Proceedings

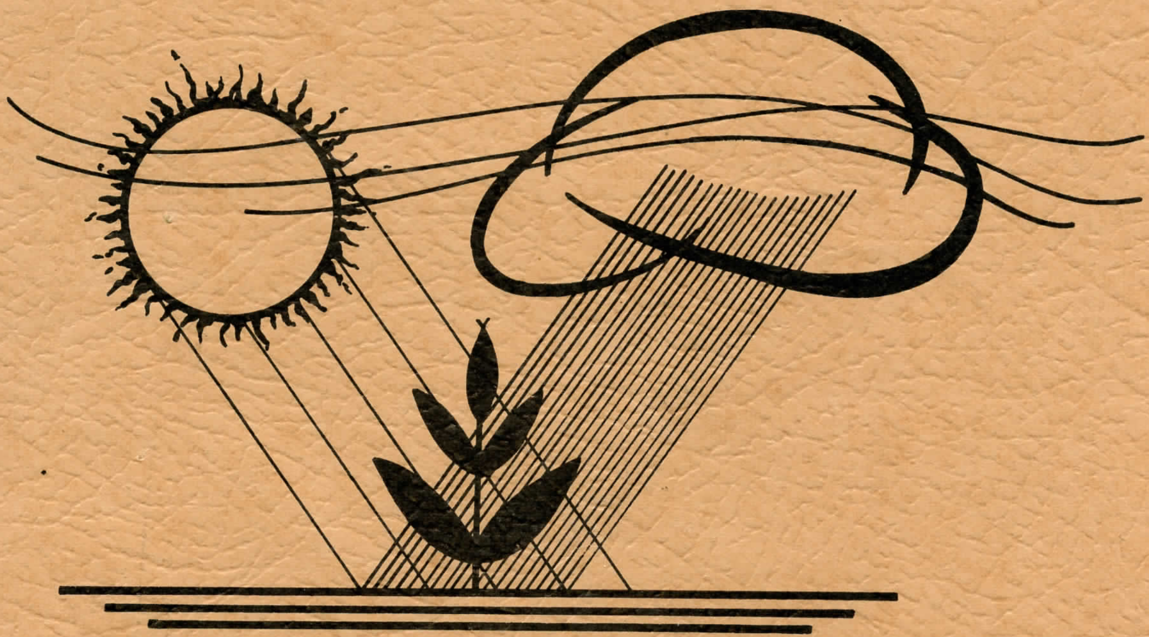
First Annual

CALIFORNIA PLANT and SOIL CONFERENCE

Sponsored by the

CALIFORNIA CHAPTER - A. S. A.

Sacramento, California
January 11, 12, 13, 1972



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AMERICAN SOCIETY OF AGRONOMY

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CONFERENCE REPORTS

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WELCOME AND GREETINGS TO CONFERENCE PARTICIPANTS

D. S. Mikkelsen
President, California Chapter ASA

It is a pleasure for me to open this first annual meeting of the California Chapter of the American Society of Agronomy. I want to extend you a cordial welcome on behalf of the Organizing Committee, who have worked to strengthen our professional ties and to improve our communication with the general public.

During the past decade we have all witnessed the declining image of agriculture. Many among our general public have been convinced that the world is on the brink of catastrophe unless we renounce the use of fertilizers, pesticides, and many of our agricultural practices and go back to what is referred to as "the natural way".

Many among the general public have been led to believe that science and technology are entirely responsible for our problems today. Ecologists often view farmers and agricultural scientists as interested only in profits, with no concern about the environment and human health.

Other criticisms, well known to us, are that agricultural research leads to increased production and to further embarassing increases in food surpluses, which add to government costs and increased taxes.

This critique is based on the concept of agriculture and research that the main objective is the growing of 2 blades of grass where only 1 grew before; that farmers are exploitive and have a "devil-may-care" attitude about the soil, the water, the air. Admittedly there have been, and are, abuses in the agricultural section. We need and want to avoid these, but few people outside of agriculture want to believe this. They fail to recognize that agriculturists were among the first to be concerned about preserving or improving the environment and have developed virtually all of the research information we have about the natural environment in which we live. Agronomists are also concerned with such matters as quality improvements, nutrient value, improved consumer products, and inherited resistance to diseases and pests. They are concerned with stabilizing and lowering the costs of food production, have emphasized intensive production practices on a relatively few acres, in contrast to the mismanagement of extensive land areas. They have rationalized marketing, improved the standard of living for the urban as well as the rural community, developed labor-saving devices and labor-reducing techniques, providing a surplus from agriculture beyond our need for food, which could be diverted into industrial products--and in general, contributing to man's intellectual and cultural development.

Many of the adverse attitudes about agriculture have developed because we in agriculture have been quietly going about our business of efficient production without attempting to tell our story, to correct misinformation, or to challenge sensational stories.

There has also been an unfortunate tendency among research people to regard the final product of his work as a paper published in a scientific journal, probably limited in circulation and reaching only a few other scientists. We have sometimes failed to broadly recognize that the objectives and concern of all agricultural scientists should be that research results, properly assessed and interpreted from an economic and social aspect, should be made available in the shortest possible time not only to farmers but the city dweller, too, and to the processor, the factory, to state and national planning groups, and all those concerned.

With an awareness of this communication gap and the need for society to benefit from a thorough, accurate understanding of the facts, both favorable and unfavorable, a group of concerned agronomists met last April to determine how we as a professional group could respond. With your encouragement, a California Chapter of the ASA was formed. Today we are beginning a course which we hope will correct as best we can some of the deficiencies of the past.

Our objectives are essentially the same as those of our national parent organization: 1) to promote effective research; 2) to disseminate scientific information; 3) to foster high standards of education and to maintain high standards of ethics; 4) to promote advancements in the profession; and 5) to cooperate with all organizations having similar objectives.

Today we hope to launch a new era of understanding among California agriculturists and producers, processors, agricultural service industries, educators, and the consumer--the general public. Our progress to date is due to the unstinting efforts of a few of your colleagues who have served your interests in organizing this Chapter. A number have made contributions and you will hear and see many of them today. Even though giving credit invariably leads to omissions, I do want to recognize the efforts of the organizing committee in arranging this program and in drawing up the Constitution and By-Laws of the California Chapter. For their contributions, may I thank the following:

Iver Johnson	P. F. Pratt
M. H. McVickar	H. M. Barron
O. A. Lorenz	Don Smith
M. D. Miller	J. W. Biggar
R. B. Bahme	L. E. Whittsell

G. R. Hawkes, Secretary and Treasurer

We appreciate the support of each one of you here today. The assistance we have obtained from ASA President J. Ritchie Cowan and Vice President Matthias Stelly has been most valuable, and we greatly appreciate their presence here today.

This is the first of what we hope will be a long and successful series of Annual Meetings of the California Chapter of the American Society of Agronomy. It is our hope that these meetings will be helpful, in a collective way, to further the acquisition and dissemination of scientific knowledge concerning the nature, use, improvement, and interrelationships of plants, soils, and our environment.

LOOKING OVER THE HORIZON

J. Ritchie Cowan*
President, American Society of Agronomy

Today great changes are taking place in our ways of life all over the world. They are almost certainly the most sudden and widespread and dramatic changes that have occurred in any generation of mankind. A 100 year old man today will have lived through the coming of the telephone, the electric light, the automobile, the airplane, the motion picture, the radio, as well as television, nylon, atomic age, space travel, man landing on the moon, oral contraceptives and principles of social organization such as communism and pay-as-you-go income tax.

These changes are not merely technological and social changes. In a broad sense they are also biological. For one thing, they grow out of man's biology. Our greatest achievements in science or in large-scale social organization are shaped by biological demands and emotions. They depend on our curiosity, speech and reasoning, and on our ability or inability to teach, to learn, to plan, and to work together with other men. At the same time these new developments also change man's biology, for they affect his foods, drugs, his houses and habits, his health and diseases, his population pressures and wars and his inter-relations with the rest of mankind and with all of the rest of the biological world of plants and animals which he multiplies or destroys. Perhaps what we are seeing is a modern counterpart of the prehistoric invention of tools, fire, and speech which occurred it is estimated something like 2 million years ago.

These new technical developments almost necessarily force all mankind to communicate and interact more and more strongly and to become more closely knit together as a society whether we like it or not. This is producing great new problems as well as new national and international stresses. These stresses could annihilate us. But if we have the sense and the will to solve these problems and to learn how to survive together over the next few years it seems almost inevitable that we will move toward some entirely new form of human organization and interaction around the world. Thus the next few years could be very critical.

In examining the areas of recent technical change, we fine that two features are very prominent. The first is the fact that changes today have taken us far beyond the ways of earlier societies. The second is the problem of estimating how much farther or how short a distance they may take us in generations ahead. The changes from the past have truly been enormous. Things are not merely two or three times faster or more powerful than before, but they are changed by many "orders of magnitude", that is, by many "in powers of ten" so that they go hundreds, or thousands, or millions of times beyond the ways of previous centuries.

*Head, Agronomic Crop Science Department, Oregon State University

We are used to the assumption that the rate of change is increasing in such a manner that it may go on forever. This may be true in some fields like basic science, biology, and intellectual creation where there seems to be no physical limits to our growing knowledge. But in the more technological areas when we discover the finiteness of the speed of light, or conversely the almost infinite supply of nuclear energy, we adapt our technology to these facts and the adaptation may be almost complete within our generation. We have been changing rapidly because we have been passing through an intense and stormy adolescence and the times may become much calmer as we move toward the structural limits that will determine our future state.

It is not generally realized and recognized that in this century we have essentially reached the end of the era of evolution of plants and animals by natural selection. It is an era which has lasted for some supposedly 3 billion years during which all forms of life on earth have proliferated. However, today evolution by natural selection is giving way to evolution by human selection. The population of many species on the globe is increasingly determined, accidentally or intentionally, by human breeding, protection, predation, or pollution. We are continually breeding new types of food plants and animals and even new types of fungi to make penicillin and other drugs. Undoubtedly the speciation of plants and animals will continue and the varieties may even become more varied and numerous than in the past.

During the current century remarkable strides have been made by medicine. As a result, a marvelous control of disease has been effected which has decreased our death rates at far greater rate than the reduction of birth rate. As a result, world population has now shot up to more than 3 billion people and the doubling time is now expected to be within the next 30 or 40 years. It is estimated that at the present rate of population increase there will be a net gain of four every second by the year 2000. Brazil had a population of approximately 80 million in 1965; it is now at 100 million. It is anticipated that it will be 300 million by 2000. This illustrates the fantastic population increase that is taking place around the world. We hear and read much about this today but it bears emphasizing on this occasion.

We must concern ourselves about this philosophy and factual information of the current situation as we see it today. Agriculture is the basis of survival. It provides the food and fiber which in turn nourish and clothe the body and provide shelter. Thus if we are to take a realistic look at what we might anticipate during the balance of this century we must recognize the role which technology has played and its future social impact. At the beginning of the 20th century, farming was primarily a way of life. Today it must be considered a business. About half of the total land area in the 50 states of the United States is devoted to farming. Food for all of us starts with approximately 3 million farmers who produce the food which we Americans consume at the rate of nearly 3 tons per year for a family of four. Daily everyone's mind turns to food at least three times. We are a nation with a tremendous food production capacity. This has been generated largely through the current century. The establishment of the Land Grant College over a hundred years ago was one of the key steps in bringing into focus more attention to the many complexities of the business of producing food and fiber. It also had another significant feature in that it provided a type of higher education which previously had not been recognized.

Research is a term which conveys certain amount of mysticism and magic to some. It is a term which was quite likely not known to the average farmer a hundred years ago. Possibly today the farmer as a citizen is more cognizant of the significance of research than most citizens of our society. He recognizes that it has been through research that improved technology, varieties, and improved animals and poultry, etc., have been made available for him to use as the basic ingredient in his business of producing food and fiber. This does not mean that there has not been great strides made in many other fields of research, but possibly as a group the farmer population has given it more attention in recent years. Searching for new information has been characteristic of man as long as he has had an opportunity to stop and reflect about his destiny and future. Man is naturally curious and wishes to have an understanding of the world about him and his universe. For eons of time he did not have the opportunity to do much of this nature because his major, if not sole, attention had to be given to his survival in search of food, raiment, and shelter. Thus as soon as agriculture was able to move into the era of becoming a business whereby food and fiber could be produced in large quantities so that others might do other things then major advances in knowledge and technology became possible at a higher frequency.

Modern man has felt that there was little value in accumulating knowledge if it were not put to some useful purpose. The Land Grant College, in its evolution, provided a very unique system. The research arm sought hitherto unknown truths; the resident instructional program trained future scientists and teachers; and the off-campus teaching program commonly known as Extension, carried on a most effective educational program among the youth and the adults throughout a given geographic unit. This combination has been most successful and no other system such as it has prevailed throughout the world. Of recent years the University in general has been a target of considerable criticism. Frequently it is forgotten by our modern generation that the function of the university has undergone such criticisms in the past. In England, for example, there were violent repercussions when Henry VIII separated Oxford and Cambridge from the church; when Cromwell separated them from the crown; when the Parliament in the middle of the last century separated them from the Anglican aristocracy. In Germany at the time of the 30 Year's War with the battle over the Reformation, this also tore universities asunder, and again when Humboldt started the University of Berlin in the beginning of the 19th century. In France when Napoleon took institutions of higher learning and sought to turn them into servants of the new state. Then subsequently when the United States created a modern university taking over where the classical college a century or so ago and later when Lowell and then Hutchins attempted a counter-revolution. These historical facts are mentioned merely to illustrate what confrontations we have experienced in the recent decade are not necessarily new to the so-called intellectual community.

For the United States the years from 1957 to 1967 have been expressed by some as constituting an Education Decade. There may be education decades again but it is unlikely that there will be another quite like this one. It began with Sputnik and the charge to education to win the Cold War. It ended with a Hot War and the growing realization that education is a long term answer to mankind's problems and must not be confused with social engineering. The danger now is that we are becoming disillusioned with education without realizing that we are only beginning to try it.

Enlightened education is the answer to mankind's problems. The future depends on it. Education is a never ending process of developing characteristic ways of thinking and behaving on the part of individuals, nations, and in fact, mankind. Each generation has access to a long heritage from which to derive perspective. Its thinking is shaped by current books, magazines and newspapers, by movies and television and by a great array of events and stimuli which are a part of everyday life. Schooling, elementary, secondary, and higher constitutes the most planned and ordered but not necessarily the most influential part of this process.

What does this have to do with agronomy? Where do we, as agronomists, fit into this total scheme? What value will knowledge of this nature be to us as we look ahead during the balance of this century? Agronomy as we know it today had its origin sometime early in the beginning of this century. It is stated that the University of Illinois had one of the first Agronomy Departments in this country. Oregon State had a department which was identified as Agronomy from 1907 to 1916. In general it tended to be that area of study which encompassed the growing of field crops and the related cultural practices used to maximize production. There is no clearcut definition. In some instances it embraced intensive work in the production of plants and a better understanding of soils while in other cases it included as well farm management inasmuch as it had a bearing on the economics of production plus the mechanization of tilling the soil to the management and harvesting of the crop. Today, in general, it seems to be narrowed primarily to the crops and soils aspect. Nevertheless, it does either embrace or utilize many different disciplines, if you will, genetics, cytogenetics, physiology, pathology, soil chemistry, clay colloids, herbicides, insecticides, fungicides, etc. Some of these may be relatively indirect and in some instances they may actually be a function of the part and parcel of what is interpreted in certain situations as agronomy. Thus, a clear cut definition of our profession is possibly somewhat nebulous. On the other hand, we do have a very distinct and clear cut goal that is to aid society in the production of food and fiber in as economic and of as high quality basis as possible.

Traditionally research in agronomy was done primarily by public agencies either the Land Grant University and/or the United States Department of Agriculture. This is somewhat a different pattern than one finds in other countries around the world where there is a tendency for it to be done either by a federal government, the provincial or state governments or research institutes. Of recent years as an outgrowth of a very extensive agricultural research program, and agronomy has been no exception, many private enterprises found that it was advantageous to have research programs which would aid them in meeting the competition of others who were engaged in the same business. We have found that there has been extensive private research in development of new varieties, in the herbicide and in the fertilizer fields, etc. Those persons engaged in industrial agronomic research have played and are playing an important complementary role in seeking solutions to the many problems facing an ever increasing complex agriculture.

A hundred years ago agriculture research and education was directed primarily to the rural community. This was logical because it was on the primary production front where the assistance was needed. As new technology was adopted and there were less persons required to serve on the primary production front, other areas developed such as transportation, marketing, and all the other facets necessary to get the food and fiber to the consumer. Thus, the time came when the total consuming public had even a greater stake in a productive and prosperous agriculture. It has been difficult to adjust our educational program so that it was being directed to the consumer as well as the producer. There was a tendency to define agriculture as being only the producer when really the job is not complete until it is purchased by the consumer. Thus, agriculture really is production, wholesaling, transporting, and retailing. These dramatic changes in its component parts presents new educational audiences for agricultural educators. A still newer dimension has been added in recent years with greater attention being given to the environment and leisure time involving the need for recreation. The agriculture scientist and educator is in a position to provide leadership and disseminate knowledge in these areas because it has been his primary goal to conserve these renewable resources if a successful production program is going to be guaranteed for the future. At the same time, by his very understanding of biology he was in an excellent position to provide leadership in the conservation and management of natural resources for the most effective type of recreation programs for those in society who found themselves confined to the metropolitan areas of living.

A handful of scientists who had identified themsleves as agronomists organized the American Society of Agronomy in 1907. It has flourished and grown from that time from a very small group to a membership of some 8,000 strong in many countries around the world. The goal of the professional society has been and still remains a service to its members. This takes on many different forms. Initially its primary service was to provide some structure and organization that would set up an annual meeting as a means for fellow scientists to get together and discuss mutual problems and to publish a magazine which would retain for posterity some of the prime findings of this particular scientific group. As the years went by there seemed to be a need for expanded publication, and today we have several: Agronomy Journal, Proceedings of Soil Science Society, Crop Science, Journal of Environmental Quality, Crops & Soils, Monographs, Special Publications.

We cannot remain as an island unto ourselves, we must interrelate with other professional societies having somewhat similar goals, either directly or indirectly. We actively work in a liaison manner with the following: American Forage and Grassland Council, American Society of Agricultural Engineers, Weed Science Society of America, American Water Resources Association, American Society of Animal Science, American Dairy Science Association, American Meteorological Society, American Society of Range Management, Soil Conservation Society of America, Entomological Society of America, Genetic Society of America, Society of American Foresters, American Society for Horticultural Science, American Phytopathological Society, American Agricultural Economics Association. We have, over the last twenty years, organized a headquarters office which enables the Society to offer even greater services for the membership.

In recent years it has been more and more evident that with the dwindling population on the primary production front that our Society in general has become less and less cognizant of the significant role which agriculture plays in their daily lives. Thus, it has become most apparent that more attention must be given to public relations which would be straightforward and informative providing people in general with a better understanding of the role of agriculture. Environmental quality receives an inordinate amount of attention today. Certainly there is ample evidence that we must focus more of our attention on this important aspect of living. With greater frequency critics would infer that preservation of our natural resources and maintenance of quality of environment is of no concern to the agronomist. You and I know that this is not correct. However, we are going to have to do a better job with factual public relations.

Ever since Rachel Carson wrote "Silent Spring", the pollution snowball has been gathering momentum. Social reformers from every part of our society have jumped in to give that snowball a push, many of them solely because they must have a "cause" for which to fight if they want to survive. For this reason, emotion must be kept in its proper perspective. Everyone should be concerned about pollution. To be apathetic about it can be fatal, but before anyone has the right to make demands, he or she should have the facts--facts that can only come through carefully conducted research. Both government and private industry are involved in just such research now and have been involved in it longer than most of the "overnight conservationists" have known the meaning of the word "ecology".

Frequently the question is raised "where would we be if we had not used pesticides and inorganic fertilizers". It is ridiculous to think that we could raise enough food for the ever increasing population of the world by using nothing but organic materials. However, when reacting to these many phony claims which are made on an emotional basis, we must be certain that we support our position in a scientific, factual, and professional manner.

This is the world in which we find ourselves! It is indeed perhaps one of the most exciting times which mankind has ever experienced. As we look ahead into the balance of this century, what do we see as to the nature and the structure of the role of the University? Where will public and industrial education and research fit in the total picture of agriculture? It is very easy to look into the crystal ball, but it can be very cloudy to discerning eyes. There are those who would be very pessimistic and submit that agriculture per se has no further role to play in the realm of higher education. There are those who would reflect that Extension as a method of education commonly known to those of us in agriculture has done too good a job and hence overproduction, thus it is no longer needed. Change is inevitable. We must accept this fact. As scientists and teachers we have a responsibility to delve into the future and postulate what turn of events might take place. It is only through doing this that we can set goals and objectives for the responsibilities which we hold. What is our goal? What do we really want to achieve? That is the reason we are convened here this afternoon so that as a group we might better prepare for the future than if we approached it strictly on an individual basis. We all have a common purpose in mind, that is to better feed and clothe the peoples of the world. We cannot confine ourselves just to the concerns and problems of California, of the United States, or of the world. We must think of all of them together.

At times the question is raised as to whether there is value in researching the many challenging wonders of nature. In August of 1970 it became very evident that we were faced with possibly one of the most devastating epidemics of a disease to hit any major crop in the United States. The southern corn leaf blight swept across the United States, slashing 20 or more bushels per acre off of corn belt yields and reducing those in the southeast at least by half. Prospects of making a full crop of corn in 1971 were extremely dismal. In the fall of 1970, seed companies took inventory of their resistant seed supplies. An all out effort by plant breeders to produce more seed, by Extension workers to spread accurate information and by dealers to stretch their seed supply as far as possible, met with a resounding success. Currently, 1971 one year later, the United States is harvesting one of the largest corn crops in its history. Once again the American agri-business complex, keyed on the farmer himself, has proven no production job is too big for it. We must not be complacent and apathetic, however. It was only because of a good educational program, appropriate and proper use of seed resources, and the fact that there had been an ongoing research program that we were able to counteract what, in times gone by, would have been a most devastating experience and possibly initiated a series of poor harvests and, hence, famine for possibly many years. This is just one illustration, and an extremely dramatic one. It does point out the necessity of an ongoing research program. Thus, it is going to be important that the University and private industry continue to have a strong and realistic research program. With the ever increasing competition for tax dollars, the agriculture industry itself will need to allocate more of its fiscal resources to research. This may mean that it will have to have the courage to structure its prices relatively higher so that the consumer will be contributing to this need to retain a strong and healthy agriculture.

We will see more international involvement. This will have two primary benefits: one, it will assist those in other countries around the world to better serve themselves, and at the same time it will provide new knowledge on a worldwide basis which will be extremely valuable in solving our problems at home. A good example is CIMMYT. This is an international research laboratory with its primary base of operation near Mexico City, in Mexico dealing with the improvement of wheat and corn. It has research operations in South America and the Middle East and in Southeast Asia. By carrying on a well coordinated program, the germ plasm that evolves from this program is much more valuable than had it only been developed in one particular area such as Davis, here in California. This is a real bonus to those scientists who will use this material as opposed to what previously was available to them. I predict that we will see more of this type of intercontinental research.

Education will continue to play an important role. It will take on a different character than what we have grown accustomed to thinking of its composition. In addition to the cytogeneticists, the biophysicists, the colloid chemists, we must give attention to training of the agronomist. This person has not had much prestige, particularly during the last two or three decades. However, we find ourselves in a plight where we have developed a lot of sub-disciplinary specialists who have contributed greatly to our vast store of knowledge but these persons have not been able to put the plant together to make it work. We need both, however; we have not been encouraging students to pursue this most rewarding area of agronomy. A person who understands how all of these complexities can be put together into a plant to produce a high quality food or fiber is badly needed in today's society. This is something which universities, and particularly Agronomy Departments, must address themselves to and make it attractive and appealing to students to pursue.

In general, the Extension phase of our education has been directed primarily to the producer. The Extension worker will need to seek other audiences who might be better able to serve the producers' needs. When you stop to think of it, the person who most frequently comes in contact with the producer in today's agriculture production is the industry representative, whether it be for a seed company, a fertilizer company, herbicide or insecticide company. Thus, the Extension worker may find himself using his time to a greater advantage by working with these rather specialized groups of persons who in turn are the people from whom many farmers and ranchers seek advice when buying products or services necessary in their business or marketing. The Extension worker

RESEARCH NEEDS FOR ENVIRONMENTAL QUALITY

Dr. Emil M. Mrak
Chancellor Emeritus
University of California, Davis

When I was first asked to present a paper concerned with needed research in relation to environmental quality, I found it difficult to decide where to start and end. I can visualize needed research in this broad area with respect to almost anything that comes to mind. However, since this is a society of agronomy and you have an intense interest in agriculture, I shall limit my discussions to this general area. I shall also touch on some of the evolving needs as a result of changes that have and are taking place.

The spectacular advances in agriculture are, without doubt, responsible for our high standard of living. We have solved the problem of food and we have an adequacy of food. We don't need to worry about food, and I have felt in many cases we are actually living in a fool's paradise as a result of our accomplishments. And this has happened in the United States in spite of our great increase in population.

We have even improved our foods over what nature has been able to do and we have taken a great part of the work of preparation out of the kitchen and placed it in factories. We have convenience foods, we have standardized foods, we have a diversity of foods such as we have never had before. We even have organic foods whatever they may be. We have the most nutritious food in the world but are not necessarily the best fed people in the world because, for some reason or another, we don't all seem to eat well balanced diets. The one thing, of course, we have not controlled is what people eat.

In any event, great developments in agriculture have enabled our people to turn their thoughts elsewhere to the improvement of what we call our standard of living. This means, of course, automobiles, rapid and easy transportation, fancy clothes, electrical gadgets in the kitchens and above all packaging--including glass, tin, plastics galore, cardboard and once in a great while, even wood.

We have controlled temperatures in our homes so in the summer we can cool them and in winter we can heat them.

I can also assure you that our standard of living, our food supply and all are so advanced over what the rest of the world has that it is tragic we do not realize this. Improving the standard of living in many nations seems hopeless--Why?--because agriculture is so far behind on the one hand, and population is increasing at such a rate on the other hand.

I had an opportunity to see this firsthand when I had the privilege of participating in the Rockerfeller and Finch missions to the Latin American countries.

Until a few years ago, agriculture was a favored industry to our people. I can recall very well during my period in college the attitude of the legislators and government toward agriculture and agricultural experiment stations was so very favorable. Agriculture could do no wrong and even such environmental abuses as the burning of smudge pots were tolerated.

But agriculture is no longer a favored industry and, in fact, many consider it a well healed and abusive industry. In other words, one might say the dog is now biting the hand that feeds it and we are certainly injuring the goose that has laid the golden egg.

As already inferred, this change is well manifested by the actions of Congress, the legislature and even in court judgments. Accordingly, research support is dwindling though the problems for agriculture are increasing at a fantastic rate.

Let's look at a few of the changes taking place and the increasing need for research. Consumerism, of course is becoming an important development in this country and the general impression I have is that anyone involved in producing for the consumer is to be mistrusted and is either negligent or even dishonest. It is so often said that foods are not nutritious, they are contaminated with pesticides, they may be mislabeled, they lack flavor, and they are ruined by synthetic fertilizers.

But why do I mention such factors when I am supposed to cover research needs as related to the environment. They are in fact related to the environment.

The environmentalists are active and are having their greatest day and as far as agriculture is concerned, their actions range from air pollution to the production of poisoned and non nutritious foods.

Insofar as air pollution is concerned, we hear about agricultural burning and as you well know there are restrictions in this area. If there is any place where we need intensive research, it is on the handling of stubble and waste products on the farm in a manner whereby they wouldn't have to be burned. We may as well be realistic and accept the fact that the burning days of old or even the present are limited. I presume Mr. Maga will tell you more about this tomorrow. In any event, we do indeed need more research in this area.

Water pollution has also been a problem to agriculturalists. Even though they may not have been responsible or perhaps not involved at all, they are often blamed for some of the contaminations that occur in our streams. Most certainly, there is concern about pesticides, animal waste, nitrogen fertilizers, and even eroded soil in our waters. Even though little of any of this may be agricultural in origin, the finger of guilt points at agriculture. Even though some of the chemicals involved may be of industrial origin or from home gardens, parks, golf courses and even swimming pools, they have been confused with pesticides use on the farm. Furthermore, only recently have we heard about such things as polychlorinated biphenyls, mercury or hexachorobenzene and things of this type of industrial origin. We need research in this area to determine what the substances are, their origin, what they do to wildlife and how they may be involved in human safety and the environment in general and, above all, how to analyze for them. Recently, the water people in the Environmental Protection Agency made a study of the possible number of chemicals contaminating our water systems and it was astonishing to me to learn that the number may well be over three hundred and fifty. Most of these, of course, would be industrial in origin.

The solid waste problem is no longer an easy one to handle in spite of those who would go back to organic farming, whatever that is, and insist that we grow everything with natural fertilizers. As you well know, there would not be enough manure to supply the needs of the entire nation and if there was, it would not be economically feasible to use animal wastes because of the cost of handling, transportation, and 'its limited value. Yet the material continues to collect at race tracks and farms to the point where it is now a serious solid waste problem. As a matter of fact, if we consider all animal wastes, we do indeed have an unsolved problem. Bear in mind that one large animal contributes many times what a single human does. Research in this area? yes, indeed, it is needed. A few months ago, I happened to visit the University of Illinois and learned they have found by collecting the total waste, both solid and liquid, from a number of pigs, they could separate by filtration small particles. When dried, this material contained five times as much high quality protein as an equal weight of corn. It was, therefore, protein as an equal weight of corn. It was, therefore, recycled through the animal--this is an example of recent research in this area. More is needed.

But, animal waste is not the only waste of concern to the farm. I have already mentioned agricultural burning and the need for research in this area--the need for research on stubble, tree trimmings, and things of this type. There is also the matter of empty containers in which agricultural chemicals are brought to the farm. At present we are in a dilemma as to how to handle these containers and what to do with them. Those concerned with the environment are talking about collecting cans, bottles, and newspapers and recycling them. The question is, what can we do with pesticides and chemical containers--how can they be recycled, how can they be reused? Various types of incinerators have been suggested--open pit, mechanical, closed system, and so on. We are in dire need of experimental work in this area. The Commission on Pesticides and Health recommended to the Secretary that an experimental closed system plant be constructed, but the possibility of such a development was lost for the time being in the shift of solid waste research from HEW to EPA. Presumably the end products of such a facility would be CO_2, H_2O, metal and glass.

The environmentalists are concerned with wildlife and, of course, blame pesticides for many of the problems. Recently I read about the poisoning of ducks as a result of their ingesting the BBs that collect in the feeding grounds as a result of poor marksmen like myself. I might say I do not hunt very much, but when I do, I always give the game fowl a sporting chance and a good one indeed. They are now experimenting with stainless steel BBs. There is a need for research in this area, for before making a change, we should know what an abundance of stainless steel BBs will do to the environment and in fact the ducks.

Agriculture is also blamed for many of the poisoning of wildlife. I can very well visualize lead poisoning of ducks being attributed to mercury as a result of seed treatment. When the ducks die as a result of botulism occurring in some of the feeding grounds, the first thought of our news reporters is that it might be caused by agricultural chemicals. When a tremendous number of fish died off our coasts a few years ago, the first reports were that it was DDT. Later, it was indicated it was due to something else, perhaps a bacterial disease. Research in these areas is direly needed so we may have a better understanding of the problem and too--so we may solve it.

Above all, the area of tremendous concern to agriculturalists today relates to pesticides. I refer not only to insecticides but also herbicides, fungicides, defoliants, rodenticides, avicides, growth agents, and so on. Perhaps I should use the word agricultural chemicals and also include fertilizers.

There are those who say we could do without pesticides, that they would not mind eating wormy apples, but this is easier said than done. It would mean a change in our culture, it would mean a change in our attitudes toward quality and, even if we could change these things, then there would be the matter of changing the laws. The present Food and Drug laws just do not permit the sale of wormy or mouldy products.

I have often said it might be well, for the purpose of demonstrating and education, to go back to the situation of fifty years ago, for awhile, providing we could again advance the clock to our present high-yield agricultural production. It might bring some people to their senses. In any event, a great many questions have been raised about pesticides. The manufacturers, distributors, the users, of course, are on the defense. There are many questions that are unanswered and, in my opinion, there is considerable justification for raising these questions. On the other hand, I do not believe we should panic about the situation and make emotional and unfounded and unreasonable judgments. This, I can assure you, has happened in a few cases--and it has happened because we do not have the needed information and we have not as yet sought to expand the funds needed to develop the information so direly needed.

We need to know more about the type and quantity of pesticides to use. There are some who say that we can do without them entirely, there are others who say we can use them in part, and still others who say we must use them as extensively and intensively as we are at present. We need a great deal of thought and research in this area. It may sound strange to say we are not even certain of what all the problems are relating to pesticides. This is why I used the word "thought" as well as research. We do know it would be highly desirable to develop more specific insecticides for specific insects. We need chemicals that degrade rapidly. If this is done, however, we certainly need to know about the cost involved, and the feasibility of using such chemicals. We would also need to know about the products of degradation that might be harmful to wildlife, the environment, and, of course, humans. We need to know what happens in the air, water, soil, plants, food, to the workers and other humans from the standpoint of safety. There is so little information in so many of these areas and yet I do not see anyone at the Federal or State levels taking the leadership toward developing a more highly organized program and toward sponsoring intensive research in these areas.

I can speak from firsthand experience with respect to the needs of research on foods and residues on foods. As you may know, I was Chairman of Secretary Finch's Commission on Pesticides and Their Relationship to Environmental Health. It was quite a revelation to me to realize how little we know about many of these chemicals on the one hand, and on the other hand, how many and how extensively they might be used. Above all, we found a deficiency of information on safety and especially from the standpoint of carcinogenesis, teratogenesis, mutagenesis, and interaction. Furthermore, we are so often in the dark with respect to the production of metabollic products and the products of degradation.

By carcinogenesis, of course, is meant the relation to cancer production. Teratogenesis refers to prenatal malformations and by mutagenesis, we refer to gene changes thay may show up in later generations. By interaction we refer to the effect of one chemical on another. For example, it is known that DDT tends to counteract the effect of Phenobarbitol. On the other hand, there are instances when chemicals may be synergists such as is the case when piperonyl butoxide is used with pyrethrin aerosols.

It is well for us to say we will test environmental chemicals for safety, but then comes the matter of how are we going to conduct such tests, what methods should we use, and what are the reliable protocols. It was most astonishing to me, when serving as Chairman of the Commission, to learn that there are no generally accepted protocols for testing for the safety of environmental chemicals. We just do not know whether or not the procedures we are using to test for safety are satisfactory or reliable. The question has come up over and over as to whether or not there is a threshhold value for chemicals. We do know threshhold values exist in many instances, as for example in the case of table salt. You may recall the instance in an eastern hospital when a number of babies were injured and some even killed by including table salt in the diet rather than sugar. On the other hand, if we do not have salt in our diet we cannot survive. Then again, Vitamin A, as you all know, is certainly an essential vitamin. On the other hand, if given in excessive doses, it is a powerful teratogen. As a matter of fact there have been instances when individuals have been harmed, believe it or not, by overindulging in polar bear liver, which happens to be very rich in Vitamin A. We are told that coffee may be a mutagen and so it goes. The question is then, what type of procedure can be used to test in these areas to determine whether or not there is a threshhold value and whether or not there is a level of safety.

As a result of these questions, a recommendation was made that HEW establish a laboratory just for the purpose of developing protocols so we can answer some of these questions, so consumers may have assurances and so the manufacturers may know what to do when testing new chemicals for safety. What procedures should be used that will be accepted by all concerned.

After much consideration, a recommendation was made to the Secretary of HEW that the Pine Bluff, Arkansas Facility for Microbiological Warfare be converted into a center for the development of protocols for testing for safety. This was approved by the Office of Science and Technology and eventually by the President, and as a result it has been turned over to the Food and Drug Administration and the Environmental Protection Agency. They have a joint policy board administering the facility which is now connected with the Medical School of the University of Arkansas at Little Rock. They are now in the throes of seeking a director and considering the possibility of developing a consortium of universities to operate it. There are many questions to be resolved with respect to its administration and operation, but the important point is we have made progress in this direction. Its objectives are first of all to develop protocols for testing for safety and, too, reliable methods of analyses. We hope that this facility and its operation will answer the questions of how many animals should be used; how should chemicals be administered; by feeding as one normally ingests food, by using tremendous dosages, perhaps up to thirty thousand times what one might expect to take in on a daily basis; by injection; by using the pure chemical or mixing it with a carrying agent which in itself might be toxic, by implantation, by inhalation, by rubbing on the skin; or heaven-knows-what. These are questions that must be answered in order to deliver us from the morass of confusion and uncertainty in which we find ourselves today with respect to environmental chemicals.

You have inquired about needed research; here is an area in itself that is so vast, it will require a tremendous amount of support. To start with, we have about two and one half million dollars; we expect this to go up another million or so in another year, at least we hope so, and eventually to about ten million per year. In my opinion, if this operates the way we hope, it will answer many questions and will certainly fill a need for research in the area of safety of environmental chemicals.

We also hope, of course, this facility will be useful in developing methods of analysis for this in itself has been a serious problem.

Let me give you an example. The occurrence that brought the Secretary's Commission into existence was the discovery of excessive amounts of DDT in Lake Michigan Coho Salmon. The question was, what to do about it. The tolerance was then 5 P.P.M. and the FDA was finding as much as 15 P.P.M. Upon delving into the matter, we found that the Food and Drug Administration was analyzing the whole fish except for the viscera, in the raw state. In other words, the places for accumulation of DDT in the belly fat and the head were included in the analysis. They did not analyze the parts as such or after cooking. Furthermore, the question was raised, why 5 P.P.M., why not more or less. The answer seemed to be that in the judgment of the FDA, this was a reasonable tolerance, but it was admitted that there was no sound data to back this up. In any event, the tolerance was raised to some extent, but this still did not answer the question.

After some months, it was realized that the material thought to be DDT might very well be a mixture of DDT and polychlorinated biphenyls. And, as a matter of fact, it might have been, in some cases, largely polychlorinated biphenyls. Subsequent feeding tests indicated quite clearly that DDT, Aldrin and Dieldren in salmon were not harmful to mink, but the PCB's were. The question then came down to what type of analysis to use to separate the two chemicals. One of the first reliable methods used for separating the two in food was developed by a food company. This was called to the attention of the Department of Agriculture because the company had found PCB's in poultry, and Agriculture handles matters relating to poultry.

It has been said by some officials in hew that any analyses of DDT over two years old can no longer be considered reliable. This means, therefore, that we must develop sound methods of the analyses of the specific environmental chemicals and in a variety of substrates. Furthermore, we must develop analytical methods for the products of metabolism and those that occur as breakdown products such as ethylene thiourea derived from ethylene bis thio carbamate.

We had a similar situation with mercury. So much was said about the use of mercury on seeds and, in fact because of this restrictions were placed on the use of mercury for this purpose. Yet phenyl mercury acetate has been used very extensively in swimming pools and until quite recently its use was not banned or even restricted. But, here again, there were problems on methods of analyses. The Food and Drug Administration had established a tolerance of a half a part per million based on using the so-called wet method of analysis. But the Dow Chemical Company pointed out that such a method gives only about half the level of mercury and if the atomic absorption technique is used, the results would be much higher. This, the FDA did but at the same time retained the tolerance level of half part per million.

We need to know a great deal more about the organic forms of mercury, believe me, for in our ignorance we have taken some hasty actions. To be specific, it has been found that museum samples preserved in 1878 contain about the same amount of mercury as do the fish we analyze today.

I could go on and on and give a great many examples, but I will only mention one more and this relates to the herbicide 2,4,5-T and its contaminant of dioxin. There is a great deal of argument regarding analysis for dioxin, when does it occur, its harmful effects and so on. We certainly do need new methods for these purposes. A rather interesting aspect of the 2,4,5-T picture relates to the extensive reviews made by the Environmental Protection Agency which hereafter I shall call EPA. The best scientific judgments consisting of one of EPA's own panels and scientists in the Office of Science and Technology indicated that from the scientific standpoint it is perfectly safe to use 2,4,5-T and it should be continued. On the other hand, there were those who brought up for consideration what have been termed the social aspects. It is difficult for me to define the social aspects, but I believe it relates to the number of people that might be put out of work, the effect a restriction might have on the economy, aesthic considerations, and so on and so on. For whatever the social aspects might be, we now need consideration of this area and a definition if possible.

The most recent chemicals that have come to the fore--chemicals of the month as I term them--are the pyrethrin aerosols. There is a question as to whether or not these should be used around food plants or in areas where food is handled or stored. This would include such items as tomatoes before being shipped from the field to the cannery, grain storage, box cars, and so on. With respect to the tomatoes, I might point out that one of the problems has been the accumulation of fruit flies and the need to control them. There have been instances, therefore, when pyrethrin sprays have been used in the field as well as at the cannery or packing house. Now the question comes up as to whether or not this is in order, whether the tomatoes should be covered before the sprays are used. We don't know a great deal about these materials and much thought is being given to them right now. Some believe in connection with such materials the "rule of reason" concept should be used as a guideline. Since it is difficult to unequivocally prove a negative or that a low level exposure does not adversely affect humans, there must be a reasoned basis for evaluating risk versus benefit. There comes a time, the Supreme Court has said, when the government administrator of a law must apply the "rule of reason."

We can expect more chemical problems to arise as time goes on. One of the most recent ones relates to ethylene bis dithiocarbamate which converts after application, in part, to ethylene thiourea. This is a fungicide used very extensively and in some instances the residues permitted have been quite high. A rather interesting aspect of this chemical is that most of the work has been done on the chemical itself rather than on the byproduct of conversion. It now appears that the byproduct, ethylene thiourea, fed to rats causes thyroid cancer when as much as two hundred to five hundred parts per million are included in the diet. This seems to be an extremely high amount but at the same time we are confronted with the Delaney Clause that says when suitable tests are used and if carcinogenesis takes place then the material must be banned. Here again, we have the question coming up as to what is a suitable test. The most important part of this to me is that when the chemical was first developed it seems as though there was not enough attention given to the breakdown products and whether or not they are harmful.

While on the subject of pesticides, I would like to point out that we also need a great deal more information in the area of what I would term monitoring. We need to know more about what happens to chemicals in the air, are they converted, how long do they stay in the air, and so on. Likewise for water, soil, food, the plant, and the body burdens of wildlife, domestic animals and humans. These, to me, are urgently needed monitoring studies and studies I do hope may be conducted at the Pine Bluff Facility.

We need to know more about the application of pesticides, how to apply them, their management, and so on.

A great deal has been said about integrated control. I think this ought to be given an extensive trial and funds should be made available so that we will know when this might be used and when it cannot be used, or can it always be used. Likewise we might say the same about biological control. Then again, there is the matter of genetic control as suggested by Benson in a recent article in BIO SCIENCE. As I understand it, Benson is suggesting that we develop strains of insects that may be susceptible to the pesticide and then release them for breeding with others so that the susceptible genes will be introduced in the species. This, of course, would be costly and require an enomorous amount of testing. Whether or not it would work, we do not know, but it seems it is something worth exploring. We need to know more about phermones and attractants.

The Legislature and Congress have been giving consideration to the possibility of financing more work on integrated control and biological control. Most certainly this has merit and should be done. I don't believe, however, that we should ballyhoo this to the extent where people will expect results that may not come. There is a place for all these approaches and what we must do is to carry on research to the point where we can come to reliable and logical conclusions as to what can and should be used and what cannot and should not be used.

We need more extensive studies on herbicides and rodent control.

The problem of cockroaches is increasing and while we usually associate these with restaurants, hotels and homes in the cities, they do occur in storages and to control them certainly requires different procedures than for farm insects.

Finally, we cannot overlook nitrates. We are hearing more and more about contamination of our environment with nitrates and even to the extent where efforts are now being made in some states, particularly Illinois, to limit the application of nitrates. Yet, when we look at the consumption of proteins in this country and compare it with the use of nitrate fertilizers, there is a direct correlation. This all brings me to the point that we need to know more about these matters before we make up our minds. We just don't have the information.

AGRICULTURE IN THE NEXT QUARTER CENTURY*

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It was not long ago that projecting the future was a pastime reserved to novelists, science fiction novelists in particular. Not so today. Novelists have been joined by economists, sociologists and various other species of scientists in projecting the dimensions of the future U.S. and world societies. Futurists, as those who engage in such activity have come to be known, are to be found in universities, government, foundations, and business. The techniques of the futurists range from very informal, subjective speculations of things to come to the construction of statistical and mathematical models in which variables are projected to year 2000 and beyond.

All such projections have two common properties: (1) they are based on simple techniques and very large assumptions; (2) they involve extrapolation of past or current trends into the future, a procedure which assures predictive error in a society marked by rapid and fundamental change as ours is. Despite the growth in numbers of futurists and their attempt to provide a scientific aura to their projections by applying mathematical and statistical methods, the unfortunate fact remains that all of us, the television oracles and newspaper astrologers excepted, remain unable to foresee the future. There is still much wisdom in those ironic words purported to be a Chinese proverb: "To prophesy is extremely difficult--especially with respect to the future."

You will surmise from these remarks that I have had some difficulty in grappling with the very complex subject of my remarks this morning--agriculture in the next quarter century. I might have chosen to present simply the quantitative projections of output, consumption and income which have been projected for agriculture in the year 2000 by the Economic Research Service and by economists in the University of California. Or in the manner of Reich in his book, Greening of America, and Toffler in Future Shock I could have attempted to let my imagination run rampant and made a quantum jump to the year 2000 without resort to quantitative projections.

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As you might expect I have chosen instead the middle ground between those approaches. The quantitative projections do provide a useful perspective of some of the possible configurations of agriculture in the next quarter century and the possible paths of development to that year. Judging from the past we might expect the future to be shaped in part by currently prevailing trends and for this reason projections of those trends may provide some perspective of the future. But reliance upon any mechanical method of projection has its limitations. Seldom do such projections pick up the "turning points," the "discontinuities" or "surprises" of the future. It may be far more useful to ask the "what if" questions--what if there are major changes in public policy related to agriculture; what if there are constraints on technology employed in agriculture?

My approach will be to present briefly the principal results of the USDA and U.C. projections of agriculture to the year 2000, to outline my own subjective views on possible organizational configurations of agriculture in that year and to pose some public policy issues emerging or likely to emerge with respect to agriculture in the next quarter century.

1. Future Requirements for Food and Fiber

Several attributes of our affluent, service-oriented economy have important implications for agriculture.

1. Total demand for food and fiber at the farm level is not greatly affected by growth in per capita consumer income. Our per capita consumption of food in total has been nearly stable on a national basis over the past two or three decades. The principal beneficiaries of economic growth are the service and luxury goods sectors of our economy. The principal stimulant of growth in aggregate demand for farm products within the U.S. is our growth in population.

2. Although increased income in our economy generates little quantitative change in per capita total food consumption, its impacts on individual commodities are highly uneven; it has a large impact in a qualitative sense and upon consumer expenditures for food. Generally increased per capita incomes have been accompanied by:

(a) decline in per capita consumption of cereal products and sugar;

(b) increased per capita consumption of high protein food, red meat being the outstanding example;

(c) a shift toward convenience type foods, that is, processed prepackaged foods; the shift from fresh fruits to canned and more recently frozen and dehydrated fruits is a good example;

(d) increased reliance upon away-from-home food retailing. That market today accounts for about one-third of our $120 billion annual expenditures for food; it is by far the most rapidly growing sector of the food industry.

Simply expressed, affluence provides consumers with the opportunity to indulge their tastes for higher priced, higher quality, more convenient forms and outlets for food. I see no reason to not expect these pervasive tendencies to prevail as a general orientation of our food industry in the next quarter century.

If these are the pervasive general tendencies for the food industry, what implications can be drawn with respect to the next quarter century?

1. In terms of quantities of food (farm weight equivalent) aggregate demand for food might grow at a rate of 1.0 - 1.5 percent per year depending on which of these two population growth rates one assumes. Compounded this means a total growth of 30 - 55 percent between 1971 and 2000.

2. Assuming recent food consumption patterns and continuance of relative prices for food similar to those prevailing in recent years, the growth in demand for beef and veal, chicken and turkey, processed (particularly frozen) fruits and vegetables should be substantially in excess of the 1.0 - 1.5 annual rate; milk (fat solid basis), potatoes, wheat and pork should experience lesser rates of growth. These projections assume growth in per capita real incomes ranging between 3.1 and 4.1 percent per year--an assumption open to question in light of recent performance of the economy but not greatly different from that of the 1950's and 1960's.

3. The major growth in the food industry will be in the marketing sector--processing (particularly freezing), packaging, away from home retailing, etc. We have projected $170 billion retail food sales by 1980--a growth of nearly 40 percent in a decade. Extending that rate of growth to 2000 would result in sales more than three times greater than in 1971. One can readily understand why many farmer cooperatives are seeking ways of participating more extensively in the food marketing system. In a very real sense that is where the action and the profits likely will be in the food industry in the years ahead.

But is it reasonable to assume that the next quarter century will be an extension of the trends of the past, even the recent past? Are some discontinuities likely to emerge to invalidate, distort or moderate those trends?

Possibly! For one, we might not achieve the economic growth rates assumed in our projections. Some economists have suggested that as we shift more and more to a service economy, productivity and therefore real per capita income growth will decline. Such developments might alter the rate of growth in projected demand for food but not the direction of growth.

One might envision strong inflation in retail food prices to the extent that expenditures and consumption patterns would be altered. More than half the $68 billion dollar cost of marketing domestically produced food is in payments to labor; if food prices were forced up at retail by inflationary wage-price policies consumer resistance could become a factor to be reckoned with.

What about the possibilities of synthetic foods? Great progress is being made in some fields, proteins from vegetable and petroleum sources for example. Technological improvements resulting in lower per unit costs of production of synthetics might result in further inroads in the food market. Should prices of farm produced food rise sharply in the years ahead, development of substitute and synthetic products would be accelerated. I do not expect major inroads to be made in markets for milk, meat, or fruit juice during the next decade. But I do expect the projected high growth in the away-from-home food market will gradually encourage use of substitutes and synthetics for farm produced foods.

Consumerism! That too is a fact of life--better organized, more aggressive, better informed, more quality and health conscious consumers. I doubt that we shall revert to a nation of "natural" or "organic food" consumers. I doubt that we are prepared to pay the costs which such a food system would generate. I don't doubt, however, that consumers will be much more vigilant with respect to how food is produced, processed and marketed. Nor do I dismiss the possibility of additional, more stringent standards being imposed on the food industry by consumer interests. Many of these restraints may be cost increasing at least in the short run.

On balance, the projected growth in demand for food should be comparatively favorable for California agriculture. The fruit, vegetable, tree nut and specialty crops industries should experience relatively rapid growth in demand. So should the beef and turkey sectors. Although the growth in population in California has declined, projections still suggest a 1980 population of 23 million--a growth rate about equivalent to that projected for the U.S. A major question is whether California farmers can remain competitive within this growing market with producers elsewhere in the Nation and abroad.

2. Production Potential for Food and Fiber

As to whether American agriculture is capable of producing increased amounts of food and fiber to meet the projected requirements of 2000, the economists' response is a virtually unanimous yes--provided that severe technological restraints are not imposed upon the farm sector.

Increased output could be derived from several sources:

1. More extensive and efficient use of known technology as farming concentrates among fewer, better managed farms.

2. Development of new, output increasing technology from "on-stream" and additional research.

3. Water and land development of the type now occurring in the San Joaquin Westside, the Columbia Basin, Nebraska and Colorado.

4. Return to production of part or all of the 60 million acres of cropland now idled through government programs. In addition there are some 250 million acres in land capability classes suited to regular cultivation but not now used as such.

We have recently completed projections of cropland that would need to be harvested nationally in the year 2000 under various assumptions with respect to population and economic growth, foreign market demand, restricted and unrestricted use of technology, (fertilizers and pesticides primarily). Assuming unrestricted use of technology our projections indicate another 15 - 47 million acres would need to be harvested in 2000 relative to 1970 depending upon projected food and fiber needs. Such an increase (5 - 14 percent) could easily be achieved by bringing idle cropland back into production, converting pasture and rangeland to cropland or some combination of the two.

Those projections were based upon assumptions of significantly increased crop yields per acre--nearly 50 percent for corn and rice, 40 percent for cotton, 30 percent for wheat and nearly 70 percent for hay and pasture. There is some doubt that the historic rate of growth in crop yields assumed in our study can be maintained to the year 2000 even under conditions of unrestricted use of technology. You are better judges than I of those possibilities.

Dean, King, Carter and Shumway in their projections for California agriculture indicate that harvested cropland in the State would need to increase about 15 percent to 9.7 million acres relative to the average of 1961-65 to meet California's projected share of national food and fiber requirements in the year 2000. Even while allowing for a fairly high rate of conversion of land to urban uses (about 35 percent increase in land in urban uses between 1980 and 2000) and a relatively high rate of population and economic growth in the U.S. and California, their projections indicate sufficient land would be available in 2000 to meet California's share of projected food and fiber requirements provided: (1) yields continued to increase at fairly high rates; (2) shifts in cropping patterns occurred to exploit California's comparative advantages in producing commodities such as fruits and vegetables; (3) there was a shift in pasture, rangeland and non-irrigated cropland to irrigated cropland.

The growing concern with environmental quality poses the distinct possibility that increasingly stringent regulations may be applied to farmers' use of fertilizers, pesticides, feed additives and in disposal of solid wastes. There is, it seems to me, a dearth of reliable quantitative evidence of the relationships between agricultural production practices and environmental quality however defined and measured. There is a dearth of "hard" data by which one might measure the trade-offs between restrictions in use of these technologies, changes in environmental quality, crop and animal productivity. We do not have adequate measures of the costs and benefits or their distributions within society to adequately appraise the impacts of programs to improve environmental quality.

On the basis of this admittedly imperfect knowledge and use of some simple techniques and large assumptions we have made projections of the possible impacts of restrictions in farmers' use of technology. Assuming that such restrictions would depress the rate of increase in crop and animal yields (for example, a 20 percent instead of 50 percent increase in corn yields between 1970 and 2000), we would need a 94 million acre increase in cropland nationally (a nearly 30 percent increase relative to 1970) to meet the highest projected levels of food and fiber requirements nationally and abroad. Although such an increase in cropland would require a rather massive shift of pasture and rangeland to cropland, result in higher per unit costs of farm production and require return to production of most of the cropland idled by government programs, it appears that we would be able to meet such requirements if it were economical to do so.

I cite these very crude projections not to engender complacency about our long-term abilities to produce food and fiber to meet the needs of growing populations at home and abroad or to belittle the very genuine concerns which we have or should have concerning protection of our natural resources and deterioration of environmental quality. We do need more adequate policies and more effective public programs at the state and federal levels concerning natural resources and environmental quality. One would hope that we would not be panicked into adopting inadequate or unwise policies and programs, that we will greatly step up our research and educational efforts in the universities and government to more adequately measure the complex interrelationships and trade-offs involved in various types of programs.

The projections which I have cited suggest a huge production potential will remain in agriculture for at least the next quarter century, that the specter of a food shortage or sharply increased food prices because of short supplies of food is not preordained in the next quarter century assuming even fairly restrictive policies on farmers' use of technology. My opinion is that several sectors of agriculture including some here in California are likely to be marked by abundance or in terms of farm prices and incomes, overabundance, during at least the next decade or two.

3. Agriculture, World Trade and Development

At this juncture it is appropriate to examine briefly some aspects of U.S. agriculture, world trade and development. I will touch upon only two of many aspects which might be explored time permitting: (1) commercial trade; (2) foreign agricultural development and U.S. programs to assist in meeting world food needs.

I need not dwell upon the current economic importance of export markets for California commodities such as rice, canned and dried fruits and vegetables and cotton. In the year ending June 30, 1971, U.S. exports totaled $7.75 billion of which $6.7 billion was commercial and a little over $1.0 billion was shipped under government programs. You are aware that very important trade issues are pending before the U.S. and its major trading partners in Europe, Canada and Japan.

If, as I have suggested, U.S. agriculture will have a huge production potential during the next quarter century, possibly surpluses in at least part of that period, what are the prospects of developing foreign markets for that output? What are prospects for food production in the developing countries? Will a world food shortage exist if not in the U.S. in the developing nations throughout the next quarter century? What are appropriate U.S. policies with respect to the developing nations?

On the commercial trade side one thing can be said with certainty: competition in major foreign markets is intensifying and very likely will continue to do so in the foreseeable future. The increased tempo of competition comes from several sources: (1) increased production within the foreign market--the European Community for example; (2) increased production in competing third countries--Africa, South East Asia, Australia; (3) realignment of trading blocs--U.K., Norway and Denmark's entry into the E.C.; (4) continued or increased protectionism--E.C., Japan. On a more encouraging vein, the increasing emphasis upon animal agriculture in Eastern Europe, U.S.S.R. and Japan may provide new trade opportunities for U.S. feedstuffs. The opening of the Mainland China market to the U.S. poses the possibility of significant increases in export demand initially in wheat and possibly in some specialty food products.

It is difficult to provide very specific projections of future U.S. exports. I feel that we will be able to increase exports of commodities for which we have and can maintain a strong competitive advantage. That would include soybeans and feed-grains, possibly some processed fruit and vegetable items. I am much less optimistic with respect to rice and cotton although we could of course choose to continue export subsidy programs for such commodities.

I am of the opinion that to maintain growth in exports will require substantial realignment of our trading patterns. Regularization of trade relationships with the Communist world is to be expected. Such regularization plus growth in markets of some developing countries in South East Asia and Latin America should encourage realignment. One of the very important determinants of our future trade position is associated with our abilities to competitively produce for world markets. That in turn is enmeshed with national anti-inflation policies, the size, scale and efficiency of the agricultural plant.

With respect to foreign agricultural development and the so-called food-population race we seem to have attained at least a temporary advantage on the food side. The "Green Revolution" has made significant progress in increased food production in Mexico, parts of South East Asia, India and Pakistan. But the advantage is tenuous and could easily be tipped in an unfavorable direction by two or more successive crop failures in those areas. And, projecting population growth in the developing countries at anywhere near rates of recent decades poses somber implications in the longer run.

I doubt the efficacy of long-term U.S. policies based on the premise that U.S. farmers should feed the hungry world. Not only are such policies not well received in some foreign nations.

They can be quite costly and destabilizing in the U.S. as we learned from our experience of the late 1960's. I would assume that our emphasis in the next few decades will continue to be that of providing economic and technical assistance to increase output in the more hard-pressed foreign nations and the use of U.S. produced food to offset short-term, sporadic food shortages. The effects of such policies upon U.S. exports can be both negative and positive. To some extent we may displace U.S. exports and stimulate competition with our own products in third markets. But economic development may increase imports of other of our farm products as it has already in some parts of Asia and Latin America. While the net effects may be uncertain, the risks of political and social upheaval without such programs may be the overriding consideration in the decades ahead.

As an economist, I would hope that we might move toward freer rather than more restrictionist trade in the next quarter century. But I cannot be optimistic that this will be so in the near future. The danger is that protectionist policies, once entrenched, are difficult to reverse. I think that world trade conditions may have regressed rather than progressed in this sense during the past few years.

4. Future Organization of Agriculture

I have implied that U.S. and California agriculture seems to have the capacity to meet projected growth in domestic and foreign commercial demand for food and fiber in the next quarter century. But to do so will require major changes in the organization of agriculture.

Economists in recent years have been talking and writing a good deal about the industrialization of agriculture. In the sense that machinery and other embodiments of capital have been substituting for labor industrialization is really not new particularly in California agriculture. Other aspects of the industrialization process include the trends toward more specialized farming and marketing activities, a tendency to tie these specialized operations together in a tightly coordinated system by means of contracts, direct buying and vertical integration through mergers and acquisitions, the entry of "non-agricultural" firms into farming and increased use of corporate concepts of planning, management and capital acquisition and use.

In this process many of the older established market institutions and marketing methods are being bypassed and made obsolete. New, more tightly coordinated production-marketing systems are being developed. Instead of farmers producing and then marketing they are producing to a market in which product demands are increasingly narrow and specific with respect to price, quality attributes, volume and timing of deliveries, etc. These aspects of organization are perhaps further advanced in California than anywhere else in the world.

Accompanying these changes, indeed making such changes possible, there has been a large increase in the average size of farms and large decrease in the number of farms, farmers and persons residing in rural areas. On the marketing side the same general trends have been evident. Concentration in the marketing system has increased; it has also increased in farming. In fact we really have at least three types of farming based upon size or value of sales:

1. A group of some 223,000 large farms (sales of $40,000 and over) representing only 8 percent of all commercial farms in the Nation but a little over 50 percent of all cash receipts from farming and 36 percent of total realized net farm income.

2. A group of small farms selling less than $20,000 annually totaling 2.3 million or 80 percent of all commercial farms but accounting for only 25 percent of the cash receipts and 30 percent of realized net farm income.

3. In between are about 400,000 farms selling between $20,000 and $40,000 of products annually: 12 percent by number, 25 percent of cash receipts and 34 percent of realized net farm income.

As you know, there has been a high net outmigration from agriculture--over 1 million per year since 1950. Nationally the farm population represents 4.6 percent of our total resident population and even less in California. The rural population is down to about 50 million--about 25 percent of the total. Significant problems reside in those changes: overcrowding of urban areas, depopulation of some rural areas and poverty (a little over one-half of all persons living below the poverty level of $3800 are in non-metropolitan areas). What does the future portend? If it is assumed that industrialization of agriculture continues along the paths of recent decades, what might we expect in 2000?

Again on the basis of some large assumptions and simple techniques, we have made the following projections assuming continuation of trends of recent years:

1. There would be about 900,000 farms in the U.S. instead of the 2.9 million of today.

2. About 600,000 farms would be commercial: the balance would be part-time, part-retirement, etc.

3. About 150,000 of the 900,000 would be very large farms (likely incorporated) selling $100,000 and over per year; about 65 percent of national output would come from those 150,000 farms.

4. For the U.S., farms might average about 1800 acres vs. current 370 acres.

5. Average capital investment per farm would increase several fold to well over a million on commercial farms.

6. Farm employment might total only 1 1/2 million compared to 4 1/4 today.

7. Net income per farm (commercial) might average about $23,500 in 1971 dollars vs. $15,000 today.

I do not have comparable projections for California, but I would expect changes of comparable magnitude. In addition we might expect:

(1) land ownership to become increasingly divorced from the operating function--i.e., farmers would concentrate on acquiring machinery and equipment and renting land;

(2) large numbers of incorporated operations and much more extensive use of public security markets as a means of acquiring capital;

(3) a well organized farm labor force but a smaller, more permanent labor force;

(4) virtually all of our fruit, vegetable, poultry production to be produced under contract and large proportions of our fed beef, cotton; open markets for these products will have disappeared; instead we will have negotiated prices;

(5) large cooperatives on various kinds of joint ventures with large private food processing and retailing firms;

(6) collective bargaining between labor and farmers and between farmers or their cooperatives and food buyers;

(7) a large growth in the management service industries for agriculture: accountants, lawyers, computer information specialists, tax specialists.

In brief, it would be a very efficient, highly capital intensive, industrial farm sector--a sort of huge factory-like system in which a variety of inputs are transformed into output under scientifically managed arrangements tightly coordinated to meet the exacting requirements of a massive, mass merchandising retailing system and a huge institutional market.

4. Some Policy Questions

These seem to me to be some of the possible dimensions of agriculture in 2000 if current trends persist. But will they persist? Do we want them to persist? I have my own views on these questions. I am sure most of you do. Let me conclude by raising a few policy questions for you to reflect upon:

1. Will we need programs to regulate size of farming operations? To control who enters farming?

2. What will be an appropriate rural-urban population balance? How do we get it and maintain it?

3. What would be the appropriate role of government in the kind of agriculture I have projected? Do we need several different types of programs to deal with the problems of different types of farms and farmers?

4. What kind of policies do we need to enhance environmental quality yet not destroy the economic viability of agriculture?

5. Do we need policies to regulate land use on a state or national basis? To regulate water development and use nationally?

6. If we want to maintain large numbers of independent farmers, how do we do it? At what rate are you prepared to substitute efficiency for improved environmental quality? for a different rural-urban population balance than the market forces would dictate?

7. What will be the role of public agricultural research and educational institutions in 1980? in 2000?

8. Who pays, how much and who benefits, how much from the kind of agriculture I have projected to 2000? or for any other configuration of agriculture that you would prefer?

The questions are easy. We must begin to reflect more seriously upon them.

WATER QUALITY AND THE ENVIRONMENT
RELATING TO AGRICULTURE*

Jerome B. Gilbert
Executive Officer - State Water Resources Control Board

In its efforts to keep California's water quality high, the State and Regional Water Quality Control Boards have been giving increased attention to agricultural operations. We are aware that more than 85 percent of the State's diverted water is used for agricultural pursuits. We know that an effective water quality control program must cope with wastewaters produced from this prodigious industry. Accordingly, both the State and Regional Boards have added agricultural expertise to their staffs, and nearly a year ago the State Board formed the Agricultural Water Quality Advisory Committee, consisting of agricultural leaders throughout the State, to advise the State Board in matters of agricultural wastes. Recommendations from this Committee are expected early this year. Meanwhile, considerable progress in solving the problems of agricultural wastes has been made, as will be described later.

Agricultural wastewater problems can be separated into three distinct categories. These are:

1. Pesticides

2. Solid wastes

3. Salt balance

Pesticides

Happily, there has been considerable progress in solving pesticide problems since the Porter-Cologne Act became effective. For example, you may recall that two years ago some commercial catches of fish were seized in Southern California because they contained high concentrations of DDT. Reports by state and federal agencies showed alarmingly high concentrations of DDT in anchovies and other marine species off the Southern California coast. Agricultural applications of DDT were blamed for the DDT in the ocean and a ban on DDT was advocated. Investigation by the State and Regional Boards, however, revealed that the probable source of the high concentrations of DDT was not California agricultural but industrial and municipal waste discharges. After having identified the source of the problem, the Los Angeles Regional Board and the State Board, working with the Los Angeles County Sanitation Districts, succeeded in eliminating more than 80 percent of the DDT in the Los Angeles County wastewaters. We believe that virtually complete elimination is in sight. As a result, preliminary indications are that concentrations of DDT in the flesh of some species of marine life may be substantially reduced from 1970 levels.

Solid Wastes

In the past two decades, profound changes have occurred in California's livestock industry. For one thing, the per capita consumption of beef in the United States has nearly trebled since 1955. For another, cattle feeding, dairying, and poultry ranching have evolved into highly concentrated operations with large numbers of animals on limited acreages. For a third, increased labor costs have modified both the handling and disposal of manures. The changes often result in waste discharges that are not amenable to traditional types of control. Some examples are: dairy barns that once were cleaned by hand but are now flushed clean with large quantities of water generating quantities of manure-laden water that did not exist when hand cleaning was the mode; beef cattle being fed in lots containing more than 50,000 head; more than a quarter million laying hens housed under a single roof on small acreages, and more than 120,000 dairy cows concentrated in an area of Southern California of only 12,500 acres.

Enormous amounts of manure, bedding, water, and miscellaneous solid wastes are generated by these large numbers of animals in confinement. For example, one cow produces about the same amount of manure as 15 people. If, therefore, you could imagine a city of nearly two million people with no sewers or sanitary facilities, you get an idea of the size of the solids disposal problem in the Chino area of Riverside and San Bernardino Counties. To make matters worse, manure has fallen into disfavor as a fertilizer. Most of you know better than I that synthetic sources of fertilizer nitrogen are more uniform in composition, easier to apply, and more easily transported and stored than manures. You agronomists have usually recommended that farmers can no longer pay as much as they once did for manure as fertilizer. The market has dried up to the extent that some livestock managers are no longer asking "How much can I get for the manure?" but rather "Where can I get rid of the stuff?"

During the past year and a half, the State Board has been seeking answers to some of the solid waste disposal problems. The Board has sponsored research by the University of California into the effects on groundwater of ponding the liquid wastes from poultry ranches. That research has been completed and, as a result, farm advisors will be able to make recommendations regarding holding ponds that will provide a means of handling manure without polluting ground or surface waters. The Board is supporting other projects, some of which are rather novel and exciting. For example, an impervious membrane, placed beneath the manured area, which could make it possible to recapture the water after it has been purified by nature's filter, the soil.

Vexing as the problems of solid wastes are, they pale when compared to the problems of salt balance and mineral pollution. You, as agronomists and soil scientists appreciated the enormous problems of salt buildup that must be solved if we are to have permanent irrigated agriculture in California. All irrigation water contains some salts and evapotranspiration concentrates those salts. The saline soil solution, which inevitably concentrates, must sooner or later be leached out of the root zone. These saline leachates commonly percolate through the soil until they reach groundwater. Sooner or later they will be pumped, used for irrigation, leached and so on. This cycling process causes the groundwater to become more and more saline. Some areas of the State are further along in this cycling process than others. For example, the Orange County basin, which once contained excellent quality water, is now yielding some water as high as 1,000 mg/l total dissolved solids. The fact is that although some other basins are degraded very little at this time, every groundwater basin south of the Tehachapi Mountains and every groundwater basin in the San Joaquin Valley is receiving more salt than it surrenders. Engineers refer to this condition as adverse salt balance. In the San Joaquin Valley, there are reliable estimates that only about 40 percent of the salt in irrigation waters is being transported to the ocean. About 2.6 million tons of salt are accumulating each year in the great center of food production. Inexorably, this accumulation of minerals will cause the flow of the San Joaquin River to become saltier as the years pass. Protection of these waters and the water of the Delta is the responsibility of the State Water Resources Control Board. Provisions must be made to halt the degradation of the water going to the Delta. This can best be done by attacking the fundamental problem, which can be done by bringing about adequate subsurface drainage for agriculture. Some drainage districts have been formed and are constructing works in the Central Valley. At this time, one of the outlets available for their drainage water is the San Joaquin River. Control of this discharge presents a sticky problem. It goes like this: a drainage district has a discharge which contains, say, 2,000 mg/l total dissolved solids. Assuming that we want the River to be no saltier than 1,000 mg/l TDS, we might tell the discharger that he must somehow improve his discharge to that extent. What is his most likely recourse? Left to his own devices, he will probably pick up nearby good quality surface drainage which has heretofore fed the River during summer months and use those good quality tail waters to dilute his tile drainage. He will wind up meeting the discharge requirements, but what has been gained? The overall salt content of the River will be the same if he saves his money by permitting that tail water to flow into the River the way it has always done, then dump his undiluted tile drainage into the mix. An unfortunate side effect of a requirement encouraging dilution of tile drainage is that overirrigation and consequent leaching of nitrate and earth minerals would be intensified, further degrading the River. Another approach might be to require the discharger to pump groundwater for dilution. This is a repugnant idea from the standpoint of conserving the waters of the State. A third, and perhaps better, idea might be to encourage the discharger to store the drainage water during those summer months when the River is high in TDS. He could then discharge in the water during times of flood flows. However, the controls are applied to agricultural waters in the San Joaquin, the salt that is accumulating in the valley must be moved out. The only practical sink for the salt is the ocean. It makes no sense to talk about such things as desalting in such a situation because even if we could economically desalt agricultural drainage water, we would still be faced with disposal of the salty brines.

The Imperial Valley of Southern California presents unique problems. There, the Salton Sea has been used jointly as a sink for agricultural wastewater and for recreation. Fish and Game experts now tell us that the Salton Sea will soon be so salty that game fish cannot survive. The influent agricultural wastewaters are considerably better quality, in most respects, than the water of the sea. Thus, it would be irrational to shut off the agricultural wastewater, even if we could. It appears that one solution may be to sacrifice part of the sea where the saltiest brines would be stored and evaporated and thereby save the other larger part. Other possibilities may include desalination with geothermal energy, but this possibility seems further away in time.

Many of the control considerations for agriculture wastes will hinge on the recommendations of the Agricultural Water Quality Advisory Committee. However, some things are quite certain:

1. There must be increased control of agricultural waste discharges.

2. There will be an acceleration of research on agricultural waste problems.

3. Control of water quality in the San Joaquin River will become more difficult as time passes and farmers will likely be restricted as to drainage until a master drain is available.

4. Increased attention must be focused on protection and/or rejuvenation of groundwater basins. This could mean restrictions on some farm operations.

Looking into the future, it is possible that the present enthusiasm of the public for clean water may wane as the costs become apparent in terms of dollars, in terms of individual freedoms and in terms of local unemployment. However, it is not likely that the State of California will knowingly take any backward steps in its efforts to enhance the quality of the waters of the State. It is more likely that with or without public enthusiasm, the State and Regional Boards will increase their control over those agricultural waste problems that arise from time to time. In view of the size and complexity of the agricultural industry in this State, it is likely that farm groups will at least be given the opportunity to regulate themselves. I, therefore, earnestly solicit the cooperation and assistance of you, the leaders in the agronomic sector. Be informed of the activities of the State and Regional Boards and inform your farmer friends.

With such a complexity of problems, it must be obvious that the State and Regional Boards, with their limited staffs, cannot possibly attack all problems at once. You would be perfectly justified, then in asking about priorities: where will the first efforts be made? The answer, of course, can be made best in terms of emphasis. Statewide, the greatest early emphasis will be on wastes from confined livestock operations. No doubt, 1972 and '73 will see considerable control of dairies, feedlots, chicken ranches, as well as other livestock operations. Running a close second may be control of drainage district discharges, particularly those in the San Joaquin Valley. Nutrient problems from various sources must be controlled to prevent excessive algae growth and eutrophication in surface waters. The problems of overall salt balance are, by their nature, ones that will take time, and most of the efforts in the immediate future will be in the area of research.

It has taken several decades for California's problems to reach their present state. The State and Regional Boards have no intention of taking brash nor ill-considered action to attempt corrections. We must keep in mind, however, that Uncle Sam's EPA is standing by, ready to take over if we fail. But, even if there were no EPA, we would have no intention of letting down. The Board needs the cooperation of you, the agricultural leaders. We invite you to join with us to enhance the waters of this great State.

AIR QUALITY AND ENVIRONMENT AS RELATED TO AGRICULTURE

John A. Maga
Executive Officer - California Air Resources Board

Three main concerns in California over air pollution are its effects on health, its damage to vegetation, and a reduction of visibility. The only reason for the existence of an official state agency dealing with air pollution is to try to mitigate these problems.

One of the most striking social movements in recent years has been the tremendous growth in interest and concern over the quality of our environment, with accompanying demands that often seek drastic solutions in very short periods. This movement has already caused many changes in attitudes in the public, scientists, governmental agencies, and legislative bodies. Universities are competing in efforts to establish programs in environmental control, and governmental agencies often strive to show, even if not in the control business, that they are in the forefront of this rapidly developing effort, promoted by the public, students, conservation groups, citizen organizations, newspapers, television, and politicians. Even the polluters, those affected most directly by all this control effort, have jumped on the bandwagon and are all for clean air and clean environment. New journals have been established. Almost every scientific organization has emphasized environment, and many programs now deal with environment. Perhaps the best weathervane of all is the number of newsletters established in recent years to inform government and industry of the tremendous changes taking place in legislation, regulation, and developments in this field.

Concern over the environment, of course, involves many other things besides air pollution, or pollution of the air, water and land. There has been concern about the coastline, about the rivers, about wilderness areas, about subdivision of rural lands, and so forth. But a good deal of concern over environmental quality is over the disposal of wastes--wastes into the air, wastes onto land, and wastes into water.

Much of the interest and emotion and controversy at this time centers on air pollution. The reason is probably the way we handle such wastes. Liquid wastes and solid refuse are collected and disposed of in a place removed from the public, so that there is no day-to-day contact with the place of disposal. With air pollution, however, wastes discharged directly into the atmosphere linger around us. Eye irritation is there for everybody to feel, and loss of visibility for everyone to observe. Air pollution has become a much more public and emotional issue. All of this interest and activity is part, I think, of a wind of change which at the moment is so strong that it's really difficult to grasp the full significance. It is very likely, of course, that these winds of change will abaste somewhat. Indeed, in recent months we've been hearing a few voices of caution that we are perhaps going too fast and ought to pause to take stock. But these voices are only cautioning us to slow down. It is safe to say that these winds will continue to some degree, and that changes will result.

The changes that are occurring are certain to bring about a reduction in levels of pollution. However, at the same time this great emphasis on extending air pollution control throughout the land will impose controls on the grower of crops. There already is considerable evidence that attitudes about the control of air pollution have changed. For example, recent state and federal legislation tends to set emission requirements statewide and nationwide. It doesn't matter where you are. The same emission requirements apply to a new plant, whether built in a rural part of California without very severe air pollution problem or built in the center of Los Angeles. What we are saying more and more, is that no one should discharge pollutants into the atmosphere without putting in controls that are defined by the best available technology.

Even in the more rural areas of California people are concerned about air pollution and complain about it. Recent experience has indicated that the problem of agricultural smoke from rice stubble burning is viewed by people in the northern state as a serious air pollution problem. For example, one day when we had forecast a burn day, smoke blew into the Sacramento area. You can't believe the number of calls of complaints and letters we got about this. This has nothing to do with photochemical air pollution; this is smoke, pure and simple. However, this is not only a public reaction. The air quality standards that have been developed also requires us to the control smoke emissions. So, very stringent air quality standards have been set for particulate matter--that is, the dust and smoke in the air.

The first concern about air pollution developed from the discharge of individual industries around the turn of the century when large industries were being constructed and emissions from these industries affected both people and vegetation nearby. It was easy to identify crop damage due to emissions from chemical plants, smelters, and other fairly large industrial operations. One could identify the pollutant that was discharged, like sulfur dioxide or fluoride, and in turn recognize typical damage on the plant. Much of the reason for air pollution control studies around the turn of the century was due to damage to agriculture.

This, in turn, led to a very extensive study of the problem of vegetation damage in the San Francisco Bay Area by the famous Selby Commission. That Commission, near the turn of the century, undertook what is recognized as a classic study of damage to vegetation from sulfur dioxide (sulfur dioxide was being emitted from the Selby Smelter, located near the Carquinez Bridge). It led to extensive controls of sulfur dioxide at the plant as well as the construction of very high stacks to dilute the waste. In fact, that was the highest stack in the United States for many, many years. Sulfur dioxide was a source of damage frequent enough to lead to the development of the first good instrument for monitoring sulfur dioxide in the air. This instrument was the forerunner of other instruments for measuring pollutants on a continuous basis.

This pattern of discharge from one plant and the damage to specific crops changed radically in the mid 1940's in the Los Angeles area. At that time Los Angeles experienced a type of air pollution never known before, but too well known since. Public reaction was extremely widespread, because of eye irritation. At the same time there was extensive damage to broadleaf crops. This type of damage, observed by Dr. John Middleton and his co-workers at the University of California, had never been identified before. In 1951 Dr. A. J. Haagen-Smit, Chairman of the Air Resources Board, demonstrated that the new type of damage was the result of photochemical reactions; reactions that were taking place in the atmosphere between hydrocarbons and oxides of nitrogen. The concentrations of hydrocarbon and nitric oxides in the atmosphere were not toxic. When they reacted in the atmosphere, however, they produced extensive damage to broadleaf plants in the Los Angeles area. These findings were to have far-reaching effects from the standpoint of air pollution control. They brought into the field many scientists who had never before worked in air pollution control. Plant pathologists became far more interested in air pollution control. They brought into the field many scientists who had never before worked in air pollution control. Plant pathologists became far more interested in air pollution than they had been before, and meteorologists became more involved. Larger air pollution control agencies resulted.

The pattern of air pollution control agencies started to change in about the mid 1940's. Prior to that time, most air pollution control agencies had consisted of smoke inspectors in the eastern United States. These individuals were concerned with the discharge of smoke from improperly operated boilers or the combustion of low grades of coal. One of the most significant developments from the Los Angeles experience was the identification of the automobile as a major cause of the problem. This started a very complicated and difficult program for the control of emissions from motor vehicles in California. It added a whole new dimension because of the large number of sources involved. Always in the past, control of air pollution, and even of water pollution, was directed at individual discharges--cities or industries, where you're usually talking of a few thousand sources. There are something like 13 million registered vehicles in California, and over 100 million motor vehicles in the United States. The problem is doing something about these large numbers of motor vehicles and extending controls over how they are operated. Instead of an adverse effect being felt in one area now, the effects are felt in very broad areas over the whole south coast basin and large parts of California.

The air pollution problem was really related more fundamentally to how our society had developed. Not only did cities grow because of a natural increase in population, but large numbers of people moved in from rural areas and California grew with a great influx from other states. Shortly before World War II about half the people lived in metropolitan areas. Now the proportion of people living in metropolitan areas is more like 75%. It is projected that before long about 80% of the people will live in metropolitan areas. Thus, people have concentrated into a very small percentage of the total land surfaces. The industry and the automobiles have also become concentrated in the same small area, creating a pretty good mechanism for polluting the air. In addition, the growth in population was outstripped by a growth in affluence and demands for transport, petroleum products, power, electricity, and goods. Emissions from the effort to produce more goods and transport produced a growth in wastes that actually increased much faster than the population. For example, in California the population has been doubling about every 25 years, whereas the demand for electricity doubles about every 8 or 9 years. Through an expanding affluent society we've created a good system for producing a lot of waste.

This concentration of pollutnats in an air mass has affected broad areas of California. Instead of sulfur dioxide damage we have identified damage such as that due to ozone or oxidant or peroxyacyl ntirates (you may know it better as PANs) over much of California. As you would expect, the severity of the problem varies pretty well with the population. The problems are most severe in the south coast area, the San Francisco Bay area, and the San Diego area. This is true throughout the United States and the rest of the world. The severest air pollution problems are in places such as London, Tokyo, New York, Chicago, Los Angeles, and Mexico City.

One of the things that has resulted is the potential for causing considerable damage to vegetation over wide areas. Perhaps the best example of this is the polluted air mass caused extensive damage to the pine forest in the San Bernardino Mountains. As the wind blows to the east the air flows up the side of the mountains and exposes the pine forest to the photo chemical smog products.

This communitywide air pollution problem developed during a period of growth from around the turn of the century. It is not due to simple causes, so we will not be able to solve it overnight. Much of what is desirable in life--high standard of living, freedom to move in individual cars, air conditioning in our cars and homes, abundance of consumer goods--are the result of technical developments of man in industry and the utilization of the emergy in fossil fuels to do much of the work for us. This desire seems to be at cross purposes with our desire to have clear air. I doubt that society is very likely to give up most of what it has achieved through the technical developments of man, and also is unlikely to give up its demand for better air quality. The answer to this dilemma must be found in a better balance between these two desires.

This dilemma is probably best illustrated by the burning of fossil fuel--that is, natural gas, oil, or coal. The heart of the air pollution problem is the burning of fuel to create energy, to drive industry, operate your car, and produce electricity. Everyone expects that the fossil fuel demand will continue to increase. A number of agencies in government have estimated that the United States' energy requirement will increase by 260% in the next 30 years. Some of this incerase is going to come from nuclear fuel, but most will come from fossil fuel, posing a difficult technical challenge if we are to reduce air pollution levels below what they are now.

The past few years have seen extensive changes in laws, expansion of control agencies, and inauguration of numerous control measures. I would like to cover some of the items that are involved in this and tell you a little bit about the functions of the Air Resources Board.

The Air Resources Board's role is to divide the state into air basins that have similar topography and meteorology for air pollution control. We've divided California into 11 air basins, quite similar to the 9 areas of the Water Regional Control Borad. We were required to set air quality standards for these basins, in an effort to define a level of air that will not have adverse effects. This has been done. Once these standards were adopted, it is incumbant upon the Board and local agencies to design control programs to meet these standards. A major program we have is that of motor vehicle emission control and this has been our most difficult and complicated undertaking. The Board maintains an air qualtiy network to determine air quality through the state. We also conduct research in the area of motor vehical emission control--a $9 million program over three years. If our air quality standards aren't met in local areas and the local people don't design a program to meet them, then the Air Resources Boeard must assume that authority of local agencies, establish emission requirements, and see that the standards are met. This program is just going into effect. As a matter of fact, implementation plans of local agencies are required to be submitted to the Board by the first of the year.

Somewhat the same kind of a program is found at the federal level. The federal government sets quality standards, divides the United States into control regions, requires the states to submit implementation plans to meet their standards, and has the authority to come in control emissions and do it if we don't do it properly. We are now right in the middle of developing implementation plans in California to meet the federal standards. These plans must be submitted by February 1 of this year. Our problem in developing a satisfactory plan is the result of two things. One is that the federal government has set air quality standards near background levels and, therefore, the addition of very little pollution exceeds the standards. The second thing the federal government has done is set a time schedule of three years for meeting these standards. The two requirements are simply not compatible in our large metropolitan areas. We see no way of achieving some of the standards within three years in placed like Los Angeles without depopulating the area. For example, our estimates are that if we control motor vehicles the best we can by putting on smog devices, if we convert large numbers of vehicles to gaseous fuel, if we put the strictest possible control on stationary sources, we would still have to reduce vehicle traffic by 90% if we are to approach the oxidant standards within three years.

Something is obviously going to have to give, but you can still expect strict control of emissions. The standards may be changed and the time extended, but there still remains a demand to control pollution which will bring about large reductions in motor vehicles or or changes in the transportation patterns.

Now, what are we doing to control motor vehicle emission? Starting in 1963, California required a crank case devices on new cars. Today, virtually all cars in California have crank case control devices which remove about 25% of the hydrocarbons. In 1966 California required the control of hydrocarbons and carbon monoxide from exhaust. In 1970 California required the control of evaporative losses from automobiles. This reduces about 10 or 15% of the hydrocarbons. In 1967 California required the control of oxides of nitrogen from new cars. A new car as sold today represents about an 85% control of the hydrocarbons, 70% control of the carbon monoxide, and 30% control of the oxides of nitrogen--we've just started on oxides of nitrogen. For the period 1970 to 1975 the motor vehicle emission standards in new cars become more strict. If the standards are met in 1975, the vapors displaced from the gas tank will exceed the exhaust hydrocarbons exhausted from cars.

You have probably either read or heard that the auto industry has said the 1975 emission standards can't be met. The National Science Foundation recently issued a report that the auto industry may not be able to meet the 1975 standard and that it is unlikely they can meet the 1976 standards for oxides of nitrogen (the 1975 standards are for hydrocarbon and carbon monoxide). In such case, the administrator of EPA must set interim standards that the industry can meet. If the standards I mentioned won't be met, then some other type of very stringent standards will be met. What does this mean for cars? It is going to add at least $300 to the cost of the car, you may use 10-15% more fuel, and cars are not going to have the zip and pep they have now. There is concern that new cars mass produced at assembly plants do not have low emissions when they are new. As a result, California has required that every car sold in the state starting January 30, 1973 will have to be tested at the assembly plant for emission control to insure they comply with emission standards. We are really getting tough.

The next question is what to do about cars operating on streets and highways. Studies by the Air Resources Board show that emissions from these cars can be reduced by periodic maintenance. There are many questions still to be answered on the best kind of air inspection program for emissions control, but I think that before long we're going to have mandatory maintenance programs for motor vehicle emission control.

Steps are also being taken to control nonvehicular sources. Local agencies have recently submitted implementation plans to the Board which include a number of new requirements. Many of the regulations prescribe a Ringlemann I from stacks. Ringlemann II is a common standard now, so additional controls will be needed to meet a Ringlemann I standard. More extensive control of organic solvents are being proposed in larger metropolitan areas. This regulates the kind of paints that can be used, many of these regulations are designed to change from reactive hydrocarbons to nonreactive hydrocarbons in solvents. Other regulations cover the loss of gasoline vapors at refineries and storage tanks. One of the most significant and newer rules being adopted deals with the emissions of oxides of nitrogen from power plants. Such rules in Los Angeles and Orange Counties are preventing the construction of power plants in those counties. The Air Resources Board's policy is fossil fuel power plants should not be built in our large metropolitan areas; we ought to build nuclear plants. This is at odds with the people who attack nuclear plants because of safety.

In rural areas more and more attention will be focused on problems of disposal of agricultural waste. The main problem of agricultural waste, as related to air pollution, is the burning of crop residue. Even today, steps have been taken to deal with this problem. Recently enacted legislation requires the Air Resources Board to predict days of burn and no burn. Farmers can only burn agricultural wastes on selected days. We have been doing this in six air basins and will extend the program statewide this year. As a part of this effort, the Board is funding research to try to find alternate means of disposal of agricultural wastes. Some of this work, of course, is also being funded by the agricultural industry.

As you can see, we are getting to the point where we are running out of ideas on how to invoke further controls by technological means. Further large reductions in emissions will probably require some social changes. An example of such a change is in transportation. What we really need in metropolitan areas is a coordinated transportation system that balances individual car use and public transportation, and speeds up traffic movement. A transportation system for metropolitan areas should be aimed at reducing the number of vehicle miles driven. Another example of social change is the emphasis on nuclear instead of fossil fuel power plants in large metropolitan areas. We are thinking about periodic inspection and maintenance of motor vehicles and land use planning. You can see, that air pollution control is approaching the point where society must judge if it wants all these changes and if the costs are going to be too high. None of this is going to be cheap or free; it is going to cost money.

Happily, air pollution isn't getting worse all over the state of California. There are some places where air pollution levels have increased. Typical places are Riverside, Livermore and San Jose. All places that are growing rapidly. However, particulate matter throughout California is a little lower than it was five years ago. If you consider all of the stations in the San Francisco Bay Area and the south coast area carbon monoxide and oxidant have been decreasing. This decrease will continue as more emission control goes into effect.

I think the people have spoken, and it is my belief that, by and large, government has responded. To some, these efforts have seemed divided and may not seem to get the priorities they deserve. I think this is really the priorities that society has to decide. We might think about what Napoleon once said about how to defeat an army. He said, "You can't defeat an army. First you must defeat a squadron, then you defeat a platoon, then a company, then a battalion, and then there is no army." I think in the case of air pollution, and other environmental problems, one must also attack the problems pretty much on a case by case basis.

RESEARCH ON AGRICULTURAL WASTES

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Agricultural wastes may be considered to fall into three major categories: 1) Wastes resulting from harvesting only the most valuable portions of crops; 2) wastes arising from the processing of food crops; and, 3) wastes associated with the raising of economic animals. Considerable experience in food process development, and in the utilization of field crops (cereal grains, rice, forages), has pointed WRRL's research efforts at harvesting and food processing wastes.

For wastes from processing operations, emphasis is on reducing the quantities of wastes produced, rather than on their treatment; i.e., "preventive waste management." Exemplifying this approach is the "dry caustic" peeling process which was developed for white potatoes. The process modification greatly reduces effluent BOD, and increases substantially the yield of product (equipment costs are quickly recovered). The small amounts of peel wastes produced are used in cattle feeds. It has been successfully adapted for use on carrots, sweet potatoes, table beets, pears, apricots, cling and freestone peaches. Commercial demonstration and adoption of the "dry caustic" peeling process were greatly facilitated by the Federal Water Quality Admin, the National Canners Assoc., and private industry. Studies of the food processing industry reveal that by modification of various operations, major reductions in water usage are possible. Systems are being developed for reducing wastes in blanching and cutting operations, and for reclaiming salt brines.

The problem of harvesting wastes is being attacked in a number of ways. An example is the development of field processing of tomatoes, a crop whose waste disposal problems have been magnified by mechanical harvesting. A process was developed for making hot-break tomato juice at field locations prior to transport to a central plant for final processing. By eliminating the long delay between harvest and initial processing, a spoilage loss of about 10% is avoided. Acid treatment of the hot-break juice, another modification, further increases product yield. The solid wastes from field processing can be readily returned to the soil, and liquid wastes may be disposed of through irrigation. Waste disposal problems at canneries are significantly reduced. Many harvesting wastes are essentially irreducible and, for these, acceptable disposal systems must be devised. Plant residues, such as straws and stubbles are most easily disposed of by incorporation into the soil. Where soil structure does not permit this practice, and where field incineration may be banned, major disposal problems arise. This is the case with rice straw in the Central Valley of California, and the grass seed producing acreages of the Willamette Valley in Oregon. Research is in progress to convert a variety of cellulosic wastes (straws, sugarcane bagasse, and oilseed hulls) into higher energy ruminant feeds and, thereby, offset ever-increasing costs of disposing of these wastes.

NITRATES IN THE UPPER SANTA ANA BASIN

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Extensive groundwater supplies in the Santa Ana Basin constitute a valuable resource which must be protected from excessive degradation if long-term beneficial use is to be realized. Nitrate in some of the basin's well waters already exceeds 90 mg/1, well in excess of drinking water standards of the U.S. Public Health Service. A multidisciplinary approach was used for analyzing problem areas of high nitrate concentrations in the groundwaters. Scientists and engineers from the Agricultural Experiment Station and the Agricultural Extension Service took part in the study.

The specific objectives included a review of available data to identify and quantify existing high nitrate concentrations in groundwater; a review of the history of land and water use; waste disposal, and other practices in each problem area to form judgments on causes of the high nitrate concentrations; and a development of guidelines for rates of fertilization, water application, and animal waste disposal which will appreciably reduce the potential for nitrogen pollution of surface- and groundwaters of the basin consistent with reasonable levels of agricultural production.

High concentrations of nitrate in the groundwater were identified in the Bunker Hill basin, Middle and Upper Chino basins, and the Riverside-Arlington basin. In each of these basins, early land use patterns were examined in relation to crop acreage, populations of humans, cattle and poultry, and waste disposal systems. Nitrate movement within the soil was related to soil properties, fertilization rates, crop production, and water use. For citrus and vegetables, nitrate concentrations were measured in the soil profile below the root zone.

Guidelines for controlling the pollution of the groundwater with nitrates were formulated based upon kind of crop, amount and timing of fertilizer application, crop water requirement, and leaching fraction. Considerations were also given to the recycling and disposal of animal wastes.

NITRATE IN THE UNSATURATED ZONE UNDER AGRICULTURAL LANDS

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During the past three years we have determined the NO_3^- concentration in the water in the unsaturated zone between the root zone and the saturated zone, or water table, in 27 sites in the Chino-Corona dairy preserve and in 25 sites in citrus and row-crop fields outside of the dairy area. All sites were in the Santa Ana River Basin. Objectives were 1) to relate the NO_3^- in the water moving through the unsaturated zone to N input rates and 2) to develop an approach to the prediction of NO_3^- leaching based on soil profile characteristics and water and crop management.

Financial support for the project from the Water Quality Office of the Environmental Protection Agency and from the Kearney Foundation of Soil Science of the University of California made the work possible. Help of W. W. Jones, V. E. Hunsaker, D. Adriano, F. Takatori, O. Lorenz, and S. E. Bishop is gratefully acknowledged.

In the dairy preserve the average NO_3^--N concentration was 70 ppm. The NO_3^--N concentration in the top of the saturated zone encountered at depths from 65 to 100 ft varied from 14 to 200 ppm as compared to about 6 ppm NO_3^--N in water from wells where water came from depths of 150 ft or more.

The average cow density in the dairy preserve was about ten per irrigated acre on which manure was disposed. Thus, we can equate the waste from ten cows with 70 ppm NO_3^--N in the unsaturated zone. Our estimate of the N balance is as follows; 1) one-half of the approximately 1460 pounds of N defecated by ten cows in a year was lost by volatilization as NH_3, 2) the other half, or 730 pounds N per acre, was incorporated into the soil, 3) crops recycled 265 pounds N per acre per year leaving an excess of 465 pounds per acre per year in the soil, 4) one-half of the excess N was lost by denitrification or was incorporated into the organic N pool leaving 232 pounds N in the NO_3^- form, and 5) this NO_3^- was dissolved in the water leaving the root zone at a leaching fraction of about 30 percent giving an average NO_3^--N concentration of 70 ppm. Our estimate was that the land had an overload of at least 100 percent and that the load should be reduced to about 3 to 5 cows per acre.

In the analysis of the data from citrus and row-crop fields where commercial fertilizers as well as animal wastes were used we assumed that NO_3^- moved at the same rate as the drainage water and that the amount of N in the organic pool was constant. Drainage volumes were estimated from the equation

$$D = \frac{\overline{LF}\,\overline{ET}}{1-\overline{LF}} \qquad [1]$$

for citrus fields, where D is the drainage volume in surface cm per year, $\overline{LF}$ is the leaching fraction calculated as the ratio of the Cl^- concentration in the irrigation water to the Cl^- concentration of the drainage water and $\overline{ET}$ is the evapotranspiration in surface cm per year. In row-crop fields D was estimated as the product of the volume of irrigation water used and the $\overline{LF}$.

The transit time for water and NO_3^- to move through the soil was calculated from the equation

$$T = \frac{S\theta}{D} \qquad [2]$$

where T is the transit time in years, S is the depth of the soil in cm, θ is the volumetric water content, and D is the drainage volume in surface cm per year.

The NO_3^--N concentration in the unsaturated zone was calculated from the equation

$$NO_3^- = \frac{10\ N}{D} \qquad [3]$$

where NO_3^- is the NO_3^--N concentration in ppm, N is the N input minus N removal in harvested crops, in kg per ha per year, and D is the drainage volume in surface cm per year.

Transit times for water to move 30 m or 100 ft varied from about 10 to 50 years. Nitrate-N concentrations of 21 to 70 and 36 to 123 ppm in the water in the unsaturated zone were found for citrus and row crops, respectively. Nitrogen balances for citrus varied from 22 to -56 percent of total N inputs where positive values represent net unaccounted-for inputs and negative values are unaccounted-for losses presumably by denitrification. In row-crop fields the N balance varied from 73 to -56 percent. One high positive balance was in a field that had been in a beef feedlot and evidently had a high level of organic N that was mineralizing rapidly.

A plot of the ratio of the predicted NO_3^--N concentration, calculated from equation 3, to the measured concentration against calculated N balance showed that the predicted and measured NO_3^--N concentrations were nearly equal when the N balance was within 20 and -20 percent of the total N input. At greater positive N values the ratios were less than 1 whereas at greater negative values ratios were higher than 1. In most fields with high losses the soil profiles had layers that obstruct water movement and these profiles could be expected to have producted conditions conducive to denitrification.

The dilution factor needed to dilute the water in the unsaturated zone to the 10 ppm NO_3^--N U. S. Public Health Service standard for drinking water varied from 2 to 7 for fields in citrus and 3.6 to 12.3 for fields in row crops. Recommended practices for fertilizer N for citrus are such that, when combined with adequate leaching and good yields, would probably put no more than about 20 to 30 ppm NO_3^--N into the drainage effluent, assuming no denitrification. Recommended practices in row crops would put the NO_3^--N concentration between about 20 and 50 ppm, assuming no denitrification.

FERTILIZER PLANT DESIGN TO PROTECT THE ENVIRONMENT

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Concern across the country over environmental quality control is well known. It is of importance to every citizen of every community. Cooperation between companies to solve pollution problems is increasing and is to be encouraged.

Reasonable standards must be set, and everyone must realize that the cost of meeting these standards will result in increased manufacturing costs which must be passed on to the consumer.

The impact of meeting these emission standards is illustrated by a three phase case history of our Richmond, California plant. The original plant was built in 1956 at a cost of approximately $3,000,000. Pollution control consisted of simple cyclones for the dry dust recovery and a low energy scrubber for fume control from the reactors. This was typical in the industry and represented about 6% of the investment.

Between 1966-1970, the product line was changed, and increased dust loadings were encountered. Also, air pollution regulations were tightened. Wet scrubbers following the cyclones were installed and a high energy scrubber was added to the reactor fume system. This increased the investment in pollution control equipment to 17% of the total investment.

We are now modernizing the plant to achieve better operation and meet the new emission standards. All pollution control equipment was pretested on small scale units and the process was modified to reduce emission at the source. Baghouses are being installed to replace existing cyclones and wet scrubbers on the dust control system. The $1,500,000 investment in pollution control equipment represents about 50% of the new plant investment. What we are doing to protect our environment is probably quite typical of what is being done or will have to be done throughout our industry.

NUTRIENT CYCLING IN FORESTS

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The uptake and storage of the nutrients C, N, P, Ca, Mg, and K on forest sites of 100-year-old lodgepole pine (Pinus contorta Dougl.), 80-year-old white fir (Abies concolor Lindl.), and old-growth redwood (Sequoia sempervirons Endl.) in northern California were studied to determine the distribution and variations of these elements in leaves, branches, wood, bark, and roots of the trees, and in the associated leaf litter, and soil to 1 meter depth. In a related study, the ranges in storage of nutrients in the soil were determined and arrayed by timber site quality classes.

In the first study, representative trees from each stand were felled and sectioned into uniform height increments, and the foliage, branches, wood, bark, and roots were sampled for weighing and analysis along with leaf litter and soil under the trees. All analytical values were converted to storage values and equated as weight in grams per square meter, depending on crown projectional area of the trees. The extractable cations were treated as equivalents per square meter in the trees, litter, and soil. The ranges of nutrients in the soil to 1 meter depth were obtained by analyzing 210 soil profile samples representing 74 California forest soil series.

The proportions of nutrients stored in the soil were generally larger than those in the tree and litter except for P. More than 60% of C on the sites was stored in soil of the high elevation pine and fir sites, while redwood had only 14%. Other soil storage proportions were N--68-83%; extractable cations--80-90%; and P--from 2% in redwood soil to 30% in the others. Litter had more P than other nutrients; with lodgepole pine having the highest at 66% of the site, and the others about 30%. N amounted to 2% in redwood litter and ranged from 15-25% in the other sites. C amounted to 3-12%, and extractable cations 2-9%, being the lowest in redwood litter. As expected, the proportion of C in redwood to the total site was 84%, while the other species had 28%. N ranged from 6-15%, P varied from 50% in redwood to about 34% in the other trees. Cations ranged from 4-13%.

The storage of nutrients, in g/m^2, to the 1 meter depth in forest soils was arrayed in four site quality classes. Results showed that C and N increased as site quality increased and amounts ranged from 9-31 kg/m^3 and from 370-1280 g/m^3, respectively. Water soluble P was lower in both low and high site classes and higher in medium and ranged--16-31 mg/m^3. Ca and K was highest in medium site class and ranged from 37-52 and 3.3-4.9 eq/m^3, respectively. Mg decreased continuously from low to high site and ranged 14-28 eq/m3.

The results of these studies suggest the importance of maintaining an adequate storage of available nutrients in forest soils. If only stems or tree trunks are removed in a harvest cutting of a forest, only 2-5% of the nutrients in the site are lost, except for carbon. Amounts of carbon in wood and bark range from 8-84%. Leaves, branches, and roots left to decompose would return to the soil as additional storage.

CROP RESIDUE DISPOSAL BY SOIL INCORPORATION

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Disposal of crop residues by soil incorporation is as old as agriculture. The high yields and bulky residues associated with present-day farming have made burning of residues an economical and convenient means of disposal. Incorporation as an alternative to burning involves several important considerations, including the following:

1. Ease of handling. In general chopping or shredding greatly facilitates handling and increases rate of microbial attack

2. Susceptibility to microbial decomposition. Most crop residues are cellulosic and readily degraded if particle size is small enough to allow ready access of soil organisms to the residue.

3. Fall incorporation, especially in heavy wet soils involves temperature and moisture conditions relatively unfavorable for decomposition.

4. Survival of plant disease organisms and insect pests may be greater with residue incorporation than with burning.

5. Residue incorporation frequently produces a temporary deficiency of nitrogen and may alter the availability of other plant nutrients.

6. In wet soils residue incorporation may cause production of toxic substances inhibitory to crops if planted shortly after incorporation. Bulky accumulations of residues may cause localized problems over a period of several weeks.

Experiments with rice straw incorporation have shown that contact with the soil is important for effective decomposition. Residues lying on the surface of the soil, when chopped to allow intimate contact with the soil surface, decompose as rapidly as those incorporated if moisture content is maintained.

Addition of fertilizer nitrogen to the residues has only a temporary effect in increasing decomposition of residues, lasting only 3-4 weeks. Even if temperature and moisture conditions are very unfavorable for decomposition during the winter months, a period of 6-8 weeks of favorable conditions is sufficient to permit 40-60% decomposition of rice straw.

Field trials at two locations comparing the effects on rice grain yields of burning rice straw and incorporation by various tillage practices have shown no differences in the first year of operation. It is too early to draw general conclusions, but in areas where stem-rot is not a problem rice straw disposal by incorporation may prove to be a feasible alternative to burning, although at some increase in cost.

THE SAN LUIS DRAIN AND WATER QUALITY

Edgar P. Price

U. S. Bureau of Reclamation, Sacramento, California

The U. S. Bureau of Reclamation is now constructing the San Luis Drain, adequate to meet the drainage requirements of the San Luis Unit, from Kettleman City to the western edge of the Delta near Antioch, a distance of 188 miles. This construction, authorized by the U. S. Congress in 1960 by the San Luis Authorizing Act, was initiated after seven years of an unsuccessful attempt by the Bureau and the California Department of Water Resources to permit the State to construct the first stage of the State's San Joaquin Valley Master Drain.

Kesterson Regulating Reservoir is being constructed as an integral part of the Drain to provide operational flexibility to control discharge into the Delta whenever or for whatever purpose it may be desired or required.

The Drain will not, by itself, drain any lands but will receive, convey and dispose of subsurface agricultural drain flows and thus permit development of on-farm drainage systems and drainage collection systems. Drainage service will be provided to irrigation districts only under contractual arrangements which would preclude discharge of pollutants.

Careful consideration has been given to the possible impact of the drain discharge upon the receiving waters. Studies have shown that salinity, herbicides and pesticides are no problem but questions remain regarding possible effects of nutrients. The Bureau has been engaged in an extensive Delta Surveillance Program and an Agricultural Wastewater Treatment Research Program to help determine the need, extent, method and cost of treating drain flows. The construction of the Drain will include treatment or control facilities to either minimize adverse effects or maximize beneficial effects.

IN MEMORIUM

MR. JERRY W. FIELDER, DIRECTOR OF THE CALIFORNIA DEPARTMENT OF AGRICULTURE AND A PROMINENT LEADER IN STATE, NATIONAL, AND INTERNATIONAL AGRICULTURE, WAS KILLED IN A AIRCRAFT ACCIDENT ON WEDNESDAY, MARCH 22, 1972. MR. FIELDER WAS PILOTING A SINGLE ENGINE AIRPLANE, RETURNING FROM A BUSINESS MEETING, WHEN THE AIRCRAFT WAS APPARENTLY STRUCK BY LIGHTNING, CAUSING THE PLANE TO DISINTEGRATE AND CRASH. HE WILL BE SORELY MISSED.

A NATIVE OF CALIFORNIA, MR. FIELDER WAS GRADUATED FROM THE UNIVERSITY OF CALIFORNIA AT DAVIS. DURING WORLD WAR II HE SERVED TWO YEARS AS A NAVAL OFFICER ON A DESTROYER. HE LEAVES MARY MARGARET, HIS WIDOW AND TWO CHILDREN, MRS. RUSSELL DURKEE AND JERRY FIELDER, JR.

MR. FIELDER GAVE THE BANQUET ADDRESS AT THE FIRST ANNUAL CALIFORNIA PLANT AND SOIL CONFERENCE AND WAS EDITING HIS MANUSCRIPT FOR THESE PROCEEDINGS AT THE TIME OF HIS ACCIDENT. SINCE THE EDITING WAS NOT COMPLETED, HIS REMARKS CANNOT BE INCLUDED IN THE CONFERENCE REPORT.

PLANT BREEDING IN THE SEVENTIES, A NEW CHALLENGE AND OPPORTUNITY

I. J. Johnson
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Nearly all of us in our professional careers as plant scientists either have participated in or benefitted from the development of new theories and practices in plant breeding. It is essential that our profession be creative to assure continued progress, to be analytical to place in proper perspective the alternative approaches to solve a problem, to be aware of responsibilities to our sponsoring agencies and to the public and in the new era of plant variety protection to become "diplomats" to assure strong support and proper coordination of efforts between basic and applied research in public and private research programs.

Historically, the gains made in food production on a world-wide basis have been closely related to progress in crop breeding. This has been true because the transition from old to improved varieties or hybrids has not required large expenditures of funds. Often overlooked is the need to implement the change through an orderly process of seed production, processing and distribution; largely a function of a seed industry. The full values of superior genotypes usually cannot be maximized unless production practices are geared to match genetic potential. Results with maize, sorghum, wheat and rice clearly point the way to new inter-disciplinary cooperation beyond the classic concepts of genetics, pathology and entomology. The ultimate value of a new product also is determined to a large degree on how well it fills a specific need within a dynamic market.

Our goals and opportunities, although clearly defined, may often be difficult to achieve except on a short-time basis. Changes in the complex environment under which crops are grown and in the equally complex uses they must satisfy surely dictate that plant breeding will continue to be a vital force and will challenge the best capabilities of both public and private research programs in the years ahead.

Plant breeding in the seventies will require greater emphasis on "engineering" to more nearly fit varieties to specific uses, both to the producer and to the consumer. New varieties also will need to combine resistance to many pests as a part of the necessity for reducing pesticide uses.

Finally, plant breeders will need to devote part of their efforts in working to achieve a greater level of support for research more appropriately within their respective public or private domain to assure that important objectives do not lack research attention.

CONSIDERATIONS IN RICE BREEDING--PRODUCTIVITY, PROTEIN POLLUTION AND PEOPLE

Howard L. Carnahan
California Cooperative Rice Research Foundation, Inc.; Biggs, California.

In the last decade rice breeders world-wide have emphasized plant type to a greater extent than previously. The improved plant-type consists of non-lodging shorter stiff culms, short erect leaves, and erect profuse tillers. Research has shown the advantage of "sustained growth" types in contrast to "early growth" types. Research on the physiological basis of improved yields through these morphological changes is reviewed.

Progress and problems in utilizing tropical rices as a source of improved plant type in breeding improved varieties for California are discussed.

The heterosis in F_1 hybrids is exciting, but very poor cross pollination as related to flowering behavior and genotype by environment interactions in heading time are major deterrants.

In the F_2 and F_3 from crosses differing in percent protein there was no effect of glutinous vs non-glutinous endosperm on protein of the seed. High protein was correlated strongly with early maturity and low yield.

The development of varieties with smooth hulls and leaves is contributing to a less polluted environment around rice harvesters and mills. If sources of insect and disease resistance can be found and incorporated into adapted varieties this will result in the use of fewer chemical pollutants and perhaps minimize the need for burning the rice straw. Increased grain-to-straw ratio in improved varieties would result in less straw for disposal.

People are an important consideration in rice breeding. In California they are taxing themselves to support an expanded research effort. People of different areas have culinary preferences for rice varieties that are based on the percent of amylose and gelatinization temperature of the seeds' starch. People's taste judgements are also a source of error in taste panels.

NEW DIRECTIONS IN CEREAL BREEDING

C. O. Qualset
University of California, Davis

California winter cereal production--barley, wheat, oats, and triticale--has undergone some rather drastic changes during the past 10 years. In wheat, the severe outbreak of stripe rust (Puccinia striiformis) in 1961 resulted in a rapid change from California varieties to Mexican varieties. The new introductions were resistant to stripe rust, yielded more grain than the California varieties, even in the absence of rust, and had grain qualities that were very different from the widely used California varieties. Although the first Mexican varieties were tall, subsequent introductions with short stature have resulted in even higher yields and improved quality. Most of the California wheat acreage is now planted with varieties derived from the joint program of the Mexican government and the International Maize and Wheat Improvement Center (CIMMYT).

With barley, the "grain revolution" in California began with the introduction of two varieties from the University of California barley improvement program--Numar and Briggs--with improved lodging resistance and about a 10% yield advantage over the varieties widely grown. These yield advances were attained in spite of the lack of resistance to several of the major barley diseases. A more striking improvement in grain yield was evident with the incorporation of yellow dwarf virus resistance in the variety California Mariout. The new variety CM67 has given about 15% yield advantage over its original type and in fields where yellow dwarf was moderately severe much greater increases in yield have been recorded.

Triticale, a new feed grain, appeared within the last 10 years and has come into production, still on limited basis, in California. Many features of the triticale plant suggest that improved productivity might be forthcoming. Based on extensive tests in California, the presently available triticales did not compete well with wheat or barley on a yield per acre basis. Additional plant breeding is underway and genetic improvements in this crop are anticipated.

In view of these developments and the recognition of new problems, it is important at this time to reconsider the objectives of breeding programs for cereal improvement in California. The primary objective must remain breeding for greater genetic potential for grain yield. This may not seem critical in view of the spectacular advances realized during the past decade, but increased yields are needed to meet increased costs of production and also to cope with more recently recognized problems in maintaining environmental quality. A major issue is maximum utilization of applied nutrients, especially in irrigated production. With increased genetic potential for grain production high rates of fertilizer will be used by the plant and problems with nitrate leaching can be minimized. Over-fertilization is common and matching genetic and environmental potentials through careful fertilization is important.

A corollary problem arises through high fertilizer usage--maximizing grain yield generally results in increased straw yield. Soil incorporation of straw presents several problems and it has been most expeditious in many areas, primarily in irrigated valley production, to burn the fields after harvest. The short-statured varieties were believed to produce less straw than the old tall varieties. This was not true with the introduction of the first short-statured wheat varieties such as Pitic 62, Sonora 64, Siete Cerros 66, and INIA 66. However, more recent varieties, so-called triple-dwarfs, have maintained or improved grain yields with less straw production. It is expected that with reduced straw production it will be possible to eliminate burning as a standard agricultural practice. Continued emphasis on short stature is needed in wheat and major breakthroughs with dwarf barley and triticale are anticipated but require intensive research.

Maximizing yield and improving environmental quality have many common grounds through plant breeding. Most obvious is by developing disease resistant varieties so that pesticides are not needed for production. With the exception of chemical seed treatment to control some diseases, it has not been economical to use fungicides on winter cereals in California. Now, however, mercury-based seed treatment compounds can no longer be used, thus control of Helminthosporium stripe, covered smut (bunt) of wheat, and possibly some fungi associated with root rots will have to be facilitated in other ways. This presents a particularly urgent need in wheat since the Mexican varieties now widely used are susceptible to bunt, whereas the California varieties which they replaced were resistant.

When considering breeding for maximum yield a broader view of losses due to diseases and insects is needed. Research is critically needed in wheat and oats to identify sources of resistance to the barley yellow dwarf virus. Continued emphasis is needed on stripe and stem rust resistance in wheat even though present varieties are resistant to the now prevalent races. With the imminent widespread use of triple dwarf wheats powdery mildew is expected to become important--the new varieties are not resistant. With barley, major losses occur annually due to Rhyncosporium scald, net blotch, powdery mildew, and yellow dwarf. Yellow dwarf resistant varieties are now available, but changes in pathogenicity due to physiologic races has slowed progress in developing barley varieties resistant to the other diseases mentioned. With all winter cereals, losses due to root rot are believed to be severe. Little research is now in progress and the extent of damage, pathogenic organisms involved, and role of environmental conditions are not known. Chemical seed treatment has no doubt effected some control in the past, but breeding for resistance is more desirable. Occasionally economic losses due to aphids or greenbugs occur. Control by insecticides is expensive relative to crop value and the most effective insecticides may have adverse effects on environment. A comprehensive search for resistance has not yet been made; identification of good sources of resistance would have direct benefit in reduction of insect damage and indirect effects through reduction in virus transmission.

Maximizing grain yield through plant breeding requires examination of environmental factors that limit production. In California, with both rainfed and irrigated production, moisture is often limiting. Two additional factors--low temperature damage and salt toxicity--result in yield losses at least as great as those from diseases. Although some genetic differences among genotypes for drouth, frost, and salt tolerance are known, further research is needed on techniques of evaluation before intensive breeding programs can be initiated.

In recent years there has been much theoretical attention given to relationships of plant morphology and grain yield. It has been suggested that leaf size and angle, tillering and plant height should be altered to increase genetic potential for grain yield. Interactions of plant type with nutrient and water availability are expected and, through plant breeding, plants with combinations of characters optimum for various environmental conditions may be found. Research was initiated in 1970 at Davis using a variety of Triticum sphaerococcum with extremely erect and small leaves in hybrids with both tall and short wheat varieties. Isolation of plants with various combinations of characters has already been possible allowing direct tests of theoretical models of plant type.

A final consideration for breeding for maximum yield deals with breeding varieties that are specifically designed for multiple-cropping situations, i.e., winter-planted wheat or barley followed by summer-planted crops. Double-cropping has been widely used in certain areas in California, with winter cereals followed by beans, grain sorghum, various summer forage or vegetable crops. Barley or wheat have not been used in the summer plantings, but may offer possibilities in special situations such as for seed increase of new varieties. New research should consider both economic and agronomic factors of multiple-cropping. Breeding programs can then be initiated to modify the crops to better fit the tight scheduling required for multiple-cropping.

California wheat, barley, oats, and triticale are used primarily for livestock feed; however, there is much greater demand for feed than is currently produced in the state. A portion of the wheat crop is milled if the quality is acceptable to the millers, but, as with feed, there is a production deficit for milling wheat. It is advantageous to both growers and millers if varieties with acceptable milling quality are grown. From a three-year study of milling and baking quality of wheat varieties grown at 4 locations in California it appears that varieties with pastry wheat characteristics (low protein content) should be bred for certain areas, as for example the upper Sacramento Valley, while it will be possible to develop bread-type wheats (high protein content) for other areas (Sacramento-San Joaquin Delta and San Joaquin Valley). Additionally, for the major rainfed production areas it should be possible to develop high protein bread wheats. Breeding programs designed to meet these needs have been initiated.

Little attention has been given in the past to the quality of grains fed to livestock. Often varieties developed for human use that do not meet quality standards are used by the feed industry. California barley is almost exclusively used for feed. Attention should now be given to the quality of feed grains so that varieties producing maximum digestible energy can be developed. Attention should be given to protein quality for monogastric animals. Genes for high content of the amino acid lysine have been found in barley and recent studies in Nebraska and at Davis have indicated usable genetic variability for lysine in wheat. Coordinated research in animal nutrition and plant breeding will provide the needed impetus to make major progress in realizing efficient feed usage in animals.

THE CHALLENGE OF BREEDING VEGETABLES FOR PRESENT DAY AGRICULTURE AND THE 21st CENTURY

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Statistics on California vegetable production are summarized and comparisons are made with other California crops.

Breeding problems that are unique to vegetable crops or that require special emphasis are discussed.

A foresighted vegetable breeding program that saved the $135,000,000 tomato processing industry for California and the U.S. is used as an example to describe effective vegetable breeding programs.

Techniques used to produce hybrid vegetable seed are listed and use of the Gynoecious character and chemically induced Gynoecious plants for producing hybrid vegetable seed are discussed.

The magnitude of the challenge - "Vegetable production to help feed the exploding population" is presented.

GENETIC ENGINEERING IN OILSEEDS

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The use of nuclear magnetic resonance (NMR) techniques to measure oil content, and the gas chromatograph to measure fatty acid composition has greatly facilitated the improvement of oilseed crops through breeding.

Oil content has been raised by reducing the non-oil and non-protein portion of the seed (the hull in the case of safflower and sunflower), and by increasing oil at the expense of the protein component. Genes with major effects modify the hull content of safflower seed, but no such genes have been found which modify the proportions of the oil and protein.

In safflower three alleles at one locus (ol) modify the proportions of oleic acid (monounsaturated) and linoleic acid (polyunsaturated) in safflower oil. The three resulting oils are: regular safflower oil with levels of linoleic acid between 70 and 80%; high-oleic oil with levels of oleic acid between 70 and 80%; and an intermediate experimental type with 40 to 45% of each of oleic and linoleic acids. The latter type is temperature-sensitive, high temperatures raising levels of oleic acid, and low temperatures raising levels of linoleic acid. An allele at a second locus (st), when homozygous, will raise stearic acid levels from about 2% to 5 to 10%. Palmitic acid contents in safflower oil have varied between 5 and 8%.

Safflower types with oleic acid levels some 10 to 15% higher than they are in the regular high-linoleic types are under study as a possible source of modifying genes that would raise oleic acid levels higher than they are in high-oleic types. Data now available suggest that it will be difficult to raise oleic acid contents much above 80%..

Sunflower oil is made up of the same fatty acids as safflower oil. The weedy sunflower types, which are closely related to the cultivated type, appear to be a source of considerable variability in fatty acid composition, extreme types resembling regular and high oleic safflower oils.

In Canada and Sweden rapeseed oil has been changed genetically by removing the long-chain eicosenoic and erucic acids, and the new "erucic-free" rapeseed types are in commercial production. The new product has been called "canbra" oil, the term derived from "Canada" and "*Brassica*".

Oilseed meals have been improved genetically by removing toxic substances. One example is cotton, where gossypol-free types are available, which probably will permit the use of cottonseed meal in many products of the human diet. A second example is rapeseed, where thioglucosides in the meal may cause metabolic disturbances when fed to certain classes of livestock. Evidence to date would indicate that the thioglucosides can be greatly reduced or eliminated by breeding.

CONTRIBUTIONS OF SOME WILD GRAPEVINES TO THE BREEDING PROGRAM

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ABSTRACT

The first cultivated grape varieties are thought to have originated from a single species, Vitis vinifera L. of Middle Asia. After being introduced into eastern Asia and the New World this species introgressed with other native species, at first spontaneously and then by planned breeding.

Despite the large gene pool available in the many thousands of cultivars, important contributions can be made by going back to the wild prototypes still available.

Examples are given of some unexpected bonuses from a single collection of feral vines from northern Iran: (a) in the study of sex conversion and inheritance; (b) in demonstrating mutation of a gene controlling anthocyan acylation; (c) in the utilization of inflorescence production from dormant buds to escape spring frost; and (d) easy shedding of the berries as a useful character for mechanical harvesting.

The vinifera grape is, however, very susceptible to many parasites of American origin. To obtain resistance the Vitis rotundifolia Michx is being used successfully as a donor, even though it is placed in another genus by some botanists.

IN a collecting trip to Iran in 1948, wild grapevines were found south of the Caspian Sea, in regions of scattered deciduous forest. These are assumed to be progenitors of many of our wine grapes and belong to the species vinifera. The principal differences are the smaller clusters and berries. As expected, seed from these vines when grown at Davis produced male (unfruitful) and female (fruitful) vines in equal numbers. Some male vines occasionally produced a few berries which were unexpected. This conversion from male to hermaphroditic flowers proved very variable from season to season. We found no common environmental conditions responsible, so we decided to try the effect of various plant regulators, since the arrested growth of the ovary is typical of the male flower. A synthetic kinin was almost miraculous in its effect, a single momentary dip of the cluster was enough to convert the young male flowers to functional ones bearing fruit (4). The suppression in the cell divisions to produce the complete ovary was removed. By growing progeny of these selfed "converted male" vines, we were able to prove that the male sex is heterogygous, and obtained 1 MM : 2 Mm : 1 mm, or 3 males to one female. Sex determination is thus very primitive since homozygotes are viable and only a single locus is responsible.

A biochemical investigation of the fruit pigments showed the wild vines to have all of the pigments found in cultivated wine grapes of this species (7). However, some cultivated vines have lost the ability to produce pigments that are acylated. This has been found to be conditioned by a mutation to the recessive condition. Varieties breed true if the phenotype is non-acylated. Such varieties are lower in color and produce wines of a mellower character. The astringency often associated with high pigment formation was likewise reduced.

The small population of wild vines, even though obligatory cross-pollinators, when inbred by selfing males, were remarkably uniform and fertile. This was in distinct contrast to our highly heterozygous cultivated varieties that as a rule produce weak and unproductive offspring. No one to my knowledge has ever produced a variety of any merit by sowing self-pollinated seed of any cultivated grape. Now we may question whether our cultivated varieties are really descended from a single species (vinifera) as has long been claimed. It appears more likely that our cultivated forms represent intricate products of crossing of many species or subspecies. We must return to a more intensive study of the native populations in Middle Asia for the answer to this question.

The fruit of the wild Caspian vine is edible and makes wine of passable and very pronounced character. We reasoned that in the course of cultivation many selected varieties now in use may have lost flavors as well as pigments. Would the use of the wild vine introduce this quality factor if bred to our standard wine grapes? This is in fact the case, and even first generation hybrids of wild x cultivated have scored above average in flavor and aroma.

Still another characteristic of the wild male vine may have significant advantages over its cultivated prototypes. Wild male vines are extremely floriferous. If a spring frost kills the young shoot growth, the regrowth from dormant buds produces an abundant show of flower clusters, a characteristic now present in cultivated varieties. We have been successful in introducing this characteristic of the male vine into fruitful forms, so varieties should be available before long to plant in areas particularly subject to low temperatures in the spring, thus widely extending the limits of grape culture.

Finally, the wild vine was found to shed its ripe berries rather easily from the clusters, so by vigorously shaking the vine, many of the berries can be removed in intact form. New grape harvesting machines act on the principle of striking or shaking the fruit from the vine, but most cultivated varieties have persistent berries that can only be removed by smashing them, releasing much juice in the process. This represents considerable loss in the harvest. Wine quality is negatively correlated with the amount of juice that is dispersed, because of oxidative changes.

The vinifera grape, esconced in its Middle Asian homeland and later transported to Europe, was readily propagated from layers or dormant cuttings and was particularly free of destructive parasites for at least two millenia. When some curious Europeans began to import American vines, the parasites rode along and by 1847 powdery mildew was attacking vines in France. It was finally controlled with sulfur dust. A more unwelcome immigrant was the root aphid, phylloxera, from which the first vines were dying in 1864. The French solution was to return to American native vines in the Midwest, to use as resistant roots, then the fruiting vinifera vine was grafted to them above ground. The large majority of the world's vineyards continue to thrive because of this chimeral union of two different vines -- rootstock and scion. Still another American disease made its appearance in 1878, the downy mildew, which must be controlled by frequent use of expensive copper sprays. In more recent years, many virus diseases have been taking their toll (1).

USE OF THE NATIVE ROTUNDIFOLIA

In a search for resistance to these destructive parasites of the *vinifera* grape, we turned to the native muscadine (*V. rotundifolia*) of the humid southeastern U. S. This vine is so different it is placed in a separate genus and has 40 somatic chromosomes vs. 38 of *Vitis* species. The first attempts at hybridization failed because the cross only succeeded when *vinifera* was a female parent. The F_1 hybrids were very healthy, largely resistant, but also completely sterile. A series of cytogenetic studies revealed the causes of sterility (2,6). Finally partly fertile derivatives were obtained and by a series of backcrosses to *vinifera* fully fertile wine grapes have been obtained. These are now being screened for disease and insect resistance. Several have proven resistant to Pierce's virus disease, a killer that prevents culture of the *vinifera* grape in the whole tier of southern states from Texas to Florida (3). From the standpoint of world viticulture, the gene contributions of these wild vines may far surpass our elite cultivars.

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CURRENT STATUS OF PLANT TISSUE TESTING

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Agronomists and horticulturists do not agree on either the concept or the value of plant analysis. This difference of opinion as to the value of plant analysis can be attributed to a communication gap between the people in the various fields of the plant sciences. Not only is there no standardly accepted definition of plant analysis but many of the terms essential to its understanding and interpretation, such as critical level, nutrient content, and even yield have been defined in more than one way. Things are further confused by the failure of many to differentiate between the basic concepts of plant analysis and the accessory concepts which are necessary to integrate plant analysis into a comprehensive system where the nutrient status of the crops is diagnosed, projections made as to yields, and recommendations made as to the fertilizer and cultural practices necessary for achieving maximum production.

In its simplest form, the concept of plant analysis is a procedure for determining the nutrient status of a plant by sampling a specific plant tissue of a given physiological age and correlating some nutrient fraction within that tissue to the desired yield. It has been found that this type of data analysis frequently produces a plant nutrient calibration curve which is a predictable functional relationship between yield and nutrient concentration. The generalized curve has certain elements which are common to most all schemes of plant analysis. These are the ascending portion of the curve, where yield increases sharply without any significant increase in concentration and a general level portion of the curve, where the nutrient concentration increases drastically without a significant increase in yield. These two segments of the curve are connected by the transition zone. The critical level is located within the transition zone and is defined as the nutrient content at which there is the first detectable decrease in yield.

All factors upon which the concept of plant analysis are based are related to the physiology of the plant itself. This implies that plant analysis is limited to a diagnostic role since it gives only the present nutrient status of the plant. If it is desired to make use of this concept in predicting the yield expected at harvest, additional information will have to be obtained. This will have to include the future direction of factors that influence the growth and development of the plant as well as those factors which influence the availability of the nutrient.

Plant analysis is a very powerful diagnostic tool that can be used to monitor and adjust the nutrient status of crops through the use of successive samplings. After several seasons of monitoring, seasonal trends can be established which can be used to predict the nutrient status of crops, as long as the environmental factors and cultural practices are the same as the period in which the seasonal trends were established.

CURRENT STATUS OF SOIL TESTING

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Soil testing is not used as extensively or as effectively as plant tissue analyses in the state of California. This is different from many regions of the United States where soil testing advanced before plant testing. With respect to methodology, soil testing is generally advanced. It is not advanced in some other respects, such as correlation of chemical analyses with fertilizer response for the many different soils and many different crops. Also, summaries of the fertility status of counties, soil types and soil areas are not available.

The objectives of soil testing are simply: 1) to correct nutrient deficiencies and 2) avoid nutrient excesses. The former was the original primary objective; the latter may be far more important today. The steps or processes of soil testing are: 1) soil sampling, 2) chemical analyses, 3) correlation of chemical analyses with nutrient uptake, 4) interpretation of chemical tests, and 5) fertilizer recommendations. While Step 1 is generally thought to be the most limiting factor, Steps 4 and 5 represent the most limiting in California.

The uses of soil testing are many and would appear to justify correcting the current deficiencies in soil testing. The uses include: 1) a gimmick, 2) better than guessing, 3) estimate crop's needs in advance of crop, 4) define soil variability, and 5) detect nutrient residuals and leaching.

Soil testing should not be expected to: 1) determine the best average rate for a nonuniform field, 2) simulate the environment during the total crop growth, and 3) assess a field if the sample is not representative.

INTERPRETATION AND USE OF TISSUE ANALYSIS TECHNIQUES

O. A. Lorenz
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We are all aware of a significant increase in the use of tissue analysis by our California growers during the past 10 years. The number of laboratories has also increased considerably, and it has been reported that there are now about 80 which supply this service. Use by growers varies from situations where the entire fertilizer practice is based on the analysis, as with some citrus, to other cases where samples are taken without any real objective in mind. Many analyses are made for trouble shooting--that is, to determine why one field or part of a field is growing better than another.

The problems of tissue analysis probably arise more with the interpretation of the data and how to use it, than with the analytical procedures. Several recent publications give good instruction for the analytical procedures, and if sufficient and representative samples are taken in the field, interpretation of the results becomes the important factor.

The University of California Soil Fertility Committee held its annual conference at Davis in December. The theme of this conference was "Soil and Tissue Testing in California." Nearly 30 papers were presented. It was evident that much more is known about tissue testing than is available in publication form. Deficient nutrient levels, selection of the best plant part, and time of sampling information are available for most of our important crops. It is realized that too little of this information has been made available to commercial laboratories to assist them in their data interpretation. The University Soil Improvement Committee is now deciding how to disseminate this information for better public use.

One point often brought out at this meeting was that the interpretation and use of the results of tissue testing can present serious problems. As examples: Are the commercial laboratories doing a satisfactory job in interpreting the results of plant analysis? Is the information from plant analysis sufficient on which to base fertilizer recommendations? If not, what other information must be available.

With many vegetable crops we have adequately established deficient and sufficient nutrient levels and have published this as well as information relating to plant part and time of sampling. The problem of interpretation and use of the information is probably more dependent on time of sampling than anything else. For example, it is not uncommon to find the nitrate-nitrogen content of many vegetables to decrease by 3000 parts per million within a weeks period. With many crops we can use either the leaf blade or leaf petiole with equal success, but obviously with different critical levels. Also, either the soluble nutrient fraction or the total nutrient composition can be used satisfactorily.

The biggest limitation in the use of tissue testing in vegetable fertility programs relates to time. Considerable time passes before the plants are large enough to sample and by the time it is definitely established that a particular nutrient is low or deficient it is often too late in the life of the plant to add more nutrients and have them do any good. All is not lost, however, as the information can be used in determining the fertilizer practice to use in future years.

TISSUE ANALYSIS IN CITRUS

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The citrus industry is an excellent sample of the use of tissue analysis in fertilizer programs. The University of California has developed comprehensive procedures and standards. Independent commercial laboratories offer reliable services in implementing the program at nominal cost. As a result, 75% to 80% of the commercial citrus acreage in our area uses the tissue analysis system either wholly or in part.

The system consists of proper sampling and sample preparation, laboratory analysis, interpretation of results, and application of results. Established procedures must be closely followed for each step if useable results are to be obtained.

Samples are collected once a year from mid August to mid October. From 50 to 100, 5 to 7 month old, spring cycle leaves, are taken from non fruiting terminals on all sides of the trees. No more than one leaf per tree is taken and only uniform grove areas are included in one sample. Sampling areas vary from 5 to 40 acres depending on the individual situation.

After sampling, leaves are individually washed and rinsed with distilled water. They cannot be washed when dry and brittle and must be submitted to the laboratory soon after sampling while still fresh. The washed leaves are dried, ground, and stored until analysed.

Standard laboratory procedures must be followed. Field or short cut methods can give erroneous answers and lead to wrong fertilizer practices, and hence are worse than useless.

The test results are compared with published standards. They can be classified as deficient, low, optimum, high, and excessive. This evaluation is compared with past years' results and fertilization practices to determine current needs. If the trend is downward, more fertilizer is needed than has been applied in the past. If the trend is upward, fertilizer applications can be decreased.

Analyses are made in the fall and fertilizer applied the following winter and spring, which makes a natural annual sequence. To be most effective, a rigorous long term adherance to the program is necessary.

USE OF TISSUE ANALYSIS IN COTTON PRODUCTION

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The broad objective of the use of tissue analysis in cotton production is to aid the manager in producing optimum yields. Specifically it is to help facilitate maximum dollar production while conserving resources and preventing pollution.

The value of tissue analysis is based upon the fertilizer trials which correlate tissue levels with relative yields. Examples of trials with nitrogen and potassium are given. Adequate levels are taken from these and other trials. The levels are 15-20,000, 5-8,000 and less than 2,000 ppm NO_3-N in petioles of mature leaves for July 1, August 1, and September 1, respectively. These levels are for the physiological stages which normally occur in the central San Joaquin Valley on the dates given and should be shifted to fit other areas. Adequate levels used for potassium are 3-4 and 1-2 %K in petioles of recently matured leaves for July 1 and September 1, respectively.

Tissue analysis is used to log levels and guide in season fertility adjustments. The following factors must be considered when making in season adjustments and may be limiting factors. They are the length of the growing season, the length of the fruiting period, soil type and variability, timing of other cultural practices, experience in the particular field, conditions particular to the current year, management ability and economics. Examples of crop logging and in season changes are given.

Results of tissue analysis from one year are used to plan future fertilizer programs. Timing of applications, fertilizer placement and other practices which affect nutrient uptake are evaluated through the use of tissue analysis. It may be used along with other techniques as a diagnostic tool in trouble shooting. Examples of the above are given.

Tissue analysis has a practical application in cotton production. The development of technique, adequate levels and critical levels should continue to be an object of research. The limitations of crop logging and of in season fertility adjustments are of particular interest. Resource conservation and pollution prevention should be considered in addition to economic factors.

PLANT ANALYSIS - A TECHNIQUE FOR DIAGNOSING THE NUTRITIONAL STATUS OF RICE

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A method of plant analysis based on the principle of limiting factors and critical nutrient values to denote probable levels of nutrient deficiency has been found to have application to rice. Through comparisons of nutrient concentrations of plants restricted in growth and yield in comparison to those not restricted "critical nutrient levels" for nitrogen, phosphorus and potassium have been developed. The probability of obtaining a yield response from the addition of a nutrient thus depends upon whether the critical nutrient concentration is above or below the critical range. When the nutrient concentrations are above the critical range until at least 80 days after sowing California rice varieties, benefits from additional amounts of this nutrient are not likely to occur. However, if the nutrient concentration is below the critical range, especially over a prolonged period, the probability of a response from fertilization is very high.

Critical Nutrient Concentrations

The critical nutrient concentrations, below which nutrient deficiencies and reduced crop production occurs, are given below for three stages of plant development.

Rice Plant Analysis Guide*

Growth State	Kjeldahl N(%) Critical Value	Kjeldahl N(%) Adequate Range	Phosphate-P (ppm) Critical Value	Phosphate-P (ppm) Adequate Range	Potassium (%) Critical Value	Potassium (%) Adequate Range
Mid-tillering	3.0	3.0-4.0	1000	1000-1800	1.2	1.4-2.8
Maximum Tillering	2.6	2.8-3.6	800	1000-1800	1.0	1.2-2.4
Panicle Initiation	2.4	2.6-3.2	800	1000-1800	0.8	1.0-2.2

*Analysis on a dry weight basis. Kjeldahl nitrogen; 2% HAc extractable PO_4-P and K.

UTILIZATION OF SOIL ANALYSIS INFORMATION

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Utilization of soil analysis for crop production can be divided into two areas. The first area is diagnosis of field problems which might interfere with normal crop growth. The second area is fertilizer programming for optimum production.

Problems may be related to parent material or to soil forming factors. They may be the result of continued use of acid forming fertilizers or low quality irrigation water. Whatever the cause of field problems might be, successful farming depends upon detection and correction of problems as they occur.

Crops grow over a range of soil pH values. Optimum growth occurs, however, when pH is controlled within narrow limits. One reason for this is nutrient availability. Proper use of soil amendments will maintain soil pH within proper limits for specific crops.

Excessive salinity or toxic elements such as Boron, seriously limit crop production. Detection of these problems through soil analysis is invaluable to a grower. Leaching to remove salts and selection of tolerant crops is possible when the problem is recognized.

Sealing of soils due to excess sodium prevents water infiltration and free exchange of gases between the root zone and the atmosphere. Crop growth is restricted under these conditions. Amendments can be employed to correct this problem once it has been detected.

Designing a fertilizer program for any specific crop is basically a simple task. The fertilizer program must furnish nutrients to supplement those available in any given soil. The difference between crop requirements and nutrient availability in a soil is the fertilizer requirement. A soil analysis helps determine the nutrient availability.

The greatest problem in soil testing is obtaining a representative sample. A chemical analysis describes the sample delivered to a laboratory. How well it represents the field, depends upon the skill of the person taking the sample. A sample properly taken, provides valuable information for crop production programming.

Most soil samples are taken to a depth of 6 to 8 inches representing the plow layer. Deep rooted crops explore a much greater volume of soil than that represented by the soil sample. Tissue testing gives a more realistic idea of nutrient availability to crops and should be used in conjunction with soil testing to develop fertilizer programs.

USE OF COLOR AND INFRARED PHOTOGRAPHY

TO COMPLEMENT OTHER DIAGNOSTIC TECHNIQUES

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Recognition of visual symptoms of physiological, pathological, entomological and related disorders in plants is a basic and practical method of diagnosing plant growth problems. Color photography is used to document and compare visual symptoms of soil and plant problems. Representative samples of the symptomized soil and/or plant material may be analyzed for comparison with authenticated standard values and/or with results from normal samples taken from the same area.

Catalog listings of color slides which illustrate nutrient deficiency symptoms in various plants and crops are available from several organizations.

There are three types of color film which are generally used to record photographically the visual effects of environmental factors on plant growth. These are Kodachrome, Kodacolor, and Ektachrome Infrared. Photo documentation may require a series of views including aerial, near, and close-up. Infrared Ektachrome photos are useful because they may detect differences in shades of color which often cannot be seen visually, depending upon the degree of reflectance of the crop foliage. Reasons for color differences should be determined on the ground.

The use of color photos complements other diagnostic techniques and may help to verify findings. Color photos also serve as educational visual aids. A series of slide transparencies has been selected to illustrate some of the factors discussed.

From a practical standpoint color photos are helpful when a large number of crops over a wide area must be examined periodically. The extent and degree of plant growth problems may be checked quickly and economically by photo monitoring.

In the final analysis, the diagnostic value of a photo depends heavily upon the knowledge and experience of the interpreter.

ANALYTICAL TECHNIQUES AT THE STATE FEED AND FERTILIZER LABORATORY

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A brief discussion of the organization of the Feed and Fertilizer Laboratory. Definitions of fertilizers and allied materials under the law together with tolerances allowed.

The handling of samples and the various methods used for analysis of Nitrogen, Phosphorus and Potassium as well as the trace minerals in commercial fertilizers and agricultural minerals.

COMPARISON OF SOIL SAMPLE ANALYSES BY FIVE AGRICULTURAL LABORATORIES

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Soil testing can and should be a valuable tool in generating farm management decision-making information. Thus, it can be a useful service for an agricultural consultant or farm chemical dealer to provide a grower.

While teaching and counseling dealer fieldmen during the past several years one problem with soil testing became apparent. This was the lack of confidence in soil testing by growers and dealers because of wide variability between laboratories in soil test results and recommendations based thereon.

To illustrate the problem, we took two soils, Tulare clay loam and Hanford sandy loam, and sent subsamples to five laboratories serving agriculture in California. We asked each laboratory to give a rather complete fertility assay of each soil and to recommend fertilizer application for four crops on each soil. The results are shown in the following tables.

Table 1. COMPARISON OF SOIL ANALYSIS RESULTS FROM FIVE LABORATORIES, CLAY LOAM SOIL

		Laboratory				
Item	Units	1	2	3	4	5
Saturation Percentage	%			65.8		73
pH	Number	7.9	8.4	7.7	8.2	7.7
Soluble Salts	mmho/cm		1.30	1.21		0.98
Soluble Salts	%	0.08				
Organic Matter	%	1.3	1.70	1.24	2.19	
Gypsum Requirement	T/A		0.45	0.0		
Lime Requirement	T/A	-	-	-	-	-
Total Bases	Meq/100 g	24.9	39.4			
NO_3-N	ppm	6	10	10.9	3.2	
P	ppm	5	9	22.0	1.14	10.6
K	ppm	400	>1000	970	36	940
Ca (exchangeable)	ppm	3400	4860		45.3	7080
Mg (exchangeable)	ppm	700	1500		9.5	384
Ca + Mg	Meq/liter			4.3		
SO_4-S	ppm	37	20	568	11	33.8
Na	ppm	250	172		204	
Na	Meq/liter			9.3		5.4
Zn	ppm	0.8	0.80	0.74	5	0.74
B	ppm	2.9	4.8	1.4	2.5	0.57
Mn	ppm	3.4	12.4	18.0	550*	21
Cu	ppm	1.7	3.82	4.2	50*	4.8
Fe	ppm	1.6	9.2	15.0	36,800*	8.4

* Analysis by acid digestion method.

Table 2. COMPARISON OF SOIL ANALYSIS RESULTS FROM FIVE LABORATORIES, SANDY LOAM SOIL

Item	Units	Laboratory 1	2	3	4	5
Saturation Percentage	%			18.0		19.0
pH	Number	5.4	4.9	6.0	5.0	4.3
Soluble Salts	mmho/cm		0.45	0.64		0.37
Soluble Salts	%					
Organic Matter	%	0.3	0.28	0.42	0.35	
Gypsum Requirement	T/A					
Lime Requirement	T/A	1.0	1.0	4.5	1.0	
Total Bases	Meq/100 g	10.8	1.5			
NO_3-N	ppm	1.0	0.62	3.2	0.6	
P	ppm	19	27	50.0	2.1	25.8
K	ppm	80	35	50	4.2	49
Ca (exchangeable)	ppm	1300	200		7.5	220
Mg (exchangeable)	ppm	100	48		4.8	60
Ca + Mg	Meq/liter			4.4		
SO_4-S	ppm	40	2	243	2.7	7.0
Na	ppm	60	58	10		
Na	Meq/liter					1.5
Zn	ppm	1.9	1.15	1.24	3.0	0.90
B	ppm	0.9	0.14	0.4	0.1	<0.1
Mn	ppm	1.3	0.6	2.4	180*	2.4
Cu	ppm	3.6	2.70	3.8	50*	2.8
Fe	ppm	11.1	24.3	37.2	20,000*	22.3

* Analysis by acid digestion method.

Although much of the data is in good agreement, there are several wide differences that are the type to discourage dealers and growers from using soil testing information with confidence.

Notable differences occur in the analyses for pH, nitrate nitrogen, P, K, Ca, Mg, sulfate sulfur, and the micronutrients.

It should be emphasized that not only did the analytical data differ among laboratories, but the differences in their recommendations varied even more widely. Thus, the agricultural consultant, fertilizer dealer, and grower have due cause to question the validity of using soil testing as a means of obtaining farm management decision-making information.

It seems likely that many of the differences among laboratories could be eliminated by using identical analytical techniques and reporting results in the same units.

CONSTITUTION AND BY-LAWS OF THE CALIFORNIA CHAPTER OF THE AMERICAN SOCIETY OF AGRONOMY

NAME

Article I, Section 1. The name of the organization shall be known as the California Chapter of the American Society of Agronomy as authorized under Article XI, Section 5 of the Revised By-Laws of the American Society of Agronomy, Inc.

OBJECTIVES

Article II, Section 1. The objectives of the California Chapter shall be generally those of the American Society of Agronomy, Inc., an educational and scientific corporation qualified for exemption under Section 501 (c) (3) of the Internal Revenue Code of 1954, as amended or a comparable section of subsequent legislation.

The California Chapter shall strive to promote human welfare through advancing the acquisition and dissemination of scientific knowledge concerning the nature, use, improvement and interrelationships of plants, soils and environment. To this end, the California Chapter, like its parent society, shall (1) promote effective research, (2) disseminate scientific information, (3) foster high standards of education, (4) strive to maintain high standards of ethics, (5) promote advancements in the profession, and (6) cooperate with other organizations having similar objectives.

The California Chapter supports the efforts and objectives of the Western Society of Soil Science and the Western Society of Crop Science and will operate in a manner consistent with their purposes.

MEMBERSHIP

Article III, Section 1. The membership of the California Chapter of the American Society of Agronomy shall consist of individuals actively interested in the objectives of the Chapter as outlined in Article II.

Section 2. Members of the American Society of Agronomy, the Soil Science Society of America or the Crop Science Society of America shall be entitled to full membership in the California Chapter.

Section 3. A person not a member of the organizations set forth in Section 2 may be a member of the California Chapter and be entitled to all the privileges of members qualifying under Section 2, except that they shall not be eligible for an elective office in the California Chapter.

OFFICERS AND STANDING COMMITTEES

Article IV, Section 1. The governing board of the Chapter shall be constituted by an Executive Committee and a Council of Representatives.

Section 2. The Executive Committee shall consist of the Past President, President, First Vice-President, Second Vice-President and Executive

Secretary-Treasurer. The term of office with the exception of the Executive Secretary-Treasurer shall be for one year. The Executive Secretary-Treasurer shall serve for a three-year term.

Section 3. The representation on the Executive Committee shall be split as evenly as possible between Industry and University-Experiment Station-Extension-State College and Government groups, and evenly between the broad groupings of Soils and Crops. The objective would be that, if the President comes from the University-Experiment Station-Extension-State College-Government grouping and was considered a Soils man, the First Vice-President would be a Crops man from Industry. The normal order of progression would be President to Past President, First Vice-President to President, Second Vice-President to First Vice-President, with the election of the Second Vice-President coming from the Council Representatives.

Section 4. The Council shall consist of nine elected representatives, 4 or 5 from Industry groups and 4 or 5 from University-Experiment Station-Extension-State Colleges-Government groups. The nine areas of representation are:

1. Agronomy and Range Science.
2. Water Science and Agricultural Engineering.
3. Soils and Plant Nutrition.
4. Vegetable Crops.
5. Viticulture, Horticulture and Ornamental Horticulture.
6. Fertilizers and Other Agriculture Chemicals.
7. Plant Breeding, Seed Production and Technology.
8. Environmental Quality.
9. Advisory and Regulatory Agencies.

Section 5. Each Council Representative will be elected to serve a three-year term. The terms will be staggered so that three Representatives will be elected each year. When a vacancy occurs on the Council because of death, resignation or other cause, appointment to fill the vacancy will be made by the Executive Committee and the appointee will serve until the next election.

Section 6. All Council Representatives and Members of the Executive Board must be Members of the American Society of Agronomy.

Section 7. The Council Representatives will be elected by the membership assembled at the time of the Annual Business Meeting. The Nominating Committee will be the Executive Committee. They will distribute the list of nominees prior to the annual meeting. Additional nominations may be made from the floor at the Annual Business Meeting. Elections shall be by secret ballot of those in attendance and voting.

Section 8. The Council Representatives and Members of the Executive Committee will elect the President, First Vice-President, Second Vice-President and Executive Secretary-Treasurer.

Section 9. The duties of the Past President, President, Vice-President, Second Vice-President and Executive Secretary-Treasurer shall be those which usually pertain to such offices of similar organizations. The Past

President shall serve as the chairman of the Awards Committee. The President and First Vice-President shall serve as program co-chairman for the Annual Meeting. The Second Vice-President shall serve as chairman of the Membership and Dues Committee.

Section 10. The President, with the approval of the Executive Committee, shall annually appoint such committees, their members and chairman, as he or the Executive Committee deems necessary to assist in carrying out the objectives of the Chapter.

ANNUAL MEETING

Article V, Section 1. The California Section of the American Society of Agronomy will hold an Annual Meeting at such a time and place as shall be advantageous to the members. The program as developed by the Program Committee shall include both invitational and non-invitational papers on subjects of wide interest to educators, scientists, farmers and those who serve agriculture. Emphasis will be on the applications of scientific developments. Sectional meetings, special symposia, joint or cosponsored meetings with other groups may be arranged by the Executive Committee and may be held separately from or in conjunction with the Annual Meeting.

DUES

Article VI, Section 1. Annual membership dues shall be set by the Executive Committee and shall be assessed and collected as provided for in the by-laws.

Section 2. Fees or dues associated with the operation of the California Chapter will be held to a minimum.

Section 3. Members in arrears for Chapter dues will be dropped from the rolls in accordance with the by-laws.

AMENDMENTS AND BY-LAWS

Article VII, Section 1. The constitution may be amended by a two-thirds (2/3) majority vote of the members present at the Annual Meeting, providing such amendments have first been presented, in writing, to the Executive Committee for consideration not less than sixty (60) days prior to the Annual Meeting.

Section 2. Amendments to the By-Laws may be proposed to the Executive Committee by ten or more members of the California Section. Such amendments must be presented, in writing, to the Executive Committee for consideration not less than sixty (60) days prior to the Annual Meeting.
A simple majority vote of the members present at the meeting is required for a change in the By-Laws.

BY-LAWS

PUBLICATIONS

Article I. The publications of the California Chapter may consist of proceedings made up of abstracts of submitted and individual papers, reports of committees, minutes of the Annual Business Meeting and such other items as shall have general interest to the members. The Executive Committee is authorized to charge for publications in such a manner as to reclaim actual costs.

DUES

Article II. The annual dues of the California Chapter shall be two dollars ($2.00). Dues in arrears for more than one year shall be cause for automatic exclusion from membership.

PAYMENT OF EXPENSES

Article III. The Executive Secretary-Treasurer shall be authorized to pay all routine expenses. Expense items other than of an operational nature shall require the approval of the Executive Committee.

ELECTED OFFICERS OF THE CALIFORNIA CHAPTER OF THE

AMERICAN SOCIETY OF AGRONOMY

THE EXECUTIVE COMMITTEE:

President:	D. S. Mikkelsen Department of Agronomy and Range Science University of California, Davis
First Vice President:	Iver Johnson Cal-West Seeds, Woodland
Second Vice President:	Malcolm H. McVickar Chevron Chemical Co., San Francisco
Executive Secretary-Treasurer:	George Hawkes Chevron Chemical Co., Richmond

COUNCIL MEMBERS (4-5 from Industry; 4-5 from University, Experiment Station, Extension, State Colleges, Government):

One-year term:	J. W. Biggar Department of Water Science and Engineering University of California, Davis
	Hollis M. Barron Leslie-Agriform Corporation, Newark
	V. P. Osterli Agricultural Extenstion Service University of California, Davis
Two-year term:	P. F. Pratt Department of Soil Science and Engineering University of California, Riverside
	L. E. Wittsell Shell Chemical, Modesto
	R. B. Bahme Agricultural Development Co., Orinda
Three-year term:	M. D. Miller Agricultural Extension Service University of California, Davis
	O. A. Lorenz Department of Vegetable Crops University of California, Davis
(January 11, 1972)	Donald Smith Pacific Oilseeds, Inc., Woodland