Proceedings

1977
CALIFORNIA PLANT and SOIL CONFERENCE

Sponsored by the

CALIFORNIA CHAPTER–A.S.A.

Quality Inn Woodlake
Sacramento, California
January 26, 27, and 28, 1977

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AMERICAN SOCIETY OF AGRONOMY

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OF THE AMERICAN SOCIETY OF AGRONOMY

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CONFERENCE REPORTS

AGRICULTURE IN SOCIETY - A NATIONAL PERSPECTIVE

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I am delighted to be here and to take part in this important discussion. Certainly there has been no time in the history of this country when the relation of agriculture to the total society has been more important.

Agriculturalists are faced today with the challenge of doubling the world food production capability within the next 25 to 30 years--this in the face of many constraints. In many countries we have few new geographical areas with potentially productive land areas to develop. There are the gambles of climate and weather. The depletion of natural resources, including fossil fuel reserves, will place increasing limits on available energy for use in mechanized production. There are new outbreaks and new epidemics of old and newly imported insects and diseases. The increasing resistance of pests and disease organisms to control methods or the reduced availability of chemical controls further adds to the problems. There are also economic and social constraints--increasing populations, wars, embargoes, strikes, and recessions--many of them unpredictable and uncontrollable but each having both direct and indirect impact upon physical, economic, and institutional structure of the world agricultural production system.

The theme of this meeting is "Agriculture <u>in</u> Society." I don't think any of us here today have any question as to what "Agriculture" means! But, what does "Society" mean? In all probability each of us will have a different mental conception.

I see "society" as a large overall landscape, made up of urban, rural, and regional scenes that blend together into one national setting. Society occupies the place within which all concepts or ideas originate, take form, and develop.

It's our physical framework, it's our institutional framework, it's our legislative and legal structure--and, perhaps most important, it's people--people from every background, every level of economic and intellectual development.

Agriculture <u>in</u> Society?

Yes, Agriculture <u>is</u> in Society. Agriculture is, in fact, the matrix that holds this diffuse, nebulous thing called "society" together. It is the foundation, the skeleton, and the protective cover of society.

Agriculture is such an integral part of society that it has all but lost recognition by society. Its role is overlooked and forgotten about in all but emergency situations.

There are only about 9 million people living on U.S. farms. Out of a total population of 213 million, this is only about 4.2 percent, or 1 person out of every 24. But, like the tip of the iceberg, these figures are not the true picture of the role of agriculture.

When we ask "What exactly makes up the agricultural sector of our society?" we have to include not only farmers, but also processors, and transporters, storers, and distributors of farm goods, along with suppliers of equipment, fertilizer, fuel, and such. All of these add up and, agriculture, in terms of percentages, is a very real part of society.

Actually, agriculture is this country's biggest industry with more than $500 billion in assets--three-fifths of the assets of all U.S. corporations. It also spends more money than any other business. Outlays for machinery, feed, fertilizer, and other production expenses totaled over $75 billion last year. Agricultural products are the largest single source of U.S. sales abroad; over 22 billion dollars in 1976 alone. Agriculture spreads into every nook and cranny--into most of our industries, our distribution and transportation systems, and into our daily lives. Yes, agriculture is the foundation of society. We should be reminded of this not only when we eat or dress but in a myriad of other ways, including much of our work.

Society is confronted with many new and pressing issues--issues that involve agriculture.

Food production capability -- hardly a subject of concern during the 60's and early 70's when crop surpluses were of critical concern. Surpluses--even though we weren't applying half the technology that was available. With a seemingly endless supply of new technology--hybrids, fertilizers, pesticides, mechanization--waiting to be applied--no one questioned our food production capability. Then in a few short years, storage supplies dwindled as exports rose, production leveled off, fertilizer costs went up drastically, and pesticides came under more rigid control.

Nationally we are currently far from a critical situation. But, on a worldwide basis, the rate of agricultural production increase, at two to two and one-half percent per year, is lagging behind the four percent annual increase needed to keep pace with world population increases and the growing affluence of some developing nations.

In short, U.S. and world food production capability is now of concern to many different elements of American society. It is of concern to the diplomatic corps, the international trade system, and to you and me. It is of concern to all of us who empathize with the millions who died throughout the world in the last several years because of starvation.

Another issue is food quality and safety. Adequate and effective nutrition is a critical national and international goal. We know little about the real needs of the human body for different ages, sizes, sexes, or under different environmental or health conditions. We are only now gaining some limited insight into the needs for and interactions of minor elements in the diet, of vitamins, minerals, and of needed amino acid balances. And yet, if we are to match agricultural production capability to national and world nutritional needs, we must have this information. This is being more fully recognized by our medical profession, by our food industry, and by the public itself in the form of concern for greater knowledge of nutrition.

While we live in a country that has the finest, safest, cleanest food in the world, we still find that food safety is a matter of growing concern. Aflatoxin, first found in peanuts, and now of concern in cottonseed products, corn, and various nuts, has presented a new dimension to a new problem. Salmonella continues to be an ever present threat. The finding of nitrosamines in a number of food products demands further knowledge of its occurrence, development, and control. New and old additives, preservatives, and residues are coming under closer scrutiny and study by nearly every segment of society--and agriculture.

This, of course, leads into another major societal issue--the protection of our environment. No longer are these concerns addressed to simply the protection of our soil and water resources but are extended to all phases of the environment and all of the factors that might impinge upon it. Of course agriculture has been in the middle of this new surge of concern--pesticides, fertilizers, harvesting and processing practices, location and management of feedlots and other intensive animal production units--all have involved agriculture in this new societal issue.

Related to our environmental concerns is the societal concern over the exploitive use of limited ground water supplies and the increasing pressure of nonagricultural enterprises on both surface and ground water resources. This, coupled with growing land use pressures--recreation, industrial parks, urban and residential areas, wildlife preserves--all combine to raise serious questions regarding how we protect these important agricultural resources.

Perhaps the newest and most critical societal issue involving agriculture is that of energy. While agriculture is not a major user of our non-renewable energy resources, we are a consistent and absolutely vital user. Much of our agricultural progress has been predicated upon exchanging fossil fuel for other forms of energy. It's not just the gasoline and diesel oil but the natural gas that dries our crops, that provides a necessary base for fertilizer production, and that is essential in pesticides manufacture. Again, every segment of agriculture is involved.

These are but six societal issues--food production, food quality and safety, environmental protection, water, land, and energy--issues that tie agriculture to society.

In fact, these ties are so strong, so complex, and so pervasive that they truly place agriculture in society. Agriculture is, thus, a vital part of a society that is seeking solutions to its critical issues.

If we accept the premise that agriculture and society are, in essence, one and the same, then we must ask what are our joint responsibilities--those of agriculture and society as a whole--if we are to successfully meet some of these critical issues.

Perhaps our first responsibility is to continue to nurture and develop the growing awareness that agriculture is a component part of society.

Awareness is the first step to understanding. One must be aware of the source of our food and fiber if one is to understand the impact that agriculture has upon daily living. One must be aware that milk doesn't start out in a plastic bottle or corn flakes in a cardboard box or carrots frozen in a plastic pouch, if one is to understand the role of the farmer in meeting production needs.

One must be aware of the processing steps that convert a kernel of wheat into flour, a can of milk into a piece of cheese, a running steer into steaks, hamburgers, and leather, if one is to understand the role of agribusiness in preparing food for our daily use.

One must be aware of the trucks, trains, and barges that bring crops together to vast storage centers, and of the ships that convey these crops to needy nations around the world, if one is to understand the complexities of national and international trade.

Awareness and understanding must replace ignorance and complacency at every level of our society if we are to truly meet the growing issue of meeting the long-range food and fiber needs of this nation and of the world.

This awareness and understanding must be broader than just accepting agriculture's role in society--it must also be an awareness of the steps and processes necessary to meet the world's needs 25 or more years into the future. The farmer, the rancher, the agribusinessman, the scientist, the engineer, the taxpayer, and the decision makers of the world must be aware of tasks that lie ahead--they must understand these tasks.

> --It must be understood that the research done today on these problems will not be having a significant impact upon production, food quality, food safety or the reduction of energy use for at least 10 or 15 years.
>
> --It must be understood that with each passing year solutions to these problems become more complex and more costly simply because the problems become more difficult to solve--the easy research has been done.
>
> --It must be understood that just finding solutions is not enough--these solutions must be carried to the user, adapted to meet their local conditions, needs, and resources--through education, testing, and demonstration..
>
> --It must be understood that solutions cannot be had to all problems at once, that priorities must be set, that goals must be established--but that society must help to develop these goals and priorities that will meet societal expectations.
>
> --It must be understood that depletion of some water resources and diversion of land for some uses are nonreversible; only prior planning and protection of these resources can preserve them for future agricultural production.

How does one develop this awareness, this understanding in anything as indefinable as a society? One might even ask--can it be done at all before it is too late?

Frankly, I am optimistic. Since 1974 there have been a number of developments that lead me to believe that there is a growing awareness on the part of many segments of society that there are growing problems that must be examined and solutions found for them; that there is a growing understanding of the national and international complexities that are involved in applying these solutions.

The World Food Conference held in Rome in November of 1974 was, perhaps, a turning point in kindling this awareness. In itself, the conference may not have been as successful as its leaders hoped it would be, but it did bring into focus such issues as:

- World population trends
- Trends in world food and fiber production capability
- Status of nutritional levels in various segments of the world society
- Trends in world reserves of food
- The impact that adverse weather conditions can have on the balance of world food supplies
- Availability and quality of water supply
- The need to protect land resources for future agricultural production uses

-- and many similar issues.

While few action plans or solutions to problems came directly from that conference, a host of activities got underway in countries throughout the world. If we look only at a few of those undertaken in this country, we can begin to see the impact that was achieved.

- In one year the Board on Agriculture and Renewable Resources report on research needs was developed and released.
- An interim report on world research needs was released by the National Academy of Sciences and its full study was launched.
- The USDA-Land Grant College consumer research conference was held in Kansas City.
- Numerous smaller studies and reports were developed.
- The legislation establishing Title XII under the Foreign Assistance Act was passed.
- The Congressional oversight hearings on agricultural research were held.
- Numerous hearings on nutritional needs were held.
- The Wampler Bill, introduced to strengthen agricultural research funding, passed the House.

This is but a partial accounting of things that have developed since 1974. Each involved many people from many parts of society. Each made a significant impact in developing a new awareness and understanding on the part of those involved and, to some degree, upon others outside of the activity.

None have paid off in any startling or significant way. Public service research funds are still barely keeping pace with inflation, thus preventing any meaningful new research undertakings. Implementation of the provisions of Title XII is still in the development stage. The legislative efforts to strengthen public service research are still confused, with up to 4 or 5 different bills being thrown into the hopper--each having its own good points and its limitations. It will take time to sort them out into a meaningful and effective thrust.

But, there is a growing awareness and understanding that there are growing problems and that we are not currently equipped with the resources to meet these problems in an effective way. No longer is there a feeling of complacency at every level. Some quarters are even developing a feeling of urgency but--at the same time there are individuals, in important decision making positions, who still do not feel that there is a consensus that these issues need immediate attention.

In 1963, President Kennedy made the statement, "We have the means, we have the capacity to eliminate hunger from the face of the earth in our lifetime. We need only the will."

"We need only the will."

I strongly believe that every agricultural research scientist has this will. They have the interest, the desire, and the dedication that reinforces this will.

We need only the way.

Each of us meeting here today, each of us meeting and working with others tomorrow, next week, next month, have a personal responsibility to maintain this will; to personally develop the needed awareness and understanding on the part of everyone with whom we come in contact. In our research we must be out in front, working in the unknown, on the cutting edge of science. In our daily contacts, we must also be out in front, dispelling the unknown and providing a cutting edge that will help society to re-examine its priorities and thus recognize that--as a part of this agriculturally based matrix--each of us has a responsibility to encourage, support, and accept the tasks ahead. Thus, each of us can contribute to finding the way.

AGRICULTURE IN SOCIETY
BRIDGING THE GAP

G. F. MacLeod
Consultant, Berkeley

It is always a pleasure to find a group who recognize that agriculture is a part of and not something separate from society. Over the past 200 years we have evolved a powerful industrial country while agriculture was being relegated to a lesser status. Strange it is that industrial power was possible, in no small measure, because increasing agricultural technology freed people to develop that power. Blythly we've lived, in our affluence, and under a cornucopia of "Food-A-Plenty".

Time collapsed and horizons vanished. We see events when they happen, not only all over the world but on planets in space. Our technologies increased until suddenly we were aware of a world headed for too many people to feed. It is hard to stop people from increasing in numbers and it is hard to increase food production to sustain them. At the same time we decided to return to "the forest primeval".

Suddenly we are polluted. We turn to our government to stop industrial and agricultural pollution by law and regulation. We are caught in a trap of our own making and must struggle to get out.

Our society is like a giant cobweb, with every strand attached to every other strand. We cannot move or change a single silken thread without doing something to all other threads. We recognize this from our war experiences.

In World War II fertilizer for food was also nitrogen for explosives. Superphosphates were a source of uranium for atomic bombs. Alcohol was a fuel, a chemical intermediate, a medicine, a by-product of grain fermentation and grain was needed for food and feed. We found hundreds of conflicting needs.

We had one, common objective--to win the war. We worked out our impact statements, our priorities, our benefit/risk ratios, and we achieved our objective.

Society today has many objectives. Agriculture, with its technological know-how, is involved with many basic facets, constraints of time and space permit discussion of only a few. The need to communicate the importance of modern agriculture and its technologies to society is widely recognized by those associated with agriculture.

One approach is to re-examine the four key words involved:

- Society

- Agriculture

- Technology

- Communication

Each of these words which we use daily, may mean different things to different people. For present purposes let me give you what they mean to me after 60 years of pursuit of Agriculture in Society.

At first glance it may seem presumptious to revert to such elementary discussions especially with as erudite a group as you are. Yet the media, our own scientific publications, seminars and conferences give rise to many shady areas where ambiguity creeps in. If we, among ourselves cannot agree as to what the words we use mean how can we explain them to others?

This is not to say that we <u>must</u> agree. We could enter into debate and argument as to what we mean until each of our key words became a book. Perhaps we need to do this. But at the risk of insulting your intelligence, becoming pedantic or even belaboring unnecessarily our common understanding let me explain my concepts.

Society

For our purposes we may define our people as an enduring community, nation or broad grouping of persons, having common traditions, institutions and collective activities and interests. We are an inter-dependent system of entities known collectively as people.

Obviously there may be much debate about the commonality of our traditions, our collective activities and our interests. An election year particularly brings out some differences among us. As for common activities and interests it is indeed fortunate that we differ from person to person and group to group. With our inherent, competitive natures life would be chaos without diffuse interests and activities.

But there can be no doubt of the common need for food, open space, recreation and shelter for every member of society. We have become accustomed to think, in this country, of those who do not have these things as "underprivileged". Yet it is the consumer power to get these essentials of our lifestyle that causes strife and concern.

Of all of these consumer items food is certainly most basic and it comes from agriculture. Nothing attracts more attention in today's media than food--its purity and its physiological effects. Many of you recently saw a TV broadcast entitled, "What is this Thing Called Food?". It told all of our people who watched and listened about the use of diethylstilbestrol (DES) and cancer.

There were several pathetic scenes regarding the daughter of a woman who, during the mother's pregnancy was given DES and the daughter later developed cancer and died. Then it showed a picture of cattle being fed DES.

Let me quote from an article by Dr. Thomas H. Jukes in the September issue of the Journal of Preventive Medicine[1]:

> "Estrogens are carcinogens. This has long been known, and has been emphasized recently because of the reported association of clear-cell adenocarcinoma of the genital tract, appearing in the daughters of women who were treated with diethylstilbestrol (DES) during pregnancy. As hormones, estrogens are also normal biochemical constituents of the body. Estrogens increase the production of lean tissue and the conversion of feed into meat in beef cattle. Residues of DES used for this purpose were estimated at 120 parts per 10^{12} in livers of implanted cattle, and 100,000 tons of such liver would therefore supply 12g of DES, the amount administered per pregnant woman in one series. The total annual U.S. production of beef liver is 140,000 tons. The proposed ban on DES is estimated by the FDA to cost consumers $503 million annually. A ban would cause a substantial increase in the amount of cattle feed needed for beef production. If the residues in beef were DES, the cancer risk from beef production from implanted cattle is calculated to be less than one case per 133 years in the U.S. population. However, recent studies indicate that at least 99% of the residues consist of conjugated forms of DES that may not be carcinogenic."

Time has been taken to present this example because it is one of many which illustrates some important considerations:

- Several million people saw the TV presentation. Not more than a hundred or so would read and understand the article.

- Contradictions create societal confusion.

- Fiction is entertaining--truth quite dull.

- Professionals talk to themselves. The media talks to everybody.

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1. Jukes, T. H. Diethystilbestrol in Beef Production: What is the Risk to Consumers? Journal of Preventive Medicine, Vol. 5, pp. 438-453. September 1976.

- Emotion, fortified with ignorance, produces a fantasy of pseudo beliefs. Facts produce doubts to be tested further.

About five percent of our society produce our food. Another 20 percent process, transport, package and market it. But 100 percent eat it. How can we tell the 95 percent not involved in production about the technologies needed in starting this complex machine?

Agriculture

Everyone knows what the word "agriculture" means--or do they? We tried to define it in 1970[2] and encountered real difficulties. Strangely enough we have never received any comments although our definition is very different from that in the dictionary. Essentially we agreed that it is not so much a finite, measurable entity as it is a field of emphasis. It is a focus for the efforts of many people: farmers, capitalists, manufacturers, public officials and a surprising host of support people. Resources, knowledge, management skills and vital inputs are organized to improve productivity and profit, consumer service and enjoyment, convenience and economy. All elements together, directed toward long-term public satisfaction--that is modern agriculture as we see it. It is not, nor should it pretend to be, all things to all people but it is a main strand in the cobweb of society today.

Agribusiness is a term generated to denote the importance of off-farm inputs required to produce, transport and market our food and fiber. Over the years farm production practices have come to depend more and more on the goods and services of our industrial world. The chain of consumer demands generated by modern agriculture impinges on suppliers who provide all of society with its working needs. Energy, capital, machinery, labor and management skills all compete in agriculture in our society.

There is no need to explain the supermarket to people. The task is to explain where and how the food got there for the consumer to pick and choose. There is much ado about price and who gets how much of the food dollar, little of which is understood or retained by the shopper. We hear of variable proportions of consumer income devoted to food procurement but we are unimpressed by explanations of what has caused the rise or fall of prices.

Opportunity to create an understanding of our agriculture on the part of our society was never better. Today's home gardens, the "organic" faddism, world hunger and domestic malnutrition offer many possibilities of explaining the importance of agriculture to modern society. We never had it so good!

Technology

This word is so commonly misunderstood that it has come to possess a sinister meaning. It really is the totality of the means employed by people to provide itself with the objects of material culture. We are a consumer society, seeking things to buy. For us today in agriculture it means the science of the application of knowledge to practical purposes--the production of food, fiber, forests and pleasurable living.

Note that knowledge, the product of research, is the basic ingredient. The real marvel in our country today is the ingenuity with which we have applied that knowledge to practical purposes.

Research is a broad activity in which critical and exhaustive investigation and experimentation is pursued to discover new facts or to revise yesterday's facts. Viewed in that manner some so-called "research" is less than monumental.

For myself there is no difference between basic, applied or problem-solving research. Too often "basic research" is a term applied to unplanned playing with devices or hobbies. All knowledge is useful and in every applied research problem of my own I have always encountered the need for more basic research to help solve a problem. There is an ever-present need to publicly support carefully planned research for use in developing new

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2. Buchanan, Mark T. and G. F. MacLeod. Agricultural Science Review. Vol. 8, No. 2 & 3, p. 51-52. 1970

technologies with which to serve our demands on agriculture to produce more food, more economically, for more people. No generation can afford a gap in support lest a later generation suffer.

But we do need to assess our old, our new and our proposed technologies[3]. The current discussion of recombinant DNA affords a good example. It can be done in a scientific manner. It should identify and clarify problems and provide a process of arriving at reasoned benefit/cost or benefit/risk impacts. This would surely be an improvement over some of the present opinionated, value judgments with questionable bias. It should be emphasized that to buttress any rationale or evolving opinion the synthesis of intuitive judgments from knowledgeable people can be of value. Such synthesis is suspect in the same manner as the opinions being synthesized since all involve value judgments.

The necessity for constant review and assessment of our technologies becomes ever more pressing. For any given project we need to:

- Identify all program impacts,

- Determine cause and effect relationships,

- Determine alternatives and their impacts,

- Measure and compare total impacts of a program and its alternatives,

- Present analytical findings clearly.

Such steps need to be taken within the total societal framework, identifying all foreseeable impacts on the social, economic, legal, political and natural sectors. We need more funding for study of societal studies. There has been scant recognition of the costs of our environmental ideals.

Communication

Efforts, values, ideas and programs along with most other things are valueless without communication. Every organization I have ever been associated with has said, "We need to improve our communications". The larger the groups get, the poorer communication gets. The skills to improve communication are often elusive, vague, frequently irritating and seldom entertaining.

In essence communication is an art that deals with expressing and exchanging ideas effectively in speech, writing or through dramatic or graphic arts. Let's take that apart.

First it is more of an art than a science. Also it embraces exchanging rather than force-feeding ideas. To be a good communicator, be a good listener.

About half of the upper 12.5 percent of high school graduates seeking admission to the University of California could not pass simple student aptitude tests, either written or oral, last year. Is it any wonder parents have trouble communicating with their offspring?

Much of our trouble with regulations to implement laws comes from widely varying interpretations of intent. It seems that laws for our complex society cannot be clearly written. Our courts are busy unraveling controversies about congressional intent. The solutions often appear more obscure than the original question after the judicial process.

Nothing is harder to understand than the legal jargon from law to court decisions. So we pile laws on laws, regulations on regulations to "clarify" some ambiguity which poor communication ability started.

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3. A Study of Technology Assessment. Report of the Committee on Public Engineering Policy, National Academy of Engineering, Washington, D.C., July 1969.

Only occasionally do those of us who seek to present information have recourse to the graphic or dramatic arts. Recently, at a scientific meeting, the thought again occured to me that we should either stop using slides or improve our technique. You have all suffered the frustration of a slide full of figures too small to read, projected on a defective screen by an inadequate light source. Often even the speaker can't read it. As a means of improving communication among scientists in a common discipline there should be just as critical a review of graphic material as there is of paper content.

Then there is the "Educational Film". So often committees who produce films are like committees who produce camels. They are groups of the unwilling, appointed by the unfit, to do the unnecessary. One or two committee members wind up doing the job. Why not choose a director if we must make a film?

There are some pretty fair films and they are excellent vehicles for communication but there is room for improvement. We need to stop making films in praise of ourselves.

Dramatic arts are a neglected part of communication for agriculture. How many of you know a song, a play, or a musical or a comic monologue used as a means of putting modern agricultural technology before people? How recently has your child in school been asked to write a poem, a story or anything else about food? Would they write about "Bubble Gum is Better", "Three Yuks for Spinach", "Jive with Junk Food", or what? Agriculture can use the potential of dramatic arts to tell their story.

Communication is selling a product, an idea, a need or a proposition. Our public, our society, shudders at the word "salesman". The first image is of some character who is going to make us do something against our will--or get some of our money for something useless, broken or dangerous.

Think for a moment of the endless stories about the traveling salesman--none of them good. Note your daily junk mail and ads in the papers. How often do they say "No Obligation" or "No Salesman Will Call"?

Within the halls of ivory, where students supposedly seek culture and knowledge, as well as a mate, you will find no curriculum on selling. To most academicians selling means a sell-out and this does not mean all the tickets are gone but rather someone has betrayed someone. This is a common societal belief. It is not confined to academe.

What "we the people" need to do is change our ideas of selling as a profession. Every human being, throughout his life, is a salesman trying to sell something. Remember when you tried to sell your mother that you were hungry? Just a scream would do it. Remember when you tried to sell that pretty girl or boy in the next seat in school that you were tops? A tug of their hair got their attention anyway. Remember when you tried to sell Dad that you needed the car more than he did on a particular evening? Pleading your cause took <u>some</u> selling!

All people are salesmen and all people must communicate. A really good salesman does something <u>For</u> you--not <u>To</u> you. How many good salesmen for agriculture do we have? We could use more.

<u>Agriculture in Society</u>

(Summary)

Modern agriculture does not fit the dictionary definition of "the art and science of husbanding the soil". We need a more accurate description of the direct and derivative features of this field of emphasis. We must not only agree but also understand so that we may sell our convictions to others.

Agricultural technology comes from many fields of knowledge: biology, chemistry, physics, engineering, economics, social and political science and so on ad infinitum. All knowledge can be oriented around a focus of agriculture by a devout agriculturist.

There is a constant need to assess all of these agricultural technologies in the framework of total society: natural, social, legal, political and scientific. Only then shall we have valuable benefit/risk or benefit/cost ratios based on best analyses. Only then shall we have viable impact statements. Only then can we communicate with conviction in the society of which we are a part.

We have not exhausted the possibilities of communicative skills but there's trouble ahead. We have produced a permissive generation defective in their use of spoken and written words. Johnny not only cannot read, he cannot write, speak nor figure correctly. That must be changed quickly.

We can hope that we do not need a war to unite us as a society with a common objective. Of our many problems food for a growing population is not the least. The challenge to explain modern agriculture to the public stretches into the future as far as we can see.

We have a vast storehouse of knowledge. We need constant research for more. We have some, but not all, of our technology at work now. We need more technology, not less. We must communicate the importance of modern agricultural technologies to society--not to ourselves.

OUR RESEARCH AND SOCIETY

Robert S. Loomis
Agronomy and Range Science
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Agricultural research, by expanding our information base, plays an important role in changing the technology and practice of agriculture. Most of us in research view this as a vitally important task which contributes to the evolution of a better society. In my youth, I saw that agricultural research was an activity well esteemed by society. My experiences have been good though less than my expectations. Our numbers and support in public research institutions have declined steadily of late and we have found that society tends more and more to question the social value of much that we value as progress. And questions of value seem to lead to questions of credibility. The point came home on a visit to Chile, where I found the professions with highest status to be in science and law enforcement--both at a very low ebb in the United States.

We must be aware that the relations between research and society are extremely complex. Let me make three introductory points in the matter. The first is that changes in technology created through research and innovation are very important determining factors in society. They lead to changes in society. Roman technology in agriculture led to a magnificent food base and (with alfalfa) to magnificent war horses and thus to a capacity for success in war, empire building, and societal stability. Barbed wire, the steel plow, and the railroad were key elements in opening our western prairies to farming. These lands contributed to an enormous increase in food production which has greatly depressed agriculture in the rest of the world during the past 100 years. We could develop a good argument that the American prairies, barbed wire and all, were a major driving force in the overpopulation of the world during those 100 years. More recently, western irrigation and the cotton picker contributed to a shift of cotton production from the southeast to the southwest. Share cropping went out, and 10 to 14 millions of people migrated from the south. The Watts riots in California were at least a symptom of the technological changes in agriculture. But the cotton picker is simply a small example in mechanization. The tractor and nitrogen fertilizer have contributed to massive reductions in farm labor requirements and to the change from a rural to an urban society.

My second point is a corollary of the first--that changes in society are a determining factor in research activities and technological evolution. Fine violins and fine wines were developed in affluent, stable societies. The same is true for some kinds of science. Other kinds of research flourish in response to crises. We can turn the Roman story around: The Roman success in war led to the Roman peace and the evolution of a sophisticated rural society, a society that accumulated information on farming and wrote books on agriculture. The agricultural technology resulted from a stable society. One of our political scientists, in commenting on the poor state of Russian agriculture, pointed out that Karl Marx was a city boy; the society he created doesn't understand the use of land. Prairie farming in the United States can be viewed as a product of an industrial society with a strong ethic for achievement. Lord Nelson's victory at Trafalgar led Napoleon to the sugar beet, and New Zealand to English rule and grassland agriculture. I am impressed that the use of agricultural technology in Japan, Indonesia, California, and elsewhere is very much dependent upon society. Although those agricultural systems are very different, the biological and environmental principles are the same. In Indonesia they optimize very scarce nutrient inputs by using large amounts of labor, in Japan they optimize scarce inputs of solar radiation through heavy external inputs such as in fertilizer, and in the United States we are optimizing labor and capital but much less intensive use of land and labor than in the other two places. The uses of technology and research are determined by the larger society.

The third point can be illustrated by considering the vulnerability of our agricultural systems to weather. A list of weatherproofing technologies might include bigger tractors capable of preparing land for planting in a much shorter time, thereby avoiding the hazards of a wet spring. Similarly, grain dryers allow safe harvest of grain when fall rains are early, and nitrogen fertilizer frees agriculture from rotating legumes, giving independence from the success of legume crops. Although much background research has been aimed at decreasing vulnerability to weather, the resulting technology is not always restricted to that purpose. The bigger tractor is used to farm more land. The corn dryer is used every year for later-maturing varieties. In California, fertilizer nitrogen allows one to grow whatever crop has the highest market expectation, and the California farmer, at least, has become a market speculator. The farmer's uses of these technological tools is determined by competitive economics causing him to retain much of the same risk to poor weather. In this sense, research conducted as a public good, ostensibly in service of farmers, has served to exploit the farmer's energy and managerial talent. Given new tools and new technologies, the farmer must adapt and the public good is achieved as we get more from the land. A side effect of increasing sophistication in agricultural technology is that it forces channelization. The farmer must know more about each crop, thus limiting the range of crops he feels competent to grow. Some cotton farmers, rather than diversifying the number of crops for stability of income, actually increase their specialization in cotton production by growing cotton also in Mexico and Australia, achieving diversity over markets and climates. A similar channelization occurs in research. Certain crops become so important that the research required for their maintenance may limit explorations of alternative systems and new ideas.

We have time for a very brief assessment of agricultural research. The agricultural research capability in the United States is divided into three parts of about equal weight. The public sector (the USDA and the state experiment stations) represents about a third of the activity, involving about a half billion dollars yearly and a few thousand scientists. Another third is in the corporate sector. To these we might add a third based on farmer innovation.

My own background and expertise are in the public sector. My perspective is that this research effort is very small relative to our needs and to our land and our agricultural activity. It is especially small in comparison with other things we do in society. The USDA effort barely equals the figure we heard for Du Pont's efforts in fiber research. Compare it with the enormous sums spent in medical and defense research. The comparison worsens when the degrees of sophistication and focus are considered. Agricultural research, despite its tremendous diversity of organisms, systems, and problems, employs a very few thousand people, in contrast to the many thousands in medical research alone.

Agricultural research embraces not only technology--better formulations and applications for herbicides, for example--but also scientific questions about how the fertilizer nutrient affects the metabolism of the plant to increase yield. Universities have not been careful in making this distinction; instead, they talk of basic and applied research. These words don't fit our activities. Both technology and science require new information (basic) and the application of old information (applied). It is much more useful to ask whether the work is significant and well or poorly done.

A second characteristic of our research is that it is multi-level. Farmers operate with fields of plants; they never see cells. So research must deal at the field level while seeking explanations and basic principles mostly at the molecular and cellular levels. Terms I have encountered recently in serious conversations on agriculture included not only minimum tillage and water use efficiency, but also elicitors, phytoalexons, plasma genes, repression, induction, partitioning, and feedback inhibition. These are words which farmers and the public would not associate with agricultural research. There is an enormous gap, then, between where the research activity has to be and has to go, and where the farmer is.

Another characteristic of agricultural research which is widely misunderstood is the continuing need for tuning and maintenance research. Our agriculture cannot be sustained by its own momentum. It needs expertise in pathology and genetics, and in soil and water science. Historically the USDA and universities have met this need by organizing along commodity lines. Multidisciplinary teams of plant breeders, physiologists, pathologists, economists, and engineers focused on sugar beet or tomato research. This was an excellent tool for both advances and maintenance, but with shortages of manpower there are now serious conflicts between this approach and that required for fundamental advances. Commodity research has come to have a bad image in science.

Overall, we find that we have created larger expectations for ourselves than we can fulfill. It is much like the farmer who has time and resources to use only half of what he knows in farming. We are doing reasonably well in both maintenance and information research. But all of us would agree that we are not doing nearly well enough. Compared with the activity and accomplishments in agricultural research early in this century, our present record is very poor indeed.

Some of the reasons for the present slackening can be illustrated with examples from my own experience and my own department. During the past 20 years, the U.S. has become a strongly urbanized society focused on issues and problems other than agriculture. This society, oversold on science and technology through the space program, increasingly questions the value of research. Add to this the enormous food surpluses and student activism of the 1960's. One result is that our own research unit, which had 33 professionals in 1960, now has only 22 even with recent additions of young staff. Before those additions, I was one of the youngest in the department; the median age in the USDA, and indeed in this audience, is past 50. In contrast, at a recent industrial research conference I was one of the five oldest people among seventy in the room. We are an entirely different age structure. The USDA and universities have been starved too long. They desperately need new, young blood with new skills and new perspectives. In the same 20 years the teaching load in Agronomy and Range Science at Davis has doubled and is now three times that budgeted by the state. (In 1975-76, our department offered 30 formal courses exclusive of special problems and research and also concerned itself with the research and professional training of 80 graduate students; 12 faculty served as academic program advisers--the State provided 3.7 positions for teaching!) And pressure exists to expand our teaching. We have a strong commitment to teaching, but it causes our capability for research to be very much less than is budgeted. Similarly our space is 30% less than the standards set by the State Department of Finance. Equipment and supplies are scarce and outmoded, severely limiting the quality of research. Research budgets are very small, providing $3,000 to $4,000 annually per researcher, plus some technical help. The concept of an Experiment Station as an organized research unit is largely a myth. We don't really have the capability for research that is suggested by the term Experiment Station. A similar syndrome exists in the USDA. The core of the USDA Plant Physiology Institute is focused on UV-B radiation effects--in response to the Department of Transportation's concerns about the SST and air pollution. Both are legitimate concerns and the USDA is highly qualified for the research--but these are not heart-and-core problems in agriculture.

Poor funding is a contributing factor to a more serious issue--the poor quality of American science in both conception and execution. Examine the next issue of Crop Science or Plant Physiology. See how many times conclusions are unsupported by data, how many times appropriate controls are lacking, and how many times an association between two things is transferred into hypothesis and then somehow becomes fact. A recent example was an ecological hypothesis that high biological diversity leads to stability. Agriculture, then, is bad because of low diversity and potential instability. After a good deal of fuss, it turns out to be largely the other way around: high diversity accumulates in stable environments. My feeling is that the quality problem is actually greater in the larger scientific community than it is in agriculture. There are too many fads, too much oversell, in our science. Instead of the hard careful business of unraveling the way things work, we see tremendous swings from a focus on energy to a focus on protein deficiency, from air pollution to nitrogen. Millions have been justified for soybean research from outmoded data (1967) indicating that the world is in the grip of a serious protein deficiency. The 1972 allowances reveal that carbohydrate supply is the problem. Soybeans deserve research, but I object to the huckster element. We don't seem to have enough rigor and objectivity to sort out the basic issues and stick with them. The public asks for quick, innovative breakthroughs, for catalytic research. Science administrators extend this pressure to the research level. Great emphasis is given to short-term grants, 1 to 2 years, and what you propose must be different. The syndrome shows particularly at the federal level, where the National Academy, ERDA, and NSF-RANN compete with the USDA toward being the catalyst that creates changes in society. The USDA and the Experiment Stations are forced into the same mode of opportunism. Researchers with high visibility and newsworthy ideas take the inside track, even when their science is poor.

To a considerable extent these symptoms are products of underfunding, understaffing, and the consequent underachievement in agricultural research. They also are symptoms of the wide diversity of levels in our research establishment. Many of our best cellular and molecular scientists lack the perspective to extrapolate their work to agricultural fields. With a dearth in intermediate researchers, the molecular scientists are under pressure to find applications for their ideas. Better research properly involves problems in need of answers rather than answers in need of problems.

Marc Faye has shown us that a similar gap exists between agricultural research and farmers, who have less technological understanding of plants and soils than they did 20 years ago. Success in agriculture during these 20 years has depended more on business management and economics.

I have painted a rather discouraging picture because I think we need the criticism. But overall, the USDA, our experiment stations, and my department are still basically good institutions with basically good people doing good work. The deficiency is more between what we are doing and what we could or should do. So I am not all that pessimistic. The state of our research in many ways reflects the state of the larger society. It has been said that the U.S. is the only country that has gone from revolution to decadence without passing through civilization. A clever jest, but not to be taken as a serious proposition. I would much rather believe that we haven't reached decadence and that our problems in achieving a good agricultural science result from our existence as young, boisterous society. I refuse to accept the idea that we should lower our expectations for agricultural research. Rather, our scarce resources provide a stiff challenge that we make harder judgments, improve our science, and raise our professional sights.

There is one final worry in all of this. We have all accepted to some degree that the role of agricultural research is to meet a "food crisis" as the real problem for society. But, returning to where we started, we must ask questions about the extent to which agricultural research and excellence in research have created a "people crisis." We will see a continuing oscillation between those two points of view as we proceed.

KNOWING HOW IS NOT ENOUGH

Marc Faye
Farmer, Knights Landing

As a farmer, I am particularly pleased to be here and to be on the program. I understand the percentage of farmers in the United States is down to about 2% now. I would like to ask a little audience participation here. Are there any farmers in the group this morning? That's about 2-4%. How many come from a farm, that is whose parents were farmers? Most of you! And here's where you are now, in agri-business. We are certainly all in the food system, either as a producer, or a processor or maybe in marketing or perhaps as a modifier of the food system, trying to improve it, as many of you are in research and in the university systems; perhaps as an educator as so many of you are; perhaps as a regulator - many of those in government are regulators of the system; or, in the end, certainly as consumers, which makes us all involved. There is a bumper sticker that I like that says, "If You Enjoy Eating, You Are Involved in Agriculture." Did I leave anybody out?

Don talked to me some months ago about being on the program today and explained that he felt it would be at least entertaining to you to look at a real farmer. Perhaps I could give my perspective on how things are today. Then, this fall he nailed me down and said he had to have a title for my talk. Since I had been giving it some thought, I felt perhaps the least I could do was demonstrate that I am aware of some of your problems and share with you what I think are some of my problems. One of the truths of which I have become aware in my lifetime, my father particularly put this into my mind, is that in farming one can't simply stay on the farm and do his thing. He's got to be involved in society. So I told Don that my talk would be "Knowing How is Not Enough." Beyond knowing the skills of pruning, fertilizing, irrigating, cultivating, harvesting and shipping my crops, I should be involved in other things in society. Don took that back and when the program came out I see it said "Knowing is not Enough" which then made me think about my first problem, communicating. Guy MacLeod mentioned communications this morning and, of course, he's right. It's perhaps a fundamental thing, even if we are overworking the word, I think still we must recognize that sharing ideas and problems is, above all, the element that will keep us together in the end. Many of the things I consider to be problems have no solution. There is a middle road or there is no road at all that will get us where we want to go. But if we let one proponent of an idea go too far, certainly, it's going to affect everybody else or somebody else adversely. So, I feel the first thing is communication. Agriculture is accused--we accuse ourselves--of doing nothing but talking to ourselves. At Farm Bureau meetings we tell each other our problems and eventually somebody says we have to get out in the community and talk. Today is at least an effort in that direction for me, although, as we've seen, most of you are still pretty close to agriculture.

What I want to do today is review my area of expertise--my own problems. I found in listening to the program yesterday and today, too, that many of you are really experts on specific parts of those problems so I won't delve into them too deeply. I toyed with the idea of coming up with some statistics and what I might call meaningful aspects of agriculture, but I don't think I should because you already have access to information as good as I can get. What I really would like to do is share with you the fact that I believe you are right in many respects, or if I disagree, perhaps say that I don't think so. I want to first caution you that I can't claim to speak for all of agriculture, I can only speak for myself, which in itself points up a problem. Agriculture is well diversified. California, as you may know, has over 200 major commercial crops, and I believe California is the leading producer of some 47. You couldn't possibly say what is good for one grower is going to be good for everybody else. So I must first qualify anything I say by noting I am only speaking from my point of view, and from that point of view, I hope you might get some meaning out of it.

I divided my view of problems into three general areas, first of which I would call somewhat long-range, but abstract. Next are long-range and very real problems that I personally will have to confront. And third, there are problems that I would consider to be right now, related to whether or not I will be in business next year.

Under long-range, abstract, I have already mentioned communication, and I still want to list that as a prime item, but I won't say anymore about it.

I would say "people" comprise a long-range problem. Farmers are certainly a shrinking minority and how to be heard in society in view of our one-man, one-vote approach is going to become more and more of a problem. So many decisions that affect us are made either in courts or in the legislature that we feel in many cases that we are losing our management prerogatives. It has been said that agriculture had too much voice in the past, and maybe now the pendulum is going the other way. I wonder if possibly the production of food and fiber will become so important to society that there will be more and more interest in politicizing it or perhaps even eventually turning it into a public utility. An example perhaps would be in the production of wheat. The new U.S. Secretary of Agriculture has already indicated he tends to favor wheat reserves. We don't presently have any. The issue in my mind is not whether we should have a store of wheat, but who is going to control that store of wheat. Is the government going to control it? That could lead to government price control through the avenue of "dumping" stores on the market when natural prices appear to be going up. Or, are farmers going to control, obviously with the intention of regulating the supply available to keep the prices strong? Is there a right or wrong for such a question? I can't really say. Obviously, I'd like to see farmers own the wheat if we're going to store it. But many people would probably say, no, the government should because it would have better control. To me, government control means absolute control, in effect - a slave system, to keep the farmer on the farm producing, but just barely surviving. That's a problem.

There's a magic word that we overuse, too, and it's called the family farm--another problem. I consider myself part of a family farm. I farm with my father and my brother and we employ, today, about 45 people but seldom less than 20. Still, I consider myself a family farmer because we provide all the management; we provide all the capital, and as much labor as we are able. We are, in fact, a corporation. We incorporated for many reasons. Financing was one of the best ones. It's a lot easier to go down to Production Credit when they know your corporation is not going to be dead tomorrow if you get hit by a truck. Estate planning; my father is past 70 and he wants some kind of an organization. I have a sister who is not involved and he wants to include her in some way. Taxes, obviously, are part of the reason. One of the most important reasons we incorporated was liability. Again, as an individual, I take actions but many of my actions are in behalf of the corporation and if I make some mistakes, which I do, then it's the corporation rather than I who has its neck out, and there's some comfort in that. At any rate, farming has provided me a lifestyle that is important to me, the concept of family operations. It may not, however, be that important to all society anymore except as sort of a myth that America's stronghold somehow is founded in the family farm. I'm not so sure it is anymore--a problem.

Another abstract problem, to me, concerns just the sheer numbers of people who are involved in the government. There are many people who feel the fastest way to solve unemployment is to increase public employment. Yet, it is very simple economics that somebody's got to produce the basic wealth for the country, and the government doesn't do it. In fact, government spends a good share of it. An element of public employment that is coming up more and more is the right of public employees to walk out on strike. The implications of this problem are frightening to me, and yet how can you deny that any individual hasn't got the right to do this? I consider that a dilemma. On the one hand, it seems to me if one accepts employment from the public, he made that choice voluntarily and he has no right to strike. And yet, there is a human right involved. I have no answer to that one--so much for abstracts. Those issues are all ones that concern me, yet are not within my direct control.

Another set of problems are more real to me, and are still to be considered long-range, my second category. These problems actually will influence the cultural decisions I must make as a farmer.

First, let's consider land use. There are at least two land use bills before the California legislature, AB222 by Warren and one by Boatright and Zenovich. As near as I can figure, the difference between the two is a matter of degree. The first wants the state to regulate all prime or best soils of some 10 to 12 million acres. The other would allow more local control, but be extended to include lesser soils to a total of about 23 million acres. We are asked to support one or the other. To me it's like asking me to choose between the guillotine and the ax. In either case, it's my neck. Yet I recognize that too much of our best soils are covered with houses and highways. Farmers have a pretty good record, however, of developing new lands as old lands get covered up. Look at the west side of the San Joaquin Valley. Only a few years ago regarded as pretty poor farm land, today it is being fought over like no other land since the days of homesteading. How can we say absolutely that we must prohibit development of prime land around our cities? It's a problem.

Our concept of private property is changing and as such poses a definite problem to me in the future. The right to own land and to do with it what we wanted was basic to the formation of our nation 200 years ago.

Today we see more and more restriction placed on it. The land use issue is just one. Building restrictions, code requirements, environmental impact statements, and an infinitum of so-ons have eroded, some say, 50% of the rights we had as a new nation. One of the latest is by the new Agricultural Labor Relations Board which administratively has legislated a change in our right to protection from trespass. It's all right, the ALRB says, for union organizers to enter your property at certain times and for certain purposes whether or not you approve. A growing number of citizens in our country have never owned land. They are not quick to be alarmed or even care if farmers think private ownership of land is being threatened.

This leads me to some worries about water rights, rather special in California. Riparian rights mean, essentially, if you are on the stream you may use the water as long as you don't ruin it. Under the conditions of dry years, like we're having, some people are thinking differently about those rights.

After all, the "state" gives out those rights in the first place. Isn't it reasonable to think the "state" will modify those rights when it feels the rights no longer serve the needs of all the people?

Another long-range concern for me could best be expressed as competition for financial backing. We borrow capital money from the Federal Land Bank and operating funds from the Production Credit Association.

Farming along the Sacramento River on heavy reclamation soil has its own problems. Seepage from the river on normal years; heavy, wet soil that must wait two weeks after the prime soils around Woodland before it can be cultivated; odd-shaped fields, most smaller than 150 acres, with hardly a square corner due to the meandering nature of the river and the old drainage sloughs are but a few. Yet, we are competing with farmers along the west side of the San Joaquin who are farming in some cases as many as 3 or 4 sections squared off and all in the same crop. Can I ever be as efficient as they might be? If my production record is not as good as theirs, can I expect strong financial backing when competition for ag dollars gets tough?

As an example of the decision facing me, I must consider whether to remove about 80 acres of oak groves we have left on the ranch. To me, their beauty, the wild life they shelter and the protection from north wind and summer heat constitute a part of a life-style I chose when I decided to make my home on the ranch.

Will the need to expand our acreage, the pressure of increasing taxes on idle pasture land, on some assessor's opinion that it is in reality a valuable recreation area, eventually force us to remove the trees and farm the land?

Let me touch on the inevitable, taxes. No need to dwell on it, but I should record some elements that are affecting our long-range thoughts. Many of us in farming got here because our fathers took us on and then left the farm to us. I suspect many of you who raised your hands when I asked who was from the farm are not in farming today because your father just didn't have enough left to pass on and still offer a livelihood that was at all attractive. By far, the majority of farms are operated by individuals or families. And the majority of production still comes from these farms, despite the emergence of large corporate or consortium ownership.

Recent tax legislation will make it more difficult to pass on anything but a subsistence operation from generation to generation. All the noise about deferred taxes and low interest rates is a lot of whitewash. The next generation still has to buy the farm over again and the attractive rates and terms are only available to farms that cannot get loans from any source other than the government. That isn't going to be much of an operation in the first place. The result of our tax policies, I think, will be continued sales for development purposes, trading that inflated land for land further from the urban area, again at an inflated price that could never be justified if the land had to pay back the price in 20 years on its own earnings.

Tomato growers in the Woodland area have paid in the neighborhood of $3000 per acre for land. How can any long-term, normal crop program pay that back? Sure, you'll hear of individual farmers who get 60 tons of tomatoes at $55 per ton, but I submit it can't go on at that rate. Maybe I'm wrong, or too conservative, but it looks like a problem to me.

The foregoing doesn't say much about county-levied property taxes or that dream of many legislators and educators--statewide property taxes. Suffice it to note that these taxes aren't going down as people think up more and more programs for somebody else to finance.

Speaking of the government, and one must if we are considering problems, we find it taking a greater and greater role in the management of our operations. From burning residue, spraying crop protection chemicals, and safety and health conditions, to land use restrictions, endless reports and tax collecting demands, farmers find themselves spending a good deal of their time satisfying the requirements of an insatiable bureaucracy.

Whereas, I believe the government's role in agriculture should be one of collecting and disseminating information that will enable all of us to make better decisions, it seems to me the government is more content to make the decisions first, then try to get someone to implement them. Government should monitor the system, not attempt to manage it.

How about energy as a problem? Certainly the increased cost of energy, in whichever form we select to buy it, is going to be passed along in the form of higher prices. This, in turn, is going to force us all to look at more alternatives, since the cost of anything is best measured in terms of its alternatives. I'm a prune grower. Will people buy prunes at a higher price. They don't buy them at a lower price. For some farmers, it will force a review of the practice of replacing labor with machines. Machines use energy. If any of the unemployed people around have any energy, it may be better to use them.

Still talking about long-range issues the last I want to mention is marketing. Most people don't know very much about marketing. In fact, most <u>farmers</u> don't even know very much about marketing.

Some government appointed officials last year became very enthusiastic about direct marketing, that is, grower to consumer, and spent a good deal of state money to encourage it in California. The idea was to save everybody money and beat the more than 100% markup in cost of food from the farmer to the ultimate buyer through several handlers and distributors. It's a fine idea, as long as the government's role is one of facilitator, collector and disseminator of information. But at best, it can have a very limited application to a few farmers close to urban areas. Most real commercial operators already have their crop outlets contracted through independent processors or with marketing cooperatives, so the appeal of the direct market outlet is going to be limited to surplus, overripe or inferior quality goods. By its nature, it won't be a significant amount and, if it isn't good quality, people ultimately won't buy it, as Mrs. Thom pointed out yesterday. The experience of 1976 was that far less farm goods were sold than was estimated when state funds were allocated to the project. The cost to taxpayers was accordingly much higher per unit, yet the project was called a success. You may expect to see it again this year, and, I hope, more successfully. The real problem here is to keep the state's investment in perspective and avoid a bureaucratic mass of public effort for very little result.

Up to this point I have been focusing on what I think are problems that will affect me, mostly in the future, either in an abstract way or directly. Now, I should like to turn to the third and last general area of concerns I wanted to share with you today--real problems, today. I'll note six or seven I feel are influencing my daily decisions.

First is water. We are forced with a curtailment of from 30 to 80 per cent. How am I going to change my operation to live with that? Sure, I can be more efficient, but not that much. I must alter my crop pattern. I'm an orchardist primarily, but I can't very well alter trees. What I can do is irrigate less. Obviously, I'm going to do just that. What will that cost in quality and total yields? Now the P.G. & E. is threatening rolling black-outs, wherein they simply stop all power to me for several hours. Here I'm going to be considerably less efficient. Where I have sprinklers and short water runs, it won't matter much. Where I have surface irrigation in ditches a mile and a half long and irrigating furrows for those ditches 2000 feet long, it will be horrendous. The inefficiency starting 300 siphon pipes over after they've run out of water frightens me. How about the effect on the irrigator, or to be realistic, irrigators, because I shall certainly have to hire another for every one I have. This is a tough problem for me if it becomes a reality.

Labor - never gets enough pay. New laws providing for time and a half over 10 hours or 60 hours per week will have an impact. If farming could happen 6 days a week and in 10 hours a day some of you might have stayed on the farm. I'm looking forward to the day when it's 40 hours and 5 days. I'd love that, if I'm included.

The latest is unemployment insurance, an added cost of nearly 5% on top of workmen's compensation, social security, health insurance, housing, utilities and the other costs we pay. At what point do I consider replacing labor with a machine? Mechanization is certainly no great solution; it certainly doesn't save any money. What it does do is replace labor, or in effect, pre-pay labor for five years or so.

Usually the decision for me whether to buy a machine has been made on whether people were available at any price to do what the machine does. If people are available, it usually has been better to use them. Now I must re-evaluate that in the face of another 5% increase in labor costs.

I want to mention research, both private sector and university oriented. Agriculture is often the target of criticism for receiving too large a share of the results of research. Now, I ask you, who ultimately benefits? The consumer, of course! Sure, some individual may get a short term windfall because he was first to adapt a new variety or technique which resulted from research, but competition quickly picks up the idea through widespread media coverage and through a highly efficient extension service. It is just this that makes the United States a leader in the world.

Bob Loomis earlier commented on research and society's exploitation of agriculture's ability to respond to research. He's right, of course, but how many understand it?

Another problem I face daily is employee housing. We are 15 miles from Woodland, far enough for workers to realize it takes a lot of gas to drive out for work. I also find that housing in town is particularly expensive for the kind of people who work in agriculture. I was in one family's home this winter which could only be described as a shack. He was paying $90 per month. As a result of these conditions, we get a lot of pressure to provide housing. We have some pretty good housing on the ranch along with some shacks of our own, and I find to get good, dependable people, I must make it available. They don't work cheaper, even though they save in transportation and in housing costs. It's more a question of getting them at all.

And yet, the laws are such that if I provide housing, even though it is free, it is considered a labor camp, and as such, it comes under pretty close scrutiny from several regulating agencies. Complying with all these requirements is a constant headache. Just the question of how to get minor repairs done is a continual nag. Do I do it myself, hire a carpenter on our payroll or get a contractor to come out 15 miles. None of the above is a good solution, yet I must get the job done. That's more than a problem, it's a dilemma.

How about health insurance? Doctors are getting all the press about increasing insurance rates, but you all know how your own costs are going up, not to mention those of employers. The premiums for the off-job medical insurance for our key employees are so high we're considering insuring ourselves and limiting outside policies to major medical. Besides, it seems that our insurance never pays for whatever is wrong when someone does need care. For most employees and their dependents, it's the small outpatient things that concern them most. As a fringe benefit, fine sounding exotic treatment described by the plan does not impress them.

I said I was not going to use statistics, but I would like to use a few to score the next issue on my list - that of farm prices, or the farmers share of product prices. In 1954 farmers in general got some 43% of what we paid in the store. The rest was in services after the food left the farm. You know the story - storage, processing, shrinkage, grading, packaging, shipping, advertising and on and on. Twenty years later, by 1974, the answer to the same question was 40% or 3% less. On the other hand, we as consumers, paid about 22% of our income for food in 1954. In 1974 the figure was 17%. Both examples are only a matter of a few percentage points, but translated into dollars and over 200 million people it gets significant. At least it points out a trend and serves to remind us that American food is still one of our best bargains.

That leads me to my final point - a word about consumerism. Despite the figures I have just noted, farmers get a lot of adverse press for prices. I suppose one reason is that food has become one of few cash items in our budget, most else having gone the way of the finance company or at least credit cards. Food is purchased frequently and with changing seasons and all the hundreds of variable prices changing, the buyer is quickly aware of increases. And since most food items have alternatives easier to select than say houses or cars, choices are constantly being made.

There is only one way that occurs to me to deal with this problem. After leading you all around Robin Hood's red barn, I bring you back where we started - communication. We must tell our story whenever we can, not asking for anything except perhaps understanding as we try to work with the problems society offers.

As for me, I wish to thank Don Smith for the chance to be here, and thank you for sharing your time with me.

AGRICULTURE'S ROLE IN THE SOCIAL REVOLUTION

Daniel G. Aldrich, Jr.
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The history of American agriculture is the story of free men transforming the natural resources of a continent into wealth. The land and its minerals, the trees and the grass, the water, the open space, and the people themselves have been combined to create a miracle of production.

The first men who were to farm the wide new continent of America wanted to build their homes on land that they owned. They came from countries where their ancestors had been lowly peasants, tenants, or even serfs bound to feudal lords. They and their forbearers had dwelt in a caste society where few could rise, where custom reserved the ownership of land, with all it meant in security and prestige, to a privileged few.

For the immigrant from the old world, the chance to become a possessor of a farm in his own name was a magical lure.

Within a century, American farmers had set their plows to turning up the virgin soil or were pasturing their growing herds in every fertile, watered region of their 3,000 mile wide continent.

Try to picture it: the stupendous feat of plowing a continent from coast to coast, a feat that was performed willingly and eagerly by multitudes of men, many of them strangers in a strange land. The toil was enormous. Difficulties and dangers, discouragements and disappointments confronted the plowmen nearly every step of the way.

But no one forced the pioneers to cultivate the new lands--they were lured by the promise of better futures. The Constitution provided them with a government that left each man free to seek and enjoy the rewards his endeavors might earn. To become owners of land and to live as free and independent citizens, men faced incalculable perils in pursuit of the American dream.

The wilderness spread so far and wide that every individual who wished land could have it. That seemed beyond a doubt. Thomas Jefferson expected that a thousand years would pass before all the vacant lands would be occupied. He favored giving land to those who would build homes upon it and cultivate it. The ambitious farmer wanted title--legal and indisputable--to his acres.

Besides the land that passed directly or indirectly to farmers by way of homesteads, military bounties, cash sales, and private claims, Congress gave millions of acres to the states for building schools and colleges, for canals, drainage projects, and other internal improvements. Still more millions went free to corporations to help them build railroads. The state and railroad lands, if they had agricultural value, were sold to farmers.

Finally, after the best lands were taken and it became plain that no one could make a living on only 160 acres of poor land, particularly on the semiarid western Great Plains, the Homestead Act was changed to increase the claim limit to 640-acre tracts.

Thus, only 30 years after the Homestead Act was declared and only 100 years after George Washington's inauguration day, the lure of land and freedom had indeed plowed the continent.

During that 100 years of stretching agriculture across the continent, the farmers recognized the great need for machines that would make their labor more productive. When they had to rely largely upon their own muscle, they adopted the cradle, in place of the sickle, to harvest grains. With the same effort, they could accomplish more. Later, with reaper and many other inventions, they literally harnessed the energy of horses and mules. Then, from steam, from internal combustion engines, and from electricity came new sources of energy which revolutionized the age-old art of farming.

In 1800, during the time of the sickle, an average of 56 hours of labor were required to produce an acre of wheat. By 1880, when the horse-drawn reaper was widely employed, it took 20 man-hours to grow and harvest an acre. Today, on the Great Plains, less than two hours of labor will do the jobs and do it better.

A single mechanical cotton picker can gather as much fiber as 40 pairs of human hands. Go into the country on a summer day, and there one man may be seen to bale and load 10 tons of hay in an hour while sitting down; 20 years ago, two men, working with pitchforks, could not have done that much in a whole afternoon.

By 1910, when horse-drawn implements had taken over a substantial part of corn production, 147 man-hours were required to raise 100 bushels. This was quite an improvement over the 344 man-hours needed in the hand-hoe days of 1800. But today a few exceptional farmers in the corn belt raise 100 bushels of corn with less than four hours' labor. Better seeds, pesticides, and more fertilizers, as well as machinery, have made this progress possible.

In 1961, the irrigated fields of southern California got a glimpse of the first self-propelled lettuce packers, which cost over $20,000 each, and pack 600 boxes of lettuce per hour right in the field. These mobile factories, which lumber down the lush green rows like dinosaurs, carry 10 workers and a boxing crew. The workers wrap and seal each head of lettuce in a plastic cover, while the boxing crews pack them for trucks that follow. The trucks carry the cartons to the cooling plants at rail sidings, and within a few hours the lettuce is on its way across the continent.

For a long time, it was thought that the culture of tree and bush fruits could not be mechanized, but now there are dozens of operational models that prune and pick. Modern orchards look like giant hedgerows that have been trimmed by buzz saws, mounted on hydraulic beams, transported by tractors. Some fruit growers have reduced field labor forces at harvest-time to one-tenth of former requirements by using mechanical tree-shakers and fruit-catchers, which wrap around the trees like firemen's life nets.

The technology and improved efficiency of modern agriculture are as fabulous as the conquest of outer space, and they are far more significant for the welfare of mankind. Yet, as we marvel at this miracle of production which has made it possible for one man to produce an abundance of quality food for himself and 43 others, we are aware that serious economic and social changes have been wrought by this achievement.

During the period 1850-1910, the first of the major changes in the population on the rural landscape occurred. The Indians of the Great Plains were confined to reservations, Negro slavery was abolished, and the total of farms increased from 1.4 million to 6.4 million, most of them owned and operated by single families.

Now, agriculture is undergoing a second major period of change--the revolution of science, mechanics, and heavy capital investment. While it has not yet done away with the family farm, it has gone a long way toward getting rid of the farm family.

In 1935, American farm units reached an all-time peak of 6.8 million. Since then, there has been a precipitous drop in numbers. By 1961, there were only 3.7 million. In 1970, 2.9 million and within another decade, this figure will very likely be cut back to 1.4 million.

Since this was the starting point in 1850, the cycle will then be complete.

Eventually, as the story is told of how this nation grew and changed, the era of the small family homestead will appear brief. With its demise, any influence which wide-spread security in land ownership may have had upon the American psyche will cease to exist.

A hundred years ago, when there were only about 32 million people in the United States, about 65% of them lived on farms. By 1980, less than 5% of the people will live and work on the soil.

While it is conceivable that many people would prefer that this major reduction in farms and farm population had not occurred, it should be remembered that the course of agriculture has been adjusting since the beginning of civilization. The whole process of economic advancement begins with reducing the amount of human effort it takes to provide the basic necessities of life and then using the work power thus released to produce other kinds of goods, more comfortable living, more leisure, the arts.

If these conditions are an indication of the achievement of the agricultural enterprise, then American agriculture may well be considered the greatest success story the world has ever known. Yet, in achieving this success, it has been the primary contributor to the greatest social problem this nation has ever faced--the problem of the inner city or what some have called the urban crisis.

Under the twin spurs of advancing technology and the economies of scale, thousands of people have left the farm for the city. In the present generation, the net migration was heaviest during the 1950s, when it averaged 800,000 persons a year. And the trek to the cities has persisted at a rate of well over 100,000 annually.

To a very substantial degree, the inner city has been created by the heavy influx of southern sharecroppers, Puerto Ricans fleeing the little fincas and huge sugar and pineapple plantations of the island, and farm-raised boys from Maine to California who simply reject farming as a way of life for them.

The trouble is that farm workers, once they decide to leave the land, do not automatically turn into skilled, or even semiskilled factory employees. The adjustment to city life is, of course, much more difficult for the Black, who, for long decades, has been an essential part of the rural south. As a laborer, he has been replaced by such devices as the mechanical cotton picker. As a farmer, he typically has run the smallest and, therefore, the least efficient operations.

Squeezed between declining farm employment and racial and educational barriers that kept him from taking other jobs, 3.5 million southern Blacks have fled north in the past generation. About 100,000 of them still move north each year.

As a result, 12 million Blacks had crowded into the central cities of the United States by 1965, making their race for the first time relatively more urbanized than the white population. By 1975, the cities housed some 18-21 million Blacks. The challenge to government, to business, to education to help these urban newcomers get an education, jobs, and a decent place to live is obvious.

What is agriculture's role in meeting the needs of these people whose rising expectations are at the heart of America's social revolution? Washington and local governments, alike, have one hopeful answer--industry. The United States Department of Agriculture now spends four dollars for broad purposes of community development for every dollar it pays out in the much more publicized effort to support the income of the nation's farmers.

Spurred by this outlay, the "second America," as Secretary Orville Freeman called it, has been adding jobs at the rate of some 5% a year versus 4% in the cities. Here and there, industry has been heeding the call. New plants are being located in rural areas. New Hampshire, which most people think of as mostly farm country, has quietly become the second most industrialized state in the nation, after Connecticut. The state government, which has taken a strong hand in attracting industry, imposes no income or sales taxes.

Another ally of the back-to-the-land movement is the increasingly popular financing device, the industrial income bond. Now legal in 41 states, these tax-free bonds, which use local or state credit to attract corporations to areas of labor surplus, have shown remarkable vitality, and last year the total volume sold exceeded 1.5 billion dollars.

Marion Clawson, writing on the long-run future of American agriculture and the problems that face agriculture's castoffs as they stream from the country to the city, suggests that direct federal help be extended to them as they move to new locations and new jobs. This help might take the form of retraining for new jobs, including income or support payments during the retraining period. It might take the form of counseling services before, during, and after moves. It might include some financial help for the direct moving costs. And, lastly, it might include some modest supplementary income payments for a limited term in the new location to facilitate the pains and pressures of change.

Other suggestions by Clawson involve shifting the emphasis of federal aid programs from commodity price supports to farm income and the tying of this support to people, rather than to land; funds for early retirement programs for presently active, but older, farmers; aid to residents of rural small towns who are dependent primarily upon agricultural supply businesses for their existence; cooperative programs for restructuring rural land settlement pattern and rural social services; and a direct attack on rising land prices.

While the possible impact of these federal programs on the welfare of farm, and farm-town people is described, both time and circumstances preclude such discussion, since I should like to conclude my remarks on agriculture's role in the social revolution with comments on how agriculture in an institution of higher education, such as the one I serve, might respond to the challenge.

In an earlier effort to meet this challenge, I suggested that the concept of agriculture must be broadened. No longer should we define agriculture solely in terms of the fields which grow our crops and the pastures and ranges which produce our livestock. We must change our definition to include all land--cultivated land, grazing land, forest and wild land, and open land adjacent to our cities. It must also include the waters in our lakes and streams.

I also suggested that our agricultural researchers and planners broaden their concepts. In the past, they have generally concentrated attention on the allocating of resources as these affect agricultural production and the marketing of food and fiber. They must now extend their thinking beyond these objectives and consider how farmers and urban people can live and work together, each obtaining full use of our natural resources and each paying his fair share.

When we look at projections made by our leading agricultural researchers, we find them estimating that agriculture will be able to meet food and fiber demands a decade hence with some 50 million fewer crop acres. A change of this type, in spite of its great progress, creates problems. Among them are:

How can we adjust agricultural resources to provide maximum benefit for society as a whole, but with minimum hardship for a few?

Since lands withdrawn from agricultural production must be readily available for production in case of a national emergency or for use by future generations, what type of cost-sharing will be equitable and feasible?

What are the best uses of land withdrawn from agricultural production? Do we need new types of property arrangements to shift lands to best uses for an intermediate period?

It has been estimated that our expanding population will continue to subtract approximately one million acres of agricultural land annually for urban development. Any expansion of this magnitude creates inequities, particularly in the rural-urban fringe. Again, there are unanswered major questions:

How can a community develop its resources in an orderly manner? In particular, how can it prevent the common urban sprawl or leap-frogging type of growth without infringing upon the property rights of individuals?

What method of taxation is equitable in a mixed residential-agricultural area?

How can the esthetic values of open space be preserved?

Are some communities selling their long-run economy short when they promote subdivisions and urban development at the expense of some of the best agricultural land?

Again, estimates have been made that the demand for open space will increase tenfold by 1980, including space and facilities for camping, hunting, fishing, hiking, and the enjoyment of open spaces and nature in general. The potential market for recreational use of agricultural land is almost untapped. Research is needed to answer such questions as:

What are the demands? What are the dimensions of both demand and supply?

How can farmers sell recreational privileges to an urban society which looks upon these as an inherited right?

If recreational privileges are to be kept free, how can farmers be reimbursed for the use of their land and its wildlife?

Do we have a trespass problem? What is it? How do we solve it?

These and many other questions must be answered satisfactorily, if agriculture is to develop its full recreational potential. The areas of inquiry are almost limitless:

How will automation affect living and recreational habits of our citizens released from many types of work?

And in an entirely different field--what are the social sciences discovering about man's need to be physically linked with nature?

In this same earlier effort to take up the gauntlet thrown to agriculture by an urbanizing society, I described the changes which would occur in the organization and content of the curricula in the college of agriculture and the coordination and integration of its teaching programs more closely into the operation of the total university of which it is a part.

I also indicated that, in spite of its magnificent past contributions to the agricultural community and to the welfare of the nation, the Extension Service is the component of the agricultural educational system that probably will have to make the most sweeping changes, if it is to meet the emerging needs of a people living in a bewildering and challenging time.

A decade has passed since I made this attempt to describe the challenges that urban America presents to its agricultural institutions. I believe most of what I said then makes some sense today.

But in the light of the present condition of social change, I know that it was not visionary enough. Its view of the future was based on an imagination that counted heavily on technological solutions to basic current problems and assumed that an intelligent application of present technology would make things work right and keep the future under control.

It was an imagination dominated by the "now" which aimed to imprint the "best" of now upon the future. The trouble is that the "best" of now with regard to the social revolution and agriculture in the university, or the university as a whole, is not very satisfactory.

The problems of urban people and the pattern of their lives and the changing content of knowledge combine to suggest the imperative of a continuum in the educational process. The insulation of "campus"- the place and the social system--will no longer do in an urban setting. The exclusiveness and separateness of "university" are no longer acceptable, given the educational objectives we have established in this country. A new unity in educational activities at all levels is required.

To achieve this new unity, our universities must rely upon a much broader range of talents than they now employ. Many of the people upon whom the academic institution will have to rely should not, and will not, devote full time to the university. Tomorrow's universities will have to be innovators in the mobilization of the best of the total community talents in order to teach, do research, and serve society.

For those of us in agriculture, this view of an educational institution responding to the needs of society is neither new nor startling. For more than 100 years now, the land-grant college system, of which we are a part, has labored imaginatively and productively in behalf of agriculture to research, to teach, and to share the results of our efforts with all who were willing to listen or expressed interest in it. The consequence of this, we know, has been to produce, among other things, the most productive and efficient agriculture the world has ever known.

To establish this concept of teaching, research, and service as the modus operandi of the total university and to direct it to solving the problems of an urban society is startling.

But I am convinced that this is the direction in which our tax-supported universities must move, and certainly no group of people are more experienced, better prepared or philosophically attuned to this challenge than the faculty and staff of our colleges of agriculture and their associated research and extension organizations.

Agriculture's role, therefore, in the social revolution, is to help create a university that will respond to the rising expectations of man in a troubled society, a university that is as large in spirit as these times demand.

SOILS AND LAND USE IN CALAVERAS COUNTY

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The soil resource is one of the most important in an area as it is the growth media for plants, it largely controls the storage and purity of water resources, and it contributes to the stability of roads, buildings and other man-made structures. Soil is formed over many thousands of years, yet it can be destroyed in days by inappropriate use of modern technology. Land-use planning should, therefore, account for differences in soil properties and suitability for various uses. An understanding of soils is particularly pertinent in areas of changing use, such as those where urbanization or leisure-home developments are encroaching agricultural, range or forest lands. As the need of society change, so does the balance between differing land uses change. Foothill grazing land converted to leisure-home development not only reduces agricultural productivity but may initiate other problems; the soil may be capable of supporting trees and cattle, but quite unsuitable for disposal of septic tank waste-waters or intense road and building activities.

Subdivisions and leisure-home developments are encroaching range and forest land in Calaveras County, California. We are investigating the relationships between soil and land use in such regions of this county. Classification of land uses over a twenty-five year period has enabled us to identify the conversion of areas and soils to different uses. Documentation of land use has been accomplished by means of photo-interpretation of aerial photography taken in 1944 and 1969 (a period in which changes occurred). The recent State Co-operative Soil-Vegetation Survey of the area has provided invaluable data of soil properties and vegetation cover. Correlation of such properties with land use changes will help the planner identify problem areas and also help in establishing guidelines for future planning. For example, we have conducted statistical analyses elucidating relationships between septic tank problems and soil properties. Intelligent land-use planning requires an understanding of the soil as a non-renewable resource. The rate of soil development is insignificant compared to the rate of changes in land use, and consideration of soil factors may aid the planner in determining the best us of the land.

VALUE JUDGEMENTS OF AGRICULTURAL LAND IN LOCAL PLANNING

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Agricultural land in rural areas of the state such as San Luis Obispo County easily make up the greatest proportion of the total land use. There seems to be adequate amounts available for agricultural pursuits and, therefore, the concern to protect this resource is not found to be of interest to all county residents. This is a problem for determining local land use planning goals.

Efforts to conserve agricultural lands has been primarily through the Williamson Act. This has brought a good share of the County's agricultural land under a Land Conservation Contract. However, prime agricultural land is not all in the preserves. This is primarily due to the fact that much of this land is in the way of urban encroachment and the tax incentive offered with a Land Contract is not enough.

Table 1. Land Use in San Luis Obispo County

Public Lands	Urban Uses	Agricultural Lands	Acres with Land Contract
420,000 acres	200,000 acres	1,500,000 acres	641,715 acres

The issue of property rights and the rights that society gives land owners is the political question that will eventually determine how parcels of land will look in the future. Scientific assistance in the form of better appraisal of agricultural potential for various properties will aid in making the political decisions necessary. Modern Soil Surveys presently in progress in the County will be an important part of the value judgements.

San Luis Obispo County is California in miniature. What happens to the agricultural lands of the County may be a good indicator of what will happen to other agricultural lands in California.

LOCAL POLICIES FOR AGRICULTURAL LAND CONSERVATION

Robert L. Wall
Planning Director
Tulare County, California

Agriculture can be, and is, a pragmatic expression of the culture of the local people. It is not surprising then, that local people in Tulare County have called upon their Board of Supervisors to provide decision-making tools in the form of planning policies which are designed to conserve agricultural land for use by this farming culture.

In the summer of 1975, a number of commercial farmers in Tulare County approached the Board of Supervisors with recommendations that a land conservation program be instigated through the planning policies and zoning operations of the County. The Board of Supervisors directed the Planning Staff to do a Rural Valley Land Study and to subsequently devise a Rural Valley Land Plan which then became an amendment to the Tulare County General Plan on December 2, 1975. That Plan, subjected to a number of public hearings and dozens of public meetings and study sessions, is an expression of the goals of the local society embodied in a set of text and maps expressing those goals to conserve agricultural land as a base for their preferred way of life--commercial agriculture.

The Rural Valley Land Plan Amendment to the General Plan contains two basic parts. Part A calls for the establishment of large-lot, exclusive, agricultural zones over most of the rural area of Tulare County. There are a number of kinds of land uses which are not agricultural, excluded from the initial zoning in Part A. Part B of the General Plan Amendment calls for a "structured loophole" -- providing for the change of zoning on small parcels of property throughout the rural area which are later proven to be unsuited for agricultural use. Examples of such kinds of places would include very small parcels of property; perhaps triangular pieces remaining from highway construction acquisitions in the past; perhaps an old gravel extraction area; or pieces of property which are totally surrounded by urban land uses, are quite small, and are generally unusable for agriculture.

Part A, large lot agricultural zoning, is not necessarily innovative as a device among California Counties, or counties in the United States, for the preservation of agricultural lands. However, Part B -- the use of a weighted factoring system for determining which parcels of property, within the context of the applied agricultural zones, are essentially not suited for agriculture and thus eligible for rezoning to some other classification of land use is unique among California counties and to our knowledge has not been used elsewhere in the country.

These systems were determined by a group of up to 58 farming persons who produced the factors which they considered to be important in evaluating properties eligible for removal from agricultural zoning status and, also what weight should be applied to each of the factors chosen. Thus the decision-making process embodied in this Plan is a product of the representatives of the farming society of this County, and included members of packing, processing, financing and marketing groups related to direct production of agricultural products.

The Plan, and its implementing devices, were thus structured to express and to help attain the societal goals of the agricultural community, and to sustain the basis of commercial agriculture on land in Tulare County, and additionally to meet many of the expressed goals of the State of California to conserve agricultural lands.

TOWARD AN AGRICULTURAL LAND POLICY - THE RATIONAL APPROACH

Darwyn Briggs
Planning Staff Leader
SCS, Davis

Before a rational agricultural land policy for the local, state or national level can be developed, the reason for the preservation or use of the agricultural lands must be determined.

First, the question of why preserve the agricultural land base must be answered honestly and the public must have a full understanding of the consequences of the answer.

The answers may include: to feed the hungry world, to barter cereal grains for oil, to maintain a favorable balance of international trade or simply to maximize the net return to the region's agricultural sector.

The lands best suited to the production of those crops identified in the above alternative answers must be evaluated as to their relative productivity versus the capital cost, labor and energy requirements and the potential impact on the land and water base.

The ultimate selection of how many acres of which lands, their location relative to rail or water transportation must be fully evaluated. The evaluation must include not only the physical, economic and environmental but also the political implications.

Only after the above exercises have been completed with public input by all sectors of the population's special and general interest groups and their support expressed can a rational "Agricultural Land Policy" be effective.

Only after the above rational agricultural land policy has been established can the problems of how to preserve agricultural lands be intelligently addressed.

IS FEDERAL LAND USE LEGISLATION NEEDED?

Larry E. Moss
Planning and Conservation League
Sacramento

An outline of Federal land use law was presented which presently controls decisions of federal land managers and how this law effects land management in California. Comprehensive land use legislation has been considered at the national level during the past few years. Such concepts as comprehensive land use planning, critical area protection, taking, and enforceable restrictions for property tax assessment were analyzed.

DIVIDED WE FALL

Janice Gentle
President, Central Valley Chapter
California Women For Agriculture

Agriculture, California's leading industry, is essential to the economic stability of California and the nation, and to the stability of the entire world.

One of the most indicative facts supporting this premise is that one out of every four jobs in the United States' private employment ranks relates to agriculture in some way. Approximately 13 million people either process or market goods or provide the growers with supplies. Many of the jobs in these farm-related industries are situated in the larger cities. The economy of these urban giants, thus is often dependent upon the employment opportunities that agriculture has created. How many urbanites even consider how closely they are aligned to agriculture from this perspective?

Many "city folk" have begun to take agriculture and their food and fiber supplies for granted. Few in the cities have even considered how hard they would be hit if the State or the Nation incurred a genuine farm income disaster.

Because of this basic public ignorance of the significance of our industry, a new organization, California Women For Agriculture, was formed in January, 1976. The primary goal of this group is to bridge the gap between the farmer and the consumer by uniting members of each group.

To accomplish this goal, our members concentrate on educating themselves on the most significant issues concerning agriculture. We use our knowledge by communicating to everyone who will listen to our story. The women in our organization know that we have a story to tell. And we attempt to reach as many urbanites as possible in an intelligent and informed manner with our vital information on behalf of agriculture.

Farmers have lost touch with city people simply because those "in town" are two or three generations removed from the rural farmer. Just 150 years ago, however, farmers out-numbered the rest of the United States' population by better than three to one. There is still the same number of farm people today as there was 150 years ago - about nine million, but they are now out-numbered by non-farm people, twenty to one.

This loss of contact between the farmer and the urbanite is demonstrated by the way urban centers vote - generally in opposition to the way rural centers vote. Many of the disagreements between these segments are precipitated by misinformation, misrepresentation by the press and primarily by lack of communication.

Lack of communication in agriculture not only affects our relationship with those outside of the industry, but more important, it has atremendous affect on those within California Agriculture.

Within the huge diversity of California Agriculture, some segments are organized so they can speak with one strong voice through properly paid managers. They have made political investments and social adjustments that have kept them up with the times. They have invested time and money and have united the best brains in their fields.

Unfortunately, this unity and organization applies only to a minority. Most of the time in agriculture, we have a house divided - its shots scattered and its leaders galloping off in all directions.

Regardless of the differences of opinion that any or all of us may have had in the past, we must now organize and extend a mutual hand to each other, despite our varied commodities. And then we must gather in as many friends in industry, labor and government as possible. And we must tell our story intelligently, truthfully and effectively.

We must do more than just talk to ourselves. Who will control agriculture in the future depends in large measure on how accurately agricultural leaders of today read the significance of agricultural production and how they react to it. If these leaders recognize what's happening and organize with strong well-financed progressive programs, they can start a new era for United States' Agriculture - one in which agriculture is a full partner in the political and social decisions, and in which agricultural producers share equally in this country's prosperity.

There are areas where agricultural producers need to "bite the bullet". In some instances they must take a tougher stand - in some other areas, a more concilliatory stand.

To effectively combat unfair legislation, for example, the grower must realize that he has a very powerful argument and that his tool is even stronger. He produces what people can't and won't live without. There is a bumper sticker in circulation which reads, "Boycott the Farmer - Don't Eat". That's how, from one point of view, ridiculously simple this whole issue is.

We really don't have the political muscle to push our way through in agriculture; so we must use our resourcefullness to begin to educate ourselves on all commodities and their problems. Then we must educate and convert others to our side.

We must, in other words, tell and sell our story. It will require listening as well as talking. It will require giving a point to gain a point - not giving in, but being reasonable. It's time for agriculture to realize that in this modern world, to maintain your independence, you must become interdependent with other people.

It is my hope that California Women for Agriculture will aid growers and consumers alike in pointing the way for all of us to combine our information, our resources and our energies, to move in the same direction to protect California's most vital industry, and to insure adequate food and fiber for the State, the Nation and the world.

We must all <u>unite</u> now. Divided we will never accomplish our goals.

HOW MUCH FERTILIZER SHOULD YOU APPLY?

A. D. Reed
Extension Economist
University of California, Davis

There are many important decisions to make in fertilizer application. Questions such as kind of fertilizer to apply, how to apply it, where to place it in relation to the plant, and time to apply, must all be considered. However, the amount to apply remains one of the major decisions to be made and usually the decision with greatest economic consequences.

The amount of fertilizer to apply will depend on the reaction of the crop to varying amounts of fertilizer. Such data can be obtained from test plots where varying amounts of fertilizer are applied to the crop being grown and yields recorded from the various rates of fertilizer. Another procedure is to obtain all of the information possible on yields and fertilizer applications which, with sufficient observations, should give a good relationship between the amount of fertilizer applied and the yields obtained.

The University of California Cooperative Extension in conjunction with the California Fertilizer Association has been collecting data on yield response to fertilizer application and these data are being analyzed to determine the most economical rates to apply fertilizer.

An economic decision on how much fertilizer to apply is based on the assumption that you are trying to maximize your profit from the application of fertilizer. The economic principle involved in this decision is that you should add fertilizer to the point where the last dollar of fertilizer applied returns you one dollar of the commodity being fertilized.

The economic analysis made to date indicate that you should apply fertilizer at rates which are very close to those excess rates which decrease yields. The results also indicate that neither the price of the commodity or the cost of the fertilizer have much affect on the most profitable rate to apply. Substantial drops in prices of the commodities do change the application rates which are most profitable but the normal year to year changes in most commodity prices will not affect the amount of fertilizer to use.

MODERN AGRICULTURE'S DEPENDENCY ON HONEY BEES
(Apis Mellifera)
FOR DEPENDABLE POLLINATION

W. F. Huston
Huston Honey, Inc., Corona

Apis Mellifera, the common European honey bee, has been known since 7,000 years BC. This lowly creature has been pollinating food crops, native and cultivated for over 9,000 years and perhaps longer. The birth of modern apiculture commenced in 1853 when Langstroth discovered the bee space, and fashioned or invented the first hive with moveable frames. The next jump forward came with the railroads. Bees were moved from California by cattle car and then re-distributed by teams and wagons to the apiary sites. Then came the motor driven truck in the early 1920's and the last step was the discovery of chemotherapy to control bee diseases. We are now living in the time when bees can be moved 2,000 miles from the mid-west into the San Joaquin Valley to pollinate almond orchards and return to the mid-west.

The three principle uses for honey bees are:

1. The pollination of crops for increased yields such as: alfalfa for seed, almonds, cherries, cucurbits, etc.

2. The production of honey.

3. The recreational value for the hobbyist.

The most important function of the honey bee is the pollination of agricultural crops. The largest single producer of honey in the world is alfalfa, and close behind are other legumes such as clovers and beans.

Pollination is essential for flowering plants to produce fruits and seeds. Noted below are the major California crops that require or benefit from honey bee pollination. Without the bee, the yields of these crops would be drastically reduced.

MAJOR CALIFORNIA CROPS REQUIRING
HONEY BEE POLLINATION

Crop	California's Share of U. S. Production	Total California Acreage	Bee Colonies Per Acre Required
Alfalfa seed	25.9%	39,708	3
Almonds	99.9%	229,896	2
Avocado	78.9%	27,383	
Ladino clover seed	100.0%	8,200	1
Melons: honey dew	75.7%	77,500	
cantaloupe	64.5%		
Plums	60.8%	24,010	
Prunes	98.8%	75,395	

Source: State Department of Food and Agriculture, Crop & Livestock Reporting Service, 1973

The value of controlled pollination through the movement of domestic honey bees in and out of agricultural crops was not recognized and understood until around 1930. One of the first groups of farmers realizing the benefit of honey bees for pollination was the apple growers. Quite by accident, they began to realize that they obtained more apples when there were bees present in the apple orchards. Some scientists had discovered the value of pollination for apples and were having a hard time convincing the apple growers not to use lead arsenic during the apple blossoming period to control codling moths since they were killing the pollinating insects. The apple industry in the Northwest employs bees for pollination and coordinates the use of bees for pollination and the application of pesticides to control their worm problem. The bee industry has to be well organized to get into and out of the apple orchard very quickly so that the pollination work can be done and the apple grower can protect his fruit after the bees are gone.

The first organized alfalfa certified seed pollinating service was done in 1951 by Ward Waterman, a seed grower, and Alan Dyer, a bee man, at Maricopa Flat, Bakersfield. Since then there is an acute awareness of the value of honey bee pollination. At present much money and research effort is being spent studying effective methods as to ways of cross pollinating soybeans, cotton, safflower, and many other crops.

The two fields of crop pollination that Huston Honey Company participates in every year is alfalfa seed and almond pollination. We follow the acceptable theory of moving our bees into the fields of alfalfa in a systematic pattern to where we have super-saturated the fields with bees. When the bees arrive at the field, they have no previous experience in foraging on alfalfa. The newly arrived bees go out and trip a tremendous amount of alfalfa flowers. The newly hatched bees have had no experience in foraging, and in their first few days of foraging, they trip most of the flowers that they forage on. Both the newly arrived bees and the bees in their non-experience period soon learn how to forage on alfalfa without tripping the flower. The other importance of super-saturating an alfalfa field with honey bees is the need for pollen to feed their larvae. If the field is super-saturated, and there are not too many competing pollen plants in the immediate area of the alfalfa field, the bees will be forced to trip the alfalfa to gather pollen to feed their prodigy. An alfalfa field which is not super-saturated with pollinating insects will only produce 200 or 300 lbs. while one that is super-saturated with honey bees may produce up to 2,000 lbs. per acre.

In order to pollinate almonds properly, most varieties of almonds need an alternate variety for cross pollinating. It is unnecessary and undesirable to put a beehive under every tree in the orchard because the almonds blossom early in the spring and the bees are eager to gather the nectar and pollen which the almond orchards provide. The bees can be placed in orderly groups of 25, preferably off the roadways, around the orchard or down through the middle of the grove so the beekeeper can get to the hive in wet and stormy weather and see that the bees have the attention that is necessary. Bees have a working flight range from 1 to 3 miles, but I feel it is necessary to systematically distribute the bees at the rate of 2 or 3 colonies to the acre.

The beekeeper receives a fee for alfalfa and almond pollination and can expect to harvest 40 lbs. of honey per colony from alfalfa seed fields. From the almond blossoms the beekeeper benefits from the stimulation the beehive gets early in the spring before there is any other major pollen source. In the Sacramento Valley, the package and queen bee people receive about half of their package bee benefit from the almond orchards and about half from wild forage. The package bee producer sells from 4 to 8 lbs. of bees per hive in the form of package bees. Package bees are sold in 2 lb. packages with a queen, and the price has been substantial. Huston Honey Company does not sell packages or bulk bees, and our economic gain from almond pollination is in the fee that we receive plus the tremendous buildup we get of young bees to move onto citrus and sage to make honey. The honey producing enterprise can attribute much of its economic success to almond pollination.

The beekeeping industry produces a very large portion of the total crop of honey from agricultural crops that are not pollinated for seed, such as alfalfa hay, permanent pasture, clovers, cotton, safflower and citrus. Alfalfa hay people do not need bees for alfalfa hay, and many of these other agricultural crops will produce an economic crop without honeybees. It is my opinion that well over 50% of all the honey produced in the United States is produced from agriculture crops that are not being pollinated scientifically for an increased yield.

The pasture lands in the foothills contain weeds and pasture forage, such as crimson clover, birdsfoot trefoil, burr clover, filerie, etc. that are pollinated and cross pollinated by honey bees. There are many trees in the Sierras and foothills that require pollination to make seeds for succeeding generations of that particular variety of trees. Very little interest has been put in the effects of pollination on this natural wild type of forage and trees. It is not really necessary because it is carried on whether we note or observe it or not.

I have had cattlemen tell me that they can remember when their pasture was solid burr clover and grass, and the burr clover has been taken over by grasses, some of them not the most desirable such as needle grass. I have had some of these people express to me that they noticed an increase in burr clover and filerie after they had allowed bees on their range in the spring for several years. This should be considered in range management and some research money spent to prove these points.

I cannot make a talk like this without discussing the African bee. The Africanized bee is a tropical bee and does not cluster when the temperature falls below 55° F. For this reason, the Africanized bee winter kills and dies out from exposure. The Africanized bee has been in the United States for at least 100 years and some of their Africanized genes are floating around in our gentle bees which we are now keeping.

VEGETABLES AND THE QUALITY OF LIFE

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Man, in his early beginnings, was once food himself. He had a nomadic existence as a hunter and forager for food and was in fact a prey for stronger carnivores. But, he learned to survive and he began to cultivate the land and developed permanent settlements. Vegetables--a leaf, a root, perhaps a flower part or a fruit of some now extinct plant--played a significant role in the development of the land. As man tilled the soil, the cereal grains became established as the foundation of his caloric and protein supply because their low water content allowed them to be stored for relatively long periods with no special effort. Vegetables--high in water content and with a relatively short storage life were available for only limited periods in the more temperate parts of the world--provided an equally important contribution in terms of nutrition and the emotionally satisfying qualities of variation in diet. Vegetables are an important source of vitamins, minerals and fiber not available in the cereals and animal products. They can supply virtually all of the nutrients (including calories and proteins) needed by man if you ate enough of them--say ten pounds per day. Since this would be rather boring, as would any other single food diet despite its nutritional balance, vegetables contribute to the quality of our diets by supplying essential nutrients as a visual and organoleptic pleasing contribution to the variety of foods we can choose from.

Vegetable Production

For thousands of years man was tied close to the land, living near the sources of food that meant survival. Famine was common and food preservation and food storage a chancy thing. In the early 1800's a successful canning method was developed which provided a new way of preserving foods, particularly fruits and vegetables, without greatly changing their appearance, flavor, or nutritional value. Freezing of certain foods in the cold areas of the world has been long practiced but the technology of quick-freezing to preserve quality in vegetables evolved in the late 1940's and another method of preserving and distributing food became common practice. Today, some 25 or more major vegetable items are available as fresh produce virtually on a year around basis in the U.S. This availability is primarily the result of technological developments in refrigerated storage and transit which has allowed for the expansion of the borders of fresh market production areas. Previous to about 1860 fresh market vegetable production or truck farming was unknown in the United States except to a limited extent along steamboat and railway lines leading out about 50 miles or so from the larger northern cities. Economists focusing on agriculture and food needs tend to be most interested in those commodities that can be easily counted and those that move in channels of national and international trade--cereals, soybeans, sugar, beef. Fruits and vegetables were difficult to count historically because they moved only short distances or were consumed on the farm. The census of 1900 was the first attempt to make any detailed report of truck crops by states. In 1916 the USDA Yearbook gave statistics for cereal crops and potatoes and by 1920 they listed unloads in 66 markets for eight selected vegetables (cabbage, melons, celery, onions, potatoes and sweet potatoes). By 1924 they added lettuce and sweet potatoes and by 1926 this list had grown to 18 and to 21 by 1936. These statistics again include only those items which enter into commercial trade and do not include those vegetables produced and consumed at home. Current figures show about 2,485,000 acres in commercial production of vegetables for fresh market and processing, or about 500 sq. ft. for every person in the U.S., with about one-quarter of that used for fresh market production. There are approximately 60 different kinds of vegetables produced commercially in the U.S. with 26 considered as major commodities and the rest as minor crops for specialized markets.

Home gardening has become rediscovered in recent years and there has been a slight but steady increase in the number of home gardens over the past three years. A recent national study, "Consumers' Food-Related Behavior, Attitudes and Motives" conducted by the USDA (3) has shown that 43 percent of the households in the survey planted a vegetable garden in 1974, 46 percent in 1975, and 48 percent in 1976. Numerous reasons for gardening were given but the preference for the taste of fresh vegetables, the desire to save money and cut down on the food budget, and an interest in gardening as a hobby were the three predominant reasons. This survey indicates that the interest in home gardening generated in the United States three or four years ago amid fast-rising food prices may be becoming firmly established and not just a transitory phenomenon. The total impact of home gardening will be difficult to quantitate accurately in pounds produced or in dollar value, but there is no doubt that the vegetables produced add to the quality of the meals prepared and the nutrition of the family. Rough approximations of per capita consumption of vegetables, potatoes and sweet potatoes from home garden production starting in 1909, shows around 160 pounds per person at that time and this has gradually declined over the years to around 97 pounds in the 1950's.

Nutrient Composition

The nutritional importance of vegetables in the normal diet is a function of the nutrient composition of the vegetable and the quantity eaten. The major nutritive contribution of vegetables in our diets are vitamins A and C. Certain vegetables are recognized for their contribution of particular nutrients. Tomatoes, cabbages, melons, dark green, leafy vegetables, potatoes and sweet potatoes are rich in vitamin C. Carrots, sweet potatoes, spinach, tomatoes and broccoli are good sources of vitamin A amongst the vegetables.

Fruits and vegetables provided about half of the vitamin A and over 90 percent of the vitamin C in diets in 1971, which was about the same proportion as in 1925-29 (4). There were some shifts amongst the fruit and vegetables over this time period in maintaining these relative contributions. For example, the proportion of vitamin A supplied by sweet potatoes in the 1920's declined and this was offset by an increase in all other fruits and vegetables. About three times as much vitamin C is now contributed by citrus fruits and considerably less by potatoes. Despite the relative importance of animal and grain products in supplying other nutrients, the vegetable and fruit group provide a significant contribution. They contribute about 20 percent of the thiamin in our diets, 30 percent of the vitamin B6, 25 percent of the iron, and 20 percent of the magnesium.

A comparison of the relative nutritive value of 39 crops ranked for proximate concentrations of vitamin A and C, niacin, riboflavin, thiamin, potassium, phosphorous, calcium, iron, and sodium and the relative contribution to nutrition obtained by multiplying the nutrient concentration times the total yield in 1970, shows that the crops that are highest in nutritive value are not consumed in large quantities (5). Table 1 shows that carrots and sweet potatoes are the only vegetables that are in the top 10 foods both for relative nutritive value and contribution to nutrition based on production. A number of vegetables can significantly contribute to vitamin C nutrition, Table 2. Peppers, broccoli and brussels sprouts are rich sources of vitamin C, but potatoes and oranges provide the most to vitamin C nutrition. Again, vegetables that have the highest nutritional value are not necessarily those that contribute most to the nutritive needs of the population. Generally fruits and vegetables are purchased for flavor, appearance and variety in the diet--for eating enjoyment. The good meal planner knows that by including fruits and vegetables in the diet, a nutritious balance will be maintained--but seldom is a particular vegetable or a particular fruit chosen on the basis of its nutritional value.

Consumption Patterns

In considering consumption trends over the past 50 years, it is clear from the data in Table 3 that there has been a significant decline in per capita consumption of fresh vegetables which has been offset by a sharp increase in the use of processed vegetables--from 45 pounds in 1925-29 to 184 pounds in 1972-74. Considering only fresh vegetables other than potatoes as shown in Table 4, the per capita consumption is about the same as it was 50 years ago, but the consumption of processed vegetables has increased markedly. Changes in consumption of individual items has had significant nutritional impact. For example, the consumption of sweet potatoes, both fresh and processed, has declined from around 21 pounds per person in 1925-29, to only five pounds today--a significant decline in vitamin A nutrition.

These consumptive trends for the U.S. are derived from data on population numbers and disappearance of food produced. They lead to an average estimate at nutritional level but tell little about the distribution of food and individual consumer nutritional status. Malnutrition--faulty nutrition--is manifest in: 1) Under-nutrition and inadequate supply of calories and protein; 2) Lack of one or more essential nutrients in a diet; 3) A physiological condition which prevents utilization or digestion of nutrients; and 4) Over-nutrition and obesity. Infants up to the age of five or six, pregnant women and lactating mothers are the most susceptible to these forms of malnutrition and it is difficult to assess the nutritional status of these groups from the per capita consumption data available. The USDA has made periodic nationwide food consumption surveys--in 1936, 1942, 1955, and the most recent one published in 1972 based upon 1965-66 survey data. It is not possible to compare diets over the span of these surveys because there were changes in the survey methodology and the Recommended Dietary Allowances (RDA) which served as standards were changed (1, 4). It was possible, however, to compare the spring 1955 and the spring 1965 survey and this comparison showed fewer households had diets that met the RDA in 1965 than 10 years previously. The nutrients most often found below the RDA in 1965 were vitamin A, vitamin C and calcium. (It is significant to note that these two vitamins are nutrients which can be supplied in significant amounts by vegetables.) The 1965 survey described variations in dietary levels by level of money value per person for food at home. Table 5 compares variations in consumption at different money levels. Diets classified as good were based on meeting the 1963 RDA and those rated poor, if it supplied less than two-thirds of the allowances for one or more essential nutrients. At each money value level, households having good diets used a larger share of their food dollar for milk and vegetables and fruit than those having poor diets. In those having poor diets, the higher expenditures for meat, poultry, and fish did not directly result in the poor diets observed. Indirectly, however, their allocation of less of the food dollar for milk and milk products and vegetables and fruit resulted in the relatively low nutrient levels observed most frequently for calcium, vitamin A and vitamin C. Households with good diets used larger quantities per person of all food groups except meat, fish, poultry and beverages than households with poor diets at the same money value level and their choices within food groups contributed meaningfully to the quality of their diets. For example, households with good diets used one-half cup more milk per person per day than those with poor diets at each money level. Households with good diets used one-fourth to one-half pound more vegetables per person per day, including much more dark-green and deep-yellow vegetables and tomatoes than their counterparts with poor diets. While these surveys do not reveal how food was distributed among family members, it does provide an indication of food choices and the impact of vegetables on the quality of diets. There is no doubt that good nutrition education of the consumer could lead to vastly improved quality of nutrition with the existing food supply and economic situation.

In summary, it is clearly evident that vegetables have always been and will continue to be a significant item in contributing to the quality of life--contributing in an economic fashion as the commercial production of millions of pounds of them are grown, harvested, processed and distributed locally, nationally and internationally;--contributing to the organoleptic and visual pleasure of our diets by providing variations in color, texture, flavor and taste;--contributing to the nutritional quality of our diets, with particular contributions in vitamins A and C nutrition;--contributing to an emotionally satisfying hobby in home gardening for many. The vegetable industry has evolved into a highly sophisticated food producing system in the short 100 years since the first commercial farm developed along the transportation lines of the times. As population continues to increase and the balance between food consumption and food production becomes more precarious, there is no doubt that vegetables will become increasingly important in diets and adequate nutrition.

Table 1.--Vitamin A concentrations of several crops and their 1970 production of provitamin A. Included are the top ten crops in each category from among 39 major fruits and vegetables.

	IU/100 gm	Provitamin A (Tons - 1970)
Carrots	11500 (1)	62 (1)
Sweet Potatoes	8800 (2)	37 (2)
Spinach	8100 (3)	9 (7)
Cantaloupe	3400 (4)	14 (4)
Apricots	2700 (5)	3 (11)
Broccoli	2500 (6)	2 (13)
Peaches	1330 (7)	12 (5)
Cherries	1000 (8)	2 (16)
Tomatoes	900 (9)	32 (3)
Asparagus	900 (9)	1 (21)
Peppers	420 (14)	5 (10)
Corn	400 (16)	6 (8)
Lettuce	330 (17)	5 (9)
Oranges	200 (21)	9 (6)

Table 2.--Vitamin C concentrations and 1970 production of this vitamin by several crops. Included are the top ten crops in each category from among 39 major fruits and vegetables.

	mg/100 gm	Tons (1970)
Peppers	128 (1)	471 (7)
Broccoli	113 (2)	342 (11)
Brussels sprouts	102 (3)	57 (28)
Cauliflower	78 (4)	184 (21)
Strawberries	59 (5)	292 (14)
Spinach	51 (6)	188 (20)
Oranges	50 (7)	7891 (1)
Cabbage	47 (8)	1116 (5)
Grapefruit	38 (9)	1434 (4)
Cantaloupe	33 (10)	443 (8)
Asparagus	33 (10)	85 (27)
Tomatoes	23 (16)	2729 (3)
Potatoes	20 (18)	6497 (2)
Corn	12 (20)	603 (6)
Bananas	10 (26)	360 (10)
Apples	7 (32)	436 (9)

Table 3.--Vegetable consumption per person

Total all vegetables including potatoes

	1925-29	1947-49	1957-59	1972-74
Fresh	272.8	246.3	200.8	151.9
Processed	45.7	80.1	115.8	183.9
Total	318.5	326.4	316.6	335.8

Table 4.--Vegetable consumption per person

Excluding potatoes

	1925-29	1947-49	1957-59	1972-74
Fresh	105.0	120.5	104.3	99.9
Processed	45.5	79.2	97.1	119.8
Total	150.5	199.7	201.4	219.7

Table 5.--The percentages of the food dollar used by households with good and poor diets using food worth $5 to $7 and $9 to $12 are shown below:

(1965 survey)

	$5.00-$6.99		$9.00-$11.99	
	Good diets	Poor diets	Good diets	Poor diets
	Pct.	Pct.	Pct.	Pct.
Milk, cream, cheese......	16	13	14	10
Meat, poultry, fish	28	35	32	40
Eggs, dry legumes, nuts..	6	6	5	5
Vegetables, fruit........	21	16	21	14
Grain products...........	14	14	12	11
Alcoholic beverages......	1	2	2	6
Other....................	14	14	14	14
Total	100	100	100	100

PUBLIC MEMBERS OF AGRICULTURAL MARKETING BOARDS A BRIDGE BETWEEN THE AGRICULTURIST AND THE URBANITE?

Jeane Thom
Public Member of Cling Peach Advisory Board, El Cerrito

A cursory review would indicate that the consumer and the agriculturists have assumed adversary positions to each other in California. A closer examination reveals this to be so, but the antagonists are few in number. The opponents are the self-appointed professional consumer advocates and fairly high level spokesmen for agri-business who invariably over-react to the shoutings and schemes of these consumer advocates. Strangely, these confrontations have centered more around fruit productions and its processing than any other group of commodities with the possible exception of milk.

Such over-reaction occurred in the last 2 growing seasons with considerations about what to do about processing fruit crops which were in surplus. The consumer advocates saw the problem as easily solved by the farmer selling the fruit directly to the consumer and/or to retailers. At their urging in 1975, the Director of Food & Agriculture waived the quality and sizing standards contained in the Fresh Peach Marketing Order, without consultation with the principals and 76 tons of processing clings were sold by the Consumers Co-op of Berkeley. This act in turn caused some dislocation in the freestone market. The reactions of the shippers and packers of fresh fruit ultimately caused a special hearing of the Assembly Agriculture Committee which in turn led to a departmental hearing on marketing order promotion activity. In 1976 the consumer advocates pushed for a direct marketing program which was initiated, but with no waiver of standards. Again, agribusiness leaders went into a tizzy of editorials about how horrible were farmers markets, etc., and marshalled their forces to defeat a direct marketing bill which would have appropriated $20,000 dollars to encourage and foster alternative marketing methods.

Although without a true constituence the professional consumer advocates exercise great influence on the present administration. It was this influence which led to the requirement that each marketing order board appoint a public member and alternate. This, too, faced opposition from the top echelon of agriculturists. Nevertheless, the first appointments were made in July 1975. Since ½ of the state marketing orders in existence at that time covered fruit these appointments were and are significant to the production of California fruit. During their tenure public members have come to the fore on a number of occasions when legislative and administrative considerations were being decided and each time have supported marketing orders and more often than not have aided their fellow industry board members accomplish specific goals.

Public members are a cross-section of the educated middle class. Eighty-five percent of their number are women, not, unfortunately because of the recognition of women's rise on the public scene but because women are more prone to volunteer work than men, and because the male dominated agricultural society sees women as housewives and thus the buyers of food. For the same reason an inordinate number of members and alternates are trained home economists and nutritionists. At this point in time we are completely accepted as peers by our fellow industry members on the boards and by most agricultural leaders, albeit at times grudgingly. On the other hand, the consumer advocates who fought so hard for the appointment of public members ignore their existence. They are bitter because they were not consulted about the appointments and are firm in their belief that unless the public make up the majority of the boards they cannot be effective.

Agriculturists are constantly advised to cooperate with outside forces if they expect to have much of a role in shaping farm policy. Yet all campaigns aimed at informing the urbanite about farm labor matters, surplusing, marketing orders and mechanical harvesting drive a larger wedge between the city dweller and the farmer. If we are to sustain a healthy climate for fruit production in California, the grower in particular, and agribusiness in general must establish this communication with the public at large. Only in this way can we hope to build the relationship needed for the betterment of all. Growers must learn to recognize that pleas, for example, for farmers market are not aimed at destroying them, but rather a desire for tree and vine ripened fruit and melons, unobtainable in super-markets. What they are saying is that it is virtually impossible to tempt children to eat bland fruit when they are bombarded with tasty junk food. They are asking growers to help them assure a future market for fruit. The consumer must learn who benefits from marketing orders and also when large corporate farming fits in the agricultural picture. Generally, people have much sympathy for the independent farmer and will listen and help if growers stop talking and listening to themselves about communicating with the consumer and just do it. The public members can establish contacts for communications. They cannot do the entire job.

WASTEWATER RECLAMATION - AN ACTION PLAN FOR CALIFORNIA

Archie Matthews
State Water Resources Control Board

The State Water Resources Control Board approved the adoption of Basin Water Quality Control Plans for California in the Spring of 1975. The basin plans indicated that water shortages were occurring in many areas of the State--shortages which are being met, in part, by overdrafting groundwater. This evaluation also indicated that by the end of this century such water shortages would occur in the major basins of California. These present and projected water shortages, as well as projected increases of highly treated wastewater, prompted the State Board to review the extent to which the legislative directives of Division 7, Chapter 7, "Water Reclamation", of the Water Code were being implemented.

The Board concluded that a comprehensive policy and action plan is required to implement Water Code directives and to guide the Board in making decisions on funding of proposed wastewater reclamation projects. As a consequence, a 55-member task force representing many interests was formed to draft a policy and action plan that would guide the State and Regional Water Quality Control Boards and recommend actions to be implemented by other state, federal, and local agencies to encourage reuse of the State's reclaimed water resources.

Public hearings were held on the proposed policy in Los Angeles on October 18, 1976, and in Sacramento on October 20, 1976. The final draft is scheduled for consideration for adoption by the State Board at a public meeting scheduled for December 16, 1976, in Sacramento, California. Mr. Matthews will discuss the "as adopted" version of the Policy and Action Plan.

WATER RE-USE IN A METROPOLITAN SEWERAGE SYSTEM

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The Sanitation Districts of Los Angeles County provide wastewater treatment and disposal services for almost 4 million people in 72 incorporated cities and considerable unincorporated territory in Los Angeles County. The total flow of wastewater treated in this large metropolitan system is approximately 420 million gallons per day. The Sanitation Districts have long considered these wastewaters as a natural resource to be managed for the best interests of society. Recognizing that wastewater treatment processes can make the water suitable for a variety of uses, the Districts have participated over the last 25 years in several planned water reuse programs and have advocated a substantial expansion in the area's water reuse effort.

Among the advantages of a reclamation program in a metropolitan area are the economies of scale that can be achieved with large treatment facilities and the ability to segregate flows into usable and unusable fractions based on quality parameters. Disadvantages include the salts and specific contaminants contributed by industrial discharges and the lack of agricultural land to receive reclaimed water.

At present, about 30 mgd of reclaimed water is being reused from the Sanitation Districts' system, primarily for groundwater basin recharge along the San Gabriel and Rio Hondo Rivers. The Districts' facilities plan projects that, in the next 30 years, this could be expanded to between 100 and 200 mgd, depending upon costs, health problems, technological considerations, social acceptance, and alternative water supplies. It should be remembered that only about half of the water distributed for use in the metropolitan area actually reaches the sewerage system, and that only half of the wastewater in the sewers can be reused without introducing expensive desalination processes. For this reason, water reuse should never be considered more than a low cost supplemental supply for selected purposes.

Although reclaimed water will not substitute for an adequate basic supply, it may still play an important role in the total water budget for the State. By the year 2020, it is expected that 10 million acre-feet of the 40 million acre-feet to be used in California for all purposes will be classified as urban. Optimistically estimating that 20 percent of the urban usage could be practically reclaimed would indicate a potential

2 million acre-feet would be available for reuse. Although this projection amounts to only 5 percent of the State's anticipated water demand in the year 2020, it could provide a satisfactory substitute for the 2 million acre-feet proposed for development during the next 50 years along the northern coast of California. Water reuse would thus help to preserve several of the State's wild rivers and conserve such natural water resources until even greater needs may develop in the centuries ahead.

WASTE WATER RECLAMATION POTENTIAL FOR SAN FRANCISCO BAY REGION

Don Finlayson
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Department of Water Resources

The amount of waste water produced by the urban complexes surrounding San Francisco Bay is large. The quality of some of these waste waters is somewhat of a paradox. On one hand the quality of water delivered to these urban areas is for the most superior but when it comes into the waste water treatment plant, after a one time use, it has been greatly degraded. The amount of degradation makes it obvious that our society has in the past treated water as something to be used and then thrown away. Today's concern with putting a stop to a throw-away society extends to water but in the case of water controlling the quality degradation is going to be a long, bitter, and costly battle.

Urban waste water reuse within the Bay Area is currently extremely limited when considered as a percentage of quantity available. There are currently three types of reuse being practiced. One is ornamental irrigation in the immediate vicinity of the treatment plant. The amount of waste water used in this manner is very small. The second reuse is for irrigation on lands in the general vicinity of the plant. This type of use is increasing in areas where discharge of waste water to a water course is being restricted or prohibited. The type of use is generally for a fodder crop. The third use is for industry. The first significant project along this line is by the Contra Costa County Water District in serving industries in Northern Contra Costa County.

Because of the large number of unknown substances ranging all the way from salts to carcinogens and our inability to remove, let alone identify all of them, the direct reuse of waste water for drinking supplies is presently out of the question. This is also true if we are guided by a simple rule that the water supplies used for drinking and food manufacture should be the safest available.

Use of waste water for ornamental landscaping, parks, greenbelts, etc. is not by itself going to be significant due to the areal distribution of the market. However, this type of use may add significant amounts in the future when used in combination with other uses or when major irrigated recreation areas are planned and sited to use waste water.

There are three possible moderate to major uses for urban waste waters -- irrigated agriculture, power plant cooling, and augmentation of Delta outflows. All three of these uses have quality, cost, and environmental problems to overcome to become generally acceptable. The overnight large-scale reuse of waste water is not as simple as some avid conservationists hope, but neither is it as remote a possibility as some water project developers claim.

A careful step by step approach by govenment in cooperation with the agricultural industry is necessary to first attack the problem of matching water supply to crops in each area and secondly determining if the problem can be resolved by additional treatment, mixing with other waters, and additional controls on degradation of the source. Solutions may require innovative approaches to institutional and financial barriers. In attaining a conservation of our water resources, it will be necessary to constantly be on guard not to destroy an equally valuable resource -- productive land.

SANTA ROSA EFFLUENT IRRIGATION STUDY

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A two year irrigation pilot project was carried out to determine the practicability of agricultural reuse of secondary treated effluent in California's Santa Rosa Plain. The study showed that land application of this effluent eliminates the need for tertiary treatment facilities at the City of Santa Rosa's Laguna Wastewater Treatment Plant. Under the effluent irrigation scheme, the Laguna Plant would no longer discharge to surface streams during the six-month dry season. Instead, the secondary effluent will be disposed of on land or will be supplied as irrigation water to nearby farms and dairy ranches under long-term agreements. As part of this long-range plan the capacity of the Laguna Plant is currently being expanded to 15 million gallons per day to serve as a regional treatment facility for the central part of Sonoma County.

The two-year study involved the establishment of a 12-acre experimental farm adjacent to the Laguna Plant, commencing in the spring of 1974. In this experiment, four crops consisting of barley, corn, sudan and pasture grass were raised. The farm was divided into 33 plots, about two-thirds of which were spray irrigated with secondary effluent. The remaining plots were used as controls, and were irrigated with local well water or well water obtained from the City distribution system and were conventionally fertilized with commercial nitrogen and phosphorus. An area of about one acre was also set aside as a spray disposal site (with no crops raised) to determine maximum loading rates for evaporative loss of water. These latter plots also yielded data on the maximum rates at which effluent would be sprayed on land without causing excessive percolation to groundwater or runoff from the soil surface.

Throughout the two growing seasons, an extensive analytical program was undertaken to evaluate the effects of effluent on soil and crops. Irrigation water received the standard mineral analyses plus trace metal examination. Soil samples were obtained at the beginning and end of each season from a point near the center of each plot and were analyzed for sodium, calcium, magnesium, potassium, cadmium, chromium, copper, lead, zinc, boron, and other constituents. Changes in the population of indicator, pathogenic and nitrogen-fixing bacteria also were monitored. At the end of each harvest, crop yields were recorded and crop samples were analyzed for protein and fiber content, as well as for trace elements such as cadmium and zinc.

The results of these experiments indicate that forage and grain crops can be grown at a commercial scale utiliz ing secondary treated effluent. Crop yield in effluent irrigated plots receiving 50 lbs of nitrogen fertilizer per acre was equal to or higher than the yields in fresh water plots receiving 150 lbs of nitrogen fertilizer and an equal amount of phosphorus fertilizer. No significant difference was observed in the food value or chemical quality of crops irrigated with fresh water or secondary treated effluent.

Results of chemical analysis of soil samples showed some buildup of heavy metal and salts in effluent and well water irrigated plots. However, these accumulations appear to be too small to cause any irreversible detrimental effects in the soil. Based on conservative safe heavy metal loading criteria, (zinc equivalent loading limited to 5 percent of the cation exchange capacity in the top six-inch layer of soil), it was estimated that the effluent can be safely used for crop irrigation on the same soil for over 200 years before the above limiting load is approached. Results of soil bacteriological analysis showed a complete absence of pathogenic Salmonella and Shigella in all effluent irrigated plots. Higher concentrations of fecal coliform and fecal streptococci were found in the surface soil layer of some of the effluent irrigated plots. However the random nature of these results and occurrence of these bacteria in significant numbers in fresh water irrigated plots and in control areas indicate that disinfected secondary treated effluent may not significantly contribute to the buildup of bacteria in the soil mantle.

Monitoring of deep percolation under the project area showed that no significant recharge of the shallow groundwater occurred due to the efficient irrigation and disposal operation maintained in this project.

In summary, the project results show that secondary effluent is a valuable source of irrigation water in this water-short region. It appears that effluent irrigation for silage corn or pasture production is feasible and would benefit the local dairy industry.

This project was carried out by Brown and Caldwell, Walnut Creek, California for the City of Santa Rosa and the California State Water Resources Control Board. The writer was project engineer for Brown and Caldwell on this study.

POTENTIAL OF INNOVATIVE IRRIGATION TECHNIQUES FOR EXTENDING THE USE OF WASTE WATERS

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The use of waste water on agricultural crops as a means of providing a living filter to remove excess nutrients and toxins is a valid practice for extending the use of municipal water supplies by recycling. But after a sufficient number of re-use cycles, the salinity of the water supply rises above limits acceptable for municipal use. Because the permissible salinity of water for agricultural crops (Maas and Hoffman, 1976) is greater than that for municipalities, irrigation can serve the additional function of end use for water that is no longer fit to recycle through the municipal system.

In some instances this waste water from municipal systems is a valuable resource to agriculture; in others the agriculture enterprise exists primarily to reduce its volume. In either case, whether the purpose is to conserve a valuable resource or to reduce the volume of a waste stream to be disposed of, the agricultural enterprise serves best by extending the use of the waste water as far as possible.

Two strategies can be used to minimize the drainage outflow from an irrigation enterprise. In one, the drainage from fields where waste water is first applied is collected and applied as irrigation water to other fields. This requires progressivly more salt tolerant crops to be grown as the salinity of the recycled water increases, but it does not require sophisticated irrigation management to control water precisely. The other strategy is to bring the waste water to its ultimate concentration in a single pass through the soil profile by efficient irrigation that reduces deep percolation to a minimum. Minimizing the deep percolation not only reduces the volume in which dissolved wastes are carried, but in some instances it can harmlessly precipitate slightly soluble salts within the soil, permanently removing them from the system (Rhoades et al., 1974). But achieving leaching fractions sufficiently small to accomplish these ends requires sophisticated irrigation systems and management techniques. The advantage of the latter strategy is that it permits high value crops to be grown on the entire irrigated area. Crop growth has been found to be considerably more dependent upon the minimum salinity within the root zone than upon the maxiumum (Bernstein and Francois, 1963). The minimum salinity within the root zone is always equal to that of the irrigation water. As the crop roots use water, they leave solutes behind that reach maximum concentration at the bottom of the root zone. If this water is collected and used as irrigation on a subsequent field, the minimum salinity in this root zone is greatly increased. The result is that saline water left to concentrate slowly near the bottom of the root zone in one field has far less deleterious effect on crop growth than it does if it is brought to the surface and used as irrigation water on a second crop. This advantage may often make the extra care required to control water precisely (Rawlins and Raats, 1975) worth while.

Another factor that affects the extent to which waste water can be used by agriculture is the magnitude of its supply in relation to the evapotranspiration demand. Unlike the normal situation where water is allocated on a schedule to meet demands, like the supply of water anticipated at one time from nuclear desalination plants (Hammond, 1969), the supply of waste water will not increase and decrease in concert with the seasonal variations of evapotranspiration demand. Of course storage facilities could help match supplies to demands, as well as could expanding the irrigated area in winter time. But these alternatives are always expensive, and sometimes are impossible. An innovative irrigation scheduling technique that takes advantage of storage capacity within the unsaturated zone of the soil profile (Fischbach et al., 1974), has potential of helping to alleviate this problem. The primary objective of this technique is to gradually deplete stored water from the soil profile during the period of high evapotranspiration, and to gradually replenish the soil profile during periods of low evapotranspiration. By frequent irrigation during the period of high water use, water can be gradually withdrawn from storage within the soil profile without imposing sufficient drought upon the crop to reduce yields.

Extending the use of waste waters to their maximum by irrigation will require innovative water distribution systems and scheduling techniques to match the supply to the spacial and temporal demands of the crop. Some progress has recently been made in these techniques, but the surface has just been scratched. Application of the principles of water management now being tested for salinity control in river basins (van Schilfgaarde et al., 1974) offers encouraging prospects for using and disposing of waste waters.

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USE OF TAILWATER RUNOFF AND EFFLUENT WATER FOR IRRIGATION IN IMPERIAL VALLEY, CALIFORNIA

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1. Our knowledge of the volumes of tailwater runoff and effluent water comes from the annual reports of the Imperial Irrigation District. They contain the total volumes of: a) water entering the Valley below Drop No. I (influent water), V_{inf}, b) water discharged into the Salton Sea from the Valley (after excluding the volume entering the Valley from Mexico through the Alamo and New Rivers), V_{eff}, and c) water delivered to the farmers, V_{farm}. The following brief report summarizes the data, evaluates the irrigation efficiency in the Valley, and discusses the varied problems facing farmers and scientists in relation to reuse of tailwater.

2. Figure 1, shows V_{inf} and V_{eff} water balance index, WBI (V_{eff}/V_{inf}) for the years 1944-1973 and for the months of 1973. As shown in the figure WBI's ranged: a) from 0.37 to 0.43 with an average of 0.40 from 1944 to 1954 and b) from 0.31 to 0.39 with an average of 0.36 from 1955 to 1973. The monthly flow variations of V_{inf} and V_{eff} appear to reflect the irrigation practices and cropping patterns. Inflow peaks occur in September and April when winter and summer crops are planted. WBI's are highest during October to February when large areas of winter crops are being irrigated under conditions of low evapotranspiration (ET) demand; for example, the monthly WBI during 1973 ranged from 0.51 in February to 0.28 in July. The weighted WBI for 1973 was 0.36.

3. During 1973 it was estimated[1/] that the irrigation efficiency (E_{irr}) in the Valley [(estimated consumptive use/water delivered to farmers)%] was about 70 per cent. This compares favorably with a Western United States average farm irrigation efficiency of about 45 per cent[2/].

The non-beneficial use of irrigation water in the Valley is due mainly to the tailwater runoff which is estimated by IID to be 2.5 to 3.0 times the farm subsurface drainage water. The volumes of tailwater and farm subsurface drainage water constitutes about 95 per cent of the effluent water.

4. Great concern for the gradual increase in the level of the Salton Sea has prompted use of new conservation methods to reduce runoff, such as construction of storage reservoirs, checking of tailwater during irrigation, and taking (by IID) immediate steps to reduce unreasonable tailwater waste. The main effective means of increasing E_{irr} in Imperial Valley have included: a) concrete lining of farm ditches and distributary canals, b) providing lands with subsurface drainage, c) increasing use of sprinkler irrigation for emergence of crops (crop germination), and d) improving on-farm water management by better leveling and by decreasing irrigation runs from more than 0.5 to 0.25 miles or less.

5. Some potential and effective means of reducing runoff waste water include: a) application of near-level irrigation or dead-level irrigation, b) careful scheduling of irrigation, and c) reuse of tailwater. More information is needed about the effectiveness of near-level and dead-level irrigation, and means of improving irrigation scheduling. Reuse of tailwater and possibly effluent water is an efficient means of attaining high irrigation efficiency. The practice is not new to the Valley. For a few years during the fifties some drainage water from the Alamo River (EC 3 mmho/cm) was pumped and mixed with canal water. Analysis of tailwaters showed that their salinities do not differ appreciably from that of canal waters even from highly saline soils. For instance, a saline field with ECe of 30 to 40 mmho/cm was diked for leaching and the EC of canal water and tailwaters were 1.5 and 2.1 mmho/cm respectively. When the runoff was decreased, its salinity was increased to EC 3. Another test was conducted in a cotton field where every other furrow was irrigated. Irrigation water was then run in every furrow and canal irrigation water and tailwaters from the old irrigated furrows and from the other furrows with accumulated salts were 1.55, 1.65, and 1.68 mmho/cm respectively. The slight increase of salinity in the two tailwaters with respect to irrigation water was probably due to evaporation rather than to picked up salt from the soil.

6. Some farmers object to the reuse of tailwater because of their content, sometimes, of NO_3, silt, pesticides, and weed seeds. These ingredients may preclude the reuse of tailwater for certain crops. However, the overriding factor that will affect the reuse of tailwater is the cost of pumping. Some tailwater may be reused without pumping.

7. Present and future enforcements of water regulations to decrease tailwater runoff will undoubtedly increase the practice of tailwater reuse for irrigation. In addition to extra cost incurred by the practice, the salinity of effluent water discharged into the Salton Sea from the Valley will increase because of increased ratio of subsurface drainage water in the effluent. For instance, the effluent water from the Valley now has an average EC of about 4 mmho/cm. A reduction in the volume of tailwater from 2.5 to 1.5 times the volume of subsurface drainage water would result in an increase in the EC of effluent water to about 6 mmho/cm. Reduction in the volume of the effluent water and increase in its salinity would automatically increase the salinity of the Salton Sea, thus creating a new problem to be dealt with.

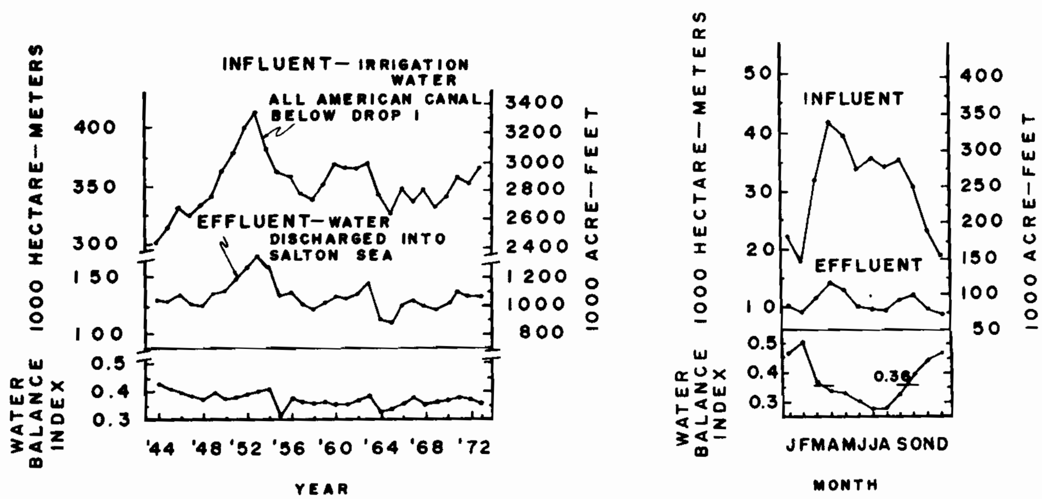

Fig. 1: Influent and effluent waters in Imperial Valley and the water balance indexes (WBI) for the years 1944 to 1973 (left) and months of 1973 (right) of 0.36 is the weighted average WBI for 1973.

PLANT RESISTANCE, THE ULTIMATE BIOLOGICAL CONTROL SYSTEM USED ON APHIDS IN ALFALFA

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Insects attacking plants can be controlled by developing plant types capable of resisting the damaging effects of the destructive insect. Since resistance is built into the plants, it is purchased with the seed and is instantly available when an insect attacks. No spraying is necessary, nor is it necessary to wait for the buildup of another organism before control is possible.

Alfalfa has three important aphid pests--the pea aphid, spotted alfalfa aphid, and blue alfalfa aphid. The pea aphid is a native species and least damaging of the three aphids. Development of resistance to the pea aphid was a low priority research project from the 1930's through the early 1950's. Resistant cultivars were finally released in the 1960's by using techniques developed for the spotted alfalfa aphid.

The spotted alfalfa aphid was introduced from the Near East in 1954. It caused severe damage by restricting growth, killing plants, and depositing honeydew which resulted in breakage of harvesting machinery and reduced hay quality. However, adequate funds were made available rapidly, and a strong multi-disciplined program was activated. This included work on biology, insecticides, predators, parasites, and plant resistance. Results were fairly rapid on all programs except resistance, but control was always incomplete and elusive.

By 1957 a small amount of seed of a resistant Cultivar called Moapa was available. This was planted over a large acreage and essentially controlled this insect by 1960. However, in the intervening time aphids resistant to chemicals had developed, and, in 1958, evidence of aphid strains capable of attacking some resistant plants was obtained. It was soon found that the new aphid strains attacking previously resistant plants could be completely controlled by monitoring and updating resistant varieties.

The most recent aphid found attacking alfalfa was the blue alfalfa aphid, an introduction from Japan which caused stunting, yellowing, and reduced growth. It was more destructive than the pea aphid but less damaging than the spotted alfalfa aphid. By drawing on knowledge gained in previous resistance work, parent plants of a new cultivar were selected in weeks after the blue alfalfa aphid was identified as a new alfalfa pest. The new cultivar was tested and found to be resistant to the blue alfalfa aphid as well as the other two aphids, a good example of multiple insect resistance.

Most of the work on insect resistance to date has been on sucking insects, but little work has been done on the chewing insects or worms which are much less selective in their feeding behavior than aphids. Work on the chewing insects seems to be in relatively the same position or state of knowledge as was the work with the pea aphid in the 1930's and 1940's. It appears new techniques and germplasm will have to be developed before alfalfa varieties with resistance to the chewing insects can be released.

Plant resistance has been an effective, clean, inexpensive method of controlling aphids in alfalfa. As more is learned about breeding techniques and, if agressive action is possible, rapid progress will be possible for many other pests. On the other hand, if heavy spraying must continue, pest types resistant to chemicals might develop and loss of effective control can be expected.

BREEDING SWEET CORN FOR RESISTANCE TO ACUTE OZONE INJURY IN THE LOS ANGELES BASIN

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Sweet corn is one of many crop plants which can suffer leaf injury from air pollutants, especially ozone. In parts of Southern California, severe damage to certain varieties has been noted for several years. The injury can be both chronic and acute. Chronic injury is evidenced by premature mottling, yellowing, and dying of the older leaves and can result in weakened plants with poor ear quality. Acute injury occurs principally during episodes of high ozone and high temperature. Under such conditions, large sections of fully expanded, healthy leaves in susceptible varieties can be killed in a few hours; if several episodes occur over a period of weeks during flowering and ear development, ear size and kernel development are seriously impaired. Chronic injury may occur on many varieties which show very little acute injury.

In experiments with Dr. C. Ray Thompson at Riverside, plants in outdoor chambers in ambient (unfiltered) air were shorter, lower in dry weight, and had more cull ears than plants in filtered air, even though acute injury was not great. In studies with Dr. M. R. Kaufmann, the importance of light in increasing acute damage was very evident. Plants in greenhouses subjected to high ozone and high temperature, but with low light, showed mottling but very little acute tissue killing. At the same time, sister plants under similar culture, placed outside, showed immediate acute injury under high temperature and ozone.

There is a high degree of inheritance for susceptibility and resistance to the acute type of injury. Resistant parents have so far given resistant offspring, while susceptible X resistant crosses usually give susceptible hybrids. After several generations of inbreeding, resistant sublines remain resistant, but visibly susceptible sublines give more variable progeny. Fortunately, several existing sweet corn hybrids withstand ozone air pollution fairly well. Under conditions similar to the Los Angeles Basin, only the more resistant varieties should be planted.

JOJOBA - A PROMISING NEW OIL CROP

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Jojoba (pronounced hohoba) Simmondsia chinensis has long been known as a valuable browse plant and has been widely planted as an ornamental. More recently it has received widespread attention because the liquid wax produced by the seeds is a possible substitute for sperm whale oil--a product derived from an endangered species.

Endemic to the Sonoran Desert of Mexico and the United States, jojoba's natural habitat comprises approximately 100,000 square miles between latitudes 25° and 31° North. There are many separate populations within this area varying from a few individuals to several hundred per acre, and some extensive populations with millions of individual plants occur (for example, in the vicinity of Superior, Arizona, and on the high desert plain of San Matias Pass in Baja California). In the Sonoran Desert, jojoba occupies elevations between 2,000 and 4,000 feet, rarely going lower but, in Baja California and in some localities in Sonora it occurs down to sea level. Jojoba is usually restricted to well-drained, coarse, desert soils and coarse mixtures of gravels and clays. In loamy to clay-loamy soils, the plant has shown ability to develop without additional water in an 8-inch annual rainfall area. Although it does occur in the desert proper, where the rainfall is less than 5" annually, its greatest dominance is where the rainfall is 15" to 18" annually.

Usually bushy, and two to six feet tall, it may grow to ten feet in stature and offers a thick cover in the desert where cover is at a premium; the natural life span appears to be over 100 years and may exceed 200 years.

The jojoba fruit is a capsule that takes about six months to mature, finally splitting open and allowing the peanut size seeds to drop out. The capsule and seed can be harvested before this happens although the total wax content may not be as high as for fully mature seeds.

Following the enactment of Endangered Species Conservation Act of 1969, sperm whales were put on the protected list and imports of sperm whale oil were banned as of December 2, 1971. Therefore a substitute must be found for the 55 million pounds of sperm whale oil annually used in the United States. Sperm whale oil was classed as a strategic commodity and was stock-piled against national emergencies. Since jojoba oil resembles sperm whale oil both in composition and in laboratory tests, it might serve well as a sperm oil replacement.

Jojoba oil has advantages over the similar product from sperm whale: it possesses no fish odor and indeed has a mild, pleasant odor; the crude oil contains no fats and little besides the liquid wax and requires no refining for use in most industrial processes; it has a very high viscosity index and very high flash and fire points which are important industrial parameters; it will take up larger amounts of sulfur than will sperm whale oil or lard oils (about 25% more); it does not darken to the same extent as other oils on sulfurization and the highly sulfurized jojoba oil remains liquid, when highly sulfurized sperm oil requires the addition of mineral oils to do so. Perhaps jojoba oil's most important property is that it is undamaged by repeated heating to high temperatures and does not change viscosity with temperature change.

Chemically speaking, jojoba seed oil is not a fat but a liquid wax like sperm oil. Fats, including the seed oils of most plants, are composed of a molecule of glycerine to which three molecules of various fatty acids are attached, but waxes are composed of one molecule of a long-chain alcohol to which one molecule of fatty acid is attached.

The expression of jojoba seed yields about 45% liquid wax which requires little or no refining for use as a lubricant. The wax content of seed does not decrease with long-term storage, and has remarkable resistance to bacterial degradation. Potential uses appear almost limitless. Because jojoba oil does not become rancid, it might well replace ordinary vegetable oils where rancidity is a problem, such as in foods, cosmetics, and hair oil. The oil is also a source of long-chain alcohols, useful in the preparation of detergents and lubricants.

Hydrogenated jojoba oil is a hard white crystalline wax reportedly harder than any other wax on the market except carnauba, for which it may be an attractive substitute, as well as having use in the preparation of waxes for floors and automobiles, waxing of fruit, impregnation of paper containers, manufacture of carbon paper, candles, and many other products.

Jojoba may be direct seeded, transplanted from potted nursery stock, or grown from cuttings of new wood treated with root promoting substances. Irrigation of young plants is desirable and may be necessary to produce a good stand. Excessive irrigation especially on poorly drained soils may result in death of older plants. Shrubs will produce seeds in 3 to 5 years. As jojoba is dioecious, it is necessary to have both male and female plants in the plantation.

Jojoba tolerates the extreme daily fluctuations of temperature. In its habitat, readings of 110° and 115° F shade are usual during the summer. Mature shrubs may tolerate temperatures as low as 15° F but seedlings are sensitive to light frosts of 22° F or lower. It is drought-resistant and grows well under soil and moisture conditions not suitable for agricultural crops.

WATER CONSERVATION IN THE LANDSCAPE
THE PROBLEM-WATER SHORTAGES ARE IMMINENT

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California is a state of legendary beauty and plenty, a land where supposedly all you have to do is add water to receive a seemingly endless blessing of flowers, fruits and vegetables. Because of the quietly effective work of most municipal water agencies, there almost always has been enough water to go around; because the water was always there when we turned the faucet, we lost what little awareness we might ever have had as to just where that water came from; and we have never had to ask that question: What if we ran out of water?

Suddenly and severely, a drought in central California has made the question -- and its apparently inescapable answer -- a real one in many communities. But perhaps rather than look upon the 1976 drought as an experience unique in our lifetime, one which soon will fade into the realm of bad memories, we should instead consider it a harbinger of conditions that potentially could become more common in the future, not so much the result of an act of God as the result of inescapable pressures of a growing population creating a demand for water that exceeds the natural supplies available.

In every community we can easily find ourselves surrounded by new houses, with these houses surrounded by new gardens. While the water required for those gardens varies widely from area to area, depending on the climate, the size of the garden and the things grown in it, it can still safely be said that at least half of the water supplied by domestic water agencies in California goes on the family garden.

In most communities this will be far more than is used inside the house, far more than is used by industry, and far more than is used by business. The garden is in fact the largest single type of water consumer in most western cities and as such is the most visible target for water conservation programs. A water supply agency charged with the responsibility of meeting its public's demand for water not only today but indefinitely into the future must look at the gardens and what is in them and how they are watered -- and often the sidewalks and gutters along with them -- and wonder if there is not something in California's gardening habits and traditions that needs prompt and long-lasting attention.

Even before the drought of 1976, there were several water agencies in California which were encouraging their customers to use less water in the garden by using plants which require less water and by using methods which guarantee efficient consumption of such water as was used. The number of water agencies committed to a long-range program of changing the gardening of the West will grow, as will their requests and expectations for assistance from the businesses and industries which also serve the home gardener.

PRACTICAL LANDSCAPE CONSIDERATIONS
FOR CONSERVING WATER

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Kellog Supply, Carson

CONSERVATION! This word has been of tremendous importance for a great number of years on a wide variety of subjects. Although the conservation of water is not a new one, it has had added emphasis recently as water shortages have become serious in California as well as different places throughout the nation.

When we had to suddenly wait in lines in an effort to obtain sufficient gasoline for our cars, most of us started to heed warnings on how to make more effective use of that which we had. As water became limited and began to be rationed, those affected became seriously interested in ways to reduce their water consumption. Where many previous reports which had described methods for reducing water use were accepted with little interest, they are now receiving increased attention.

Besides shortages of water, still another factor has awakened a need to investigate ways to reduce water use -- that of dollar costs. When one looks at the tremendous increases in the prices of water over the past years, we can't afford not to seriously look into ways to reduce water usage. Energy costs for pumping have soared correspondingly as much as water itself, so in some instances these increases have become more important than the water.

An example of what can be accomplished in the saving of money from irrigation can be given by learning the importance of five minutes of water. If previous practices had been to have a 45 minute water set and by better aeration, sprinkler adjustment, or a change in irrigation practices this could be reduced to 40 minutes, many may say, "big deal -- so what!" This five minutes is 5/45 or 1/9 which equals 11%. Should your annual water bill be $20,000 (and many are much higher, some into six figures), this is $2,200 a year, or $22,000 in 10 years for five minutes of water which wasn't needed. Often savings are much greater than these, so you can determine what this can amount to for your own situation.

Savings in the amount of water used and irrigation costs can be realized from several ways, including more even distribution of water from sprinklers, new methods of water application, sensing devices to aid in determining irrigation frequency and duration, cultural practices, and a knowledge of better irrigation practices. Perhaps one or more of these ways may be practically adopted into your program.

For turfgrasses and most landscape areas, sprinklers is the principle way that water is applied. Tremendous wastes in water occur from unevenness of water application from the sprinklers. Usually for most areas, frequency of watering is determined by the driest spots, although these may only be 10% to 15% or less of the area. This means that the majority of plants are overirrigated in order to supply even just enough water for those in drier areas to survive.

Sprinkler can tests may be conducted to determine how evenly water is being distributed. This is where cans, such as pint size ice cream or cottage cheese cartons are placed evenly over an area, the sprinklers are run for a given period of time, and the amount is measured in each carton and plotted for its location in relation to any sprinkler. From the results, it is easily apparent where dry and wet areas are. Methods for correction are then determined.

The newer systems of drip irrigation have been yielding very favorable results for more effective use of water with improved plant growth. The drip method involves frequent low volume application of filtered water through devices called emitters. Water is thus supplied slowly enough to prevent excessive accumulation on the soil surface and allowing water movement into the root zone of the soil. In agricultural trials, because of the low volume of water applied in drip irrigation, reductions in water use up to 50% have been obtained plus substantial increases in growth. Wholesale grower nurseries have received highly significant savings in water used and costs from the use of drip irrigation, especially when coupled with sensing devices.

Reduced water losses from total evaporation from the soil surface can be achieved by using drip irrigation in the landscape where only a limited soil is wetted, such as for shrubs and small trees, and the root zone is relatively small.

Tensionmeters are instruments which measure the availability of water in a soil. They have been in use for over 15 years with agricultural crops. During recent years, they have been used more extensively for turfgrasses, nurseries, and landscape locations. Highly significant savings in water use have resulted from their use in the landscape. Although it requires some time and effort to learn how to use these instruments, the results are overwhelmingly in favor of their use.

The tensionmeters may be used either as a guide to manually controlled irrigation systems, or in conjunction with automatic timing devices. The tensionmeter sensing override will only permit the controller to operate on those days and hours as preset, when water is actually required by the plants. This may be for different soil depths which contains varying amounts of roots.

Examples of the benefits received from the use of tensionmeters in the landscape are as follows:

TREES

Los Angeles State and County Arboretum, Arcadia, (Francis Ching): In eleven out of twelve stations, frequency of watering was greatly reduced so that instead of an average of every ten days during the spring, summer, and early fall, watering was only required an average of once per month. In another area, watering was done once every four months. These results were received without any evidence of plants in the area suffering from lack of moisture. In one area, near a eucalyptus tree, watering was necessary twice per month where it was previously thought necessary only once every three months.

Prolonged dry spells or very light rains during the winter months can be misleading in trying to determine the plant's needs for moisture. In most cases, the soil becomes extremely dry and almost impervious to water. Inital watering will result in a quick runoff and then short but repeated watering is necessary.

Light to medium rains (less than 2 inches) will penetrate to approximately 18 inches over a wide range of soils but not to 30 inches. Thus, additional irrigation was needed even though it was thought sufficient rain had fallen.

Although long range timing is not predictable in most cases with the use of tensionmeters, it is possible to determine to within 7 to 10 days when the next watering is needed.

Hawthorne City Parks, (Elmer Swanson): Where watering trees in a medium divider was done once a week with a watering truck before the tensionmeters were installed, the results showed this could be lengthened to at least every four weeks or more.

Forest Lawn Memorial Parks, (Bob Davidson and John Nolda): Significant reduction of water applications through the use of tensionmeters as a guide to the frequency and duration of irrigation has resulted in great improvements in plant health and growth.

TURF

U.C.L.A., (Frank Schacht): The first completely automatic location where tensionmeters were installed in conjunction with automatic timing devices resulted in water reductions of 54%.

University of California, South Coast Field Station, Irvine, (Dr. Al Marsh and Stan Spaulding): Research trials in turf comparing standard practices of automatic irrigation with irrigations controlled by moisture sensors have been conducted over a period of several years. Comparative studies were made using evaporation pan loss and three different moisture settings on sensors (one very wet, one medium moisture, and one drier than standard practice) as compared to irrigation scheduling done in the same area by the maintenance director of Leisure World, a housing and recreational development nearby.

Although there was some differences in water use between the St. Augustine and bermudagrass turf used, savings of 25% to 40% in water resulted in the automatically controlled plots with moisture sensing.

Covina City Parks, (Glenn Adams): Records were kept on four separate parks showing per acre water use each month for several years. In 1967, two parks where semi-automatic controllers were used, the total water usage differed only seven cubic feet in a total of nearly one million cubic feet irrigated, because the two systems were set so identically. At another nearby park, with moisture sensing tensionmeters installed, 48% less water was used. Both turf and trees have benefited.

Bremar Country Club, Tarzana, (Chuck Schardt): The first completely automatic system on a golf course where the tensionmeters were used with the timing device was installed at Bremar Country Club. The efforts here resulted in 38% water savings.

Whittier Narrows County Golf Course, Rosemead, (Andy Rodarte): Using the tensionmeters as a guide to manually control the irrigation on the greens at this location yielded savings of 87%.

Mt. Gate Country Club, Santa Monica Mts. (Rich Kubiak): This golf course built on a landfill was required to carefully regulate their watering to minimize settling and possible erosion. Significant savings in water use was realized from the use of tensionmeters. In the period from April to July, 1975, (2.3 inches of rainfall) with the use of moisture sensing, 37.3 acre feet of water was used. During the same period in 1976 (1.1 inches of rainfall) when the new management did not use the tensionmeters as a guide for irrigation, 85.2 acre feet of water was used.

Another new method of irrigation for high value areas such as golf course greens, football fields, confined planting beds for shrubs and trees, etc., is the Purr Wick and PAT systems from Purdue University. This is where a complete heavy plastic basin is formed at the base of the installation. Sand is placed above this, topped by a sand-organic surface zone.

Water is supplied from beneath, at the bottom, just above the plastic barrier. Water will than move upward due to capillary rise. A float valve then serves as a means to allow more water to be supplied, when needed, as it is lost through evapotranspiration from the surface. Highly successful results have been achieved from these installations, both in healthier plant growth and up to 50% in water savings.

CULTURAL PRACTICES

MULCHING

Vastly under taught, the benefits which come from mulching are numerous. Of importance now is its role in the conservation of moisture, which may be from 30% to 70% reduction in evaporation.

Organic mulches may generally be from one inch to two inches in thickness. As the organic materials break down into humus, this improves the structure of the soil, thereby allowing better water and air movement into the soil. Temperatures are also modified by mulches. These benefits to the soil environment results in greater root growth and activity which means plants can make more effective use of water in the soil.

Crusting of the surface soil which contributes to water runoff and soil erosion is also reduced by the mulching.

Usually, the finer the organic particles, the better will be their moisture holding ability and the less will have to be used. Some materials, such as grass clippings, leaves, peats, etc., may mat and restrict moisture entry into the soil. It is therefore suggested that a mixture of a long lasting, coarse type material such as woods and barks, be mixed with humus type of material. A compost mulch is rated as excellent. Remulching should be done annually after about mid-spring.

AERATION

There is no other cultural practice that can do the turfgrass manager so much good for so little cost. It is the only effective way now known to minimize the detrimental effects of soil compaction with grasses. The open holes leave a passageway for entry of water, air, and fertilizer into the soil. Roots grow well in these open spaces provided by the aerator.

In one set of trials of Forest Lawn Memorial Park, Glendale, where tensionmeters were installed to serve as a guide for irrigation, watering was reduced between 45% to 50% in the aeration plots compared to the control area.

THATCH CONTROL

Some thatch (a layer of undecomposed and partially decomposed organic material between the soil surface and green verdure of the grass) is beneficial to the growing of turfgrasses. It can help cushion the turf against wear and retards the loss of water from an exposed soil surface. It is when the thatch layers become excessive, possibly greater than 1/8 inch or so, that problems arise.

Thatch makes mowing more difficult, contributes to disease, insect and weed problems, and restricts the movement of air, fertilizer, and water into the soil. In one location where the thatch buildup was in excess of 1/2 inch, after 45 minutes of irrigation by sprinklers water had not penetrated through the thatch layer into the soil.

This thatch accumulation is hydrophobic (resists water) which contributes to water runoff. Under conditions when climatic conditions are unfavorable for a thatch control program to be started, a surfactant (wetting agent) can be of considerable benefit in allowing water movement into and through the thatch, which will also reduce surface runoff.

MOWING

The height which grasses are mowed can affect irrigation requirements of turf in two ways. When height of cut is too low, rooting is drastically curtailed which means more frequent watering is necessary because there are less roots throughout the soil to make effective use of the water which is there.

When grasses are mowed higher and less frequently than needed, this allows a greater leaf surface for water to be lost from the plant to the atmosphere by transpiration.

First consideration when determining the height which grasses are to be mowed should be its use. If there is an allowable range, then select that which will favor a good root system without allowing excessive growth to deplete the water in the soil any more than needed. Often a compromise in mowing height will have to be made which will favor either depth of rooting or water conservation.

FERTILIZATION

Timing of fertilization, amounts used, and the ratio of the nitrogen-phosphorus-potassium content can all affect the moisture requirements of the grass plant.

During the warmer summer months when irrigation requirements are higher, the application of larger amounts of nitrogen fertilization will result in lush and succulent grass which will have a greater water need. A weakened turf from insufficient nutrition will not be able to withstand the more severe climatic conditions over the hot, summer period. A management program should be aimed at sending the turfgrass plants into the summer in a strong, healthy condition by early and mid-spring fertilizer applications, and then only have smaller amounts applied, if needed, during the summer.

Nutrient imbalance, mainly high phosphorus and/or low potassium, can seriously restrict the vigor of plants and make them more susceptable to wilt and drought.

IRRIGATION

Knowing how, when, and how much to water can greatly affect the irrigation requirements of landscape managers.

When irrigation is done is important to the effective use of water. As much as practical, try to water during late night to early morning. During these times, wind is usually less and water pressure is greater so there can be better water distribution by the sprinklers. Higher evaporation rates during the heat of the day, especially during higher temperatures, can reduce the effectiveness of irrigation. Late afternoon to early evening water may also contribute to disease occurrences.

Surface runoff is very wasteful of water. This occurs when water is applied faster than the soil can accept it. Ways to reduce water runoff from the surface could then include slower applications rates, but only as much as practical to still provide satisfactory distribution and amending the soil with organic materials to increase the water infiltration rate into the soil.

Repeat cycling is of great value in reducing the waste of water by surface runoff. This is where a small amount of water is applied at frequent intervals, such as five minutes each hour, (this could vary at each location according to soils, sprinklers, slopes, etc.). The automatic time clocks now available have great sophistication in how this may be accomplished. Highly significant savings in water use can be received by this means.

Frequency of irrigation depends on climatic conditions, soil conditions, use of the turf, depth of rooting, vigor of the grass, and cultural practices. It would therefore be difficult to justify under most conditions a set pattern of how often to water.

Perhaps a simple answer to why we irrigate may be of value to us in determining how often to apply water. The reason we irrigate is to replenish water to that area of the root zone where it has been depleted.

The depth of rooting is therefore very critical when determining how often to water. A plant with a very shallow root system may require frequent watering, especially during hot and/or windy weather. This could be daily or even twice a day under some conditions such as a weaker, cool-season turf, golf or bowling greens. Contrary to this, a deep rooted, strong turf may go for a considerable length of time between irrigations. A good example could be one summer at Forest Lawn Memorial Park, Glendale. On one of the test plots at the high value Court of Freedom section, where aeration and vertical mowing was combined with the use of tensionmeters, irrigation was once delayed for 18 days during the month of August for the common bermudagrass turf there.

Although some reduction in water may be realized by better timing for the frequency of irrigation, the greatest savings in water may be associated with duration of irrigation.

After the downward movement of water from an irrigation (or rain) has ceased, the only ways water can then be removed from a soil are by surface evaporation and transpiration from a plant. Combining these two ways is called evapotranspiratinn. When rooting is very shallow, evaporation may have a considerable effect on how much water is removed from a soil, but other than this, transpiration has the dominant role.

In the rooting pattern of most plants, we can consider both a upper root zone and a lower one (or potential for roots to grow). It is in the upper zone where the majority of the roots are located. For grasses this is from an inch or so up to 8 inches or a foot and for trees and shrubs 12 inches to 18 inches or even deeper. This is where water must be replenished more frequently. Probing or digging can determine the location of these root zones. Operate sprinklers long enough, by repeat application, to wet that upper depth of rooting, then after the lower rooting zone has dried out some, apply additional water to wet this region.

It is necessary to determine how many applications of a given length of irrigation is necessary for water to move through both the upper and lower rooting zones. It is usually best to wait about four hours or so after irrigation to find out how far water has infiltrated through a soil.

The time and effort spent in improving your total irrigation management program can be richly rewarded in valuable savings in water and reduced irrigation costs.

USE OF DROUGHT TOLERANT AND DEEP ROOTED ORNAMENTALS IN THE LANDSCAPE TURFGRASSES

John H. Madison
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University of California, Davis

Estimates of water use by irrigated landscapes vary from over 40% (Denver) to over 70% (New Mexico) of municipal water use. During drought periods this use has sometimes been cut by edict. Reduced landscape use of water often results when costs of metered water are high. There is currently much talk about limiting landscape water use.

The irrigated southwest supports a large industrial urban complex. Part of the year the southwest has a climate that, at best, is suffered by the population, and tolerated because the irrigated vegetation ameliorates the harshness of the environment. Cost of water for vegetation in these areas must be balanced against alternate costs for increased air conditioning, second homes for seasonal use, and car use to "escape" the work environment at some seasons. Such a comparison has not been made.

In the meantime, water used for turf and lawns can be reduced by means which maintain lawns with minimum irrigation.

Studies at Colorado (Butler) show potential for breeding bluegrasses for reduced consumptive use, and for using grasses for turf which are not now used. In the southwest where heat stress is added to water stress experiments at Riverside (Youngner, Spaulding, Marsh) experiments suggest that water savings are difficult to achieve with grasses which suffer heat stress. Tolerance of limited irrigation can better be sought in grasses native to hot areas.

Bermudagrass is a deep rooted turfgrass of hot regions which shows good turf quality when supplied with water at ½ of the potential evapotranspiration. Zoysiagrass is also tolerant of water stress, but where bermudagrass grows slower with reduced water, Zoysia may also tend to become discolored.

Among grasses with temperature optima below 85-90° none appear to maintain turf quality when both heat and water stress are imposed. Two such grasses do survive well and show good recovery. Tall fescuegrass is deep rooted, slowly turns brown, but may go from brown to a presentable green turf within 20 days when irrigation is resumed.

'Highland' bentgrass is adapted to the Mediterranean climate and survives water stress more effectively than similarly used turfgrasses. After severe water stress of a California summer without irrigation, Highland recovered well after 60-90 days of growing weather with irrigation. Temperate season grasses other than tall fescue and Highland bent tended to be largely replaced by weeds when high water stress was imposed.

Mowing and fertilization are management practices that can be manipulated to assist survival when water is limiting.

SELECTED GROUND COVERS FOR A THIRSTY STATE

Ron Stacy
American Garden Perry's Inc., Fremont

We are living in a world of a changing environment. The past year's low rainfall has brought serious water shortages. We've been put into a dilemma and forced to do something about it. You can help relieve this situation by planting a select group of plants that are not only useful to the landscape, but able to tolerate our dry seasons with little watering. Many of these drought tolerant plants offer moderate compact growth and reduce the chore of pruning with rewards of many years of trouble free enjoyment while conserving precious water.

One must determine his or her basic needs when planning or replacing the landscape site; whether it be erosion control for a steep bank or a lawn substitute. Water conservation should be high on the list.

Consider these basic rules for planting and care of the long list of natives and other unthirsty plants:

- The right plant for site and exposure.
- Plant in fall or early winter or spring (Let Mother Nature do most of the watering). This also allows good root development.
- Plant in a well prepared soil keeping in mind good drainage.
- Plant with the crown slightly above the soil level.
- Water until soil and plants are saturated.
- Keep moist until plants begin to establish themselves.
- When plants are established DO NOT OVER WATER.

A LIST OF GROUND COVERS REQUIRING LITTLE WATER

	HEIGHT	EXPOSURE	FEATURES
ARTOTHECA CALENDULA "Cape Weed"	12-15"	Sun	Yellow flower
BACCHARIS PILULARIS "Dwarf Coyote Bush"	12-24"	Sun	Excellent appearance year round & erosion control
HYPERICUM CALYCINUM "Aarons Beard"	12-15"	Sun	Superb erosion control plant. Yellow flowers
OSTEOSPERMUM FRUTICOSUS "Trailing African Daisy"	12-18"	Sun	Good for erosion control. Three varieties, white, purple and lavendar.

	HEIGHT	EXPOSURE	FEATURES
CERASTIUM TOMENTOSUM "Snow in Summer"	6-12"	Sun	Medium textured, low-spreading, silvery gray carpet. Profuse small flowers in summer.
GAZANIA LEUCOLEANA "Trailing Gazania"	6-12"	Sun	Variable colored daisy flowers used in parking strips and bank covers.
FESTUCA GLAUCA "Blue Fescue"	4-10"	Sun	Blue-gray ornamental grass that grows in tufts.
LOTUS BERTHOLETTI "Parrots Beak"	2-3'	Sun, part shade	Ground cover on slopes. Sweet pea shaped scarlet to orange flowers.
SANTOLINA SP. "Santolina"	12-18"	Sun	Keep clipped to 1 ft. or less. Nice border plant.
MYOPORUM SP. "Myoporum"	up to 30'	Sun	Evergreen shrub, needs clipping. Wide spread of dense foliage. Use as windbreak.
ROSEMARY PROSTRATUS "Dwarf Rosemary"	12-15"	Sun	Blue flowers in April-May. Aromatic.
HYPERICUM CORIS "Hypericum"	6-12"	Sun or filtered shade	Fine rockery plant. Profuse yellow flowers.
TEUCRIUM PROSTRATUS "Prostrate Germander"	8-12"	Sun	Hardy, does well in hot locations. Rose or red-purple summer flowers.

NON-NATIVE SHRUBS AND TREES FOR MINIMUM WATER CONDITIONS

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California Polytechnic State University
San Luis Obispo

Thirty-seven years of association with the Ornamental Horticulture and grounds maintenance programs at Cal Poly have enabled the author to make observations on a wide variety of ornamental plants.

While the average annual rainfall in San Luis Obispo is 20.43 inches the precipitation varied during this period from a low of 10.30 to a high of 54.53 inches. Soil in the area is mostly clay or clay adobe with good water retention qualities.

The construction program on our campus has lent itself to some interesting studies since planted areas frequently become construction sites which are tied up for 2-3 years. Plantings in these locations often get minimum or no irrigation in the dry season; and in addition the shrubs and trees are often subjected to severe soil compaction, layers of dust, and sometimes chemical damage.

Many of the plants from Africa, Central America, and Australia do as well under minimum irrigation as do the California natives.

Successful growth of trees and shrubs under arid conditions depends upon several factors. I would emphasize the importance of knowing plant characteristics and selecting the best plant for a given location.

Proper planting techniques are also extremely important. These include digging an adequate hole. I remember reading many years ago an article by a wellknown garden writer in which he made the following statement, "I would rather have a 5¢ plant in a 50¢ hole than a 50¢ plant in a 5¢ hole". After having experience on the campus with contractors who planted gallon can plants in holes dug with a 6-inch auger, I certainly agree with this statement. If plants are to survive under stress conditions, they must be able to develop a good root system early.

Another important technique is to use a backfill in the planting hole that is not too different from the soil in which the hole is dug. For our area plants that have been grown in a heavier soil in gallon or 5-gallon cans often established better than those grown in a sandy soil.

During the late 1960s our Ornamental Horticulture Department was relocated. Construction (or I should say destruction) began in early summer of 1968 and continued for nearly two years. The first thing that the contractor did was to rip out the water lines at the old site giving us a test of drought tolerance for two summers. Certain plants flowered more profusely than they had ever done under irrigation. These included Bougainvillea, Cassia, Grewia, Tecomaria and Pennisetum.

In selecting the drought-tolerant plants for today's presentation, I consulted with 8 faculty members in the Ornamental Horticulture Department at California Plytechnic State University who teach plant materials and landscape courses. My plant list is a composite of their recommendations.

TREES

Botanical Name	Common Name
Acacia baileyana	Silver Wattle
Acacia spp.	
Aesculus hippocastanum	White Horsechestnut, Ruby Horsechestnut
Arbutus unedo	Strawberry Tree
Bauhinia galpini	Red Bauhinia
Brachychiton populneum	Kurrajong Bottletree
Casuarina spp.	
Ceratonia siliqua	Carob Tree
Cercis siliquastrum	Judas Tree
Cinnamomum siliqua	

Botanical Name	Common Name
Crinodendron patagua	Lily of the Valley Tree
Eucalyptus citriodora	Lemon-scented Gum
Eucalyptus ficifolia	Flaming Eucalyptus
Eucalyptus polyanthemos	Redbox Gum
Eucalyptus sideroxylon rosea	Pink Ironbark
Geijera parvifolia	
Grevillea robusta	Silkoak
Hakea suaveolens	Needlebush, Sweet Hakea
Heteromeles arbutifolia	California Holly
Koelreuteria paniculata	Golden raintree
Laurus nobilis	Grecian Laurel
Melaleuca quinquenervia	
Olea europeae	Olive
Pinus canariensis	Canary Island Pine
Pinus pinea	Italian Stone Pine
Pinus radiata	Monterey Pine
Platanus orientalis	European Sycamore, Oriental Plane Tree
Populus nigra italica	Lombardy Poplar
Quercus agrifolia	California Live Oak
Quercus ilex	Holly Oak
Quercus kelloggii	Kellogg Oak, California Black Oak
Quercus lobata	Valley Oak, California White Oak
Quercus suber	Cork Oak
Tristania conferta	Brisbane Box

SHRUBS

Botanical Name	Common Name
Bougainvillea glabra	
Callistemon citrinus	Lemon Bottlebrush
Cassia didymobotrya (C. nairobensis)	Popcorn Cassia
Cassia splendida	
Cassia spp.	
Cistus hybridus	White Rockrose
Convolvulus cneorum	
Cotinus coggygria	Smoke Tree
Cotoneaster pannosa	Silver-leaf Cotoneaster
Cotoneaster parneyi	Parney Cotoneaster
Crassula argentea	Jade Plant
Dodonaea viscosa	Clammy Hopseed Bush
Dodonaea viscosa 'Purpurea'	Purple-leaved Dodonaea
Escallonia	Appleblossom
Grevillea	
Grewia caffra	Lavendar Flower
Hakea suaveolens	Needlebush, Sweet Hakea
Leptospermum laevigatum	Australian Tea Tree
Ligustrum lucidum	Glossy Privet
Melaleuca elliptica	
Myrtus communis 'Boetica"	
Nerium oleander	Oleander
Oreopanax nymphaeifolia	Oreopanax
Plumbago auriculata	
Plumbago capensis	Cape Plumbago
Punica granatum "Nana"	Dwarf Pomegranate
Rosmarinus officinalis	Rosemary
Santolina spp.	Cypress
Tecomaria capensis	Cape Honeysuckle
Teucrium frutecans	Bush Germander
Viburnum tinus	Laurustinus
Xylosma serrata	

THE USE OF CALIFORNIA NATIVE PLANT MATERIAL AS A MEANS OF CONSERVING WATER IN THE LANDSCAPE

Warren Roberts
University of California Arboretum, Davis

California native plants can be successfully used to create attractive landscapes with little or no irrigation. Although not all native plants are tolerant of drought, many are well adapted to arid climatic conditions.

Some of the characteristics which help these plants perform well under low moisture conditions are:

- California native plants are often very deep rooted and capable of obtaining water from a large volume of soil.

- Many California native plants have leaves adapted to use less water in summer. Some of these adaptations to reduce the transpiration rate are fewer stomata, thick cuticle, curled leaves, many plant hairs, reflective color, and leaves turned to face the leaf edge to the sun.

- Some native plants become dormant in summer, and are deciduous or semi-deciduous during periods of low rainfall.

Most successful unirrigated landscapes which utilize Californian plants are in coastal or foothill and mountain areas where moister climates prevail or in habitats with a high water table. This success reflects the fact that most of our native plants which we use in landscaping come from these areas.

Difficulties often result when native plant materials are used in interior valley or in desert area. The major reason for this is that the quantity of really useful plant species adaptable to no irrigation in these areas is quite limited. These drier regions tend to have very hot summers and cold winters, short spring seasons, and hot, dry air and wind. Soils vary tremendously from coarse sands to heavy clays and alkaline and saline conditions are common.

At Davis, California, where the climate is representative of the California interior valleys, we have had good success in growing some native plant material. By success, for the purposes of this report, we mean the use of plant material that needs no supplemental irrigation and yet remains attractive and vigorous all year with no maintenance. A list of this plant material follows.

<u>FULL SUN</u> (low water table, no irrigation after first year)

Trees:

California buckeye, <u>Aesculus</u> <u>californica</u>
big cone Douglas fir, <u>Pseudotsuga</u> <u>macrocarpa</u>
foot-hill pine or gray pine, <u>Pinus</u> <u>sabiniana</u>
Torrey pine, <u>Pinus</u> <u>torreyana</u>
California fan palm, <u>Washingtonia</u> <u>filifera</u>
blue oak, <u>Quercus</u> <u>douglasii</u>
palo verde, <u>Cercidium</u> <u>floridum</u>

Shrubs:

foot-hill tasslebush, <u>Garrya</u> <u>congdonii</u>
desert olive, <u>Forestiera</u> <u>neo-mexicana</u>
chaparral pea, <u>Pickeringia</u> <u>montana</u>
island bush poppy, <u>Dendromecon</u> <u>rigida</u> subsp. <u>harfordii</u>
buckbrush, <u>Ceanothus</u> <u>cuneatus</u>
greenbark ceanothus, <u>Ceanothus</u> <u>rigidus</u>
bigpod buckbrush, <u>Ceanothus</u> <u>macrocarpus</u>
manzanita, <u>Arctostaphylos</u> <u>manzanita</u>
creosote bush, <u>Larrea</u> <u>divaricata</u>

Shrubs (continued)

jojoba, Simmondsia chinensis
nolina, Nolina species
sugarbush, Rhus ovata
yucca, Yucca whipplei
maguey, Agave deserti
San Fernando barberry, Mahonia nevinii
leather oak, Quercus durata
bladder pod, Isomeris arborea
rabbit bush, Chrysothamnus nauseosus
encelia, Encelia californica
chamise, Adenostoma species
Mormon tea, Ephedra species
chuparrosa, Beloperone californica

PROTECT FROM AFTERNOON SUN (low water table, no irrigation after first year)

Trees:

coast live oak, Quercus agrifolia
mesa oak, Quercus engelmannii
Santa Catalina cherry, Prunus lyonii
hybrid holly-leaf cherry, Prunus lyonii X P. ilicifolia
Santa Cruz Island ironwood, Lyonothamnus floribundus var. asplenifolius
Coulter pine, Pinus coulteri
Jeffrey pine, Pinus jeffreyi
yellow pine, Pinus ponderosa
pinyon pine, Pinus species
Sargent cypress, Cupressus sargentii

Shrubs:

manzanita, Arctostaphylos rudis, A. pajaroensis
redberry, Rhamnus crocea
coffeeberry, Rhamnus californica
Fremont barberry, Mahonia fremontii
tassel bush, Garry fremontii, G. elliptica
toyon, Heteromeles arbutifolia
redbud, Cercis occidentalis
holly-leaf cherry, Prunus ilicifolia
fuschia gooseberry, Ribes speciosum
chaparral current, Ribes malvaceum
Apache plume, Fallugia paradoxa
summer-holly, Comarostaphylis diversifolia
palo blanco, Ornithostaphylis oppositifolia
island mountain mahogany, Cercocarpus betuloides subsp. blanchea
fremontia, Fremontodendron species
wild rosa, Rosa californica
wild buckwheat, Eriogonum species

Ground covers:

California fuchsia, Zauschneria species (mow down each winter)
Catalina currant, Ribes viburnifolium
maritime ceanothus, Ceanothus maritimus
dwarf coyote bush, Baccharis pilularia subsp. pilularis

To help guarantee the success of California native plants used on very dry sites the following should be done:

- Keep the soil free of other competing plants. This includes weeds and the exclusion of other ornamentals within an area equal to twice the dripline area of the native plant.

- Mulch. This practice buffers the soil from temperature extremes, traps moisture, and discourages weeds. Mulching materials include wood chips, fir bark, pine needles, fine gravel or coarse sand, or even a dust mulch which should be renewed yearly. Asphalt, sometimes known as "Detroit mulch", has also been used successfully.

- Improve soil conditions. This may include lowering the pH, improving physical properties through the use of organic materials and gypsum, and leaching of salts.

- Make provisions for shade. Many natives succeed on dry sites if they are protected from full sun, especially in the afternoon, or if the plants' active root zone is shaded, especially important for shallow-rooted plants.

- Planting. This is best performed just before or during the rainy season. This reduces transplant shock and allows the plants' roots to establish at greater depths so that summer drought is not as damaging. When planting, soil should be prepared so that water penetrates and is retained at greater depths. Irrigation basins and mulching will help in establishment of the plants, and care should be taken so that soil will never accumulate above the root crown.

California native plants, although relatively pest free, are not without problems. Since some plant material is quite inflammable it is best to use low growing plants or to avoid planting near buildings in high fire danger areas. The reduction of irrigation on these flammable plants will also result in reduced growth and accumulation of potential fire fuel.

Diseases such as root and crown rots are often aggravated by summer irrigation or poor planting practices. Pruning can increase the danger of cankers on some natives such as ceanothus, manzanita, or fremontia and should be avoided as much as possible. Tip prune only, and perform pruning at the end of the rainy season.

The general aesthetic appearance of natives should be considered. Many plants become rather unattractive towards the end of summer unless they are watered occasionally during the dry season. Generally one to five deep waterings during this period will improve the plant's appearance considerably. The public acceptance of the appearance of drought tolerant plantings is of concern and is presently being studied at U. C. Davis.

Before choosing drought tolerant California native plants it is quite important to question the plant list being used. Often plants which are listed as performing well in dry situations for one area will be unacceptable in other locations. The use of California natives in the landscape for drought conditions is increasing but more observations and more controlled research are definitely needed to produce dependable information on their landscape use in our water-scarce environment.

EXTENDING FERTILIZER NITROGEN AVAILABILITY

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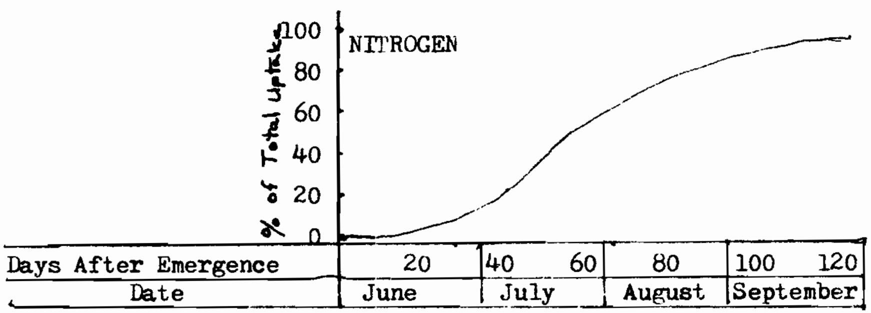
University of California - Davis

Nitrogen fertilizer is necessary in the profitable production of many food and fiber crops throughout our state, nation and the world. It is also used to improve our aesthetic surroundings at home, office, parks, roadways and many other areas. As supplies of natural resources and energy in particular are depleted, it behooves us to examine carefully how best to utilize fertilizer materials so as to maximize food and fiber production.

In order that nitrogen fertilizer might be used more effectively by plants to produce the desired result it seems most appropriate that we begin with a brief review of what happens to applied nitrogen in the soil-plant-air environment. Nitrogen may be added in numerous forms or supplied by legume fixation but will eventually become available in the ammonium (NH_4^+) or nitrate (NO_3^-) ion. If applied as an ammonium forming material it may be used by plants as NH_4^+ or be transferred to nitrite (NO_2^-) by Nitrosomonas and nitrate (NO_3^-) by Nitrobactor soil bacteria through the process called nitrification. Once in the NO_3^- form it may be used by the plant or soil organisms, leached by movement with soil water or return to the air as nitrogen (N_2) through the process called denitrification. In a very real sense, the plant we desire to fertilize is not the only recipient of nitrogen applied to the soil and in fact may be able to get very small quantities of NH_4^+ or NO_3^- if other plants or soil organisms have utilized these readily available forms or the NO_3^- form leached beyond the root zone or denitrified.

The objective in fertilization is a desirable response, be it increased grain, forage, fruit, nut, fiber or other plant or tree growth. If this is to be realized a careful examination of the normal sequence of nutrient adsorption during growth must be made. Each of these species have periods of growth during which root uptake of nitrogen is most active. An example of the uptake of nitrogen during the growing season for the corn plant is illustrated in the figure below. From the 30th to 70th day after the emergence of corn approximately 60% of the total nitrogen uptake occurs.



Annual crops exhibit much the same type of uptake pattern whereby 40 to 70% of the total nitrogen is adsorbed during the 20 to 40 day period of most rapid growth. Perennial and tree crops have similar periods of growth when sizable proportions of the nitrogen nutrient needs are taken up.

A consideration of what happens to nitrogen applied to the soil along with the uptake pattern by plants has brought about several approaches to obtaining greater utilization of applied fertilizer nitrogen. These techniques have involved either (1) a physical barrier around or mixed with the fertilizer granules, (2) a chemical which undergoes a slow rate of degradation or inhibits bacterial action or (3) a combination of these two. A few of these materials will be described and results following their use discussed by the speakers that follow.

OSMOCOTE CONTROLLED RELEASE FERTILIZERS: THEIR USES AND POTENTIAL

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Technical Director
Sierra Chemical Company, Milpitas

Various reasons for the need for slow release fertilizer technologies and considerations which should be given in the study and comparison slow release products are outlined.

The Osmocote® process, by which a wide array of controlled release fertilizer products can be produced, is described as well as the mechanisms involved in the release of nutrients from these products. The effects of external factors on release rates of plant nutrients from Osmocote are presented.

Current crop uses of Osmocote products are provided and potential uses are projected.

NITROGEN FERTILIZATION OF CONTAINER-GROWN ORNAMENTALS

Tok Furuta, R. A. Coleman, T. Mock,
R. Strohman, R. Branson, W. C. Jones
University of California

The need to irrigate plants growing in containers at frequent intervals, the leachability of nitrogen from the soil, and the limited volume of soil in the container have made maintenance of optimum levels of nitrogen difficult. Frequent applications of carefully controlled dosages are needed. Growers had turned to injecting nitrogen into irrigation water as a solution. As long as great concern was not expressed for efficient use of nitrogen or the content of nitrogen in drainage water the solution was acceptable.

In recent years great concern for efficient use and nitrogen content of drainage waters have been voiced. Thus a reexamination of the entire procedure becomes necessary.

A solution would be to incorporate a large, slowly available reservoir of nitrogen into the soil. The material should release nitrogen to meet the needs of the plant, and should not be influenced greatly by soil temperatures.

These series of experiments over a period of years show that Osmocote® comes close to meeting the requirements. The 14-month product can be used at high rates--much higher than is theoretically needed. Estimates of plant needs suggest, for a one-gallon size plant, that approximately three grams of nitrogen is needed by the time the plant reaches marketable size. However, to obtain optimum growth, incorporation of 14-month Osmocote® had to be at least nine grams per one gallon container. Apparently all of the nitrogen did not release. Some nitrogen was lost by leaching at each irrigation.

SULFUR-COATED UREA, A POTENTIAL SLOWLY SOLUBLE NITROGEN FERTILIZER

Warren J. Sharratt
Tennessee Valley Authority, Davis

Normally a crop uses an average of 40 to 50 percent of the applied nitrogen. Under favorable circumstances, up to 70 percent or more may be taken up by the crop, but conditions where only 25 percent of the nitrogen is used are not uncommon. Much of the nitrogen not taken up by the crop is lost through leaching, runoff, or volatilization. Single, heavy applications of nitrogenous fertilizer may be inefficient because N is provided in excess of the crop's immediate requirements and losses tend to be heavy. Heavy applications of soluble nitrogen may also be harmful to crops. The most obvious solution to this problem (repeated applications of smaller amount of nitrogen) lead to greatly increased application costs and is physically impractical for many crops.

Several attempts have been made to produce and market nitrogen fertilizers with controlled release properties. Compounds like ureaformaldehyde and IBDU rely on low water solubility as a means of limiting nitrogen availability. Another approach has been to coat individual fertilizer particles with a semipermeable membrane, such as a plastic material. This allows water to enter the fertilizer granule resulting in a fertilizer solution within the granule which then slowly permeates back through the membrane and feeds the associated plant.

TVA's pilot plant research work on sulfur-coated urea commenced about 10 years ago with a small plant which had an output of about 150 pounds per hour.

The process involves spraying preheated urea with molten sulfur in a rotating drum. A bright stock and polyethylene mixture is applied over the sulfur coating to seal pinhole cracks which affect the release properties. The product is then cooled and diatomaceous earth conditioner is applied to prevent tackiness and flotation of granules.

The release rate of sulfur-coated urea is expressed as the percentage of urea which dissolves when the product is immersed in water under controlled conditions for 7 days. For optimum agronomic performance, products having 7-day dissolution rates of 20 to 35 percent followed by 1 percent or less daily thereafter are usually sought.

One factor affecting the pattern of release of N from sulfur-coated urea is the thickness and uniformity of coating. Terman and Allen[1] used products with 29 and 27 percent coating weight in a column leaching experiment with Lakeland sand. The respective products were designated SCU-6 and SCU-18 because 6 percent and 18 percent of their urea dissolved in water in a 10-day laboratory test. Four inches of water were added each week to fallow soil columns to which SCU or soluble ammonium nitrate had been added.

Figure 1 shows that 64 inches of added water leached 28 and 70 percent of the nitrogen applied as SCU-6 and SCU-18, respectively. All nitrogen applied as ammonium nitrate was recovered in 16 inches of leachate during the first 4 weeks. Periods of 3 to 4 weeks elapsed between dissolution and movement through the sand. It appeared that after the initial fast dissolution, SCU-18 released urea at an average rate of 3.8 percent of the nitrogen per week, which resulted in the total nitrogen being released in 20 weeks. SCU-6 released urea at an average rate of 1.2 percent per week. If this release rate held, SCU-6 would release most of its nitrogen in about 70 weeks.

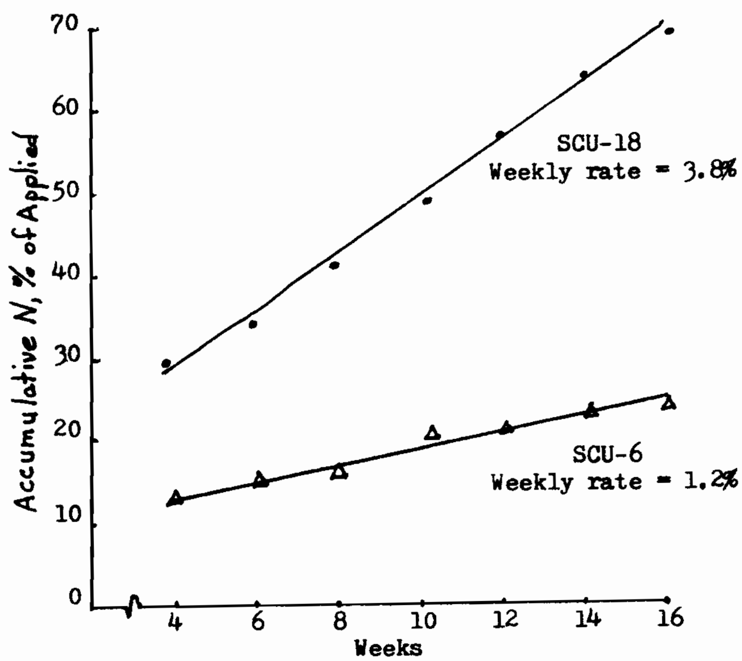

Fig. 1. Rate of N release from SCU (Terman and Allen).

1. Terman, G. L. and S. E. Allen. "Leaching of Soluble and Slow Release N and K Fertilizer From Lakeland Sand under Grass and Fallow," Soil and Crop Science Society, Florida Proc. (1970) 30, 130-140.

SCU is suited to several cropping and climatic conditions. Lysimeter experiments have shown that nitrogen leaching, even in sandy soil, is negligible when a growing crop has an extensive root system. But without such a root system, excessive water causes considerable leaching, especially while the crop is becoming established. SCU can reduce such nitrogen losses, increase recovery of fertilizer nitrogen on irrigated sandy soils, and reduce the number of applications.

Additionally, sulfur-coated urea may have other advantages. (1) In highly permeable soils there is sometimes a problem of maintaining enough soluble nitrogen for seeding growth and development while preventing toxic soluble salt levels at some stage of growth. SCU can eliminate this problem. (2) Nitrogen losses through volatilization of ammonia from surface supplied urea are significant, especially on alkaline soils when high temperatures and drying conditions prevail. Such losses can be reduced when SCU is used to diminish the rate of dissolution. (3) Soils may become waterlogged after fertilizer is supplied. Nitrate is quickly denitrified in these soils and lost to the atmosphere. With SCU, this nitrogen loss will be much less. (4) It can help overcome sulfur deficiency which is appearing in crops in some regions of the country.

RESPONSES OF CALIFORNIA ANNUAL GRASSLAND TO SULFUR COATED UREA

Milton B. Jones, C. E. Vaughn and J. E. Ruckman
University of California, Hopland

California annual grassland soils are nearly always deficient in N which limits forage production and quality. Experiments at the University of California Hopland Field Station have indicated that fall applications of soluble N fertilizers on annual range often result in greater late fall and winter forage production followed by N deficiency and low forage protein levels in the spring. Fertilization with soluble N can also be accompanied by a decrease in the numbers of desirable legumes in a pasture and excessive N leaching losses when rainfall exceeds 75 cm annually.

In 1970 experiments were begun to compare the effects of a soluble N fertilizer, urea, with a controlled release N fertilizer in the form of sulfur coated urea (SCU). Two experimental preparations of SCU (designated 3E and 5B, having seven-day dissolution rates in water of 25% and 9%, respectively) were compared to urea alone and to urea plus fine elemental S. Two rates of each fertilizer (68 and 136 lb N/A) were surface broadcast on separate plots on unseeded annual grassland in the fall of 1970 and 1971. Forage production and forage N and S content were then measured seasonally through 1973, and annually in 1974 and 1975.

Seasonal forage yield distribution was similar among all treatments during the first year of growth. However, release of N from SCU appeared to be slower because N uptake was highest from the urea + S treatments during the first winter. Nitrogen uptake from SCU 3E was generally similar to urea + S by the first spring. The more slowly soluble SCU 5B and urea alone resulted in no more total first year herbage yield or N uptake than the check treatment. Fine elemental S plus urea resulted in the highest S uptake throughout the first year. There were no differences in S uptake among the other treatments. Regression analysis indicated that S accounted for as much variability in first year yield as did N.

Studies of the long-term effects of the fertilizers indicated that most of the residual value was due to S. By the second or third spring after application, S was accounting for most of the variation in both yield and N uptake. Residual studies also indicated that S and N from SCU 5B became much more available during the second year. By the second spring yield and N content were similar for both SCU formulations and urea + S. Cumulative 5-year herbage yield and quality measurements were also similar for these three treatments. However, fourth and fifth year S and N uptake values were higher from SCU which may reflect the long-term value of larger S particles.

The slower release of N from SCU did not result in any greater apparent N use efficiency. Average apparent N recovery during the first two years after application indicated that urea + S = SCU 3E > SCU 5B = urea alone. Second year recovery was lower than first for all N carriers except SCU 5B. The response to S complicates the evaluation of SCU as an N source.

Sulfur fertilization rates were significantly and linearly correlated with both legume yield and N uptake three and four years after application.

In conclusion, it appears that SCU does not have any particular advantage over urea plus fine S in fertilizing California annual grasslands. The slower availability of SCU during the first winter following fall application is a disadvantage since N is usually applied at that time to increase the supply of feed in the winter, a season when it is in short supply. While carryover of N from SCU appeared to be a little greater than from urea + S, it is doubtful that the difference would justify the extra cost of SCU.

NITRAPYRIN - WHAT IT IS AND WHY IT IS

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Dow Chemical U.S.A., Davis

Nitrapyrin is the common name of the nitrogen stabilizer, 2-chloro-6-(trichloromethyl) pyridine. This chemical is selectively toxic to Nitrosomonas spp., the bacterial species which oxidizes ammonium to nitrite ion in the soil. Nitrapyrin is relatively innocuous to other soil microorganisms and processes when used at recommended rates. It is manufactured by the Dow Chemical Company and is marketed as N-SERVE* 24 and N-SERVE 24E nitrogen stabilizers.

When added to ammonium or urea fertilizers, nitrapyrin reduces the rate of nitrification. Under soil conditions which cause losses of nitrite and/or nitrate ions by leaching or denitrification, nitrapyrin can increase the efficiency of nitrogen fertilizers or make possible less frequent nitrogen applications.

Although nitrapyrin slows nitrification of ammonium ion, it does not prevent nitrification when used at recommended rates. Therefore, with nitrapyrin treatment of the fertilizer, the plant is placed on mixed ammonium-nitrate nitrogen nutrition.

In addition to reducing losses of nitrogen, other advantages have been reported from nitrapyrin treatment of ammonium fertilizer including:

1. Mitigation of certain plant diseases, including Diplodia stalk rot of corn and Take-all disease (Ophiobolus) of wheat.

2. Maintenance of greener color in vegetables and fuller development of ears in sweet corn.

3. Lower nitrate content of vegetables such as spinach.

4. Increased phosphorous and zinc uptake by plants.

Nitrapyrin may be applied to the fertilizer by addition to solid ammonium or urea fertilizer with a separate application as it is drilled into the soil or by addition to anhydrous or aqueous ammonia with normal injection.

* Trademark of The Dow Chemical Company.

THE USE OF NITRAPYRIN IN WHEAT ON THERMIC DESERT SOIL

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Extension Agent, University of Arizona
Henry A. Brubaker
Agronomist, Farmers Investment Co.
Aguila, Arizona

The use of a nitrogen stabilizer in short-strawed durum wheat has been proposed as an aid to fertility management in lower desert regions, since certain inhibitors of the nitrification process have been effective in reducing the rate of oxidation of ammonium fertilizer to nitrate (Hughes and Welch, 1970; Parr et al., 1971). Since oxidation of ammonia in thermic arid soils proceeds at a relatively rapid rate during late fall and winter, it has also been suggested that this method might increase yield and provide additional advantages. Other benefits might be higher available nitrogen supply at some early critical stage of development, more uniform nitrogen application than applications in irrigation water, elimination of irrigation in cold weather to supply timely supplemental nitrogen, and reduction of yellow berry content of durum wheat.

The soil selected was a sandy loam classified as a thermic arid soil with mean annual soil temperatures ranging from 15° - 22° C. or 59° - 72° F. Anhydrous ammonia was injected prior to planting at 100, 200, and 300 pound nitrogen levels in randomized 12-row replications and compared with equivalent anhydrous ammonia injections with the added nitrapyrin at .5 pounds per acre. The durum variety Produra was planted December 12, 1975, irrigated with approximately 36 acre-inches of water without additional fertilization and harvested June 15, 1976.

RESULTS

1. Application of 100 pounds and 200 pounds of nitrogen as anhydrous ammonia significantly increased durum wheat yield above the yield of plots without nitrogen fertilization.

2. Addition of nitrapyrin to anhydrous ammonia resulted in significant yield increases at the 100 pound and the 200 pound nitrogen level over anhydrous ammonia without nitrapyrin.

3. Addition of nitrapyrin with anhydrous ammonia in preplant fertilization did not significantly affect yellow berry content of the Produra wheat variety.

EFFECT OF NITRAPYRIN ON NITROGEN FERTILIZATION OF WHEAT

FERTILIZER TREATMENT	BU. WT	MOISTURE	YIELD PER A.	YELLOW BERRY
	lbs.	%	lbs. *	% *
300# NH_3 + .5 lb. Nitrapyrin	62	6.3	5649 a	6 d
200# NH_3 + .5 lb. Nitrapyrin	62	6.4	5579 a	11 d
300# NH_3	62	6.6	5132 ab	6 d
200# NH_3	62	7.0	4974 bc	16 cd
100# NH_3 + .5 lb. Nitrapyrin	63	7.2	4412 c	29 ab
100# NH_3	63	7.0	3517 d	23 bc
Check (0 lbs N)	63	7.0	1673 e	36 a

* The means within a group do not differ significantly at the .05 competence level from other means followed by the same letter.

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Parr, J. F., B. R. Carroll, and B. Smith. 1971. Nitrification inhibition in soil 1. A comparison of 2-chloro-6- (trichloromethyl) pyridine and potassium azide formulated with anhydrous ammonia. Soil Sci. Soc. Amer. Proc. 35:469-473.

VEGETABLE CROPS RESPONSE TO NITRAPYRIN APPLIED FOR NITROGEN STABILIZATION

K. Tyler, R. Brendler, L. Ede, B. Hoyle, H. Johnson, Jr., D. May
K. Mayberry, D. Ririe, M. Snyder, N. Welch
University of California

It is fairly well established that vegetable crops are heavily fertilized with nitrogen when compared with most other crops. Yet the nitrogen efficiency of vegetables, i. e. the amount of N utilized by the plants in relation to the quantity applied, is generally found to be low--usually less than 50%. It would appear, therefore, that there must be ways of increasing the nitrogen efficiency of this class of crops and thus conserve fertilizer and the energy required in its manufacture.

To investigate practices leading to improved fertilizer usage and particularly increased nitrogen efficiency in head lettuce, an effort was launched in the fall of 1974 with some financial support from the California Iceberg Lettuce Research Advisory Board. One aspect of the investigation was the evaluation of nitrapyrin as a nitrogen stabilizer in head lettuce production. This evaluation has since been extended to other vegetables, including cantaloupe, cauliflower, pepper, potato and sweet potato.

Results obtained thus far indicate that nitrapyrin as an additive at very low rates to dry or liquid forms of ammonic nitrogen can be beneficial in one or more ways where crops respond to nitrogen fertilizer application. Under certain conditions, not yet fully defined, nitrapyrin addition to ammonic nitrogen fertilizer results in higher productivity and sometimes improved quality than comparable rates of fertilizer without the nitrapyrin. Fertilizer application costs can be reduced by the elimination of postplant nitrogen applications. Also, in certain desert soils where nitrite-nitrogen has accumulated following ammonic N application to stunt or damage seedling lettuce, nitrapyrin can alleviate these detrimental effects.

Further work is needed and is presently continuing to better define conditions wherein nitrapyrin may be employed as a useful tool for vegetable crops.

CALIFORNIA CHAPTER, AMERICAN SOCIETY OF AGRONOMY
Presents Its
AWARD OF HONOR
to
HENRY A. JONES

The presentation was made by Oscar A. Lorenz, past president of the California Chapter at the noon luncheon meeting of the Plant and Soil Conference

It is a distinct pleasure and honor for me to present our award today. I have known the awardee for many years, first when I was a student and in later years as a fellow researcher. This "Award of Honor" of the California Chapter of the American Society of Agronomy is made annually to a person who has made outstanding contributions to agriculture in the field of university, government, or industry service. Our man today has been successful in each of these categories and any one of them would fully qualify him for the award.

Our honoree today was awarded the Ph.D. in plant physiology by the University of Chicago in 1918. He served as associate professor of horticulture at West Virginia in 1919 and 1920 and then as professor of vegetable gardening at the University of Maryland. He joined The Division of Truck Crops at UC Davis in 1922. While at Davis he made outstanding scientific accomplishments on many crops such as asparagus, lettuce, cauliflower, cabbage and others. His main interest was the breeding of onions. He discovered a distinctive form of male sterility that made production of hybrid onions practicable on a commercial scale. This method of utilizing cytoplasmic male sterility is applicable to all types of onions and is also used in the development of hybrids in other crops. While at Davis, in cooperation with J. T. Rosa, he wrote the book Truck Crop Plants which is still the best text available on vegetable breeding.

In 1936 he joined the U.S.D.A. at Washington D.C. where he served as principal horticulturist responsible for nation-wide programs on onions, potatoes and spinach.

Upon retiring from the U.S.D.A. in 1957 he joined the Deseret Seed Co. in El Centro. He serves as director of research but still retains his life-long interest in the breeding of onions. In the summer he can be found in the onion breeding grounds early in the morning until late at night, seven days a week.

In his lifetime, he has been responsible for the development of many varieties of onions and spinach. The publications of his research are numerous. He has been the recipient of numerous awards; the U.S.D.A. Distinctive Service Award; The National Council of Commercial Plant Breeders Award; The American Seed Trade Association Award; The Vegetable Growers Association of America Award; and an Honorary Doctorate from the University of Nebraska.

I know of no one who is more deserving of the "Award of Honor" from this society than the man who we have selected today. I am happy to present to you the "Father of the Hybrid Onion" -- Dr. Henry A. Jones.