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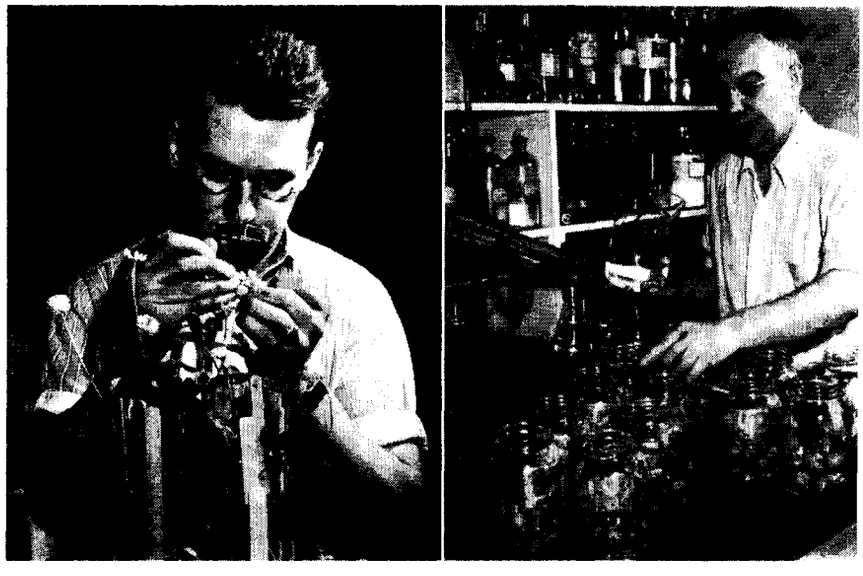
JOURNAL OF

Agricultural and Food Chemistry

Will we be able to provide an adequate diet for the world's population, now about 2.5 billion and growing fast? This, from the long view, is the most vital question facing Earth's inhabitants. Students of public health, agriculture, population trends, and political administration assure us that we must be more efficient and imaginative in achieving nutritional adequacy in the years ahead. Fundamentally this is the reason behind the establishment of the *Journal of Agricultural and Food Chemistry*. The chemical profession must play an ever more prominent role in understanding the fundamental nature of soil, water, atmosphere, plant, insect, animal, and man, if man is to survive as the fittest. Chemistry is fundamental to the problem of agriculture, food, and nutrition, but today it's a team job — the chemist must know more about insects and the entomologist more about structural formulas, and so on through the interrelationships of the various branches of science and engineering. For this charter issue of *Ag and Food*, the editors considered it eminently appropriate, therefore, to interview the leaders in many fields. Their views of the current status and future prospects of research and development set the scene and outline the scope of an area to which this new ACS journal will be devoted. By publication of timely, original information, *Ag and Food* will serve scientists and engineers in significant endeavors for the benefit of their fellow men



Research Brings Results In Agricultural Chemicals

Q. *Dr. McNew, the pesticides business volume has increased about threefold since World War II. Is it a war baby?*

A. The great upsurge was under way before the war. Researches on DDT and phenothiazine insecticides, the dithiocarbamates and quinone fungicides, and 2,4-D as a selective herbicide were well advanced before hostilities began. These materials are the historical landmarks in a new era.

What has been done since then with insecticides and miticides?

Too much to describe here. Leading products have included various chlorinated hydrocarbons, organic phosphates, and synergists: piperonyl butoxide, sulfoxide, and *N*-propyl isomer. Allethrin, ryania, and sabadilla have come into general specialized uses. Several insect repellents and fumigants such as butoxypropylene glycol and trichlorobromomethane have been developed. Promising miticides are: 2′-chloroethyl-1-methyl-2-(*p*-tert-butylphenoxy) ethyl sulfite; 1,1-bis(*p*-chlorophenyl)ethanol; *p* - chlorophenyl - *p* - chlorobenzenesulfonate; *p*-chlorophenylsulfone; and ethyl *p*-nitrophenyl thionobenzenephosphonate.

What about fungicides?

Chloranil was the first commercially successful organic material. Other quinones, dithiocarbamates, heterocyclic nitrogen compounds, quaternary ammonium compounds, chromate metallic complexes, and phenyl mercury compounds have found a place. These compounds are capable of preventing leaf rust, anthracnose, and other fungus diseases heretofore considered uncontrollable. Some have ability to eradicate certain established infections so they can be used effectively with fewer sprays and less precise timing.

And herbicides?

2,4-D opened new horizons in weed control—phenomenally low doses destroyed broadleafed weeds in lawns or grain crops. The great developments are yet to come in this field, although much manual labor already is being eliminated by using aryloxy compounds, 3-(*p*-chlorophenyl)-1,1-dimethyl urea, dinitro-ortho-sec-butyl phenol, isopropyl-*N*-chlorophenyl carbamate, phenyl mercuric acetate, trichloroacetic acid, xanthates, and chlorinated hydrocarbons.

What outstanding results are coming from growth regulators and defoliants?

Prevention of fruit drop, cotton defoliation, and other forms of growth regulations have been achieved by naphthyleneacetic acid, maleic hydrazide, disodium 3,6-endohexahydrophthalate, and naphthalphthalamic acid.

From the grouping of compounds, one is tempted to draw some general conclusions on the relationship of chemical structure to biological activity. Is that justified?

Certain general relationships have been revealed, but very little is known about the nature of the reactions of chemicals with living cells that make for pesticidal and growth-regulatory activity.

Relatively little is known about why various parts of the molecule affect activity. In general, it is becoming clear that two phenomena are involved. Some chemical groupings promote absorption of chemicals through cuticular layers and into the cells while others are toxophores that are receptive to reacting with enzymes, cell metabolites, or functional proteins usually through free sulfhydryl or imino groupings. The inside of the cell is an aqueous medium, so a polar group must be available to permit transmission from the lipoid to the aqueous phase of the biological system. It is only such materials that are capable of carrying toxophore groups to the site of operations that serve their purpose. Tests on radioactively labelled fungicides have only recently revealed how dynamic and essential these processes are.

Haven't most new biologically active materials been discovered through empirical methods?

Yes, and unless this trend is amended by some serious study as to how and why pesticides perform as they do, the entire program will suffer. The cost of developing each new pesticide is increasing. Performance standards increase

from seed to plate, scientists are pushing research and development in agriculture and food processing

with each new discovery. The amount and diversity of field testing of pesticides is probably the greatest of any commodity group because, in addition to legal requirements, the promoters of new pesticides have to satisfy one or more groups of

George L. McNew

Managing director of the Boyce Thompson Institute for Plant Research. Principal research interests in physiology of parasitism, mode of action of fungicides and herbicides, relationship of chemical configuration to biological activity of pesticides, and physical properties of fungicides.

scientists in each state and often extend their demonstrational testing down to the county level. New materials must be safe to handle, noninjurious to one or more crops and serviceable under a variety of climatic conditions. Finally, extensive toxicological tests must be made and residues on food products must be ascertained.

Are you hopeful for improvement in the matter of mammalian toxicity?

All of the biologically active compounds can be looked upon with suspicion since they are capable of immobilizing essential enzymes or otherwise changing cell functions.

However, there is a degree of selectivity in biologically active chemicals that can be utilized. For example, nearly every herbicide has some fungicidal and bactericidal activity but none is of direct therapeutic value in plant disease control as now used. Many fungicides are herbicidal but some can be selected that are safe enough for use on plants. By a comparable choice of insecticidal compositions with respect to mammalian toxicity, relatively safe materials can be and have been developed.

It is obvious that if progress is to continue in developing seriously needed pesticides, enlightened programs in research and regulatory administration must be instituted. Private initiative will be destroyed if unreasonable shackles are placed on the development of new chemicals either through failure to understand the laws of nature or through imposition of unreasonable laws by man.

Apart from the question of finding and testing pesticidal materials, how successful are advances in formulating a pesticide to get the maximum effectiveness in actual use?

The physical chemistry of compositions is just as important as the organic chemistry of molecules in determining how well they will serve their assigned function. It is only within the last three years that the exact relationship of particle size and distribution to protection of foliage surfaces from fungus invasion has been clearly established. Additional data are needed on the physical forces responsible for deterioration and persistence of spray deposits and the influence of various diluents and surface active conditioners on them.

What scientific knowledge does the agricultural chemicals industry most need to reduce the more than $12 billion annual loss from plant disease, weeds, and insects?

The agricultural chemist could solve these problems faster and more efficiently if he knew: what kind of cell membranes must be traversed by a chemical and what specific differences in nature of membranes in different species of pests or between pests and hosts can be expected; what solubilizing groups are most efficient in promoting penetration of cell membranes by different kinds of molecules; what type of cell reactions the chemicals must enter into; what constitutes a toxophore grouping; and finally, what cell dynamics prevail at the site of chemical reaction. There should be hope that chemists and biologists will not have to synthesize and evaluate almost 2000 materials to discover one successful candidate as they now do.

Agronomists Seek Higher Acre Yields

Q. *Dr. Bear, what do you place at the top of the list of contributions from the science of agronomy to the improvement of food production and nutrition?*

A. Agronomy is aiming toward higher acre yields of higher-quality feed, food, and fiber crops in large scale production. Among the most important research developments contributing toward the attainment of these ends are the soil survey, soil testing for lime and fertilizer needs, production of certified seeds of named varieties of crop plants of specific germ plasm, and chemical control of weeds.

How does the soil survey contribute?

The soil survey has for its purpose the classification of the 1903 million acres of land in the United States on the basis of its chemical and physical characteristics. This offers a starting point for intelligent land use. Soil testing procedures further the process by determining the reaction of the soil and the available supplies of plant nutrients in relation to the needs of the crops to be grown.

From there we can see that certified seed can make the best use of the productive capacity of soil so studied and the chemical control of weeds reduces competition for nutrients as well as the cost of cultivation. What might be expected from these four fields in the next quarter-century to carry this progress even further?

For one thing, as fast as soil surveys are completed, maps classifying the land in accordance with best use potentialities should be made of every farm. Soil tests should be serviced by field men trained to recognize disease, insect, and cultural troubles, as well as plant deficiencies. Many farmers are willing to pay for such service. The principle employed in developing hybrid corn needs to be more widely applied. For example, we need a perennial wheat. Use of weedicides should be expanded to kill grass and legume sods, thus reducing the cost of preparing land for grain crops and protecting it against erosion.

Firman E. Bear

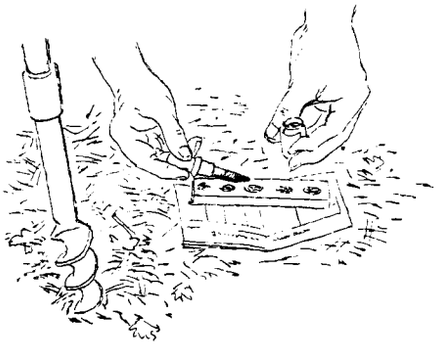
Chairman of soils department at Rutgers University and editor of *Soil Science*. Has devoted much time to study of trace elements in plants and soils. Past president of American Society of Agronomy and of Soil Science Society of America.

What are some of the other vital problems needing attention?

There are many. One of the most urgent is to meet the needs of plants for such trace elements as boron, molybdenum, iron, manganese, copper, and zinc, while avoiding over-dosage. Chelating agents are being studied as possible aids in maintaining available supplies of some of these elements.

We know that some of the trace element deficiencies have been remedied with striking results. What are some of the most troublesome spots which are still in need?

Large areas of land are deficient in boron, notably for production of alfalfa,



root crops, celery, and cauliflower. Molybdenum is deficient in acid soils for cauliflower and in Florida soils, for citrus crops. Lack of available iron is a troublesome limiting factor in the alkaline soils of the west, as well as citrus areas of Florida. Manganese is often needed in humid areas to overcome excessive liming. Copper is required when bringing new peat areas into production and often is useful in improving soil for forage crops and tobacco. Next to nitrogen, lack of zinc has been said to be the most seriously limiting factor in parts of California and for pecans in the southern U. S.

Soil conditioners are the subject of much current discussion. Do you think they have real practical possibilities?

They offer great promise for improving working qualities of soils and thereby increasing crop yields. More effective and longer lasting products of this type at lower cost are anticipated.

What do you consider the most seriously limiting factor in crop production in the U. S. at present?

Generalizations are dangerous, but I consider the lack of adequate supplies of nitrogen in the soil to be the most serious. Even when we have stepped the nitrogen level up much higher by applications of its compounds, the possibility still remains of increasing the protein content of the harvested portion of the crop. There, plant breeding comes in and much is to be expected, especially with grasses and legumes, in taking full advantage of the forage producing possibilities of our hay and pasture lands.

In your opinion, what problems need special attention by our scientists and technologists in the field of agriculture?

Less than one third of the water-soluble phosphate that is applied to the soil is recovered in the first year's crop. It should be possible to develop an organic phosphate that resists fixation. Weedicides are effective in killing growing plants, including germinating seed, but they do not destroy dormant weed seeds. A new drastic weed-killing chemical that could be used once in a lifetime to clean up the soil would be a great boon to agriculture. Protection of soil against the destructive action of raindrops and overhead irrigation is needed. This calls for developing systems of land and crop management that keep the soil covered with plant refuse or a low-growing secondary crop.

More Technology in Fertilizers

Q. ***Mr. Jacob, a century ago, commercial fertilizers were virtually unknown. How could you indicate quantitatively the progress which has been made?***

A. The manufacture of fertilizers has emerged from an industry based largely on by-products and waste materials to become a major chemical enterprise that furnishes annually to the world some 16.5 million tons of primary plant nutrients. It has been estimated that possibly as much as 25% of the total crop production in the United States can be attributed to the use of commercial fertilizers.

Would you say that this development is growing through the application of chemical technology?

Yes, and the spread of chemical and chemical engineering techniques into certain phases of the fertilizer industry is only getting a good start now. I am convinced that we shall see a great deal more in the near future.

This matter of providing enough food for the world's growing population has been and remains a great challenge. Do you think it can be met successfully?

I certainly do. Science has a way of coming up with the basic answers to many problems as they arise. For example, look at the striking advances made possible by the development of chemical processes for the fixation of atmospheric nitrogen. This was a most important and basic achievement upon which rested the advance of modern civilization.

In coping with the world's food needs in the reasonably near future, do you think that further advance in science is the most critical factor?

Well, certainly research and development must be pushed, but frankly there are other problems of education, economics, and politics which are very important. There is no doubt in my mind that the world's needs for food could be met readily if only we could put to work our present scientific and technical knowledge.

K. D. Jacob

Head of the Division of Fertilizer and Agricultural Lime, USDA. Entire professional experience with federal government in field of fertilizer technology and utilization. Superior Service Award, USDA, 1947.

We agree on the importance of that, but getting back to chemical technology, you mentioned the fixation of nitrogen as a great development. How about technical progress in some of the other basic plant foods, phosphates for example?

For many years the use of sulfuric acid has made possible superphosphates which have held first place in the fertilizer field; now other processes have achieved large-scale operation and promise to become increasingly important. The application of flotation procedures to the beneficiation of mineral phosphates has made possible the utilization of some deposits and has greatly extended the economic life of others. The principles of flotation, fractional crystallization, base exchange, double decomposition, and phase rule have been applied with success to the production of concentrated potash salts from brines and highly soluble materials.

We are told that manufacturers of phosphate fertilizers suffered most severely from the almost sudden effects of the sulfur shortage two years ago. Is this still a dire problem?

A great deal of headway has been made against this threat and excellent phosphate fertilizers are being made through the use of nitric acid or other materials which take the place of sulfuric acid, as well as the furnace processes that involve the manufacture of elemental phosphorus. However, another consideration in this matter is that the sulfur shortage has eased considerably.

What about the future? Will we make better use of resources? Is there a trend toward higher concentrations of nutrients in fertilizers?

Continued progress will be made in the utilization of low grade and marginal resources of phosphate and potash. For example, economical recovery of potash from sea water is not an idle dream. Fertilizers better adapted to the nutrient requirements of specific crops under different soil and climatic conditions are on the horizon. The manufacture of mixed fertilizers will continue to move toward chemical processing and the production of high-analysis granular products. The trend now is toward concentrations of primary nutrients of 30% or higher and toward a 1-1-1 ratio of N-P_2O_5-K_2O. Mineral phosphates will become an increasingly important source of fluorine, uranium, vanadium, and perhaps other substances, which can be recovered as co-products of fertilizer manufacture.

What do you think of the possibility for development of a synthetic resin type of material which would slowly release nutrients, nitrogen, for instance, and thus have a longer effect in the soil?

Work is now under way on such a product, which promises to be economically practical, and which will give slow release of nitrogen. The product of high interest at present is a urea-formaldehyde resin, but other lines are being followed.

Patents have been issued for products combining plant foods and soil conditioning

agents. Would you give us your thoughts on this?

With respect to any of these about which I know, the proportion of soil conditioner needed is so high that only a low concentration of plant food is provided. I wouldn't say that this won't change in the future.

Are trace elements now being incorporated into commercial fertilizers?

Already trace elements are being incorporated with some fertilizers, while substantial quantities are being used separately. Important developments can be expected in this field.

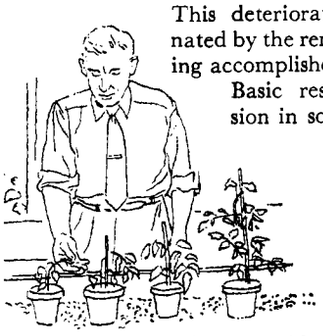
Basic Research Holds Key

Q. *Dr. Hilbert, would you tell us some of the more important specific improvements now broadly affecting food production and nutrition, which can be traced to basic advances in chemistry?*

A. A knowledge of the chemical structure of such vitamins as thiamine, riboflavin, ascorbic acid, and niacin has made possible their synthesis on a commercial scale and their economical use in the enrichment of certain foods with a resulting improvement of our national nutrition. The classic experiments of Burr and Burr showed the importance of the essential fatty acids, linoleic, linolenic, and arachidonic in the diet, and the researches of Rose and others have established the need of certain essential amino acids in the human dietary.

Frozen orange juice is now the basis of a quarter million dollar industry. Its development was based largely on chemical science and technology. We know there are other instances of progress in agriculture and food processing brought about by chemical research. Would you comment on a few notable examples?

Yes. For example, dried eggs will deteriorate on storage because of reaction between glucose and cephalin. This deterioration is practically eliminated by the removal of glucose, now being accomplished on a commercial scale.



Basic research on flavor reversion in soybean oil has led to improved methods of refining, resulting in a greatly expanded use of soybean oil in the manufacture of margarine. Another interesting problem has been the effect of moisture in dehydrated foods. After considerable study, in-package desiccation was developed and resulted in increased storage life of certain dehydrated foods.

Guido E. Hilbert

Chief of the Bureau of Agricultural and Industrial Chemistry, USDA. Studies include organic chemistry, particularly related to synthesis of nitrogen compounds; biochemistry; pyrimidines; carbohydrates; industrial utilization of agricultural products and by-products.

Farm products are valuable in producing many nonfood materials of high importance. What two or three of very recent date would you place high among those which can be credited to chemical research?

First, a synthetic textile fiber from the protein of corn. In 1952 production was about 4 million pounds, and 1953 production is expected to be about 10 million pounds. Another development is starch ethers, and one of these, allyl starch, is now starting to be produced commercially. Of more recent origin is the development of epoxidized animal oils as plasticizers for synthetic resins.

You sound convincing on the present effects of past research. What major problems now under attack by research are among the most important in the effect they will have during the next quarter century, if solved?

Considerable research is being carried out by industry and private institutions on the use of high-speed electrons, gamma rays, and soft and hard x-rays for the preservation of foods. In 1952, nearly 420 million one-pound loaves of bread, valued at some $68 million, were lost by staling. Basic research is studying the mechanism of staling in order to reduce this loss. In the case of cotton, more effective cleaning of mechanically harvested cotton is necessary; improved properties of cotton through chemical modification should encourage increased use, and a more effective utilization of new varieties of cotton developed by plant breeders may lead to new uses for this fiber. Research dealing with the biological action of antimetabolites and their utilization in the study of biological problems is being undertaken in the field of the browning reaction, a phenomenon of vital importance to the food industry, because browning is almost always accompanied by flavor changes and loss of nutritive value.

Have fats and oils benefited strongly from the work of chemists and chemical engineers?

Certainly. The refining and deodorizing of oils has been improved so that output is increased with less labor. Especially important contributions in the fats and oils field have been the trend toward solvent extraction, continuous refining and deodorization, commercial production of fatty acids, polymerized oils, fatty alcohols and esters, epoxidized animal fats, addition of extra animal fats to dog foods for additional nutritive value, and the use of animal fats in the tinning of steel plate.

Is anything being done at present on the elucidation of the biochemical factors responsible for disease resistance or susceptibility in plants?

Yes. Not only is this bureau carrying out such research, but other research agencies, both in the United States and abroad, are engaged in this field. At the Eastern Regional Laboratory, for example, we are studying the relationship between tomato wilt resistance and tomatine production. It appears that wilt resistance may increase directly with rate of elaboration of tomatine by the plant.

Plant Breeders Use New Concepts and Techniques

Q. *Dr. Cullinan, weather is a factor which the farmer must battle constantly—an early freeze is a disaster. Is the work of the plant breeder putting the farmer in a more favorable position in this respect?*

A. Yes. Crop varieties more tolerant to the hazards of weather are being developed—grasses and legumes, for example, increasingly are being made more winter hardy and less susceptible to drought. Other varieties are being made to fill in or extend the ripening season—new peaches, oranges, grapes, strawberries, and blueberries that ripen earlier or later than present varieties or at intervals during the season when traditionally there are gaps in the harvest. Adaptation to soil, climate, and day-length cycles is better: soybeans have a narrow range of adaptation to the day-length cycle, but specific varieties now are being bred to suit conditions peculiar to each geographical area.

Hybrid corn has produced a crop with much less waste or low value material than older varieties. What other steps are moving in similar directions?

Varieties of better quality, more uniform size and color, and giving higher yields than those now grown are coming along—hybrid onions, for example. Also varieties adaptable to mechanical production—grain sorghum, stiff-strawed grains, and the monogerm sugar beet all have reduced waste, time, and the risk of loss in harvesting.

What are the main areas of attention in breeding disease- or insect-resistant crops?

We are concerned with new wheats which may be more resistant to Race 15

F. P. Cullinan

Since 1942, assistant chief of the Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA. Has contributed much to research in root systems, nutrition, pruning, production, and breeding of deciduous fruits. Past president of the American Society of Plant Physiologists.

B stem rust, new corn hybrids with resistance to corn borer, new sugar beets resistant to yellow disease, and potatoes less susceptible to late blight and scab.

Can you see a comparable role in the future for plant breeding?

New concepts, tools, and techniques now coming into use foreshadow an even more important role for plant breeding by making the development of new crop varieties much more efficient. They are based on an increasing understanding of: (1) the genetic composition of both cultivated species and their wild relatives; (2) the occurrence of male sterility and its use in the production of hybrid seed; (3) the nature of hybrid vigor; (4) the physiology of plants and their response to nutrients and growth modifiers; (5) the role of photoperiodism in the initiation of flowering and fruiting and the germination of seed; and (6) the nature and occurrence of pathogenic organisms and viruses.

Does the chemical approach to disease control show possibilities?

Yes. New knowledge of the way plants absorb and translocate organic compounds is pointing to more effective uses of these compounds in plant disease control. Within the past year we have found that antibiotics, such as streptomycin, hold promise in the control of bacterial diseases. Perhaps they or related compounds offer a control for the virus diseases for which we now have no protection except in long-term breeding programs.

Plant Physiology Offers Opportunities

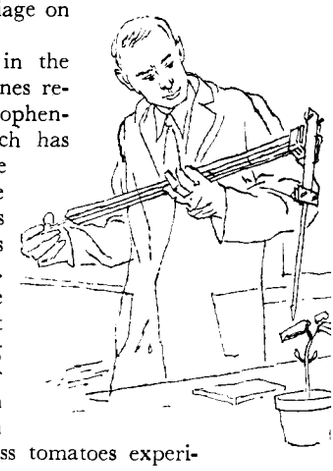
Q. *Dr. Horsfall, plant physiology has been a key science in the development of modern agricultural chemicals. Can you see possibilities for equally important contributions in the future?*

A. Plant physiology offers chemists one of their greatest opportunities for future research in the mechanism by which plants synthesize carbohydrates and proteins. Of more immediate likelihood, however, is research in the general area of the chemical control of plant growth. Weed killing has been so spectacular that we have lost sight of the possibilities of affecting growth in other ways with chemicals. For example, if the tobacco plant could be made to grow a thin leaf, the expense of enclosing thousands of acres of cigar tobacco in cheese cloth might be eliminated.

Chemistry and plant physiology also are presented with an opportunity in the field of improving the quality of food crops. Recent agricultural research has devoted great efforts to increasing yields. Quality often has declined as a consequence. Flavor and palatability are, after all, chemical factors, although relatively little is known about them at present. When we do know these chemical factors, perhaps the farmer will devote himself to bulk and the chemist will develop the flavor.

We know that plant physiology was important in plant growth hormone development. Would you describe briefly how this came about?

2,4-D has been a spectacular development. It may be considered as representative of the whole field of plant growth regulators. This compound resulted from basic research in plant physiology devoted to the investigation of plant growth factors which modify that growth. The first natural hormone to be isolated in these studies was indole-3-acetic acid. This compound, however, was too expensive for commercial synthesis and was replaced by naphthaleneacetic acid which had about the same activity as the indole compound. Almost immediately commercial applications were found for the plant growth regulators. They have been used to induce rooting of cuttings, to prevent apples from dropping prematurely, and even to preserve foliage on Christmas holly.



Further research in the field of plant hormones resulted in 2,4-dichlorophenoxyacetic acid, which has fatal effects on some broad leaf plants like dandelions, yet has no effects on others such as corn or grass. At present, we use hormones to prevent tomatoes from falling in cold weather, or beans from falling in hot weather. We can even produce seedless tomatoes experimentally.

James G. Horsfall

Director of Connecticut Agricultural Experiment Station. Studies include root rot diseases; abnormal plant physiology; vascular diseases of plants; nutrition in plant diseases; organic fungicides; cuprous oxide fungicide. President of American Phytopathological Society, 1951.

What developments in plant pathology were influential in the change from the old sulfur and copper sulfate fungicides to the synthetics now in use?

Probably the first significant development occurred in 1938, when the fungicidal action of chloranil was demonstrated. In 1939, this compound was introduced as a seed treatment, and shortly thereafter it was adopted generally for all legume crops. The success of this preparation was followed by the introduction of ferric dimethyldithiocarbamate as a foliage spray for apple scab in 1942. In 1943, disodium ethylenebisdithiocarbamate was introduced as a spray for potato blight.

Is there a specific use of antibiotics in plant pathological work at present?

Streptomycin has shown good results experimentally on bean blight, a bacterial disease. Others are being studied for various plant diseases and certainly there is lively interest along these lines.

What other research is presently under way in the field of plant pathology?

The new frontier in plant pathology is internal chemotherapy. The organic fungicides which I described are protective in action. They are applied to the surface of plants and kill disease organisms before they can enter the plant system. Internal therapy attempts to protect plants or even cure them from within, by placing the chemicals inside the plant rather than on the surface. Real progress has been made with internal chemotherapy in the control of Dutch elm disease, oak wilt, and carnation wilt. The application of this principle to food crops will, of course, require much research, especially in the field of toxicity studies.

Entomologists' Problems Multiply

Q. *Dr. Palm, it is estimated that of the 80,000 species of insects in this country, 6000 are known to cause damage to crops, animals, and man. What specific postwar research developments to which the entomologist has contributed are now showing most effective influence in combating destructive insects?*

A. The use of organic chemicals as insecticides is the most outstanding postwar achievement extending from entomological research.

DDT and many others for the first time have provided the farmer with easy-to-use, low-cost methods of control over many of his serious insect enemies. Man himself is being protected from his disease carrying insect enemies. Estimates indicate that DDT alone has saved no less than five million lives and has prevented more than 100 million illnesses since it became available in 1942.

Insects can be valuable to man in this battle by acting as parasites on harmful species. What major specific achievements have been made along these lines recently?

There has been renewed interest in the entire field of biological control of insect pests these past few years, but control by parasite is one of the most difficult methods available to the entomologist. First it is necessary to find a suitable parasite or predator. This may take years of searching in various parts of the world. Even when one is found it may not do well in this country. Although successes in this field have been relatively few, results from some have been spectacular. The citrus black fly, only a few years ago a major threat to the citrus industry of North America, now seems to be held in check by a tiny wasp parasite brought into Mexico from India. A parasite of the European corn borer—a fly from central Europe brought into the United States over twenty-five years ago—only now is showing that it can be very effective.

Much has been said about insecticide-resistant insects lately. Is this peculiar to any particular type of insect or insecticide?

Resistance of insects to insecticides has been observed and recorded for almost fifty years. The problem is becoming more acute and of growing importance. I think it is safe to say that we can expect a species to become less susceptible to a given insecticide through continuous use. However, I believe that oil is one insecticide material which has remained effective without resistance being developed. But DDT certainly is not out of date. It still is a potent and very valuable insecticide.

Eradication of breeding areas is an old technique. What are the newer ideas for hindering insect reproduction?

Prompt salvage of trees infested with the southern pine beetle is credited with bringing under control two major outbreaks of this pest during 1951. The status of that beetle has been reduced from minor to major by timber operations and its natural enemies.

A revolutionary scientific innovation in the use of radiant energy, it is hoped, may be developed to eradicate the screw worm fly, a serious pest causing huge losses to the livestock industry in the South. It involves the carefully timed liberation of laboratory insects after exposing them to sterilizing radiation. A treated female lays infertile eggs. When a radiated male has mated with a normal female in the laboratory, the eggs from the female are deposited as usual but do not hatch into the maggots that damage livestock. Studies have shown that the female mates only once in a lifetime. The Bureau of Entomology and Plant Quarantine of the USDA and the Atomic Energy Commission showed that atomic radiations were successful sources of sterilizing rays. Because of the relatively small number of flies that survive the winter in Florida, it may prove practical to rear and liberate the treated flies in numbers five to ten times as great as the number of wild flies in the area. It is hoped that by this means the fly may be completely eliminated.

What other problems would you place high in entomology today?

The "Air Age" has afforded insects as well as man a means of rapid movement to all parts of the earth. As examples of consequences I would mention the oriental fruit fly, introduced from Hawaii a few years ago, and the citrus black fly. Europe got Colorado potato beetles from North America. The Japanese beetle, hessian fly, European corn borer and others came to us from abroad.

Another continuous problem is that of public relations. The entomologist, chemist, and other scientists must work with the farmer, house owner, and other individuals to prevent losses caused by insects. The scientists and their colleagues interested in this problem must be constantly on the job to keep the public aware of what can be done and when to do it if losses from destructive pests are to be kept to a minimum.

Charles E. Palm

Professor of entomology and head of department of entomology and limnology at Cornell University. Past vice president of American Association of Economic Entomologists; last president of AAEE in 1952 until amalgamation with Entomological Society of America in 1953; president, Entomological Society of America.

Biochemistry Shifts Its Emphasis

Q. *Dr. Elvehjem, what has stimulated such a great amount of recent progress in learning about sterols, enzymes, hormones, antibiotics, vitamins, and other complex compounds?*

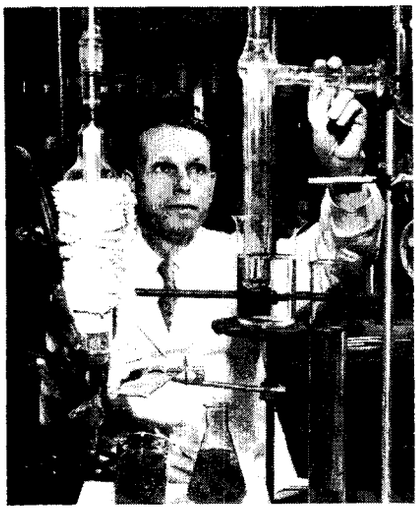
A. Much of the success was made possible by the development of new isolation and analytical procedures, particularly microtechniques. An important example is found in chromatography, where the application of microtechniques might be said to be responsible for separation of different forms of penicillin, separation of nucleic acids and their constituents, separation of organic acids, sugars, and amino acids. The use of isotopes has been so widespread that a choice of examples is difficult, but I might mention their use in clarifying the mechanism by which such complex molecules as cholesterol and hemoglobin are synthesized in the body.

Specifically, in which directions would you say the broadest significant effects are being felt?

Briefly we might mention vitamin B_{12} which is being used extensively in the treatment of pernicious anemia, cortisone which is being used in the treatment of arthritis and related conditions, the whole group of antibiotics which are being used not only in clinical therapy but in animal feeds in order to promote more efficient utilization of the feed. Crystalline enzymes and coenzymes are being used to elucidate the chemical reactions taking place in the living matter.

Much of the biochemical work is related to changes in complex natural compounds or effects producing changes. How is the problem of the changes as a part of life processes being attacked?

The greatest shift in emphasis has taken place in relation to metabolism and metabolic changes and this has indicated increasingly the similarity among all types of living matter, whether plant or animal. Where the biochemist formerly studied the intake and output of certain chemicals, he now studies changes taking place in tissues or microorganisms. Great advances have been made through the use of the Warburg respirometer.



Conrad A. Elvehjem

Professor of biochemistry, University of Wisconsin, chairman of the department and dean of the graduate school. Mead-Johnson Award, Appert Award, Osborne-Mendel Award, Willard Gibbs Medal, and Lasker Award. Research activities have involved biochemistry; animal nutrition; tissue metabolism; food composition; distribution of minor elements in foods; iron metabolism.

These studies have led to the recognition of enzymes in all living tissues and along with them coenzymes. Now we see a great interest in putting some enzyme systems back together, such as the cyclophorase system of enzymes or the enzyme systems found within the mitochondria.

Are you beginning to see connections?

Yes, through studies of interrelationships we are beginning to see that we no longer can make the best progress through separating fats, carbohydrates, proteins, and vitamins. Mineral elements are vital to many enzyme systems and vitamins are essential to basic functions. Niacin, for example, is intimately connected with tryptophan metabolism.

With respect to the control of infections, we recall studies of the sulfanilamides. They seemed to replace, with lethal effect, vital compounds of similar structure in the diet of bacteria. Where does this idea now stand?

That general idea has been developed as a result of studies of metabolism and we have come to recognize antimetabolites which are not only of interest in further studies, but may have therapeutic values. A recent example of interest is the use of folic acid antagonists in the treatment of acute leukemia in children.

Antibiotics May Meet Many Needs

Q. *Dr. Peterson, the $500 million antibiotics industry was made big business by developing mold strains and techniques which could produce commercially a product very valuable to humanity. How would you say that research in fermentation or microbiological techniques has continued to improve the contributions of this industry —and will it continue further?*

A. One of the most profitable efforts has been the production of high-yielding cultures by treatment of parent cultures with ultraviolet light, x-rays, nitrogen mustard, or other mutagenic agents. There is probably no culture in use today which is not superior to its parent culture. With penicillin, the original industrial cultures produced 25 to 50 units per milliliter; today 2000 to 3000 units are regular yields. This can be expected to continue to varying degrees.

Have antibiotics made other contributions of agricultural value comparable with that of vitamin B_{12} for animal feeding?

Yes. Addition of small amounts of antibiotics to rations results in faster growth, reduces greatly the mortality of young, and effects a small saving in feed consumption. A large proportion of mixed feed now is supplemented with antibiotics.

Are there products of this industry which are showing effectiveness in the control of plant diseases such as blights?

My plant pathology colleagues tell me there is great activity in this field. For example, streptomycin shows promise for the treatment of bean seeds to prevent a bacterial blight disease. Thioluin is being tested as a spray for the control of an apple fungus, and terramycin has given encouraging results as an inhibitor of tobacco ring spot virus. Actidione is a market product available for treatment of seeds carrying smut disease and for fungus infections of cherry trees, golf greens, and special turfs. There are many other promising antifungal antibiotics.

Food sterilization has been mentioned as a possible use for antibiotics. The U. S. Food and Drug Administration has declared that this will not be allowed. Is there a foreseeable possibility of finding antibiotics potent enough against bacteria, yet harmless to humans?

William H. Peterson

Professor of biochemistry, University of Wisconsin. Principal studies, nutrition of animals and microorganisms, fermentation, biochemistry of fungi, growth factors for bacteria. Specialist in production of penicillin and other antibiotics, nutrition of bacteria, and biochemistry of microorganisms.

No one can foresee all the possibilities of future research, but the weight of evidence is against the likelihood of finding such an antibiotic. Every antibiotic found to date has some objectionable features varying with the individual and the conditions of its use.

Are there any antibiotics showing promise against diseases which presently lie in the gaps in the spectrum of specific agents— hoof and mouth disease or rinderpest for example?

These are virus diseases. To date only the larger viruses (for example, psittacosis) have been found really susceptible to antibiotics. In spite of much effort, the search for antibiotics acting on viruses has yielded rather meager results. However, these efforts probably will continue, because of the great need for agents effective against viruses.

Would you suggest some of the most serious needs for research in antibiotics and microbiology?

Some serious needs are: A good antibiotic to combat certain bacterial infections, for example, by proteus- and pseudomas-type bacteria; antibiotics really useful in combating virus disease; constant uncovering of new antibiotics as bacteria develop resistance to the old. A better antibiotic than streptomycin for the treatment of tuberculosis would be desirable. A study should be made of the use of antibiotics in the control of insect pests. More information is needed on the biosynthesis and mode of action of antibiotics. Modification of the structure of toxic antibiotics to render them harmless to the host, and more knowledge of the structure of the many new noncommercial antibiotics are first class chemical problems.

Enzymology Involved in All Plant and Animal Growth

Q. *Dr. Copley, the importance of enzymes is constantly impressed on us with respect to life processes. We know they are important in fermentations and other reactions. What is the enzymologist's approach to improving food production and nutrition?*

A. Consider that the chemical transformations accompanying all phases of plant and animal growth from the zygote to the mature organism and even the deteriorative changes thereafter which result in decay are all largely controlled by enzymes. The enzymologist is attempting to learn more about those reactions which will be beneficial to us and also how to prevent or retard those which are not to our advantage.

Michael J. Copley

Director of the Western Regional Research Lab, USDA. Studies include molecular rays; dipole moments; magnetic moments; solubility; hydrogen bonds; physical properties of high molecular weight compounds; food chemistry. Associate member of the New York Academy.

What are specific applications of this work to food processing?

Important applications are made in prevention of deterioration of food through enzyme action. Heat has been the common method of inactivating enzymes, but often causes undesirable alterations in the flavor and texture of the processed product. The problem of maintenance of natural flavor in these foods has, at least in part, been solved by the application of enzyme chemistry. For instance, the processing of many types of foods, especially frozen and dehydrated fruits and fruit juices, now is monitored by enzyme assays to maintain a delicate balance between minimum heat-damage and maximum enzyme destruction.

We are aware of the work utilizing papain for meat tenderization. There must be other similar accomplishments.

Research on enzymes has made possible improvements in bread quality, cheese making, clarification of fruit juices, and the prevention of jelling in frozen citrus juice concentrates. Dried eggs which have excellent keeping quality are now being produced through the use of glucose oxidase, which removes the glucose responsible for the development of darkening and off-flavor in stored dried eggs.

Photosynthesis is the subject of intensive study just now. Are there any connections between that problem and enzymology?

The basic process of conversion of sunlight, water, carbon dioxide, and minerals to useful energy materials, wondrous as it is, is incredibly inefficient. Recent researches on the path of carbon in this process imply a host of reactions whose enzymes have not even been suspected until now. Future advances toward the mastery of the process certainly do depend on understanding of these enzyme systems. As for the development tomorrow of apparatus to tap solar energy through photosynthetic chemical reactions, I think that is a bit premature; but for the more distant future, I would hazard an opinion that it is a real possibility.

What about some other fundamental problems of interest to enzymologists at present – plant hormones for instance?

Our understanding of the action of plant hormones today is still rather obscure. However, on one point most investigators seem to agree and that is that the effects of plant hormones are mediated through enzymes. Some other problems of interest to us today are: What makes fruit ripen; what is the mechanism which causes dormant seeds to become active at the proper time? Where does ethylene come from in fruits? What does it have to do with ripening? Nitrogen fixation surely is mediated by enzymes, but how? How is cellulose formed? Pectin? Protein? Can isolated enzymes which catalyze such amazingly intricate and specific reactions within the plant be employed in *in vitro* synthesis, as, for instance, in the manufacture of drugs?

More Science Applied To Fermentation

Q. *Dr. Joslyn, fermentation as a means of food preservation is as old as drying or salting. Is the process likely to be replaced by newer methods?*

A. It is difficult to visualize entirely new methods, but certainly we can look forward to considerable improvement in present methods. In old methods, preservation was achieved by controlled aeration of the more readily decomposable carbohydrate constituents into substances such as alcohol, lactic acid, or acetic acid, which had preservative value. Now we know how to obtain fermented products of greater stability with less alteration in desirable constituents.

Would you give some examples?

Yes. Knowledge of the nutrients required for the growth and activity of microorganisms can be applied to deplete the fermentation medium and thus render it inert by biological control of fermentation. Also, it is possible to select microorganisms or conduct fermentation under conditions such that antibiotics are excreted into the medium. Both of these processes may be adapted to improving the stability of wines, pickles, and vinegars.

Maynard A. Joslyn

Division of food technology, University of California. Studies include food chemistry; fruit juice technology; preservation freezing of fruit and vegetable products; wine technology; pickles; industrial microbiology; enzyme chemistry; microbial metabolism; autoxidation; fruit and vegetable dehydration and canning.

Is the "art" of wine making being changed to a science?

It is becoming more closely controlled through the use of selective yeast cultures, temperature control, and sulfiting. In the California wine industry, for example, we are moving constantly toward improvement through better selection of the most suitable yeast, control of fermentation by control of temperature and extent of aeration, control of undesirable microorganisms, and the establishment of the relation of the fermentation process materials to the raw materials. But the industry's major problem still remains the production of a more stable product of better quality. We work at that constantly.

Industrial fermentation goes beyond food preservation. What raw materials from the agricultural industry could be utilized better through application of fermentation processes?

As yet, though much work has been done, there is no satisfactory method for utilizing waste cores, peels, and liquors from most fruit and vegetable processing plants. A recent revision of FDA regulations permits for the first time the production of "cider" vinegar from the cores and peels of apples. Thousands of tons of such waste have been unused each year. A method for the microbiological fermentation of fiber waste by which lignin could be fermented directly would have great practical significance.

Are you optimistic about possibilities of microbiologically produced protein for food?

To date no palatable, acceptable food or feed yeast has been produced. The efforts to make a desirable food yeast from agricultural and wood wastes might be more successful, if present research shows what constituents in food yeast are undesirable and how these constituents are synthesized during the growing of the yeast.

Another conceivable possibility is the upgrading of nonedibile, photosynthesized algol carbohydrates and protein into food for humans—microbiological agents could convert these materials into suitable food for fish, which would then be edible protein for humans. Still another possibility is the conversion of sewage to high protein feed.

Can the progress of the wine industry be translated to other fermentation processes?

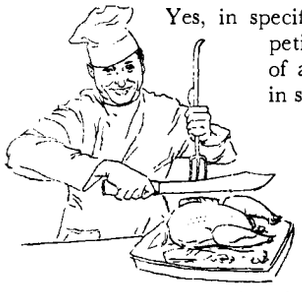
In many cases the fundamental knowledge is useful in all fermentation processes and, inasmuch as alcoholic fermentation represents by far the largest of these, others look to it for a large part of the research in the field. There is a serious problem in this connection. The alcoholic beverage industry is so closely restricted by Bureau of Internal Revenue regulations that it is difficult to introduce technical processes which are contrary to traditional and long-used methods. As a result, advancement is hampered and curtailed. While regulation is necessary in such an industry, the regulations should be more flexible to allow broadest and most advantageous use of fermentation technology.

Nutritional Advances Combat Disease

Q. *Dr. Darby, the American public is eating more than ever before, but still we hear much comment about dietary imbalance. What indications are there of positive progress in nutrition?*

A. There is a great deal of evidence to show such progress; an example is the virtual disappearance of pellagra from the southern regions where it was in evidence some years ago. In my state of Tennessee, the recorded death rate from pellagra decreased from 23.1 per 100,000 in 1927 to 3.1 in 1943. Further decreases have occurred since that time. Rickets, another dietary disease, has shown an equally striking decline in morbidity rate. Endemic goiter and sequelae are much less prevalent in many sections of the country today than formerly.

Is there evidence of loss of appetite, as well as other effects, with our highly processed diet? Do you think that there is such a thing as an "overprocessed diet"?



Yes, in specific instances, loss of appetite could occur as a result of a diet rendered deficient in some essential ingredients —say thiamine— through overprocessing. The necessity of current emphasis upon overeating and obesity indicates that this has not reduced the appetite of a considerable segment of our population. The ill effects from overprocessed diet are illustrated by the problem of beri-beri in underdeveloped areas consuming polished rice. The variety of foods available in this country afford protection, but responsible food processors and nutrition workers are alert to the need for maintaining the nutritional quality of our food supply.

William J. Darby

Professor of biochemistry and director, division of nutrition, School of Medicine, Vanderbilt University. Member of Council on Foods and Nutrition, American Medical Association. Committee on Food Protection, Food and Nutrition Board, National Research Council. Consultant, World Health Organization. Mead-Johnson Award.

What is the trend of thinking about the importance of trace elements, such as cobalt, zinc, and manganese?

Many of these elements have been demonstrated to be essential for lower animals. Indirectly they are of importance in human nutrition. Some trace elements are known to be beneficial to man—iodine and fluorine, for example. Others, such as copper and zinc, are probably of importance to man in that they play a role in normal metabolism. The occurrence of dietary deficiency of most of these trace elements in man has been only speculated upon thus far—a notable exception is iodine. Nutritionists will be keenly interested in trace elements in the next few years.

What problems in your field, if solved, might bring the greatest benefits during the next quarter-century?

Some of the most important appear to me to be:

(1) A clear understanding of the etiological role of nutrition as related to diseases of the latter half of life, particularly cardio-vascular diseases.

(2) The clarification of the role in human nutrition of a number of nutrients now recognized as essential for some species of animals but not clearly dietary essentials for man. These include hemopoietic vitamins, vitamin B_{12}, pteroylglutamates, biotin, pantothenic acid, pyridoxine, protogen, tocopherol, many trace elements, and other incompletely understood nutrients.

(3) Elucidation of specific nutrients concerned with the development of Kwashiorkor, cirrhosis of the liver, and the whole spectrum of diseases of protein malnutrition.

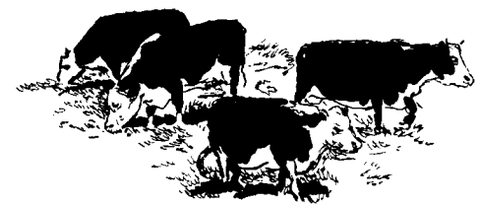
Obviously basic research is needed. Do you see room for improvements in the approach to this matter?

Yes. Basic research in human nutrition must receive continuing support but without regimentation. Under the project type of support it is difficult to maintain basic exploratory programs. Some more satisfactory system must be evolved for supporting fundamental investigative activities.

New Feeds Aid Animal Products Processors

Q. *Dr. Kraybill, what effects of scientific farming are most conspicuous in the meat industry?*

A. Improved methods of breeding and feeding have increased markedly the efficiency of producing broiler poultry. High nutrient content rations, with liberal amounts of high quality proteins, vitamins, minerals, and fats, have made it possible to reduce the cost of poultry meat production and made it more competitive with beef and pork. The use of antibiotics and, more recently, the use of



stabilized tallows and greases to increase the fat content have been shown to increase the feed efficiency. In the dairy industry artificial insemination has improved the dairy herds and resulted in a widespread increase in production. Hybridization in swine has increased the efficiency of pork production.

Recently there has been a large amount of information concerning the development of new and improved types of animal fats. Would you brief us on these improvements?

Processes, including transesterification, have been developed for the production from meat fats of bland shortenings which have stability and performance comparable to the best hydrogenated vegetable shortenings. The great disadvantage of animal fats compared to the vegetable shortenings was the development of rancidity in the former. Extensive long-term studies to demonstrate nontoxicity eventually resulted in the first approval of antioxidants for use in foods. The antioxidant butylated hydroxyanisole is unique in that it not

H. R. Kraybill

Director of research and education, American Meat Institute Foundation; professorial lecturer, department of biochemistry, University of Chicago. Studies include nutritive value of animal protein concentrates; dehydration of meat; spectral analysis of fats. Past president of Association of Official Agricultural Chemists and of Association of American Feed Control Officials.

only retards rancidity in the stored fat but also carries over into the foods prepared from the fat and retards their development of rancidity. This made it possible to produce meat fats with stabilities comparable to vegetable shortenings. It is estimated that at least 50% of the federally inspected lard is now treated with antioxidant. An important economic effect of these developments could be a greater interchangeability of vegetable oils and meat fats in shortening manufacture in the future.

The solution of the problem of food supply for our increased population could be advanced greatly by better methods of food and preservation. We have heard of the possibilities of irradiation sterilization, what are other leading developments along this line in the meat industry?

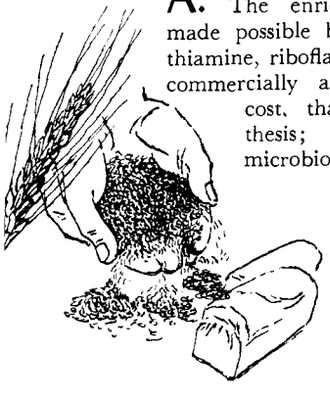
The development of nitrite and mixed nitrite curing methods have made it possible to shorten the time necessary to cure meats. Also the machines for artery pumping and injection of curing ingredients into the meat have made it possible to shorten the time of curing while yielding more uniform products of superior quality.

What is your opinion on high-temperature short-time heating for sterilization?

Processes such as high frequency dielectric type heating and mechanical means of obtaining high-temperature short-time sterilization all offer promise of producing more highly acceptable and nutritious canned foods. In the case of solid products, such as luncheon meat or whole boned hams, the dielectric type heating seems to offer the most promise. Laboratory tests have shown that these solid meat products can be heated to sterilizing temperatures with the dielectric heating techniques.

Cereal Chemists Guard Nutrition

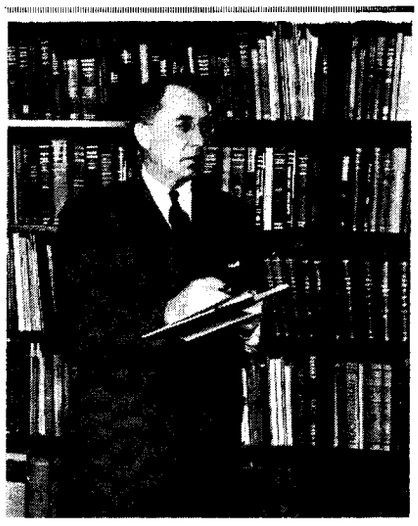
Q. ***Dr. Geddes, the enrichment of flour and bread has become almost a nationwide practice in the U. S. What research developments made it possible to put these nutritional factors into flour?***



A. The enrichment program was made possible by two developments—thiamine, riboflavin, and niacin became commercially available at reasonable cost, thanks to chemical synthesis; reliable chemical and microbiological methods of vitamin assay were developed which made it possible to carry out extensive surveys of the B vitamin levels of the cereal grains and their products.

Although enrichment is not compulsory in many states, it has been supported by industry and now it is estimated that about three-fourths or more of the total output of white flour and bread is enriched.

Enriched flour has markedly decreased the serious and widespread deficiencies which existed in the American diet in regard to intake of thiamine, riboflavin, nicotinic acid, and iron. The value of enrichment with B vitamins is shown by the decrease in B vitamin deficiencies in recent years whereas there has been no proportionate reduction in deficiency of vitamin C.



William F. Geddes

Head, department of agricultural biochemistry at the University of Minnesota, St. Paul. Professional career devoted to teaching and research in biochemistry with major emphasis on cereal chemistry and technology. Past president of American Association of Cereal Chemists; recipient of Coronation Medal and Osborne Medal.

Is there any interest in the addition of other substances to increase the nutritive value of bread?

Yes. The introduction of vitamin D into enriched bread is receiving attention. The proteins of white flour, white rice, and corn meal are deficient in certain amino acids, particularly lysine, and some nutritionists urge the addition of specific amino acids, which are commerically available, to improve nutritive value. Others seriously question the need for these additions, since the cereals are normally cooked, or consumed, with milk which supplements their amino acids to give a substantial improvement in protein nutrition.

How extensively is milk employed in commercial breadmaking and does its use create any special problems?

In 1950, baker's white bread made in the United States contained an average of 4.1 pounds of milk solids per 100 pounds of flour. Research has established that the deleterious effects of "raw" skim milk in producing soft doughs, which yield bread of poor volume and texture, can be overcome by appropriate heat treatment of the skim milk before drying. Now the use of pre-tested milk solids permits the inclusion of larger quantities in breadmaking than would be possible otherwise.

After discovery that the use of nitrogen trichloride as a maturing agent produced flour which was shown experimentally to cause fits in dogs, the milling industry voluntarily stopped its use. Despite absence of evidence of harm to humans, use of nitrogen trichloride in flour was prohibited after August 1, 1948. What substitutes are proving most satisfactory?

Chlorine dioxide was included in the flour Standards and the use of small quantities of potassium bromate was permitted in flour regardless of its protein content. These reagents have proved very satisfactory.

Sanitary requirements are high in foods. Does the cereal processor have his sanitation problems well under control?

Wheat millers are responsible for producing flour which will meet the sanitary requirements of state and federal governments. However, at present there is no state or federal inspection for the extent of insect infestation in the wheat the miller buys. Additional research is needed on the control of infestation in stored grain, including the development of rapid practical tests for routine inspection, particularly for detecting the extent of infestation within the kernel. X-ray and ultrasonic methods for detecting internal infestation are now under investigation.

All available scientific skill is needed to produce cereal varieties with the necessary agronomic properties, as well as desirable processing and other quality characteristics. What problem is greatest there?

A serious emergency exists because of the recent increase in certain physiologic strains of wheat stem rust, notably 15B. None of the present commercial wheat varieties is resistant to this strain and serious rust epidemics and crop failures could occur under appropriate conditions.

Are any new major technical developments in sight in the baking industry?

Yes. Work on the development of an automatic-flow, continuous breadmaking process gives promise of revolutionizing breadmaking in large commercial shops.

Freeze or Dry

Q. *Dr. Tressler, the preparation of food is a basic operation. Many processes of preserving perishable foods have been perfected and by changes of techniques such as freezing and by changes of form have made it more attractive and salable, but have basic improvements been made through scientific advances?*

A. Yes, real advances have been made. One of the most notable recently has been in the low temperature concentration of juices and other perishable liquid foods using high vacuum–low temperature dehydration. Another important new technique is the recovery, concentration, and return of volatile flavors formerly lost during concentration. Through these developments it is possible now to produce greatly improved juice concentrates, liquid, frozen, or dehydrated, as well as other excellent dehydrated foods which never before have been of satisfactory quality.

Refrigeration has brought about great steps in better food storage, but it is an added cost. What progress has been made in increasing storage life by means other than refrigeration?

Some of the most significant results have been achieved in that field. Means have been perfected, particularly through in-package desiccation, for reducing moisture content of foods to 1% or less. This reduces deterioration remarkably. In addition, it has been found possible to lock volatile flavors in sorbitol, as well as some other water-soluble edible products, and thus prevent the loss of quality of many foods. These accomplishments have made possible the production of concentrated and dehydrated foods having greatly improved acceptability as well as nutritive values which are retained well in storage at high temperatures.

Are you including milk in that group?

No. But I might say that the armed forces would benefit greatly if we could find a method of producing canned concentrated or dry whole milk which, when reconstituted after a year's storage at 90° F., would taste like fresh milk. Another much needed step is a method for producing frozen concentrated milk which would retain its quality for a year at 0° F.

But aren't there other foods which are in a similar position of need?

Yes, meat and bread. Great benefits would come from a canning process by which meat could be preserved for a year at 90° F. without loss of the flavor and texture of freshly cooked meat; also we need a bread which could stand storage a year at 70° F. without loss of fresh flavor.

Speaking of canning, what is your opinion on cold sterilization?

A method of cold sterilization which would also inactivate the enzymes of perishable foods would revolutionize food preservation and certainly is worth a great amount of concentrated research effort.

Donald K. Tressler

Scientific director, Quartermaster Food and Container Institute for the Armed Forces. Principal interests are freezing of foods, manufacture of fruit juices and wines, fishery by-products, and the nutritive value of fruits and vegetables. Councilor, Institute of Food Technologists.

Canners Seek Better Sterilization

Q. *Dr. Cameron, what particular technical advance is now bringing about improvements in canning technology?*

A. The most significant progress recently has come through high (temperature)-short (time) sterilization methods which are spreading rapidly. They give better quality of flavor and color as well as greater retention of thermolabile nutrient factors.

What techniques make possible "high-short" methods?

Established methods are based on agitation by continuous rotation and by presterilization followed by aseptic filling. Promising methods now in semiplant scale employ end-over-end rotation and presterilization followed by canning in a pressurized chamber. I predict great advances in the use of presterilization methods in the next few years.

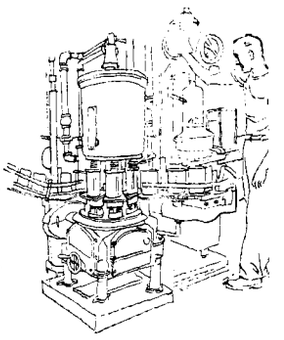
What about sensitivity to and speed of application of scientific results in the industry?

Strikingly improved. For example, proof of suitability for a new insecticide now is followed quickly by application, whereas a few years ago adoption lagged badly. Harvesting methods are improved every year.

What problem might yield to research in the future with broadest beneficial results?

I think that one or more satisfactory methods of heatless sterilization may come into use. This possibility must be balanced against that of improved efficiency in the use of heat.

But hasn't "cold sterilization" already come? We have heard very favorably of the use of irradiation.



Certainly irradiation is the most promising answer in view today. The use of cathode and gamma rays has shown long range promise. But availability of radiations, penetration, and prevention of abnormalities in nutritive and organoleptic qualities are the biggest among many stumbling blocks yet to be overcome satisfactorily.

What about sterilization with antibiotics?

Two years ago one of these was heralded as the answer and it showed promise, but not enough; although it failed to pass critical tests for safety and effectiveness, it has encouraged further exploration. To be acceptable, an antibiotic must be capable of controlling all organisms of importance to canning and must destroy the spores of *Clostridium botulinum*. And it must be innocuous from a public health standpoint. I doubt that antibiotics will be useful to the canning industry in the foreseeable future, despite their theoretical attractiveness as sterilizing agents.

Edwin J. Cameron

Director of Washington, D. C., Research Laboratory, National Canners Association. Has studied particularly classification and sources of thermophilic bacteria; food poisoning bacteria; causes of spoilage in canned foods; sanitation. Past president of Society of American Bacteriologists; past vice president of the Institute of Food Technologists.

Supersonics have created a stir from time to time. Is this a likely answer?

This has been studied sporadically during the past 25 years. While it is recognized that vibrations may destroy certain vegetative cells, nothing has come to light suggestive that bacterial spores which must be destroyed in the canning process would be affected. While no comprehensive canning studies have employed supersonics, I believe it unlikely that usefulness will be demonstrated within a predictable time.

Plastics Aid Packagers

Q. *Dr. Southwick, certainly plastics were responsible for many advances in packaging. What developments lead the field today?*

A. Polyethylene is possibly the most important, as a film and as a coating for paper, metal foil, and other bases, as well

as the well-known squeeze bottle. A new industry has grown up using the extrusion techniques to apply the resin in a fused form to a variety of bases, eliminating the use of solvents. These materials find many applications in the packaging of food, where chemical inertness, heat sealability, moistureproofness, and freedom from odor and taste are necessary prerequisites.

C. A. Southwick, Jr.

Director of research, H. P. Smith Paper Co. Entire professional career has been in development and technical service for the packaging field, as director and consultant of research. Member, Technical Association of Pulp and Paper Industry; package material testing committee; subcommittee on test methods, Advisory Board to Quartermaster Research and Development, National Research Council. Certificate of appreciation by Office of Quartermaster General and Economic Cooperation Administration.

Flexible, gas- and liquid-tight packages have made rapid strides in recent years because of the improvement in precision and speed of package forming and filling machines, as well as the development of combinations of materials with better sealing properties.

Is metal being left behind?

By no means. For example, another expanding development is the use of metal cans carrying an inert gas under pressure. An outstanding illustration is seen in packaging whipping cream. This package is relatively expensive since it is based on a heavy metal can plus plastic parts as the dispensing means. Also, the small lithographed metal can has entered the frozen food field for the packaging of concentrated fruit juice of many kinds. This food is extremely sensitive to oxidation and the hermetic metal can is necessary for long storage. Also, the metal can is ideal for rapid freezing and it makes a convenient and accurate measure when the user reconstitutes the concentrate with water.

One of our most pressing problems is tin. The world's supplies of tin are relatively limited and we have no domestic source. Meanwhile, we are consuming very large quantities because of the dependence of our economy upon the preservation and handling of foods in tin-coated steel cans.

What is being done about the tin problem?

Some research is based on the idea that a metal other than steel, for example, aluminum, could be fabricated with certain synthetic resins to make a hermetic processable can. To date, there have been no tin-free commercial cans suitable for general processing uses. This problem is difficult because of the need for soldering or welding and yet maintaining a continuity of coating which must be resistant to a wet product over long storage as well as at the temperatures of the processing cycle. This problem may be solved by a combination of steel treatments and metals other than tin with supplementary coatings of ceramics or resins. A flexible type package, that is, of paper, aluminum foil, and resins could be satisfactory for certain classes of products. Such a package could be filled hot and not given subsequent processing treatment. Development of a low-cost, flexible package capable of being packed at temperatures in excess of 200° F. will require resins other than those available today, but it is not too optimistic to think such a construction will be possible within a reasonable time.

New Equipment Cuts Costs

Q. *Mr. Ingerson, the Department of Agriculture estimates that crop and animal pests are responsible for an annual loss of $12 billion. To what extent is agricultural spraying and dusting equipment contributing to reducing that loss?*

A. Losses caused by pests are being cut by 75 to 95% where there is proper and timely use of sprayers and dusters to apply the recommended chemicals. These savings usually can be made at a cost of less than 10% of the increased crop value.

Use of new spraying and dusting equipment has resulted also in surprising savings in labor costs. A typical example comes from the apple orchards, where two sprayers, two tractors, and six men took four to five days to spray 100 acres in the 1930's. Now, one man with one tractor and one sprayer does the same job in two days. The same comparison applies to spraying potatoes, tomatoes, corn, and other large acreages of food crops.

That is an impressive improvement. What, would you say, is the development responsible for this increased efficiency?

The development of new types of automatic power spraying equipment with larger individual sprayers and dusters capable of moving continuously through the orchard instead of stopping at each tree as was formerly necessary. Modern mechanical means of refilling the sprayer has also added to the daily capacity.

Are spraying and dusting from airplanes adding something more than speed and volume?

The use of airplanes for spraying and dusting has served to introduce the practices into new areas and to meet special emergency conditions such as insect outbreaks in forest areas not accessible to ground equipment.

How can spraying and dusting equipment continue to increase yields and labor savings?

Mostly by adaptation to control of many pests not now controlled by spraying and dusting, such as grasshoppers. Adaptations to control of weeds will increase crop yields, and adaptations to chemical brush control will add thousands of acres of now-uncultivated land to our productive use.

What are the new trends in development and use of sprayers and dusters?

Two new developments are having an important bearing on food production. The trend in equipment for larger commercial sprayers and dusters is toward use of air as the carrier of liquid spray chemicals, instead of depending on the volume and weight of the spray material to carry into and through the plants or trees being protected. This will allow reductions in the total amount of chemicals required per acre of crop and per unit of harvested crop. Breaking of the spray droplets into a very fine mist avoids "runoff" of spray material. Runoff has accounted for as much as 10 to 20% of the spray chemicals applied by the older methods.

Howard G. Ingerson

Sales manager of John Bean Division of Food Machinery and Chemical Corp. since 1928. Graduate in horticulture from Pennsylvania State College. Formerly with Bureau of Entomology, USDA. Closely associated with research and engineering developments.

Considering other mechanical developments how would you sum up the most important general postwar trend in the use of agricultural machinery?

I rate the replacement of work animals with tractor power on farms of all sizes as the most important trend. The number of farm tractors increased from less than two million in 1940 to more than four million in 1952, according to USDA records. This has released from use for animal feed production millions of acres for production of food for human consumption. The same trend is bringing increases in yields by more timely preparation of seed beds, cultivation, spraying or dusting application of fertilizers, and harvesting and storing of crops.

TECHNICAL SECTION

Agricultural and Food Chemistry

- Nutrition
- Food Processing
- Fermentation
- Pesticides
- Plant Foods and Regulators

Herbicide Symposium Reviews Chemical Weed Control

• Weeds cost the nation at least $5 billion last year. Much of this might have been avoided by application of existing knowledge and technique. What clearer indication is there of the need for dissemination and utilization of information on herbicides? The herbicide symposium which begins in this issue should help by summing up current knowledge and pointing the way ahead. Minarik and Norman summarize in an introductory article. Barrons emphasizes the great number of factors to be kept in mind in choosing methods of application: physical properties, possible formulations, plant absorption, translocation, plant response, toxicology, and many others. • More fundamental knowledge of plant biochemistry is needed in studying the mode of action of herbicides, we are told by Freed. On the basis of present knowledge, he examines the action of sodium chlorate, arsenic, phenols, oils, substituted ureas, aryl carbamates, and aryloxy derivatives. • Crafts tells us that absorption of herbicides, using 2,4-D as an example, is rapid and that it migrates to vascular tissues, translocating through the stem and into the roots. On the basis of these results of radioactive tracer studies of absorption and translocation, ideas are advanced on requirements for control of weeds and brush.

Plant Food Techniques Are Improving

• Leaching of magnesium from soils is affected by incorporation of serpentine, olivine, magnesite, dolomite, and limestone. The variations in effect are described by MacIntire, Shaw, and Young. • Practical benefits are foreseen from studies of correlation of the citric solubility and glass content of serpentine-fused phosphates by Tah-Ho Huang. • The usefulness of radiocalcium in evaluating liming materials is demonstrated by Smith, Blume, and Whittaker, who have developed a more direct method than was previously available for evaluating limestones and slags.

Healthful Nutrition Calls for Balance of Protein

• Protein imbalance brought on by insufficient or poor quality diet is characterized by a shift in distribution of blood and tissue proteins, according to author Allison. His research shows that nitrogen balance is an integration of gains and losses from different tissues. It is a function of many variables such as dietary proteins, protein stores, and endocrine balance. • The types and amounts of phosphorus compounds present in cottonseed have an important bearing on the nutritive value of cottonseed products for animals. Researchers Stansbury, Pons, and Hoffpauir have been delving into the cottonseed kernels. They have come up with some interesting data and correlations on the influence of variety and environment on P in the kernels.

Food Processing Has Odor, Heat, and Isolation Problems

• If you're having trouble with the transfer of odors among stored foods, try activated carbon. That's the suggestion of Turk, Messer, and Blaskiewicz, whose panels found no significant taste differences between food stored with carbon in the presence of an odor source and equivalent food stored alone. • Heat is bad for protein, at least in cottonseed, where Sure and coworkers found inverse variation of protein efficiency with the amount of heat applied. Better cottonseed products—from a nutritional point of view—might come from the ideas presented. • Sugar is not the only chemical product one can get from cane. Kowkabany, Binkley, and Wolfrom have isolated some of the amino acids which hinder recovery of simple sugars.

Fermentation and Its Products Have Much to Offer

• There are many good and useful products to be got from yeast, and Laufer, Schwarz, and Stewart know how to get them—nucleic acid for example. • In making alcohol it is important to select the right mold strain, but also the medium of culture is worth considering. Pool and Underkofler have examined the benefits which may come from certain choices.