impressive structure of research in all the biological sciences. This structure of achievement is one, however, that the scientists in your domain, and in ours, surely regard with humility as well as with pride. One must have humility when he views what has been accomplished against the background of the pressing research that remains to be done.

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* Delivered at the Dedication Exercises for the Agriculture Building, College of Agriculture, University of Missouri, Columbia, May 4, 1961.

I have referred to the dependence of all living things upon the factors, good or ill, in the environment. These factors are animate as well as inanimate. Man's dependence upon them has been recognized in one way or another since long before there was a science. Primitive man felt that he was at the mercy of his inanimate environment; and he sought to placate the storm, or drought, or other manifestations of the inimical forces of nature. Today we aspire instead to achieve rational control, to keep environmental factors at beneficent levels that do no significant damage. If control is as yet impractical, we seek to develop measures of protection, extending even to removing the organism, man or other creature, from the presence of the harmful factor, or to creating an artificial environemnt with the given factor set at the desired level.

What is going on in this field of endeavor -- sometimes called "environmental health" -- has aspects that bring to mind the combat between the hero and the mythical monster which promptly grew two heads from the stump where one was cut off; for as familiar sources of danger are brought under control, new threats of even greater potential danger appear. These threats are visible at first only to the discerning eye of the scientist, scientist-administrator, or engineer working in one or another of the areas in environmental health.

The term, environmental health, covers a spectrum of problems that have become matters of urgent concern to those of us in public health in the past twenty years. A moment's reflection makes it easy to see why. We are living in an era of the most rapid environmental change in all of human history. During the 1930's our population increased by nine million; during the '40's by 20 million; and during the '50's by 28 million. It is expected to increase during the next decade by 33 million, to a total of 214 million by 1970. A third of the Nation's population is expected to become concentrated in 10 super cities by the end of the century. Our technology is advancing at an incredible pace, changing man's patterns of living more in the space of a few years than in all previous centuries. All this change carries with it attendant hazards to our health and well-being which involve everyone from the most devoted urbanite to the most remote farmer. Environmental health attempts to anticipate and recognize these hazards and to develop ways of either eliminating or controlling them.

Some of these hazards have come unbidden with the increasing urbanization described; others have been created by man himself. A familiar example is the danger from milk-borne agents of disease. This danger has, of course, long since been brought under control through the efforts of scientists from agriculture and public health, who have participated in bringing about the almost universal adoption of the pasteurization process in commercial milk production and who have aided in the perfection of the process.

Another danger, magnified as cities grew and their twin problems of water supply and sewage disposal grew with them, has been that of water and filth-borne agents of disease. This danger, too, has been largely overcome. Environmental health activities have, indeed, contributed to the virtual banishment of such once-dreaded diseases as typhoid fever and the dysenteries, the major hazards from sewage contamination of our water supply. Cholera infantum, or the summer diarrhea of infants, is now little more than a fearful memory.

These are only a few of the unbidden hazards to safety and life itself that could have grown to enormous proportions with urbanization of our society, had they not been restrained and brought under control.

Environmental health activities designed to control biological disease agents have now become so interwoven with our everyday lives, our structure of Government services, and our economic system as to be taken for granted by the average citizen. What family gives any thought to the refrigeration, and other food sanitation practices, in commerce or even in the home? Who but the expert in the field gives thought nowadays to the problems in the purification and delivery of water and the disposal of garbage and sewage? The average citizen accepts his environment with trust and without misgiving because of our past successes in meeting the problems of environmental health. Perhaps it is this very trust that makes him relatively unconcerned about new dangers that may be developing apace.

Ironically enough, the newer and more menacing threats from our environment are dangers that man himself has created. They are associated either with the increase in population per se, and the accompanying need for increased productivity of the land, or with the greater damands we make for things and services that are ingredients in our modern standard of living. Even the motor car, with its enormous toll of highway accidents, must now be counted a new environmental health hazard. Created for man's service, it has now, like Frankenstein's monster, turned upon its creator! The diverse and growing uses of nuclear energy, potentially of enormous benefits, are also producing a whole new spectrum of hazards to health for present and succeeding generations.

These and other problems concern us both. We stand together, agriculture and publich health, at the frontier of present knowledge; and together we survey beyond this frontier what we may picture as a vast field -- prairie indeed -- not of grain but of question marks! These represent the problems we jointly confront: questions having to do with the biological processes in man and other forms of use to him, animal and plant, and questions of the impact of these forms by the environmental factors, beneficent and malign, with which all life is surrounded.

If we could look back on this picture as it was in previous decades and on the research that has gone on in our two domains, I think we would probably be both surprised and gratified. We would see the scientists from the two domains -- all intent on the path of individual interest being followed -- moving out into the field and plucking questions here and there with their paths intermingling and crossing one another at random. For the questions in these areas, it would make little difference whether the scientist came from agriculture or public health. Scientists in agriculture have furthered research endeavors that have been basic in public health, and those in public health have supported work that has been basic in agriculture.

The Public Health Service is aiding studies in such problem areas as air and water pollution control, occupational health, accident prevention, insect and rodent control, food additives and contaminants, and food technology in general.

As you might expect from the large areas of research that are common to agriculture and public health, the NIH has made grants for research projects in colleges of agriculture. Such grant support, provided on an individual project basis, has been quite modest in the past decade, chiefly because your scientists have not been fully aware that large areas of their research interest were of considerable interest to public health. On the other hand, there has been growing recognition of this support. In 1951 there were only 39 NIH grants to agricultural colleges; by 1957 the figure was 150; but last year there were 357, amounting to $4.2 million. While this amount is less than 2% of our total research grants program, I would predict that the percentage will steadily grow. Colleges of agriculture are as eligible to apply for NIH research grants as other research institutions; and both domains, agriculture and public health, are only beginning to comprehend how truly both of us have been plucking questions from the same field!

Of the research areas in which we make grants, the one that will probably be of greatest interest to you is the area of "food research." One subarea of traditional interest to us (and to you) is that of the food-borne diseases -- those due to food contamination by pathogenic microorganisms. Society has always had to face this problem. Suitable canning procedures, developed by your own scientists, have practically eliminated disease due to living organisms in such foods. Frozen foods invite further study from this point of view.

Precut meats and poultry is another area for research directed toward prevention of food-borne disease. Processes for sterilization of packaged uncooked foods are still under study. The PHS has supported and continues to support much research in this general area of the food-borne diseases.

A related and man-made problem that is being studied is antibiotics in our food supply. These compounds are now used widely in agriculture, as you know, in order to obtain bigger, healthier products; and precut poultry may be dipped into antibiotic solution to add to its keeping qualities. PHS grantees are currently studying the effects of antibiotics on the microflora and enzymes in milk; studying the influence of antibiotic feeding on poultry products; and exploring the use of antibiotics as food preservatives.

Here at the University of Missouri, your own Dr. Robert Goodman and Dr. Herbert Goldberg are conducting studies having to do with the antibiotic residues found in edible horticultural crops. I am proud to report that the PHS is providing part of their research support.

Other chemicals, both inorganic and organic, that are intentionally added to our food supply constitute another man-made problem that will engage the research attention of interested scientists for many years to come (including those in the Food and Drug Administration). Over 400 compounds have been counted that are used at one point or another in food processing and manufacture to give flavor, color, texture, or consistency to foods, or to improve their keeping qualities. These compounds are considered to be harmless, but questions regarding the use of one or another of them urgently invite research.

Pesticide residues in food are another man-made hazard that demands a greatly accelerated program of study. They have brought with them a new era in the science of toxicology, whose horizon was formerly so circumscribed that a toxicologist was -- at any rate, in the public eye -- an odd and uninteresting character who sat on the witness stand giving scientific-legal opinions. While this limited role of the toxicologist was important, the many unanswered questions in toxicology today, pesticide residues furnishing a host of them, have dwarfed its former importance and given the toxicologist a position of prestige in the field of science.

The PHS is supporting some meritorious research in the general field of food additives and contaminants, but it believes that research in this area should be greatly expanded.

Another sizeable and growing segment of our food research program, of great importance to both public health and agriculture, is nutrition research. While the problem of obtaining ever-increasing yields of food per acre of land is a necessity in a world where whole populations are underfed, we are concerned with the corollary problems in this country of over abundance and mal-distribution. Consequently, our more acute interest lies in the problem of optimum nutrient intake, both in total amount and in the balance among the various nutrient substances. This large area contains such subareas as the effects of over- and underfeeding; vitamin and other single nutrient deficiencies to aging, to metabolism, to congenital malformations, to kidney changes, and to the central nervous system. We are attempting to determine the role of certain body structures and functions in amino acid deficiency. We want to know what the trace metal requirements are in certain nutritional deficiencies. A grantee investigator is studying the mechanism of night blindness arising from vitamin A deficiency, and he is seeking to determine the functions of vitamin A in the tissues. An Arizona scientist is studying nutrient utilization in deficient ruminants, while a researcher at the University of Maryland is exploring nutrition and bone anomalies in chicks and turkeys.

The role of nutrition in mental health is being explored; for example, at Johns Hopkins a study is in progress on the effects of vitamin deficiencies in adaptation and learning, and at Purdue a scientist is studying the etiology of emaciation in mentally defective children.

One of the most pressing questions of the generation, second only to that of cancer, is the question of a possible dietary factor in atherosclerosis. The question is now occupying the time and attention of scientists in a number of centers. Atherosclerosis causes a death toll of nearly 500,000 a year, and this figure by no means tells the whole story of the damage from this disease process.

Is high blood cholesterol a causal factor? Are large-particle blood lipids a factor? Must we cut the total of fat calories in our diet, now amounting to 40%? Do we cut the protein calories, or is it simply the total calories that constitute the fault? Whatever the ultimate answer, American agriculture has a special interest in what the answer will be.

We have mentioned the areas of environmental sciences, nutrition, and toxicology, with the special concerns regarding the growing list of food additives and contaminants. These disciplines necessarily have a larger portion of their concern in the fields of food production -- and agriculture -- than some of the other disciplines in the biological sciences. Many of the other disciplines are, however, of great importance to agriculture and food research and should be of great potential interest to workers in the agricultural field.

Some idea of the spectrum of other biomedical disciplines with an interest in food research may be gained from a brief summary of this portion of the Public Health Service's food research program.

Scientists in the disciplines of allergy and immunology are now giving attention to such problems as the antigenic properties of milk proteins and the effect of food additives on sensitization. Skin homotransplantation studies are taking place at the University of Pittsburgh in vitamin-deficient animals. At Washington University in St. Louis, Dr. G. R. Spencer has been studying the effect of milk antibody on staphylococcal infections.

Hematologists at the University of Wisconsin are studying the roles of iron, copper, and plasma proteins in anemias of infancy, while other scientists interested in metabolism are applying the new technique of gas chromatography to the analysis of fats.

We are supporting a number of research projects in the field of parasitology as it relates to agriculture and human health. A study of Iowa State University seeks to develop new information about trichinosis in swine herds, while scientists at the University of Rochester are studying the disease in hamsters. Several grantees are studying various fish and shellfish parasites, while a scientist in South Africa is developing new information on factors determining invasiveness in Endamoeba histolytica, the organism responsible for amebic dysentery.

With the growing developments in the nuclear era, radiation biology has taken on tremendous importance as a research area. In agriculture, as in many other areas, atomic energy offers great benefits and, at the same time, poses great dangers. Full utilization of the benefits and avoidance of the dangers are the aims of the bulk of radiation research.

While most of the Government-supported radiation research affecting agriculture is the specific concern of the Atomic Energy Commission, the Public Health Service has a Division of Radiological Health which is responsible for a broad program of radiation monitoring, for aid to to the States in establishing their own radiological health activities, and for research.

Another of our research grants in this area, which supports Dr. John Bird's work at Washington University in St. Louis, will have particular interest to you. Dr. Bird is collecting hundreds of thousands of baby teeth from children living in the St. Louis milkshed to determine their content of Strontium 90, the now familiar by-product of nuclear explosions, which has been scattered by fall-out over vast areas of the earth and which is taken up from the soil by plants and deposited in the growing bones and teeth of children through the milk supply.

While the results of radiation research have not as yet impinged upon practical forming practice, work in the radiation field has greatly aided agricultural research. Isotopes, in particular, are helping scientists to unlock secrets of the growth of plants and animals, as well as of the pests and diseases that injure or destroy them. The radiation field is still another of the many fields of biological science of concern to agriculture, as well as to public health.

Genetics, which started with experiments on an agricultural product, the pea, has always remained vitally important to agriculture. It has become one of the major disciplines in medical research. Genetics is seen by some as a discipline which binds many of the others together and which will some day bind them all. It cuts across the fields of radiation biology, cytology, biochemistry, physiology, the behavioral sciences, and many others. It reaches toward the more minute within the cell, the common unit of all living matter, to the cell nucleus, the giant DNA molecules within the nucleus, and the genes that make up these molecules and that control heredity. It reaches outwards from the cell toward the entities of things living, the tissues and organs, the organism, the species, and ultimately the entire flora and fauna of the world. Genetics, then, is a fertile field for both applied research directed toward a practical goal and basic research conducted for the sake of knowledge itself.

Emphasis on basic research now pervades all of the medical and related biological sciences, and there has been a steady shift in this direction in agricultural sciences as well. In a very recent estimate, we find basic research now accounting for 34 percent of total expenditures for research and development in agricultural colleges and experimental stations -- a rather sizeable portion, in a field traditionally oriented toward the highly practical goals of better crop and animal production.

The reasons for the current significant trend toward basic research in both biological and agricultural sciences may be summed up in the simple statement that basic research supports the practical in much the same way as the submerged seven-eighths of an iceberg supports the part we see. Without basic research the progress of practical research would slowly come to a halt.

In the dedication of this new facility here at the University of Missouri, our thoughts may then center on two convictions: 1) that we have in this country done much to advance scientific research and 2) that we must do a great deal more. The distance we have come and the hopes we have raised allow no other course.