Proceedings

1974
CALIFORNIA PLANT
and
SOIL CONFERENCE

Sponsored by the

CALIFORNIA CHAPTER–A.S.A.

Sheraton Inn

Fresno, California

January 30, 31 and February 1, 1974

1974

CALIFORNIA PLANT AND SOIL CONFERENCE

Sponsored by the

CALIFORNIA CHAPTER

AMERICAN SOCIETY OF AGRONOMY

January 30, 31 and February 1, 1974

SHERATON INN

FRESNO, CALIFORNIA

ELECTED OFFICERS OF THE CALIFORNIA CHAPTER

OF THE AMERICAN SOCIETY OF AGRONOMY

FOR 1974

THE EXECUTIVE COMMITTEE:

President:	P. F. Pratt Department of Soil Science and Engineering University of California, Riverside
First Vice President:	Malcolm H. McVickar Chevron Chemical Company, San Francisco
Second Vice President:	Oscar A. Lorenz Department of Vegetable Crops University of California, Davis
Past President:	Iver J. Johnson Cal-West Seeds, Woodland
Executive Secretary-Treasurer:	George R. Hawkes Chevron Chemical Company, Richmond

COUNCIL OF REPRESENTATIVES:

One-Year Term:	Donald L. Smith Pacific Oilseeds, Inc., Woodland
	M. Van Elswyk California State University, Fresno
	Milton D. Miller Cooperative Extension University of California, Davis
Two-Year Term:	Robert S. Ayers Cooperative Extension University of California, Davis
	R. L. Luckhardt Collier Carbon and Chemical Company Los Angeles
	Stephen T. Cockerham Cal-Turf, Camarillo
Three-Year Term:	Luther B. Grass Agricultural Research Service USDA, Brawley
	Luther B. Hughes Soils Department California State Polytechnic University San Luis Obispo
	David J. Thompson Ferry-Morse Seed Company San Juan Bautista

CONFERENCE REPORTS

Page

Page

EXPORTS AND IMPORTS AS RELATED TO OUR CURRENT FOOD SUPPLIES

R. E. Anderson, Jr.
Chief, Commodity Analysis Branch
Grain and Feed Division
Foreign Agricultural Service
U. S. Department of Agriculture

There is an old proverb we should keep in mind when we think about what may be in store for agriculture and farmers over the next few years. And that is: "Things are never as bad or as good as they first seem."

1973 was an exciting year for agriculture in general and for grain farmers in particular. But, thinking about what comes next can either be stimulating or frightening, depending on who is doing the speculating.

I am quite sure that no longer than two or three years ago, maybe less, you could have asked almost anyone on the street in Fresno or any other American city to name a product exported by American agriculture and have drawn a blank stare.

Today, I'll lay odds that the same question asked of anyone, almost anywhere in the United States, would get the immediate response: wheat - and with it, would come a lecture on $1-bread and the folly of shipping all our wheat to Russia while the cupboard at home goes bare.

Anyone who has read a newspaper or looked at television over the past year can confirm that the consumer has, at long last, discovered agriculture. Food prices have become Page 1 news items and U. S. crop reports have become network news not only in New York and Chicago, but in London, Frankfurt and Tokyo. The result has been both good and bad. It has been good because agriculture, for too long a stepchild in American society, is no longer taken for granted - it has become a full-fledged member of the family. Its problems and its policies have become the concern of the entire body politic and not just a few farm state congressmen in the years when the current farm legislation was about to expire.

It has been bad because the lesson that food originates not in the supermarket, but on the farm where people work hard to produce it, has been delivered the hard way. World crop shortfalls, temporary shortages of some commodities and soaring consumer prices have created myths and triggered scare stories about food supplies and agricultural exports that are hard to dispel.

Try to convince someone, for example, that the increase in U. S. farm exports to the Soviet Union last year represented only 16 percent of our total export gains; or try to explain that the price of wheat that goes into a loaf of bread could more than double without pushing the price of bread to a dollar a loaf.

It is just as difficult to try to explain that the imposition of export controls in the absence of dire emergency which would in fact cut off the export potential of U. S. agriculture is short-sighted and invites disaster to the farm economy and trouble for the economy of the nation as a whole.

I would like to talk about food supplies and agricultural trade for a few minutes today, but first I want to spend a little time on what agriculture and its trade mean to this country beyond its food supply - a good supply, I might add, that is not being threatened by exports as some would have us believe.

The world agricultural situation of the past year or so, which was marked by crop shortfalls and rising demand, has given us a good idea of the potential for U. S. agricultural growth that lies in the export market and what this growth can mean for the national economy.

Most of us are aware that U. S. agricultural exports reached an unprecedented $12.9 billion last fiscal year - a gain of close to $5 billion, and all of that gain was in commercial sales for dollars.

The whole country has benefited from these export sales. Agriculture has consistently shown a trade surplus - close to a billion or more every year since 1961. Last fiscal year's exports produced a record agricultural contribution of $5.6 billion to the U. S. balance of trade at a time when non-agricultural trade was showing a deficit of more than $9 billion.

The agricultural trade surplus for calendar year 1973 is expected to exceed $8 billion, to put this country's total yearly trade balance in the black for the first time since 1970; and if current trends continue, we will pile up an agricultural trade surplus in fiscal year 1974 of more than $10 billion.

You can pay for a lot of oil, coffee, tea, bananas, spices and rubber with $10 billion. We need to get the message across that "balance of trade" is not jargon, meaningful only to economists. It is a measure of how much we have bought and sold in the world market; and if we are going to continue to buy in the world market, we've got to sell as much or more than we buy. If we don't, we are courting economic trouble and putting the dollar in jeopardy.

Farmers have also obviously benefited greatly from exports.

As a result of expanding exports, U. S. cropland in production was increased by about 23 million acres in 1973; and according to planting intentions just released, a further 16 million-acre expansion is expected in 1974.

Exports accounted for the harvest from 85 million acres of cropland in 1973 - one in every four cropland acres harvested. For some crops, the total was even higher, as the equivalent of three-fourths of U. S. wheat production moved to export markets, over two-thirds of the rice, about half the soybeans and cattle hides, two-fifths of cotton and tobacco, and about one-fourth of feedgrains.

Exports have given the farmer the opportunity to use all of his land and all of his machinery - capital investments that cost the same whether fully used or not - permitting him to produce more agricultural commodities at a relatively lower unit cost.

A record total net farm income of $20 billion achieved in 1972 and the more than $25 billion estimated in 1973 has been brought about in large measure by the substantial rise in U. S. agricultural exports. In fiscal year 1973, for example, an estimated one-fifth of net farm income came from agricultural exports. About one-half of the 1973 increase in net farm income over a year earlier was the result of farm exports.

Without export markets, half our wheat fields would go unplanted, two-thirds of our rice fields would be drained off, and other crop production would be substantially cut back. And, either government programs would have to provide tax dollars to help the farmer, or he would be 20 percent poorer.

Expanding exports have also brought benefits for the 200 million or more Americans who don't farm. A group of USDA economists have analyzed exports. These are some of the things they found:

1. For every $1 increase in production of feedgrains, wheat, rice and oilseeds for export, an additional 90 cents of output occurs in other parts of the economy, such as transportation, storage, handling, and marketing. This means that the nearly $5 billion expansion of U. S. agricultural exports in fiscal year 1973 generated around $4.5 billion in supporting output in the rest of the economy, which went into the pockets of workers in the non-farm sector.

2. Total agricultural exports in fiscal year 1973 generated an estimated $28.8 billion of gross national product, around 60 percent of which occurred off the farm. In other words, when farmers did nearly $12 billion net in export business, they created over $17 billion worth of business for their fellow citizens in non-farm pursuits.

3. In fiscal year 1973, more than 450,000 non-farm jobs were directly or indirectly related to the assembling, processing, and distributing of agricultural commodities for export.

4. And, lastly, farm exports are saving taxpayer dollars. Because of the substantial rise in agricultural exports and resulting changes in the domestic farm programs, the cost of farm programs this year is expected to decline to less than $1 billion - down $3 billion from two years ago.

Those are some of the benefits non-farm people receive from agricultural exports; and it seems to me that this message of more jobs, more business, and a stronger economy from exports is one that those of us who work in agriculture should bring to those who don't at every chance we get.

In turning to the food supply situation, I would like to emphasize that in achieving this remarkable record in agricultural trade, this country has not run out of food. Sure, food prices are high, but compared to what? Certainly not compared to food costs in most of the rest of the world, and not compared to the run-up in prices that have occurred in recent years in, say, e.g., medical care and other services, and not compared to the price of gasoline, which hit 62 cents a gallon at some Washington stations last week.

In trying to assess food supply prospects and trade, we are talking basically about food and feedgrain stocks on hand, anticipated production, and expected world demand. We have injected a new factor into the supply-demand equation within the past several weeks; and that is the fuel situation. It has been very difficult to get a handle on this; and about the only thing that can be said at this point is that it looks as if the near-term effects on both production and demand will not be as extreme as some early projections from the hip had indicated. It looks now as though the Arabs may be loosening their oil embargo noose a bit - but they have quadrupled their prices from a year ago to nearly $12 a barrel. Problems in getting oil - and perhaps even more difficulty in paying for it - could trigger recessions in some of our major markets like Japan.

Looking at the range of basic commodities, we find that the wheat outlook remains very tight for the current crop year, but another record crop will start coming off the southern plains in May. There are plenty of feed grains in this country and a record corn crop is in prospect. A record soybean crop last fall will easily handle demand and permit an increase in our soybean carryover as of next August 31; beef supply-demand has tightened up, but larger supplies are expected later this year.

The key to this more reassuring supply outlook - compared with six months ago - has been, of course, the resumption in the upward trend in world grain production. It topped an estimated 950 million metric tons in 1973-74 - nearly 75 million tons more than the previous year and the largest grain crop ever produced. The big news was the record production in this country and the Soviet Union, which harvested a whopping 220 million metric ton crop.

Strong world demand encouraged increased plantings in most exporting countries and weather conditions were favorable.

Wheat acreage in the United States increased nearly 6½ million acres in 1973 and production totaled 1.7 billion bushels. However, utilization has been put at around 2.1 billion bushels, reducing wheat stocks to about 178 million bushels - the smallest since 1947.

As I said, this level indicates a very tight supply situation until new crop wheat becomes available; and the January report of farmer planting intentions indicates that this new crop could reach beyond 2 billion bushels. Pressure has continued on U. S. wheat supplies this season due partly to fears of a wheat shortage and the extremely cautious selling posture on the part of Canada and the European Community.

U. S. exports for the 1973-74 marketing year are estimated at 1.2 billion bushels, slightly larger than last season's record. Some think our export estimate is too low in view of current demand the outstanding sales reported by the exporters. We disagree. We follow the market very closely and get a day-to-day input from our Agricultural Attaches and other trade sources. We feel that U. S. shipments will tail-off in the second half of this year to between 16-17 million bushels per week compared with our first half export average of between 27-28 million bushels. This "tailing off" in U. S. exports can be seen in the wheat export inspections the past five weeks which have ranged between 17-19 million bushels. Also, Canada, Australia, and the European Community will be putting more wheat into export the second half of this marketing year.

When looking at a comparison of seasonal rates of wheat exports, it is difficult to see world import needs matching the volume which moved in the December-June period of 1972-73. During that period, a total of 1.6 billion bushels of wheat moved in international trade, with the Soviet Union taking 391 million bushels - mostly U. S. wheat. During the current December-June period, the Russians are expected to import only about 30 million bushels, or nearly 12 million metric tons less than the same period last year.

The European Community still has a substantial quantity of wheat to move into export this marketing year unless there is to be some buildup in their wheat stocks. Wheat export certificate issued by the Community so far this marketing year indicate that they could possibly make available for export 3-4 million metric tons of wheat during the last half of the season.

We feel that these additional supplies available for export in the second half of 1973-74 will ease the pressure on U. S. wheat supplies. Continuing favorable indications for a large 1974 wheat crop both in the U. S. and overseas should also have a quieting effect on the market during the next few months.

For feed grains, the supply situation is more comfortable. Our export estimate of 1.125 billion bushels of corn and 36 million metric tons of total feed grains will be about $3\frac{1}{2}$ million tons below the level exported a year ago.

Current indications point toward a substantial increase in world feedgrain production in 1973, sufficient to meet consumption requirements. Total world output of feedgrains is expected to reach nearly 593 million metric tons, 47 million above the previous year. The United States accounted for only about one-seventh of this increase; yet, we've seen our feedgrain acreage increase by over 8 million acres last year and production reach a record 188 million metric tons.

These larger supplies are evidence of the world's ability to produce grains, given incentives and normal production conditions. Some of these increased supplies will, of course, be offset by a rebuilding of stocks in exporting countries. Also, part of the increase in feedgrain supplies will come in Southern Hemisphere countries where any increase in availability will relate mainly to the year beginning July 1, 1974.

Continued strong domestic use of corn in the current year and near record exports will draw carryover stocks down by about 100 million bushels to about 600 million at the end of the year. However, we anticipate another record corn crop in 1974 of about 6.7 billion bushels which will permit carryover to rise to nearly 1.2 billion bushels by the end of the marketing year.

Foreign import demand for feedgrain has continued strong in 1973-74 and prices have remained firm. The reasons behind the consistent demand growth for grain in the world are simply more people and more money; and this is happening all over the world. World population is increasing at about 75 to 80 million people annually. This is like adding another nation the size of the United States to the world's population total every $2\frac{1}{2}$ years. Even more important, incomes are growing. The real output of the 24 nations in the OECD rose an estimated 7 percent in 1973 and increased 6 percent the year before. Real per capita output in both the developed and developing countries in recent years has increased by 3 to 4 percent annually.

These factors are producing a major shift in the world's demand curve: more people with more money are getting enough calories in their diets and have money left to look for ways to improve the quality of what they eat. This usually means demand for livestock products, which require more agricultural resources. It takes about $2\frac{1}{2}$ pounds of grain and protein meal, for example, to deliver one pound of broiler meat. It takes about five pounds of grain to produce a pound of pork, and about seven pounds of grain to produce a pound of beef.

In earlier years, a country with a poor grain crop merely tightened its belt and awaited the next year's harvest. Now it goes into the world market and buys grain to tide the nation over.

Russia did this in 1972. Actually, their grain shortfall in 1963 was larger than the one in 1972, but in 1963 they slaughtered their livestock and kept imports down. It took them 5 to 6 years to rebuild their herds. In 1972 they kept their herds and went into the world market for massive amounts of grain for their people and their animals.

The results of these changes are reflected in world grain consumption, which in 10 years has gone from 656 million metric tons to 942 million. World exports have risen by 45 million tons to about 140 million; and the United States has supplied most of the increase. Our grain exports have risen by 32 million tons, reaching 69 million.

In other words, countries are using more grain, they are buying more of what they use in the world market, and more of what they buy is coming from the United States.

The question then becomes, can we meet this demand? The answer is yes. The perennial surplus situation of years past caught U. S. agriculture unprepared for the sudden heavy demand pressures of the past year or so. In the succeeding months, U. S. agriculture has tooled up. Two years ago, 60 million acres of cropland were in set-aside - withheld from production under government programs. Forty-one million acres were removed from set-aside for the 1973 crop year; and farmers put about 23 million of them back into production. The remaining acres have been released for this year; and for the first time in some 40 years, U. S. farmers are free to produce to the limit of their capacity - to use all their resources as they see fit.

As a result, the Department expects even larger crops this year and further improvement in the world food situation.

All right, we are meeting current needs, but what about the long term? There is no question but what more land could be brought into crop production if demand warranted and price incentives were adequate. Despite encroachments for industrial and other uses, the United States still has extensive land resources which could become productive cropland under the right conditions.

However, the most likely increase in the next 10 or 15 years will be from higher yields, using newer and more intensive technology, and from fair price incentives to farmers.

I am bullish on America and its agriculture. We are learning now that our agriculture, in addition to being our largest industry, is also our most dynamic growth industry. Far from being a subsidized problem child, U. S. agriculture is literally bailing out our dollar and keeping the economy afloat.

The Department has tried to appraise productive capacity obtainable by 1985 with more land and higher yields. We can easily see a 9-billion bushel corn crop and wheat and soybean crops of well over 2 billion bushels each. Total feedgrain production should easily top 300 million short tons, about 50 percent greater than in 1973.

These estimates do not take into account any dramatic scientific breakthroughs, for example, in hybrid wheat, which could dramatically increase yields.

I am not trying to say that the United States could, or should, meet all the rapid growth in world demand - other countries are increasing production, too. I am saying that we need not be concerned over the ability of U. S. agriculture to meet domestic needs and at the same time to continue as the leading supplier of agriculture products to the world market.

POTENTIALS FOR EXPANDING FOOD PRODUCTION IN THE USA

M. A. Massengale
Head, Department of Agronomy and Plant Genetics
University of Arizona, Tucson

It is a pleasure for me to be with you today and to appear on the program of the California Plant and Soil Conference. I am particularly happy to be talking about a subject as important as food production.

The topic of food production is receiving more interest today than it has in recent years, especially in this country. A look into the future would indicate a somewhat tighter food supply situation than has been true in the past. Our government's overall goal has been and continues to be one of providing abundant food at low cost to the people of the United States. This policy has been successful beyond all expectations.

America's ability to produce an abundance of food represents this country's greatest potential for benefiting mankind, for competing in the world marketplace, and for generally making its influence felt throughout the world. The knowhow of American agriculture has lifted regions of this country, and the world for that matter, which previously handled agriculture by ineffectual traditional methods to new highs in performance. Our agricultural system has provided American citizens with a liberal food supply of a tremendous variety and for a smaller percentage of the average take-home pay than anywhere else in the world. In my opinion, agricultural research has been the backbone from which this bounty has come. In fact, this success stemming from agricultural research was so great that food surplus became a favorite issue with some politicians.

Food in sufficient quantities and at moderate costs is the most keenly felt need of people everywhere. I believe that we as a nation must resolve to put priorities in proper perspectives and first things first. Certainly, food must be placed at or near the top of any such priority list.

The era of cheap food is probably over. Cheap food and abundant energy have been taken for granted much too long. Now, the prophets are saying that oil is too precious a resource to burn in automobiles and that beef is so costly to produce that it will be a delicacy by the year 2000. The suddenness with which the scarcities of food and fuel developed was of concern to many of us; and it should serve as a useful reminder that global resources are finite.

The confidence that we have in our abundant capacity to produce has allowed millions of acres of fertile farm land to move into nonfarm use. Our faith has been that science and technology would always be ready to come to our rescue. I suppose our errors were that we failed to realize that the success of agricultural science and technology was dependent largely upon petroleum or natural gas; and now we are bordering on shortages of these commodities.

The general theme of my remarks today will be more optimistic than the last few comments. Generally, I believe that American farmers have the potential to significantly increase their output of major agricultural products if sufficient demand is present.

Anytime that one tries to predict or gaze into the future, they are taking considerable risks. I'm certain that is my case today. Someone has said that primitive agriculture is an economy of nature whereas industrial agriculture is an economy of man. Limitations, as well as opportunities, are natural in the former and manmade in the latter. Some would say that man is even less predictable than nature; therefore, the closer we approach an industrial economy, the less accurate we can predict it. After reading background material for this talk, I'm inclined to agree with the statement.

There are some assumptions that anyone has to make when they start talking about potentials or the future. With the general theme that I am going to take of our being able to significantly increase food production, we must assume:

1. No restrictions on the use of land.

2. That prices for farm products are favorable for increased production.

3. That adequate supplies for production are available at favorable prices.

4. That growing conditions are normal.

Let's look a little more specifically now at what are the potentials for increased food production and how do we go about doing this. The Economic Research Service of the U. S. Department of Agriculture[5] has estimated that with all-out production over the next 10 to 20 years, we could increase feedgrain by 50% over the 1973 record yield, soybeans by 1/3, cotton by 30%, a three- or four-fold increase in peanuts, and a doubling of rice production. The near term growth in livestock production is not as striking as for crops; and it takes longer to increase such things as beef and dairy than crops. However, it is believed that beef could be increased by 44% by 1985 if the demand was present.

These projections are based on economic potentials and probably fall short of the maximum because the economists did not consider many potentials from agricultural research. For example, they did not include the potentials from development of hybrids or improved cultivars of many crops, double cropping, or crossbreeding, or twinning in cattle. Also, the greatest economic potentials don't always mean maximum production.

How are we going to accomplish increased food production with a resulting increase in food supply for this country? I have listed a number of ways here; and I'm sure you can think of others.

1. Bring more acres into cultivation.
2. Increase production on already existing acres.
3. Greater efficiency in harvesting and handling food products to reduce losses.
4. Better protection and preservation of stored food products to reduce losses.
5. Shifting our diets more toward foods derived from plants and away from those derived from animals.
6. Shifting to the more productive crop species.
7. Environmentally controlled agriculture.
8. Farming the oceans.
9. Conversion of petroleum to food.
10. Decrease in food consumption per capita.

Now, I'd like to devote some attention to each of these possibilities, but primarily concentrate on the first two.

1. Bringing More Acres Into Cultivation

Until the middle of the past century, agriculture had fed and clothed the expanding world population by clearing and planting new lands. Since 1950, there has been relatively little net change in the broad categories of land use although there has been certain shifts within regions of the U. S.[5] The Economic Research Service of the United States Department of Agriculture[5] has reported that of the 2.3 billion acres in the U. S., cropland takes up about 1/5; grassland, pasture and range, about 1/4; forest land, approximately 1/3; and other uses, 1/8. Urban uses claim twice as much land as they did in 1950, but they still occupy only about 1½% of the total land area. Highways and airports take only about 1%.

Although the proportion of all land in cropland has not changed much over the past 25 years, the acreage actually used for crops harvested, fallow, and crop failure declined some 53 million acres between 1949 and 1972 - a 14% drop from 1949's alltime high of 387 million. Most of this decrease was a result of cropland idled through federal programs. For the first time since 1956, farmers in 1974 will not be required to hold any land out of production. This impact will be felt immediately in the greater use of cropland.

Even though the U. S. totals have been stable, there have been important shifts in land use in most regions. Much of the loss in cropland took place around the fringes of the Corn Belt, except in the Delta and Southern Florida. East of the Mississippi River, land went out of production because of unfertile soils and the terrain being unstable for modern machinery. Most of these losses have been largely offset by new cropland developed. In Florida, drainage and irrigation brought new land under production. Meanwhile, in the Delta area, land was reclaimed through clearing and drainage; and irrigation brought new land under production in California, Washington, and the Texas high plains.

The big question is whether or not this decline in harvest acreage will continue. In my opinion, this will depend on the prices paid for agricultural products. If prices are favorable to producers, the Economic Research Service[5] has estimated that the acreage of crops harvested by 1985 could reach some 60 million more than in 1972. The bulk of this increase would come from acres returned to production that have been diverted under government programs and from cropland pasture. A small portion would be shifted from permanent pasture and some from new development through irrigation, drainage, and clearing.

Forecasters say that even with these increases, plus the usual increase of 4% or so per year in farm productivity, there won't be enough food to fully satisfy future demands. Another factor that needs to be considered is that all of the land which could be pulled back into production is not top quality land. As additional acres are returned to production, yields will drop, more fertilizers will be required, and, in some cases, supplemental irrigation will be needed.

2. Increase Production On Already Existing Acres

Higher crop yields will contribute the biggest part to an increase in food production. These higher yields will come mainly from increased use of the same technology that pushed yields in the last 25 years, that is, by the use of such things as higher-yielding and better-adapted varieties; improved agronomic practices, such as plant spacing; careful use of fertilizer and irrigation water; weed control; double cropping; continuous cropping; the use of plant growth regulators; better crop protection; improved machinery and a greater mechanization; and better management.

One of our most promising potentials for immediate gain is the wider application for management skills already used by the leading producers. The leading producers of most crops are already obtaining yields that are at least 50% higher than average. If all producers were obtaining yields equal to the top 5%, just think of the possibilities (Figure 1). All producers, however, cannot reach this level, but it does produce "food for thought."

Some agricultural scientists believe that the basic biological information probably already exists or can soon be generated which would permit American farmers to meet the food requirements of this nation for the next 100 years, even if our population increased significantly.

Protecting and increasing the productive capacity of our croplands, ranges, and forests, as well as the deserts, oceans, and nonfarm land, is based on research. Research has provided the information which enabled us to limit the number of harvested acres.

Will the public fully support the kind of research required in America to get the breakthroughs in production we really need? Research is the key to expanding our production on a limited acreage and with a limited amount of input. We must train more scientists, which will demand financial support required from the public. If the attrition that is now affecting agricultural research in this country is not reversed, the prospect of improvement will diminish. The image of agricultural research in the eyes of certain scientists and lay people is not good. We must continue to improve our public relations.

Dramatic increases have occurred recently in the productivity of most of our major food crops, such as rice, wheat, soybeans, and corn. Wittwer[4] has indicated that an equally remarkable increase in production efficiency has occurred with most of the fruits and vegetable crops; however, in this instance, many of these remarkable yield increases have occurred through a greater percentage of the commodity being used in the processed rather than the fresh conditions and, thereby, reducing loss.

Combs[2] indicated that the steady improvements in production efficiency achieved by the swine and poultry industries over the past several years provide rather impressive examples of progress through the application of existing technology. He further states that this progress has been most evident in the broiler industry where, under commercial conditions, broilers average 3.8 pounds of body weight at 8 weeks of age on 2 pounds of feed per pound of body weight. Feed efficiency has increased nearly 30% in turkeys and 50% in broilers. During the same period, the rate of egg production per hen has increased approximately 63%.

Efficiency of swine production has been steadily improving, but, according to Combs, it appears that major improvements in metabolic efficiency and feed utilization still lie ahead. Since 1950, an industry-wide increase of 11% has been made in the efficiency that fattening hogs convert feed to grain. Combs states that this has been largely due to crossbreeding and improved nutrition.

Generally, minimal effort has been given to improving the efficiency of animal production as a way of meeting the rapidly increasing world food needs. Apparently, this has been true because of the limited feed available and the low animal efficiency in converting energy from feed to protein. Also, certain types of livestock are not able to utilize roughage and compete more directly with man for their food supply.

Some other factors that must be considered relative to increasing production on existing cropland acres are:

1. The speculator may or may not produce crops on his land.

2. The tax-shelter individual is under no pressure to maximize production.

3. The hobby farmer may utilize his three-bale cotton land for grazing pleasure horses.

4. Furthermore, my economist friends tell me that inflation tends to take the edge off farmers maximizing production. They say that it rewards ownership more than production. When you consider the capital gains tax, this is accentuated still farther. Just retaining a nonperishable good, such as land, can prove quite profitable.

3. Greater Efficiency In Harvesting And Handling Food Products To Reduce Losses

Under today's conditions, there are significant losses in harvesting and handling of many food products at various stages. This is true both for raw products and during processing and manufacturing. For example, how many tons of grain are lost each year because of poor combine adjustments or carelessness in unloading? Last year, how many animals were lost to predators?

4. Better Protection And Preservation Of Stored Food Products To Reduce Losses

A significant amount of the food produced in the world today is destroyed by pests, rodents, birds, insects, and microorganisms. Our rapidly expanding population cannot afford this waste. Ways of protecting and preserving food must be found and employed everywhere. I am sure that we can and will make significant progress in this area.

5. Shifting Our Diets More Toward Foods Derived From Plants And Away From Those Derived From Animals

As the human population continues to increase, the real question is how much longer can man afford to provide animals those foods of plant origin which are edible by man. Reid[3] suggests that to look at this question, it is necessary to determine such things as the increase and size of the world's human population, the rate and increase in the production of food stuffs of plant origin consumed by man, man's dietary energy requirements, man's food consumption pattern and the pressure of impending starvation, the relative efficiency of various kinds of animals in converting their diet to protein edible by man, and the degree of competition between man and animals for the same food stuffs. According to Burton[1], Akeson and Stahman report that an acre of corn will supply man with 234 pounds of protein if he eats the grain directly, but will only supply 87, 60, 49, 26, and 14 pounds of protein if fed to animals and recovered as milk, eggs, chicken, beef and lamb, respectively.

Some of us may still prefer to get our protein from sizzling steaks, but that is becoming a matter of taste rather than nutrition. Nutritionally, we used to consider meat a necessity, but we are rapidly reaching the point where sufficient protein can come from plant origin. It appears to me that there will be increasing competition from textured vegetable protein that simulates meat products in appearance, taste, and nutritional value. I believe that the breeding of superior new soybeans, cotton seeds for protein, peanuts, sunflower and sesame for direct human consumption will increase rapidly in the future. A recent USDA news release indicated that researchers had succeeded in making a delicious candy coming from concentrated protein of oilseed crops and so high in protein that mothers will soon be advising their children to "eat your candy because it is good for you."

Even though efficiency is markedly reduced when foodstuffs suitable for direct consumption by man are fed to animals and the animal products consumed, there is still a sound basis for efficient animal production in every country even if only on a limited scale. This is true because almost every country has cereal by-products; they have forage and rangelands that are not suitable for other uses and waste materials that can be converted to animal feed, which otherwise would probably be lost. Further, there appears to be a good possibility of recycling processed animal wastes through animal feeds.

6. Shifting To The More Productive Crop Species

As plant and soil scientists, we know that certain crop species are more efficient than others in converting solar energy from the sun into carbohydrates that are useful to man. If at some point in time, we arrive at a place where calories are the most important thing in meeting world food needs, then we could help alleviate this problem by shifting our acreage to a larger percentage of those crops that are higher producing and more productive. Of course, this would not provide as wide a variety of foods as we are accustomed to, but, under such conditions, variety would not be that critical.

7. Environmentally Controlled Agriculture

Remarkable increases in the acreage under wholely or partially protected environments have occurred throughout the world in recent years. Environmental control, whether it be growing plants in the greenhouse, under plastic row covers, or other types of control on the environment, can lead to increased yields and much greater efficiency for individual crops. Additional advantages of this system are that it enables growth of crops the year round, extends the areas of productivity throughout the temperate zone, and permits one to grow certain crops which would not be possible otherwise. The presently expanding and future use of some type of protection or covers over crops is one primarily of economics rather than technology.

8. Farming The Oceans

A few years ago many nonagricultural individuals became quite enthusiastic about the potential of food production from the ocean. I believe a more realistic approach to this has now been taken. There is some possibility for increasing productivity of food from this source, but it appears rather limited in comparison to the potentials from the land surface. No doubt this will continue to receive attention from time to time in the future.

9. Conversion Of Petroleum Products To Food

You may recall that considerable publicity was given a few years ago to the possibility of converting petroleum to protein for human consumption by using microorganisms. With the recent problems concerning petroleum products and the impending fuel supplies, I doubt that this offers much alternative at the present time. The proponents of this theory have lost considerable ground during the current fuel crises; and I shall not discuss this topic further.

10. Decrease In Food Consumption Per Capita

If each citizen of the United States would decrease the number of calories taken in by reducing the quantity of his food, this would indirectly increase the supply of food in this country. Several of us could afford to do this very thing without worry. As a matter of fact, it would probably be beneficial. However, there are some parts of the country where human diets are not adequate and this would create a hardship. If we look at this point for the U. S. as a whole, then I think we could significantly reduce the intake of food per capita.

Summary

In summary, I believe that the real hope for mankind in meeting the world's food requirements depends on man's ability to apply science and technology to economic and social needs. With the best use of science and technology and the curtailment of population growth, it should be possible to meet the world's food needs far into the future without significant pollution of the environment.

Figure 1. Data on statewide average yields of sugar per acre from sugarbeets grown in Arizona during the period of 1967 through 1973 and for the highest yield in each production district for 1973 only.

AVERAGE YIELDS		RECORD YIELDS FOR 1973	
YEAR	SUGAR (lbs/A)	AREA	SUGAR (lbs/A)
1967	4,770	Yuma	10,460
1968	5,960	East Maricopa	9,730
1969	4,550	Willcox	9,340
1970	3,930	Buckeye	9,220
1971	6,150	Pinal	8,140
1972	6,410	West Phoenix	7,770
1973	6,610	Average	9,110

[1]Burton, G. W. 1973. Agriculture---yesterday, today, and tomorrow. Proc. Sixth Research-Industry Conf. American Forage and Grassland Council. Louisville, Kentucky, pp. 35-44.

[2]Combs, G. F. 1972. Potentials for improving production efficiency of swine and poultry. Proc. 21st Annual Meeting of the Agricultural Research Institute, Washington, D. C., pp. 101-112.

[3]Reid, J. T. 1972. Potentials for improving production efficiency of dairy and beef cattle. Proc. 21st Annual Meeting of the Agricultural Research Institute, Washington, D. C., pp. 87-100.

[4]Wittwer, S. H. 1972. Potentials for improving production efficiency of fruits and vegetables. Proc. 21st Annual Meeting of the Agricultural Research Institute, Washington, D. C., pp. 69-86.

[5]- - - 1973. American Agriculture. It's capacity to produce. The Farm Index. E. R. S. - U. S. D. A. 12:(12):8-16.

ENERGY REQUIREMENTS FOR PRODUCTION OF AGRICULTURAL CROPS IN CALIFORNIA

John R. Goss
Professor, Department of Agricultural Engineering
University of California, Davis

Professor Goss's paper was not made available for publication; however, he presented the information just released in the Joint Study by the California Department of Food and Agriculture and the University of California at Davis entitled "Energy Requirements for Agriculture in California." This information is contained in a published report dated January, 1974, and prepared by V. Cervinka, California Department of Food and Agriculture; and W. J. Chancellor, R. J. Coffelt, R. G. Curley, and J. B. Dobie, Agricultural Engineering Department, University of California, Davis.

The following information is taken directly from the published report and generally summarizes the presentation of Professor Goss:

Fuel and electrical energy are essential inputs to California agriculture in its present form. Recent appearance of shortages and irregularities of supply of this energy has caused concern among all persons connected with agriculture as well as among many others who might be affected by changes or decreases in agricultural production. In order that problems of energy supply to California agriculture be dealt with in the most appropriate way, it is necessary that quantitative information be available on fuel and electricity requirements of farms, agricultural suppliers and processors of agricultural products. To meet this need, the State of California Department of Food and Agriculture, working in conjunction with the Department of Agricultural Engineering, University of California at Davis, with financial support from the California Farm Bureau Federation has conducted this study to determine energy requirements for California agriculture.

The objective of this study has been to develop a detailed estimate of the fuel and electricity requirements for California agriculture during 1972. The fuels considered are gasoline, diesel fuel, aviation fuel, LP gas, and natural gas. Requirements include those for:

(a) Field Crops, Vegetables and Fruits

Tillage and planting
Cultural practices
Harvesting
Transport to market or processing plants
Processing
Storage prior to entry into distribution channels

(b) Livestock

Livestock production and feeding
Raising of young stock for replacement of production stock
Transportation of feed by nonfarm vehicles from local distributors
Transport of livestock to local markets by nonfarm vehicles
Transport from markets to processing plants or resale markets
Processing of livestock products
Storage of livestock products prior to entry into distribution channels
On-farm feed processing

(c) Irrigation

On-farm water pumping by electric motors and internal combustion engines for purposes of crop irrigation and frost protection
Water pumping in major water supply projects that is used specifically to meet irrigation needs

(d) Fertilizers

Fertilizer production

Fertilizer distribution
Fertilizer application and transport associated therewith

(e) Agricultural Aircraft

Operation of all agricultural aircraft
Operation of ground support vehicles for aircraft loading, supply, etc.

(f) Frost Protection

Operation of heaters
Operation of wind machines

(g) Greenhouses

Heating of greenhouses by natural gas during periods of cold weather
Ventilating, air circulation and evaporative cooling of greenhouses

(h) Vehicles for Farm Business

On-road and off-road operation of farm automobiles during the portion of time required for farm business
On-road and off-road operation of farm trucks (including pickups) during the portion of time required for farm business and transport

Information for on-farm use of energy in crop production was developed for three stages of crop husbandry (crop establishment, cultural operations and harvest) for major crops in three categories - field crops, vegetables and fruit and nuts. The energy requirements for transport and processing associated with each of the common methods of processing each of these crops was also determined. Energy use in feed transport, husbandry, market transport and processing of each of several major livestock categories was also determined. For all of the other above-mentioned categories, energy use was determined on a total statewide basis without reference to specific crops or types of livestock.

The basic approach used for crop and livestock categories was to determine energy-use values for each ton of product in that category and to then multiply those values by the tons of product reported for California in 1972 by the California Crop and Livestock Reporting Service.

The units used for the various fuels and electricity were the ones most commonly used in the field, i.e.:

Gasoline - gallons

Diesel Fuel - gallons

LP gas - gallons

Electricity - kilowatt-hours

Natural Gas - therms*

When appropriate to consolidate all energy sources into a single dimension, the unit of barrels of crude oil was used.**

The computed values, indicating the amount of fuel and electricity used by the agricultural sector in California (1972), were 39.443 million barrels of fuel oil equivalent.

Natural gas is the main source of energy in agriculture, due to its usage in the production of fertilizers and in the processing of agricultural products. Natural gas represents 53.1% of all energy used by California's agriculture.

Diesel fuel (fuel oil) is the next most important source of energy for agricultural

*One therm = 100,000 British thermal units

**One barrel of crude oil = 5,800,000 British thermal units operations, about 18% (electricity 15.5%, gasoline 10%, LP gas 2%, aviation fuel less than 1%). A high proportion of diesel fuel is consumed by field crops in field operations and for transportation. There is a definite trend toward use of larger diesel tractors on the farms. The long-distance hauling of agricultural products is performed mainly by diesel trucks. Frost protection is another sector requiring large amounts of fuel oils.

A high percentage (67.8%) of all electricity used by the agricultural sector is required for irrigation. Milk production and processing consume 13.8% of agricultural electrical power.

More than 60% of all gasoline used in agriculture is consumed by farm vehicles in operations related to farm business and in short-distance (on-farm) hauling of materials.

Agricultural aircraft consumed 8.99 million gallons of aviation fuel in 1972. Considering the extent of aircraft operations on farms, the aircraft application of fertilizers, chemicals and seeds is an efficient technological operation with regard to energy consumption.

In 1972, the agricultural sector consumed only 5.07% of the total energy sources used in the State of California. Considering the importance of the agricultural sector in the State economy and in food production for the United States, the data indicate the high energy efficiency of California's agriculture.

The computed results indicate that the main energy consumers in California agriculture are the following commodities:

ENERGY SOURCE	CATEGORY			
	FIELD CROPS	VEGETABLES	FRUITS/NUTS	LIVESTOCK
Natural gas	Sugarbeets	Tomatoes	Grapes	Dairy
Electricity	Cotton	Tomatoes	Grapes	Dairy
Diesel fuel	Cotton	Tomatoes	Grapes	Dairy
Gasoline	Alfalfa hay	Tomatoes	Grapes	Dairy
LP Gas (Propane)	Cotton	Tomatoes	Almonds	Dairy

Fertilizers, their production, distribution and application, consume 14.9 percent of all energy supplied to agriculture. Of this amount, 89.9 percent is comprised of natural gas, used for production of fertilizers (13.4 percent of the total energy used by agriculture in California).

Water pumps for irrigation in California require 13.2 percent of all energy used by agriculture. Electricity is the major energy source used for irrigation. About 68 percent of all electricity used (i.e., 10.7 percent of all energy used in agriculture) is required for irrigation of California's crops.

Agricultural production has three typical operational seasons, such as crop establishment, cultural practices during crop growth and harvest (including transport and processing of harvested products).

Considering the system of energy supply, agricultural production requires a guaranteed supply of fuels and electricity for the whole period of a crop production year. A farmer cannot plant a crop without having the assurance of energy availability for cultivation, harvesting, transport and processing. In an extreme situation of having fuels for crop establishment, but no fuels for harvest or transport operations, not only would crops be destroyed, but the energy used for the crop establishment would be wasted. Both negative results are certainly undesirable ones from the point of view of both the state and national economies.

To develop some indicators about the seasonal demands for fuels, the demands for gasoline and diesel fuel were analyzed. (Natural gas, electricity and LP gas demands are correlated to the seasonal characteristics of diesel/gasoline fuel requirements.)

Field crops are the main consumers of diesel and gasoline fuels. The largest proportion of diesel fuel is required for crop establishment and transportation; the cultural practices and harvest require a high proportion of total gasoline.

Because of the size of the State of California and the diversity and degree of specialization of its agriculture, farm products must be hauled large distances between field and processor. One avenue for potential energy conservation is the development of systems, such as truck-rail combinations, for more efficient farm-to-processor transport.

Total energy inputs were calculated for field crops, vegetables, and fruits and nuts. The total energy input includes the following four components:

(a) Mechanized Operations (Field operations, transport, and processing)

(b) Fertilizers (Production, transport, handling, and application)

(c) Irrigation

(d) Other (Farm vehicles, frost protection and agricultural aircraft - if applicable)

The total energy inputs are presented in the units of 1,000 KCAL/ton for various commodities. Agricultural commodities require man-applied energy inputs for production, transport and processing. However, they also carry forward an inherent energy content. This energy content is unique as it is not derived from the man-applied inputs, but rather represents additional energy captured from the sun.

This energy captured from the sun is compared with the man-applied energy inputs (fuel and electrical) by means of the ratio of the respective, per-ton values for each commodity. The commodities are grouped according to the various types of processing considered in this study.

The data presented indicate that some products, such as corn, rice, wheat, sorghum, and potatoes have a high ratio of caloric content to input of fuel and electrical energy. This may be a realistic explanation why these foods have been considered, historically, as staple foods for man.

Energy inputs per unit of final product are considerably higher for vegetables and fruits than for field crops, and thus the costs of production for vegetables and fruits can be expected to be more directly linked to energy costs.

Various experts were consulted regarding anticipated crop and livestock production levels in 1974 as they might compare with levels in 1972.

The use of diesel fuel and gasoline for all crops was projected to increase by a factor of 1.1259. This factor was then used as a parameter of the scale of field activities and was applied to fertilizer, irrigation, and aircraft.

Greenhouse square-footage was projected to increase from 88,283,000 in 1972 to 103,164,000 in 1974 (1.1685 times).

Frost protection requirements were based on tonnage projections of citrus and thus were projected to decrease to 0.894 of the 1972 level.

Vehicles and "other" were projected to increase by a factor of 1.0635.

By energy input, this increase factor was as follows: Natural gas (therms), 1.0721; electricity (kwh), 1.1058; diesel fuel (gal), 1.0487; gasoline (gal), 1.0775; LP gas (gal), 1.0642; aviation gas (gal), 1.1259.

This study is an initial attempt to analyze the comprehensive system of agricultural production and processing practices from an energy standpoint. It is expected that continued efforts along this line will bring to light new opportunities for energy conservation and energy-efficient methods of production.

RESTRUCTURING AGRICULTURAL RESEARCH TO MEET THE NEEDS OF FOOD AND FIBER

Alex F. McCalla
Dean, College of Agricultural and Environmental Sciences
University of California, Davis

I appreciate the opportunity to be a part of this program which is indeed comprehensive and complete in dealing with the many issues that face agricultural researchers today. I interpret my topic to mean a discussion of the nature of agricultural research as it evolves over time in response to the changing needs of society. I am interpreting restructuring as the changes in the composition and relative emphasis of food and fiber research as we look ahead. I am not going to talk about organizational structure in any particular research organization because I believe that organizational structure does not create direction, although it may hinder redirection. Clearly, one must be concerned with missions, goals, and priorities before one talks about organizational structure.

The person most important in determining these research goals and priorities are scientists, not deans. The scientists have the ideas and the know-how to do research. Administrators can provide legitimacy, encouragement, and the resources. But, they cannot and should not direct research. So, the real task lies with you, the scientist, as well as with administrators. But, having said that, I shall proceed anyway and give some of my perceptions of the context in which agricultural research finds itself today and what its potential needs in the future might be.

What I would like to do is talk a bit about the contextual environment in which food and fiber and, more generally, research finds itself today and ask the question as to whether recent developments in the food and fiber industry, particularly with respect to prices and supplies, have altered that general context. I will close by commenting on my perception of what the general areas of research needs ahead are.

The societal climate within which publicly supported research in agronomy and other areas of agriculture must be discussed in 1974 is different than it was ten, twenty, or fifty years ago. I think it is safe to say that society's willingness to accord unquestioned number one priority to higher education is past. Increasingly, the public, rightly so, is asking questions regarding the relevance of higher education. Similarly, unquestioned federal support for research, particularly basic research, is a thing of the past. The federal establishment is asking two sorts of questions: 1) is research per se good and 2) what are the benefits to the broader public of the research that is done. At the state level, particularly in California, we find similar issues being raised as it relates to the impact of research and its relative balance with teaching in universities. Thus, one general context is the need for more explicit planning in higher education because of increased demands for accountability and relevance. This results from the general questioning of the proposition that higher education and research are by definition good.

More specifically, the climate surrounding organized or mission-oriented research in publicly supported state universities or in USDA has also changed. If organized research units, such as the Agricultural Experiment Station, are to receive public support, they will have to satisfy an increasingly urban society which is asking who benefits from the research and who should pay. Issues of the environment, the consumer, the innercity, race, poverty, energy, and the general quality of life are of prime concern. Therefore, the context in which agricultural research finds itself today is different than it was fifty years or even twenty years ago.

Agricultural research in the universities, such as the University of California, is part of the broader university and research picture and is subject to these general issues that I have just discussed and additional questions. In California, budgets for agricultural research have not been programmatically augmented in ten years. In the same period, budgets have experienced two actual reductions. This, coupled with the increasing complexity and the rising costs of doing research, makes our need to make hard choices more crucial. It is becoming increasingly clear that the legislature, the executive branch, and some members of The Board of Regents are concerned about who besides the ultimate consumer benefits from agricultural research. It is equally clear that they believe very strongly that if an industry or firm can be perceived to benefit directly from research, then that industry ought to pay a share of the costs of research equal to its benefits. The day when agricultural research appropriations could be justified by the general statement that it is in the public good is past.

These viewpoints coupled with the rapidly changing structure of agriculture, fewer but larger farms, more concentration in both the input and processing industry and increased vertical integration in contract farming make agriculture, particularly in California, no longer the atomistic family farm society that existed in the days of the passage of the Morrill-Hatch and Smith-Lever Acts. In sum, the backdrop for decision making in the future of agricultural research is a very new ball game. I'm not saying whether I agree with all of the above or not, but that's not important; they are, in my judgment, the facts of life. The factors that have contributed to the background that I have just described have been growing over the years as society has become increasingly complex, crowded, and urbanized. They represent fundamental changes in societal attitudes and structure and are not likely to be changed easily. Thus, the suggestion that the events of the past year as they have affected food supplies and prices will drastically alter that background is questionable. Let me expand by commenting on the issues involved in the so-called food crisis. The past year has seen spectacular rises in food prices and has resulted in public discussions on the front pages of the newspapers as to the permanence of food shortages both in the short and long run. This has led some to argue that we need to devote increasing efforts and all our attention to the question of production efficiency in food and fiber products. The issues underlying the food price situation in the last year are indeed complex and relate to other issues in addition to the issue of the biological capability of the agricultural industry in the United States and beyond to produce food. They relate to the question of devaluation of the dollar; increased incomes; and ability and willingness to trade by Communist Block countries such as the USSR and, particularly, Mainland China. They relate to drought in Australia and New Zealand; wet fall and late spring in the Midwest; fuel shortages; changes in environmental conditions under which food and fiber are produced; changes in the income levels and habit patterns of food consumers in many countries, particularly Western Europe and Japan; changes in the ability of the agricultural industry to convert and use basic research information; and capability in a research sense to produce new ideas which can be converted to technological efficiency for improvements in yields in the agricultural industry.

Whether or not there has been a major long-term shift in the structure of agricultural production in the United States from the circumstance which has prevailed for the last forty years, namely one of having excess capacity to produce to one of having insufficient capability to produce, is not clear. There are some schools of thought who argue that the current situation is the juxtaposition of a set of events which will occur once only in this combination and that, within a few years, will return to our former circumstance of production capabilities exceeding demand at reasonable prices. There are others who argue that we have seen a fundamental shift in the structure of agriculture and that with the factors such as urban and recreational encroachment on land, environmental regulations, energy shortages, etc., there has been a fundamental shift in the nature of agriculture which will yield us a shortage situation in the long run. Which of these schools of thought is correct is not clear at this point; though, if I were a betting man, I would bet on the former.

The basic question for this discussion is what impact, if any, will this set of events in the last year have on the long-term needs of future research for food and fiber. My view is that it will not cause a significant change in the basic underlying circumstances within which agricultural research finds itself. It will not alter the urban nature of society; and it will not lessen particularly the concerns with environmental health, nutrition, consumer quality, and with the health and quality of life in rural as well as in urban communities. It will not alter the circumstances with respect to energy and other issues. It will serve to bring closer in the public attention the fact that food is a very basic commodity in the society and one which is complexly produced.

Let me now then turn to comment a bit on what I see as the future issues facing food and fiber research. For many years, from the time of the passage of the Hatch Act and the development of Experiment Stations and Extension Services, agricultural research has focused predominantly on the issue of increased efficiency of agricultural production. This followed from two basic premises. First, that the U. S. was growing and that a rapid shift of population from rural to urban areas was occurring which necessitated each producer of food to be able to produce greater quantities to feed a larger population in urban areas. Secondly, it was based on the concept that if food was produced more efficiently, then everyone in society would be better off. Farming would be more profitable, consumers would have cheaper food, and society would benefit from displacement of labor in agriculture to staff growing industry. For at least the last ten years, the perception of the latter as being the single goal for agricultural research has gradually changed.

All of us, I think, have become increasingly aware that production efficiency alone does not solve all the problems of agriculture nor the broader society. Any society and economy devoted exclusively to efficiency yields secondary and tertiary effects which are not always beneficial. Rising concerns with the issues of environmental quality, consumer safety, nutritional quality, consumer acceptance, multiple land uses, increased time for recreation, urban sprawl, and, more recently, energy are all factors which have impinged upon and made more complicated the question of what should be our research program. I would suspect that if we compared the subject matter contained in the program of this meeting with that that would have occurred three years ago, or ten years ago, we would find it to be very different. Your subject matter areas today include not only plant efficiency and crop production; but environmental management, water quality, energy requirements, waste disposal, air pollution, food quality, health and nutrition, to mention only some of the topics involved in this society's meetings in 1974. You, then, as a professional society have recognized what many others in society have recognized and that is that the needs for research in the future will be different than those in the past.

The process of increasing productivity in agriculture is not a reversible process. We cannot return if we wish to production conditions and production factors as they were ten, twenty, or thirty years ago. We must look ahead. As I look ahead, I see some priorities for mission-oriented research. First, I see that the issue of efficient food production to continue to be one of importance - and it will be of importance regardless of whether or not the reason for the current food price situation is found to be short run or long run. But efforts in agricultural efficiency will be done as a contextual part of a much broader set of issues that will face agricultural scientists. Agriculture is going to have to be an increasingly responsible environmental citizen in the future. It is going to have to fit into the context of a modern complex society and is not going to be able to ignore secondary nor tertiary impact of production efficiency activity on other elements of society and of the environment.

Research in the future must ask additional questions. It must ask questions that relate not only to the quantity of production, but it must relate to the context in which that production occurs. Secondly, agriculture in the future will be but one of many competitors for the resources it uses in producing food output. It will be a competitor for land, for water, and for air; and, therefore, it behooves us to deal with research relating to the rational management and use in a multiple context of resources - water, soil, and air. Thirdly, we will be paying increasing attention to the issues of quality, safety, and nutrition in food and fiber products - production, processing, and distribution.

For all too long we have looked upon research as it relates to food and fiber processing as a mechanism only by which the producer sells more of his or her product. Clearly, issues of consumerism are with us to stay. The concern of the consumer in defining the nature of food and fiber products will be one that will be increasingly important in the total context of agricultural production in the future. In addition, I see us continuing to have a major commitment to be involved with the issues of communities, family, and human development as they relate particularly to the rural community. All of these needs that I have just described clearly are placing additional kinds of constraints or dimensions on the nature of food and fiber production on the farms of the U. S. and elsewhere. It makes devising and developing research that meets the needs of the future and producing quantities with better quality of food products that much more challenging. It suggests that traditional research methods alone may not be enough to meet future needs.

We have accomplished the yield increases that have occurred in U. S. agriculture in the past fifty to a hundred years largely by making incremental improvements in a great many factors that contribute to the overall production management. We have improved the management of water, made better use of fertilizer, developed better varieties, used better farm management and other factors that contribute in the total sense to the management of production. In the eyes of many, we have nearly exhausted this pool of productivity increase. The time is going to come sooner or later, depending on the answer to the earlier question I raised about the nature of the food situation, when we must make major scientific breakthroughs in our capabilities of producing food and fiber products. These will come about, in my judgment, from the application of very basic biological techniques to the issues of genetic engineering and other matters relating to fundamental physiology, biochemistry, and genetics of plants and animals. These are long-term objectives. These are ones that are not going to be accomplishable within the next one year. They are not ones from which we can promise that we will increase the yield of commodity X by two percent in the next two years by traditional activities of field trials, fertilizer tests, and breeding programs.

The fundamental question facing us is do we continue to attack these new issues by more extensive search for new germ plasms and continue the approach plant improvement by genetic manipulation of a natural base, or do we increasingly turn to developing more powerful tools of molecular biology to approach in a much more fundamental way the biochemical composition of gene pools and the physiological nature of basic plant processes. Clearly, the answer to that question is not do we do either one or the other. It is a question of balance. In my judgment, if we are to continue to stay ahead in the race to produce new capabilities of efficiency which will yield, at the same time, greater outputs in a context of less impact on the environment, greater nutritional quality, etc.; these kinds of things are going to have to shift more in the direction of fundamental research with a longer term payoff expected than next year. If these more fundamental approaches are to be followed, it is going to require new combinations of scientific expertise to come together and bring the power of biology and mathematics to bear on these issues. It may mean that traditional approaches on a commodity-by-commodity basis or a department-by-department basis as we currently know them will no longer be appropriate as we move ahead in the quest for knowledge.

My fundamental point is that agricultural research will be different in the future, demanding different approaches and different expertise. In fact, this is the very nature of any sort of on-going evolutionary program. Your responsibility as scientists and my responsibility as an administrator is to look ahead and meet the needs that are down the road, twenty, thirty, and forty years ahead. That challenge is clearly up to us.

CALIFORNIA'S RESPONSIBILITY IN THE FOOD PICTURE

Allan Grant
President, California Farm Bureau Federation

This subject of California's position and responsibility in the overall food area, both domestically and internationally, is to me a very exciting one. It's exciting because of California's fantastic record in providing food and fiber for our own domestic consumers. It's exciting because of our position in the area of farm exports. And third, our future productive potential - all things being equal - is possibly the most interesting part of the whole picture.

Exciting is the fact that California provides 25% or more of the nation's entire table foods, over 40% of its tree nut and fruit crops, and over 40% of the U. S. consumption of vegetables. Just as absorbing is the fact that we in California produce 90 to 100% of over a dozen crops, with a total of nearly 50 crops ranking first in the nation, others positioned second, third, or fourth.

From the standpoint of exports: in fiscal 1973, ending June 30 of last year, California accounted for more than three-fourths of a billion dollars in farm exports. This placed us No. 5 in the top 10 farm export states. These California exports, as you no doubt know, included fruits in various preparations at the top of the list for a total of some $237 million, followed by cotton, $98 million; rice, $95 million; nuts, $81 million; vegetables, nearly $77 million; and, in order, wheat and flour, feedgrains, cottonseed oil, and others, including dairy, meat, and poultry products.

It is interesting to note, incidentally, that the eleven-months' total of U. S. agricultural exports through November, 1973, not only assured a record farm export total for the year nationally, but also put this country well on its way to its first favorable trade balance since 1970. And California's three-fourths of a billion dollar figure places it in a position of having done its share and then some.

Totally, California agriculture experienced an almost unbelievable record gross income in 1973 of nearly $8 billion - the biggest growth and the best production of any year in our history. As Bru Christensen, Director of California's Department of Food and Agriculture, said in announcing the figure, "It's been agriculture's finest year."

California, a state once long ago considered useless as far as agriculture was concerned, has been the No. 1 farm state in the nation for over 25 years; and - again, all things being equal - will remain so although there are other states working very hard to figure out how we do it and how to beat us at our own game.

Dr. Boisie Day has commented that "Agriculture is not just the most essential industry on earth, it is the only essential industry" . . .an industry, incidentally, on which a number of other vital industries are either directly or indirectly dependent, with one out of every three jobs in California in one way or another related to agriculture. These are very exciting facts.

A number of things are presently being done to help California agriculture retain its position. As you no doubt know, there are studies underway which, hopefully, will bring about a long-range agricultural policy, one designed to make a significant contribution to the overall economic development of the state and based on the truism that agriculture is, and will remain, California's most significant industry.

An Agricultural Blue Ribbon Committee has been making such a study working toward "a master plan for the development of agriculture in California through the year 2000." The initial effort has been to try and determine what the total economic potential will be in the year 2000. Then through a task force approach, the committee is making recommendations on the tools agriculture will need to reach its potential - such tools and areas as land-use legislation, labor legislation, inheritance tax legislation, agricultural research, marketing, environmental considerations, transportation, energy, and others.

When Lieutenant Governor Reinecke gave the committee its assignment in this area, he suggested several guidelines to be followed. Included were these:

1. The tried and proven concepts of supply and demand must be maintained in the food industry;

2. Steps must be taken to maintain the leadership role of agriculture;

3. The consumer's right to the best food products at a reasonable cost must be protected;

4. And agribusiness must be protected and allowed to operate with as few government controls and regulations as possible.

These are excellent guidelines; and each of them has much to do with the future of California's great agricultural complex.

Basic projections for California to the year 2000 being utilized by this Blue Ribbon Committee were put together by a group of University of California economists. The projections are based on a number of points, including an expanding U. S. population, expanding employment, expanding gross national product, expanding personal income, expanding exports, and the shifting of consumer patterns to higher protein and more processed foods.

These are all important in the overall future picture. However, the projections were made in late 1970; and I doubt if our current energy shortage was as much a part of them as it must necessarily be today. Our energy problems could bring about drastic shifts in several of the basic points just listed. But more about that later.

California's agriculture is being remodeled almost day to day to fit the machine age. Cultural patterns of crops are being changed. Agricultural research is constantly moving forward. And this is research that is not only valuable to agriculture, but is just as important to consumers. Many, many things are being done to keep California agriculture in its present enviable position as well as to advance that position into still more unbelievable realms. And these things are being done successfully in the face of ever-increasing pressures of urbanization and industrialization, to say nothing of the rural-urban fringe problem and its own peculiar pressures on agriculture in many areas.

So, as of now, California's farm picture, both domestically and internationally, is excellent. And moves - both short range and long range - are being made to improve it. But, of course, all is never a bed of roses. There are a number of problems, both potential and real, as far as our farm export situation is concerned. Some of these can and will have their effect on production for domestic consumption, too.

Always, of course, there are weather and bugs to worry us. One drastic weather year could bring us - and other parts of the world as well - very serious problems, especially considering that our wheat reserves are apparently now at their lowest level since the late Forties.

Then there is the possibility that the U. S. government will again restrict exports in an effort to depress market prices for food and fiber (although it does appear to me that more and more knowledgeable sources are recognizing that controls on exports would place agriculture in a state of depression and create real problems for the rest of the economy).

Another problem area concerns the policy followed by some foreign nations which maintain restrictions on imports from the United States.

Next are our growing shortages in a number of vital farm inputs, plus constantly increasing costs of many of those inputs. And when discussing farm costs, let's never forget property taxes. California farmers today are paying property taxes on the basis of at least twice the rate of farmers in other states. And no real solution appears to be in sight.

And finally - but by no means last in order of importance - there is the energy shortage, a subject which is becoming almost as tiresome as Watergate.

You will note that I have already mentioned energy several times - which brings me to comment that although the present - and future - energy crunch is not my topic for this noon, it is, nevertheless, going to have to be threaded through most of my remarks in the next few minutes because no look at California's continuing position in agricultural production, for ourselves or for much of the rest of the world, can be taken without considering energy supplies and the various areas energy shortages can affect.

For instance, any prediction of United States agricultural trade with foreign nations is an exercise in futility if the forecaster fails to at least attempt to assess the impact of a worldwide energy shortage. I say "at least attempt" because, as of now, though predictions and rhetoric concerning the scope of the shortage are coming thick and fast from many sources, we actually know comparatively little <u>for sure</u>. In California, we do know that agriculture has been assured of 100% of its fuel requirements, as is true of the rest of the nation. But we recognize, too, that to some extent at least, the carrying out of that assurance must depend on supply. And that still seems to be somewhat of an unknown factor.

The events of 1973 have managed to outdate all past assumptions about world agricultural production and food distribution. The energy shortage will not only seriously affect the quantity and price of many of the farm inputs I mentioned a moment ago, but it also will weigh heavily on the costs of processing and transportation as well.

Countries heavily reliant on energy imports are going to find their energy costs increasing by a factor of two to three; and their net trade positions are going to be badly out of balance. Less developed countries will be forced to put ambitious development plans on the back burner due to limited supplies and high costs of energy.

In short, national economies everywhere are due for a serious shakeup and are at the very mercy of oil-producing countries - countries in position to play serious mischief in two ways: first, by regulating oil supplies and prices; and second, by the injudicious use of their vast foreign currency holdings.

One of our major questions is: What will the energy situation and its many ramifications mean to American agriculture in terms of international trade? Can we expect to see U. S. farm exports maintain a steady and strong upward climb throughout the Seventies and into the Eighties and beyond?

Under the old rules, most knowledgeable forecasters predicted strong U. S. farm commodity export markets for the near future and at least reasonable markets over the longer haul. But what were the old rules and assumptions; and do they still apply?

In essence, the old rules said - and these parallel to some extent the basic points enumerated by the University economists in their look forward to the year 2000 - first, world economic activity will remain strong and vigorous; second, personal incomes will rise in developed countries and among an emerging middle class in the less developed countries; third, international trade will continue to expand vigorously; fourth, world population will continue to increase; fifth, demand for food, particularly meat, will be strong; and sixth, European and Japanese currencies will remain strong in relation to the dollar, thereby making U. S. agricultural products cheaper and more attractive in their markets.

But I am afraid that some of those rules at least can now be questioned; and in those areas, we will have to start over from scratch. In fact, under the new rules, the only assumption still appropriate is the continuing population increase. It may even be that the energy crisis is going to strengthen this factor by promoting more togetherness in the home at the expense of travel and other types of recreation.

But the other rules have now changed to a greater or lesser degree. And they must be evaluated for their impact on U. S. - and California - agriculture in an energy-short world.

Much of the world's economic activity is based on cheap and abundant energy; and petroleum - particularly for transportation purposes - is the primary energy source. Petroleum is not only an important energy source, but it is the raw material for countless consumer products as well. Strong increases in price as well as a curtailment of petroleum supplies can only cause serious inflation, unemployment, deficit national budgets, and in the case of oil-importing nations, huge trade deficits. An expanding economy based on increasing consumption of energy will receive a severe jolt when its energy supply is diminished as we and others are already learning.

As far as balance of trade is concerned, each country must decide on the tradeoff between oil and food. Instead of deciding between guns and butter, nations will have to choose between oil and butter. Weakened national economies will instinctively restrict imports in order to: 1) protect domestic jobs and 2) balance trade. Bunker oil availability along with higher ocean freight rates will tend to reduce ocean shipping and dampen international trade. With higher unemployment, higher domestic prices, and job insecurity, domestic demand for higher-priced foods also must suffer.

Recent upward valuations of the dollar in relation to Japanese and European currencies will mean that those currencies will buy less United States goods, thereby adding another negative to the demand side for U. S. farm products.

In short, all of the present variables in the world economy except population growth indicate a reduced demand for U. S. agricultural commodities and other products.

Now it's probably true that a little foresight and planning in the past decade or so might very well have prevented the present crisis. But that's hindsight; and Monday morning quarterbacking isn't my game. We have too much of that around already. The fact is that a crisis is here; and both the increased cost of energy and its lack of availability are going to force economies that were either unthinkable or prohibited in the cheap energy era. Some of that no doubt will be good. Domestically, we can expect to see rules and regulations that required such inefficiencies as flying certain air routes regardless of load factors fall by the wayside. We can expect energy economies and conservation to determine modes of transportation rather than union rules - provided, of course, that Congress doesn't yield to political pressures. We may just learn, in all aspects of life, that we can't go on forever wasting our bounties.

It may be that increased transportation costs for feedgrains will give the grain-producing areas of the Midwest a greater competitive advantage in poultry and livestock feeding over California, thereby crimping the poultry and beef industries in our state. However, the free market system has always worked that way; and the situation I mention should not cause any great weeping, wailing and gnashing of teeth. Those who could produce more cheaply, regardless of the reason, usually captured the markets while the inefficient producers were free to pursue other fields of endeavor. The efficient producer won out because of his competitive advantage.

I mention that here only to pose this question: What happens when we introduce this principle of competitive advantage to the international scene? Our energy situation may just make it necessary to at least introduce it.

The idea of competitive advantage, of course, is generally well received by those who hold the advantage while the disadvantaged take a dim view of it. It's human nature to desire security on the job; and there is not shortage of rhetoric and union rules reflecting man's need for security.

What I am saying is that, hopefully, an expanding world economy will to one degree or another recognize the principle of competitive advantage in our energy-short world because it is adherence to that principle that can help to maximize the value of our dwindling energy resources.

This principle is not widely accepted internationally; and trade barriers have been erected by every nation to protect domestic labor and industry. Trade barriers by their very nature discriminate against efficiency and productivity because they keep the more efficiently produced goods out of the marketplace. Even when energy is cheap and abundant, inefficiency has a cost, as the European housewife can testify. Subsidies to agriculture in Europe amounted to over $4 billion last year, but this didn't mean cheaper food for the consumer. European farm commodity prices are fixed artificially high in the domestic market to keep farm income levels on a par with the rest of the economy.

At sometime the cost of maintaining an artificiality in the marketplace becomes prohibitively expensive. All I am suggesting here is that an energy crisis is going to sorely test these rigid protective barriers and, hopefully, induce some much-needed economic reform internationally.

But there are wrinkles other than price presently creeping into the world economic order. What happens, for instance, if a new element other than price and efficiency is introduced to the international trade scene, such as a lack of ocean shipping due to a shortage of bunker fuel?

Common Agricultural Policy may want to protect the inefficient broiler producer in Europe. But what happens to the broiler industry if it can no longer import the necessary feedgrains from the United States due to the lack of ocean shipping?

Every pound of dressed chicken requires about five pounds of feed. This feed-to-dressed-meat conversion factor increases greatly for hogs and cattle. My question is this: Wouldn't it be much more efficient to produce chicken and livestock in the U. S. and ship it overseas as dressed meat rather than ship all of that feedgrain and pass it through the poultry and livestock operations there? Last year we shipped 35 million tons of feedgrains overseas. Had we run that grain through poultry and livestock in the United States and then shipped the final product, we could have eliminated at least 30 million tons of ocean shipping, no trifling quantity in an era of energy shortages.

Such a far-out proposal will no doubt be rejected out of hand by foreign governments because of the adverse impact on their domestic poultry and livestock industries. And yet, those industries will find it very difficult to survive if their feedstuffs are stranded somewhere on a foreign shore because of the lack of shipping facilities. The choice might well become that of importing U. S.-produced meat or doing without.

This could be a bullish factor for American agriculture IF - and that's an awfully big if - European and Japanese governments opt for reasonably priced U. S.-produced meat rather than continue to fight the economic realities of an energy-short world. But I'm afraid I'm not overly optimistic that it is going to happen.

As you can see from these few comments and thought, the permutations of a freer market that the energy shortage could bring about are infinite and could have considerable future effect on U. S. - and California - agriculture. We could speculate endlessly on what should and what will happen. But one thing is certain: there are going to be changes in lifestyles, consumption patterns, and methods of operation.

By now, the energy shortage - and other shortages, too - should have made everyone from the factory worker to heads of state acutely aware of the interdependence of nations. No developed or underdeveloped nation is self-sufficient, nor is it conceivable that a nation ever will be, regardless of how our shortage problems are eventually solved. The economies of the world are becoming increasingly interrelated. Consumer goods have lost much of their national character. It is today as impossible for a nation - any nation - to be totally independent and self-sufficient as it is for New England to withdraw from the Union and say, "We can go it alone now." The world is changing rapidly.

Now let's spend just a moment seeing what U. S. agriculture needs on the supply side of the equation, particularly those inputs that must be imported from abroad if farmers here are to continue their fantastic production records.

For the most part, U. S. farm inputs have been relatively inexpensive throughout the Fifties, Sixties, and even the early Seventies. This is easily proven by the cheap price of food during those years, which could not have been possible with expensive farm inputs.

Some inputs, such as fertilizers, were actually more expensive 20 years ago than in early 1973. Energy in all forms has been a bargain; and this in turn has made possible the tremendous productivity of the American farmer. Research into plant production, cultivation, harvesting, and farm operations in general has made U. S. agriculture the envy of the world - and the inputs have been available to do the job.

I want to stress the point here that cheap food cannot - repeat, cannot - be produced with costly inputs. This is a message that needs to be broadcast loud and clear to all lan-use planners, environmentalists, legislators, and tax assessors. We cannot produce reasonably priced food for ourselves or for anyone else with unreasonably high-priced inputs.

What worries me greatly at the moment is the probability that the current monopolistic pricing policy on world petroleum could set off a disastrous chain reaction on other commodities as well. I am sure the temptation is very strong. In fact, this has already taken place.

Morocco, a major producer of phosphate, last year raised the price of that product from $12/ton to $50/ton. Natural gas prices are soaring in Algeria, a prime producer of that vital product. This has contributed to a doubling in the price of fertilizer California farmers must pay. And no end is in sight.

What will Bolivia do with its tin, Chile with its copper, and Curacao with its bauxite? Is everybody going to jump on the bandwagon? Current demands for all commodities are placing real strains on available supplies - and in turn producing nations are ending up in the driver's seat. This could change the entire input picture and in turn the production of many farm products.

All raw commodity prices are strong. This includes those of farm products themselves. We have no cause for complaint on that score. But just as an example: what happens if the cost of farm inputs rises to the point where $5 a bushel for wheat becomes a breakeven price? The target prices of the recently passed Agricultural Act seemed reasonable just last summer, but increased costs could hopelessly outdate those prices by the coming summer. We could, of course, restrict farm production in order to keep the price of wheat close to $6 a bushel. But are we morally justified in doing so? I think not, nor do I believe that a world dependent on U. S. farm output will stand idly by if we try to monopolize the output of food in the same manner that oil-producing countries have been restricting the output of their vital product.

The lessons to be learned from 1973 are obvious. All nations of the world are in the same economic boat; and they might just as well learn to pull in unison on the oars instead of flailing about trying to direct the boat in a narrow nationalistic direction. This same principle applies to us domestically, too. Government, business, and labor in the United States have been far too inclined to take adversary positions in regard to each other rather than to recognize their mutual interdependence.

For every action, there is an opposite and equal reaction. It would be utter folly if energy costs and costs of other U. S. farm inputs were to boost the price of bread and adversely affect its availability in the world. With economic power, nations have a responsibility; and they must act responsibly. The question, then, for every nation to ask is: "Are we going to be good eggs? Or bad actors?"

We can talk all we want to about California's responsibility in the world food area - and that was, after all, my topic today. But there are other points to consider. I firmly believe that California's farmers and ranchers are capable of doing whatever they are called upon to do - and once more I use the phrase, "all things being equal." I believe that in the long run, they will do what they must do and then some, as usual. My worry is that our worldwide shortages are developing so many ramifications and are affecting so many areas, some totally unexpected, that the question now is whether we <u>can</u> meet our responsibilities, can meet our challenges. And that, I am afraid, may continue to be the question even when our shortages are remedied, as they eventually will be, because we are now in a whole new ball game. We in the U. S. and in California are being challenged, true. But so are other nations. We must impress upon them that they too are being challenged and that their actions in the future will affect them as much as they will others.

Let's hope there are enough far-seeing and responsible "good eggs" in this old world to bring about an equitable and fair distribution of goods recognizing needs as well as wealth. That, in the long run, is the only way to go for everyone concerned. But considerable convincing may be necessary before it happens.

Please don't get me wrong. I am not discouraged about the future. It still is an exciting future. If we are wise enough to approach that future as we must, taking into consideration that we are in a new ball game, I believe that everyone can come out of this situation better off than ever.

That is not only my hope. It is my firm belief.

DEVELOPING A NUTRITIONAL PROGRAM FOR ESTABLISHED FARMING AREAS

Carl Spiva
Chief Agronomist
Occidental Chemical Company, Lathrop

In addition to the normal diagnostic techniques and other exploratory methods, fertilizer programming for established crops and soils requires:

1. Closer attention to testing soils at greater depths and examining them for compaction, impervious layers, and soil type changes. Tissue sampling is also helpful, but this can be misleading since a deficiency of one element can change the concentration (and usually does) of the other elements. Iron in chlorotic tissue can often be higher than in healthy tissue. High rates of N can change the concentration of other nutrients. Soil screening for Nematodes may be necessary, also.

2. Collecting all available information on previous cropping history, including crop varieties, their maturation, the quality of the crop, and, finally, the yield.

3. The need to know the kind, frequency, and execution of the irrigation. Too much water and leaching of nutrients occurs along with other hazards too numerous to mention. Too little and plants suffer from lack of water and harmful salts can accumulate.

4. Consideration of soil physical management practices. Working soils too wet, compaction by heavy equipment, and improper seedbed preparation can limit nutrient uptake.

   It is important to know what soil modifications have occurred, i.e., land leveling, deep-ripping, etc. Micronutrient deficiencies are more likely to occur on newly leveled soils, while deep-ripped soils present opportunities for improved fertility practices.

5. An accurate knowledge of the results from fertilizers and soil amendments used on previous crops. Repeated usage of ammonium fertilizers can result in lowering of pH below optimum levels. Heavy applications of phosphate can induce zinc deficiency. Generous applications of zinc and phosphate may induce iron deficiency. Massive dosages of potassium may induce magnesium problems. High lime soils can cause iron problems. This list is a long one.

6. A thorough understanding of nutrient interaction in the soil and in the plant. Early work showing uptake of P enhanced by ammonium nitrogen when applied together spurred other researchers to find that addition of the sulfate ion improved it even more.

   Work done by researchers from Colorado State and Iowa State indicates that a small amount of K, banded in the row with P and N, improved the uptake of both P and N even on high K soils. Work done in other countries has shown that applications of micronutrients in modest amounts affect yield and quality of cotton even when soil tests show adequate amounts of micronutrients. Dr. Chesnin at Nebraska says that from one to five pounds of zinc per acre has increased yields and hastened maturity of corn, sorghum, and other crops even where zinc levels were tested and found adequate by soil test.

   Work done in the Asian countries have shown that secondary and micronutrients increased uptake of P on rice. Utah researchers report losses of N are decreased in the presence of Ca, K, and Mg compounds. Ceylon agriculturists tell us that granular compound MPK fertilizers gave significantly higher yields than "simple" fertilizers applied singly even though at the same rates of N, P, and K. Similar work was reported from Washington State on potatoes a few years back. Czechoslovakia reports the ratio of N:P:K is more important than the total rate of fertilizer for vegetable crops.

Washington State recommends zinc be applied in combination with a nitrogen fertilizer. University of Nebraska says all micronutrients are more efficient when applied with a nitrogen source.

DEVELOPING NUTRITIONAL PROGRAMS FOR NEW AREAS AND NEW CROPS

James R. Brownell
Professor of Soil Science
California State University, Fresno

With the increased pressure on agriculture to produce, new lands are being cultivated and new crops are being grown on older less-intensively cultivated agricultural lands. To increase the chances for success in any of these enterprises, a carefully planned soil sampling and analysis procedure, based on all available information, should be included very early in the planning phase of the project. Soil profiles should be evaluated for potential rooting depth, ease of modification (if necessary), possible toxic and deficient ions, and potential disease and plant pest organisms. Any analysis should be performed using recognized procedures that can be evaluated by other professionals. Most of the "new" crops are really only new for a given area and can be evaluated in terms of past experience in other locations. When compromises in sampling intensity and analysis must be made to stay within budgetary guidelines, the investor must be fully aware of the trade-off in increased uncertainty of the evaluation in relation to initial survey cost savings.

ORNAMENTAL NUTRITION

Charles K. Labanauskas
Professor of Horticulture
University of California, Riverside

Proper feeding of the container-grown ornamental plant demands consideration of the following:

1. Nutrient level of the soil media.

2. Nutrient form in the soil media.

3. Availability of the nutrient to the plant.

4. Nutrient requirements of the plant.

Recommendations for nutrient additions or adjustments in the growth media are dependent upon knowledge of the total nutrient content of the media. Long and short range availability of the nutrient contents are vital factors to be considered in assessment of growth potential and necessary assistance considerations. Analysis of the soil mixture prior to planting is significantly important. Adjustment of soil pH is often the simplest primary alternative. Should a nutrient deficiency be discovered in the soil mixture, enrichment by addition of soil containing the nutrient or nutrients, or direct addition of the deficient nutrient, may be recommended. The amount of the recommendation will depend on the form, availability, and concentration effects of its addition.

Post-planting fertilization is most commonly liquid in nature. Time of application, amount, and concentration of the nutrients in the solution is important. Frequency of application is also an important determination since an oversupply in many instances is far more serious than a slightly short supply. Overfertilization may be corrected by leaching, but, too often at the expense of damage already sustained by the plant's root or manufacturing sites. Inclusion of peat or other soil lightners greatly assists in the leaching process should salt accumulation occur from too frequent application or too high concentration of nutrients and salts in the irrigation water. Rate of leaching does not uniformly apply to all elements simultaneously. Soluble ions, such as NO_3^-, and, to a lesser extent, NH_4^+, may be severely depleted while removing less soluble salts. A nutrient balance should be restored in a time as short as reasonably possible, either by adjustment of the nutrient combination in the water, or by judiciously resupplying the deficient nutrient separately.

Low impurity, complete fertilizers containing all of the essential micronutrients, is of substantial importance. These fertilizers may be applied to soils as special demand requires in time of development and environmental factors. Fertilizer nutrients added to the irrigation water should all be completely soluble. Other use of slightly soluble or organic fertilizers may be applied directly to the soil. Organic fertilizers are somewhat dependent upon soil biological activity for release of components through decomposition. Poor populations of soil microorganisms in peat moss necessitate use of balanced mineral fertilizers, and proper supplying of the micronutrient elements in this instance is most noteworthy.

HEAVY METAL CONCENTRATIONS OF SEWAGE SLUDGES AND POSSIBLE SOIL CONTAMINATION RESULTING FROM THEIR USE ON AGRICULTURAL LANDS

A. L. Page
Department of Soil Science and Agricultural Engineering
University of California, Riverside

The concentrations of heavy metals (Cd, Cr, Cu, Hg, Ni, Pb, and Zn) in sewage sludges are highly variable. Data reviewed from a large number of treatment plants throughout the United States showed the following concentration ranges (in μg/g air dry wt.): Cd (2-1100), Cr (20-20,000), Cu (100-12,000), Hg (<0.1-55), Ni (10-3500), Pb (100-26,000), and Zn (100-49,000). Unusually high concentrations are caused by industrial discharge into sewers. The concentrations of heavy metals are not necessarily related to the size of the population served by the treatment plant, but rather the kind and percent of industrial input. Most sewage sludges, regardless of source, contain more Cd, Cu, Hg, Pb, and Zn than are typically found in soils. Consequently, prolonged applications of any sewage sludge to soils will cause enrichment of the soil with these elements. The extent to which soils can become enriched in heavy metals from sludge applications and still retain their productivity is not known, but is no doubt related to the chemical composition of the sludge and the chemical and physical properties of the soil to which it is applied.

High percentages of heavy metals applied to soil in the form of sludge are retained in the surface horizons. Except for sandy soils with shallow water tables and possibly organic soils, it is doubtful that heavy metals applied to soil in the form of sludge will leach large distances in the soil profile and reach underground water supplies. Since heavy metals in sludge, when applied to soil, are retained in the surface horizons, runoff in the form of sediment or solution should be prevented to guard against contamination of surface waters.

Where sewage sludges have been applied to soils for prolonged periods of time (10-20 years), Ni, Cu, and Zn toxicities to higher plants have been reported. Toxicities more commonly occur and are more acute where sewage sludges are applied to acid soils or where soils become acid following sludge applications. Liming acid soils has been reported to correct Ni, Cu, and Zn toxicities of plants grown on sludge-amended soils. Although Cd toxicities to plants have not been specifically identified on sludge-amended soils in the field, a number of greenhouse studies have demonstrated Cd toxicities to plants grown on Cd spiked soil or on soil treated with Cd spiked sludge. The tolerance of plants to Cd shows a marked species dependence. Leafy vegetables, spinach, swiss chard, curly cress, and lettuce are particularly sensitive to Cd in soil; levels of 10 μg Cd/g soil in greenhouse studies produced a 25% yield decrement. Carrot, soybean, field bean, squash, and corn yields were reduced 25% at Cd concentrations in soil of 20-40 μg Cd/g; and tomato and cabbage yields were reduced 25% at concentrations in soils of 200-250 μg Cd/g. Cadmium is accumulated by many plant species in excessive amounts. At a concentration of 20 μg Cd/g in soils, the following concentrations of Cd were reported in leaves of the following crops (in μg/g oven dry wt., 70C): field bean (12), squash (17), soybean (22), wheat (24), corn (40), carrot (48), cabbage (60), swiss chard (95), tomato (98), beet (105), curly cress (154), spinach (168), and turnip (212).

It is estimated that, currently, 700,000 short tons of dry sewage sludge are generated each year in California. Practices in use in California and other locations suggest that many sludges can be applied safely to most soils for a number of years at rates of 10 short tons per acre per year. If it is assumed that all sewage sludges generated in California are applied to California soils at this rate, approximately 70,000 acres would be required. Currently, approximately 12 million acres are under cultivation in California; consequently, based upon these estimates, less than 0.6% of the cultivated land in California would be needed to dispose or recycle dry sludges from sewage treatment plants. This analysis shows that possible trace element contamination of soils in California resulting from the use of sewage sludges will not be widespread.

NEW TRENDS IN FOREST FERTILIZATION

Paul J. Zinke
Associate Professor of Forestry
University of California, Berkeley

At present, the use of fertilizers in California forests is influenced by various factors that can be grouped into those retarding and those tending to increase their use.

Factors limiting use of fertilizers in forests are:

1. A continuing harvest of the old growth timber crop grown by nature;

2. Limitations to forest yield other than soil fertility giving priority to management measures, such as clearing brush, planting new tree crops, thinning and other stand improvement measures, all of which compete with fertilization for the forest management dollar;

3. The long term nature and the attendant risk of the investment in fertilization in forestry;

4. Environmental concerns over the effects of fertilization on such important functions of forest influences as water quality maintenance and the maintenance of the forest environment as a valuable amenity;

5. And, lastly, the short supply and high cost of fertilizers.

However, there are factors offsetting these limitations tending to increase the use of fertilizers in California forests:

1. A continuing rapid rise in the value of forest crops;

2. An increase in the number of plantations to replace old growth timber which has been harvested;

3. The gradual evolution of more companies interested in growing and harvesting the future forest crop;

4. The restriction of timber crop forestry to a smaller land base by the growth of other forest uses, thus requiring that the productivity of this smaller land base be increased;

5. The establishment of a strong state forest practice act enforcing the maintenance of forest land productivity;

6. The continuing progress in mapping the soils of forest lands by the Soil-Vegetation Survey of the California State Division of Forestry and the U. S. Government providing a basis for the comparative extension of fertilization results from field trials;

7. A strong interest by County Extension Foresters in the U. C. Agricultural Extension Service for working with progressive forest management companies in establishing forest fertilization trials.

Many facets of California forestry practice are beginning to require intensive use of fertilizers. The survival and growth of tree plantations may be aided by fertilization. The addition of nitrogen may aid in the renewal of sites characterized by high organic matter contents. Nutrient deficiencies developing in second growth tree stands may be remedied. There may be a substantial shortening of the time of growth to harvest age of trees by fertilizing. Environmental enhancement, particularly in areas where unsightly erosion of infertile soils is occurring, may be accomplished by fertilization, which in turn enhances vegetative growth. The carrying capacity of heavily used recreational areas in forests may be increased by fertilization. Intensive forest crops, such as seed production, or nursery production of tree seedlings and transplants, require specialized fertilization. These will all result in increasing fertilizer demands as California forestry becomes more intensive.

To properly guide these increasing fertilizer demands in California forests, there is a need for a well-planned network of fertilizer trial plots covering the complicated mosaic of soil and forest types. The variables of forest type and soil can be used to form a matrix that will determine where trials should be located. Major forest regions of the state relevant to this are the interior mixed-conifer forests and the coastal redwood-Douglas fir forests. Plots should be located on soils representing various stages of development from immature brown soil to mature red soils with maximum profile development on each of the major parent rock types in forest regions. A minimum suggested sequence of such plots should be established as in the following table:

Table 1. Soil Series representing a minimum of conditions needed to be included in forest fertilization trials in California. (Series as mapped by Soil-Vegetation Survey)

	SOIL DEVELOPMENT		
FOREST AND GEOLOGIC REGION	Immature (soil, usually brown)	Medial (brown-reddish brown)	Mature (reddish brown to red)
Mixed Conifer			
Granite (Sierras)	Shaver	Holland	Musick
Basalt (Cascades)	McCarthy	Cohasset	Aiken
Meta-Sediments (inner coast range)	Sheetiron	Josephine m	Sites m
Redwood-Douglas Fir			
Sedimentary Rock	Hugo	Josephine	Sites

This list can be expanded to include other climatic, vegetative, geologic, and soil conditions. A standardized methodology of applications and data records should be adopted. In the absence of this minimal approach, the inevitable increase in fertilization of California forest land will be hindered by haphazard, repetitious, and poorly communicated efforts, which will be costly to all concerned.

ROLE OF THE AGRICULTURAL CONSULTANT

Ogden C. Riddle
Consulting Agronomist
Hanneson and Riddle, Davis

To attempt to describe or define the role of the Agricultural Consultant represents an opinion, in our case, based upon experience. It is viewed from the standpoint of private enterprise supported by clients' fees and based upon continuing long-time relationship with clients.

The firm of Hannesson and Riddle, Consulting Agronomists, began in 1946 when there developed a conviction of the need for on-the-farm assistance in developing production systems with potential for higher profits and greater assurance of soils so managed as to sustain permanent agricultural production at progressively higher performance levels in the future. There was a need to bring to bear on actual production more of the available basic information that could lead to higher crop performance, to improved soils and water management, and to more effective pest control. We believed that by careful selection of the most limiting factors in production for the first improvement efforts, that improvements should not only pay their way, but generate extra profits as well.

We recognized, too, the need for a very close working relationship between the growers and ourselves. We chose to maintain that relationship without written contract, but rather as a verbal agreement to continue so long as both parties were satisfied with the results.

What are some of the requisites for the Agricultural Consultant?

1. There is constant need to solve problems and design new approaches, primarily through reasoning based on a knowledge of fundamentals.

2. There is need for an intense interest in production.

3. One needs to be concerned with the concerns of the client.

4. A willingness, yes, eagerness, to work is certainly high on the list of requisites.

5. In the words of basketball coach, Wooden, of the UCLA Bruins, "It's amazing how much can be accomplished if no one is concerned about who gets the credit."

A list of the grower's responsibility in managing his operation include the following: he has to deal with people, with his land, with money, crop factors, equipment, cost accounting, marketing, legal matters, fuel, supplies, etc. His is the responsibility to obtain an end result that will generate a profit because it is only a solvent operation that will continue.

With such a complex system, there is always some room for improvement. Here lies the potential for a sound working relationship between the grower and the agricultural consultant.

The first action of the consultant is to take inventory. We use four simple categories. First is crop selection - is the operator working with the right crop and/or varieties? Second, we need to look at all aspects of soils. We have found that, generally, the soils are the least understood components with which the grower works. We have got to deal with problems related to water and, of course, the pest problems.

The next action is to develop with the grower a tentative approach to begin the improvement and to see that the job gets done. We work with management to establish a proper timing of all operations; to develop operating aids, such as crop maps and operations plans; to maintain field records and begin to develop long-range plans for improvement.

We need to maintain a flexibility of choice, but work with nature rather than fight her. There is need to achieve high performance - there is no substitute in agriculture for high performance.

In summary, the agricultural consultant must: (1) take stock; (2) analyze; (3) evaluate; (4) predict; (5) persevere; (6) accomplish.

WHAT'S WRONG WITH IMPROVING CALIFORNIA RANGELANDS?

R. Merton Love and W. James Clawson
Professor of Agronomy and Extension Range Specialist
University of California, Davis

Man is a part of nature's ecosystem. He has a rightful part in this system even though he has the power to change it consciously and purposefully. Just as man's power to modify this ecosystem for good or bad is immensely greater than that of other components, so is his responsibility to this system much greater. In considering man's role in the ecology of California's grazing lands, three clear-cut attitudes are possible. We can be completely sentimental and unrealistic by asserting that the only true ecosystem is one without man. Or, we can blindly wrest maximum short-term gains from the land with indifference to the long-range effects and competing interests. Or, we can wisely mold our impact so that nature's resources return bounty to both man and wildlife.

To manage the grazing lands of California for the multiple purposes of man and wildlife will take understanding of ecosystems and man's part in them plus compromise founded on the many disciplines we call on to solve our problems: biology, chemistry, physics, mathematics, social sciences, etc. It is also clear that management concepts for range should not limit themselves to mere management of the status quo, but also include improvement - not just for livestock, or for deer, or for nature lovers, or for flourishing watersheds, or for farming, but for all interests.

These are not just vague needs without knowledge to make them possible. The lesson of man's success in single crop culture points to the value of agriculture for solving problems of forest, ranges, wildlands, watersheds, and wilderness areas. Man can improve on nature in wildlands just as he has on his more easily tamed farmland. He must make these improvements to meet the food demands, timber demands, water demands, and recreation demands of an increasing population.

Tools at our disposal for increased management include a reservoir of knowledge of the biology of plants and animals plus a considerable amount of experience dealing with natural resources. Grassland improvement may be handled by the control of grassland weeds, precision seeding of legumes, grasses, or browse species; meeting fertilization needs and the manipulation of grazing use. Additional productivity may be gained through brush range improvement techniques involving brush removal and subsequent management procedures, i.e., reseeding, sprout control, and use manipulation.

The potential for tripling the value of California's rangeland resources exists. This value can be measured in both economic and environmental terms. Let us accept our own niche in this ecosystem and our responsibility to improve it for all. Man is the only animal with a brain that has become a mind and the only animal with sleeves. So, let's throw the first into high gear and roll up the second.

NATURAL RESOURCES MANAGEMENT PROGRAMS ON MILITARY INSTALLATIONS IN CALIFORNIA

A. B. Nielson
Resources Consultant, Burlingame

The Department of Defense, as an important occupier of federal lands, recognizes it has an obligation to the American people to act responsibly and effectively in natural resources management. This includes the obligation to preserve, restore, and improve, through wise use and management, the natural resources of the land and water under the Department's control. Because of this obligation, the Army, Navy, Marine Corps and Air Forces find themselves directly involved in land and water management, forestry, and fish and wildlife management.

In California, these military groups manage 200 separate installations, or facilities, covering approximately 4,000,000 acres of land and water.

The Department of Defense controls real property for its military use. This does not mean that the property may not also have other uses. This is the basis of the multiple use concept. To the extent it is compatible with the military mission, installations and activities are managed so as to:

1. Protect and conserve the watershed and natural landscape, the soil, the beneficial forest and timber growth, and the fish and wildlife as vital elements of an optimum natural resources program.

2. Use and care for natural resources in the combination best serving the present and future needs of the United States, California and its people.

3. Provide for the optimum ecological development of the land and water areas and for controlled public access to such areas.

The following conservation, development, maintenance, and benefits were obtained as a result of the natural resources programs carried on at military installations in California:

1. During fiscal year 1973; 407,700 acres were outleased for agricultural use at a total benefit and cash value of over $2,088,750.

2. 62,500 acres were treated for weed and brush control in lawn and landscaped grounds, fence lines, roadsides, storage areas, airfields, railroad tracks, grazing lands, training areas, forest and woodlands, etc.

3. Approximately 6,000 acres of turfgrass areas, in cantonment, family housing, and administration areas, athletic areas, parade grounds, golf courses, and cemetaries, were irrigated, fertilized, mowed, edged, treated for insects, disease and rodents.

4. Fire prevention, protection, and control was applied on 944,000 acres of impact, training, storage, manuever areas, forest, and grazing lands.

5. 31,000,000 board feet of timber can be harvested annually with a return to the Department of Defense in the amount of $4,000,000.

6. Fish and wildlife together with other outdoor recreation provide approximately 26,000 man days of hunting, 78,000 man days of fishing, and 473,000 visitors who participate in other outdoor recreation, including, but not limited to, hiking, bikeriding, horseback riding, swimming, picnicing, camping, site-seeing, etc.

THE NATIONAL WATER COMMISSION REPORT - WHAT'S IT ALL ABOUT?

Robert M. Hagan
Professor, Water Science and Engineering
University of California, Davis

The Final Report of the National Water Commission (appointed by President Johnson in 1968) was submitted June, 1973, under the title, "WATER POLICIES FOR THE FUTURE." This voluminous report (579 pages), together with 62 background reports, presents a detailed review of federal water policies and practices. The Commission examines a variety of alternative futures in which factors affecting water use are explicitly considered; and it concludes that a wide range of policy choices, tradeoffs, and flexibility in water use are available.

The Report contains more than 200 specific recommendations for national water policy. The Commission believes that adoption of these recommendations will lead to utilizing the Nation's water resources in ways "that will make an optimum contribution to the welfare of its citizens." Some recommendations are generally supported; others have been highly controversial.

This paper will point out the general themes which emerge in the Report and summarize its principal recommendations. These recommendations relate to water and the natural environment, water and the economy, water quality and pollution control, inland waterways, agricultural production, flood control, power production, recreation, and fish and wildlife. The Commission offers procedures for resolving differences over environmental and developmental values, for making better use of existing water supplies (including water pricing), legal and institutional problems, re-use of municipal and industrial waste waters, interbasin water transfers, means for increasing water supplies, better decision-making in water management, and improved organizational arrangements for agencies and governmental units involved in water. The Report deals also with water problems of metropolitan areas. A chapter is devoted to the cost and financing of water development projects, including the roles of subsidies. It concludes with a chapter on basic data and research for future progress with eight specific recommendations.

The Commission's views and recommendations may have important effects on many aspects of water development and use and especially on the future of irrigated agriculture in western state which is projected to decline with water thus released becoming available for other uses. The Report also has many implications for future agricultural research.

AGRICULTURAL WASTES AND GROUND WATER QUALITY

Robert S. Ayers
Extension Soil and Water Specialist
University of California, Davis

Of the water beneficially used in California, about 85% is used by agriculture. An estimated 40% comes from groundwater storage. Wastes can and do percolate down and contaminate the underground water storage basin. The problem of pollutants is associated with flow-through and retention time in the basin, with the salt load of total mass of pollutants added and with use and reuse of the water. The users in the upper water basin have best quality. Quality degrades down slope.

Until recently, agriculturists have only been concerned with the top few feet of soil, not greatly concerned with soil below the rooting zone. Things have changed. Environmentalists, concerned scientists, and others have raised issues. The State passed the Porter-Cologne Water Quality Control Act which, with EPA regulations, is now the "law-of-the-land."

Agriculture does have waste products. These must be disposed of and in manner that is environmentally acceptable. Food consumption leaves a waste product - sewage and garbage. Irrigated agriculture leaves waste products. These wastes from agriculture include contaminants such as naturally occurring salts, residues of fertilizers not picked up and used by crops, and animal manures.

For sewage, garbage, industrial wastes, control is simple. For agriculture, control is much more difficult. Guidelines for waste disposal have been adopted. No-run-off of polluted waters is a basic concept. Discharge permits are required for all point source discharges of wastes. Controls on agricultural wastes (salts, fertilizers, drainage) are being openly discussed.

New research results will help control salt wastes. New information from the U. S. Salinity Laboratory, Riverside, is giving us new salt management capabilities. Included are the new leaching requirement concepts. New leaching requirements allow us to reduce needs for leaching water. The old leaching requirements were 2½ to 4 times greater. Reduced leaching requirements will allow us to safely improve efficiency and safely reduce leaching losses. As an added bonus, research trials have demonstrated a materially reduced total salt load moving to the groundwater with use of lower leaching fractions.

Even with new data and every possible regulation, there seems to be no stopping completely the degradation by percolates. Contamination may be minimized by:

1. Maintaining sufficient recharge and flow-through in the basin;

2. By decreasing inputs of pollutants to the basin;

3. And by finding a way to recapture pollutants for treatment.

In waste management, there is always a final unusable waste product that must be placed somewhere. Everything must have a place to be! Where are there areas that can be designated as salt sinks? Where can agriculture dispose of unusable wastes?

ANIMAL WASTES AS CROP NUTRIENTS

J. L. Meyer
Extension Soil and Water Technologist
Cooperative Extension, Modesto

Animal manures have been used for centuries in crop production. In recent years, the variability, availability and unknown economic returns with the use of manures has caused most agriculturists to use commercial fertilizers.

The practical and wider use of animal waste is dependent upon knowing the amount of nutrients in the manure. The rate of breakdown or degradation of the manure, and a clear understanding of the amount of salts resulting from the manure decomposition and managing these salts, is essential to maximal crop production and minimal water quality degradation.

Recent studies have shown under good handling techniques that most manures contain a more uniform nutrient content today. Better uniformity in recent years is a result of both better handling techniques and uniform animal rations.

Air-dry dairy manure contains about 1% N, 0.5% P_2O_5, and 1.5% K_2O. Air-dry poultry manure contains about 3% N, 3.9% P_2O_5, and 2.1% K_2O. The rate of breakdown during the first cropping year is about 35% of the nitrogen in dairy manure and 90% for poultry manure.

Field application studies, over a twelve-year period, with yearly applications of 40 yards/acre (20 tons) and 12 yards/acre (6 tons) of dairy manure, have shown significant differences in salinity and nitrate nitrogen movement below the root zone of summer corn silage and winter oats. The lower application rate has shown no measurable movement of nitrate nitrogen and only slight salinity increases under these crops in a deep open soil. The higher rate (40 yards/acre) has shown considerable nitrate nitrogen and salinity buildup below crops.

Reasonable manure application rates appear to be rates consistent with crop requirements. The application rates can be calculated from manure analysis and reasonable degradation rate data.

OSHA AND THE AGRICULTURAL COMMUNITY

David Voloff
California Farm Bureau Federation
Berkeley, California

Before going into the nature of how Cal/Osha is expected to affect agriculture, perhaps it would be best to provide a brief historical overview.

Osha stands for a national law signed into effect by President Nixon on December 29, 1970, called the Williams-Steiger Occupational Safety and Health Act of 1970, hence, "Osha." Osha is regarded as a major piece of social legislation; in fact, some regard Osha as the most significant social legislation of the last decade.

The major stress bringing Osha into effect was the fact that since 1958 in the United States, the world's most advanced nation, industrial injury rates have worsened by approximately 20%. In contrast to this, by the way, California's industrial injury rate has improved considerably.

Nevertheless, when Osha became law, in effect all of the states were dropped into the same basket of apples. Many states had completely ignored the problem. Ohio, for example, had no state agency at all dealing with the problem of occupational injuries. A few years ago, Texas was advertising for one safety engineer who would have no enforcement authority at all. California had more than 100, all with enforcement capabilities.

When some fifty-five people die each day in the United States while working for a living and some twenty-seven thousand become disabled during that same day, it is obvious that something ought to be done. Washington's answer to the problem was to enact the Williams-Steiger Occupational Safety and Health Act of 1970. Following this, as a provision in Osha, states that chose to involve themselves in such activities could do so by submitting a plan to the United States Department of Labor, which, upon being improved, would enable the state to administer safety and would make the state eligible for federal monies amounting up to 50% of their own budget.

Early in 1971, Governor Reagan publicly announced that California was electing to administer safety and, therefore, would submit a plan. On April 24, 1973, California's plan was approved. In June, 1973, California became eligible for some five million dollars of federal funding. On October 2, 1973, California's legislation in the form of Assembly Bill 150 was signed by the Governor and became immediately effective. However, because the Appeals Board had not been established, it was decided that Cal/Osha - California's response to the federal-mandated Osha Program - would become effective January 1, 1974.

Cal/Osha is now in full swing. California Safety Engineers are now out in the field making detailed surveys of various places of employment, writing citations against unsafe conditions found; and as a result of this activity, employers are being cited with proposed penalties and some have already paid. We do not have the luxury of waiting to see what is going to happen as many people have been doing in the near past. This is a NOW situation. Agricultural employers ought to be working to eliminate unsafe conditions NOW before a survey can result in proposed penalties.

How will Cal/Osha affect agriculture? Here there have been serious misunderstandings. The federal program virtually ignored agriculture as an industry. In the federal regulations adopted early in 1971, there were only four minor inclusions involving agriculture, namely, the requirement for a slow moving vehicle sign, regulations covering anhydrous ammonia, and regulations on migrant labor camps and pulp wood logging. The federal register stated that regulations covering agricultural operations were in the process of being developed. To this day, none have come forth. Thus, many agricultural people have concluded that they are virtually exempt. The federal program in the first two years pointedly ignored agriculture; and not a single inspection was made in the United States by the Federal Osha people on farms.

This is not the case in California. California for many years has had safety orders covering agriculture farm shops, electrical wiring, etc.; and California will continue to have these regulations. Also, these will undoubtedly be augmented in the future. In California, agriculture is not regarded differently from any other industry. California's safety engineers are going to farms, making inspections, writing citations and proposing assessments.

There is a need to continue such activities in agriculture. Of the major industries regarded as the high risk industries, agriculture is number three. Many in agriculture have been concerned that their industry would be labeled a "target" industry; and in consequence thereof, a major crash program would be leveled at agriculture. Chief of the Division of Industrial Safety, Mr. Richard Wilkins, recently has stated that California, at this time, does not intend to enact such a crash program. Instead, California is developing a system whereby those employers, agricultural or otherwise, who are apparently having difficulties in keeping their injury rates down will receive priority on an individual basis. The system being developed is called the Inspection Value Index and should serve as an efficient and valuable tool in concentrating the Division's efforts where such efforts are clearly needed.

The following are some of the major aspects of Cal/Osha:

1. Every employer is responsible for providing a safe place of employment.

2. The employer must have a posted bulletin announcing the rights of the individuals, both employer and employee.

3. There will be no advance notice of impending inspections.

4. The employer has certain rights, including the ability to contest the citation, the proposed penalty, and the abatement date.

5. Upon receiving a citation following an inspection, the employer must post the citation for three days (or less if corrected).

6. Employees have the right to register a complaint and also the right against discrimination; and they may accompany the inspector during a survey (authorized representative).

7. There are civil and criminal penalties. Where non-serious violations are encountered, the penalties are not likely to be high or will be zero. However, depending upon the magnitude of the situation, going to the other extreme, there are penalties that could amount to twenty thousand dollars and jail terms.

8. If an appeal is registered, this must be done within fifteen days of the receipt of the citation.

It is important that California employers know that Osha and Cal/Osha are different programs. While there are numerous similarities, there are certain differences, such as under Cal/Osha, employers may avail themselves of the services of a consultant from a special consultant staff and Cal/Osha is administered and enforced by California Safety Engineers using California Safety Orders.

Because California has been active in agricultural safety for many years, California is believed to be in an advantageous competitive position as compared with other states. In many ways, other states will require years to catch up with California.

AIR POLLUTION DAMAGE TO CALIFORNIA VEGETATION - WHERE ARE WE TODAY?

O. C. Taylor
Statewide Air Pollution Research Center
University of California, Riverside

The atmospheric pollutant complex varies widely in different regions in accordance with man's activities in each area. In the South Coastal Air Basin, oxidants (ozone and peroxyacyl nitrates (PANs)) generated from primary reactants in automobile exhaust gases are the most prominent pollutants. In other areas dominated by inadequately controlled stationary sources, other pollutants, such as sulfur dioxide, hydrogen fluoride, chlorides, etc., may be more serious than the oxidant complex. "Smog", a universal term commonly used to denote excessive amounts of foreign materials, usually combustion gases, provides no clue to composition of the toxicant mixture. Air quality and its potential toxicity must be assessed for each individual region to accurately define the impact on vegetation in that region.

The injurious effects of sulfur dioxide, hydrogen fluoride, and other toxicants released by stationary industrial operations or by accidental spillage are fairly well documented. However, the extent of damage is influenced by plant species or variety, climatic conditions, and the rate at which the exposure occurred. A characteristic symptom syndrome on a variety of crop and native plants has been described.

Ozone, the most prevalent oxidant in polluted atmospheres, is responsible for extensive crop damage in most heavily populated regions of the state. Oxidant injury during the summer and early fall is predominantly ozone type; but during the cooler months of late fall and spring, the injury is principally peroxyacetyl nitrate (PAN) type. The ratio of PAN to ozone is higher during cooler months; and many of the cool season crops are more susceptible to PAN than the summer crops.

Air pollutant damage to agricultural crops in California was recently estimated to range between $25,000,000 and $44,000,000. Improvement in control techniques and selection and utilization of tolerant cultivars should significantly reduce this figure.

OPEN BURNING FOR DISPOSAL OF CROP WASTES - WHERE ARE WE TODAY?

George E. Miller, Jr.
Extension Agricultural Engineer
University of California, Davis

Disposal of agricultural field residues continues to be a major problem of production agriculture. Open burning has been and should continue to be an important tool available to farmers to provide field sanitation and disposal for which no suitable alternatives have been developed. However, methods of minimizing emissions from this source are possible. It has been found that proper management of residues and good combustion techniques can accomplish substantial reductions of emissions. Residues from different agricultural sources will undoubtedly require different treatments. Cereal crop residues, asparagus fern, and orchard prunings have somewhat different physical and chemical characteristics and will have to be managed accordingly.

The greatest effort has been devoted to rice straw disposal since it represents one of the largest open burning problems in the Central Valley areas in the fall and early spring periods. These studies were funded by the University of California Agricultural Extension and Agricultural Experiment Station, the California Air Resources Board, and the Rice Growers Research Advisory Board. The two largest factors affecting emissions in studies so far have been moisture content of fuel and direction of burning. Headfires (burning with the wind) typically produce approximately twice the particulate emissions produced by backfires (burning against the wind). High moisture straw (40%) that will burn under certain headfire conditions may produce eight to ten times the emissions of headfires at 10% moisture content. Humidity, windspeed, physical arrangement of the fuel, and other factors undoubtedly have some effect on emissions; these have not been fully evaluated as yet. The greatest improvement can usually be obtained by spreading straw residues to enhance drying and burning against the wind (backfiring) in the afternoon hours of the day when moisture content and humidity are at the lowest point after residues have once reached equilibrium moisture at 10 to 12%. This is usually two to ten good drying days after harvest or following a substantial rain. Another alternative having good potential is into-the-wind striplighting, which approaches backfire emissions, but reduces disadvantages of slow rates of burn and flame-outs produced in light fuel or higher moisture spots in the field residue.

We can utilize these principles of management of fuel and fire to minimize emissions for cereal crop residue disposal. More work is needed on other crop residues to determine drying and combustion characteristics before optimum conditions can be established. However, it is expected that some of these same principles will apply in most cases as far as timing of fires and management of fuel are concerned.

SEASONAL VARIATIONS IN WATER QUALITY FOR FISH LIFE

Harold K. Chadwick
Project Manager, Bay Delta Fisheries Project
California Department of Fish and Game, Stockton

Fish have requirements for water which have often not been described adequately during planning for major water projects. Two examples were given to illustrate this.

One is that king salmon populations spawning in San Joaquin River tributaries are controlled principally by flows during their nursery and downstream migration periods. Revised estimates indicate that maintenance of existing salmon runs in the Stanislaus River would require most of the yield of New Melones Reservoir.

Evidence was presented to indicate that striped bass in the Sacramento-San Joaquin Estuary have flow requirements which have been recognized only recently.

Substantial evaluations of fishery requirements during project planning and post-project evaluation appear essential to providing fishery resource protection.

Considering the general scarcity of water in California, some degree of trade-off in beneficial uses appears inevitable. Those making decisions about such trade-offs should have adequate knowledge of fishery requirements available to them and should represent society broadly.

BRIDGING THE GAP BETWEEN SCIENCE AND THE COMMUNITY

Eric Thor
Division of Agricultural Sciences
University of California, Berkeley

In the University of California, and particularly in the Division of Agricultural Sciences, creating information is our job. That is what research is. The concern of communications is delivering information. Our job is to get the information developed by university scientists to everyone who can use it.

We assume that the taxpayers, who are our ultimate bosses, did not hire us to run our interesting experiments and then keep the information to ourselves or our colleagues, the other scientists around the world who read the scholarly scientific journals.

In a simpler period in the life of this country, delivering agricultural information was a relatively simple process. Agricultural Extension's farm advisors delivered it in person to farmers in the field or orchard, right where they used the information.

The whole process of generating information and delivering it is a lot more complex today. For one thing, our clientele is a lot more complex. We're developing information for farmers on the land, but also for all of the complex of businesses and industry -

agribusiness, if you will - that has inputs into farming: suppliers of chemicals and machinery; bankers; people who handle, process, and ship products of farming. Certainly, our clientele is no longer limited by the farm fence; the clientele of nutrition information may be in the heart of the central city.

So, our delivery system, our communications, have changed. Getting information to the many clienteles of the agricultural sciences today means using all of the devices of communication available to us.

We recognize that California's agricultural business community is a pretty sophisticated clientele. We know a good many well educated people are not stumped in the least by scientific information in a fairly technical form. We publish such information for them.

But, we still hold meetings and field days; and we still go to the orchard or feedlot to meet the farmer because we are in the business of solving problems as well as giving information. We call public attention to meetings with help of the mass media: the newspapers, magazines, and television. Creating awareness of information in the first place is a vital part of the communication process.

Because we have a highly literate audience in the people of California and agricultural industry, we publish a lot of material for them to read. Our Extension specialists and farm advisors are qualified scientists; and they are all involved in communicating information. They produce a growing library of publications, from highly technical bulletins to our simple one-sheet answers. Where a statewide publication can't meet the need, our counties are quite capable of producing their own publications to meet local needs.

We are blessed in California with an extremely well-edited commodity press, the magazines that serve very specific audiences, such as almond growers, grape growers, and feedlot operators. We make a special effort to get our information to these publications, often through articles written by our research scientists themselves, because they are direct routes to our clientele.

Our farm advisors also reach people with very specific newsletters, written to take information to dairymen, field crop or vegetable growers, or other specific groups.

We tell our stories on radio and television.

All these means of taking information to people are parts of the communication process. There is another important part: that is getting information, something called feedback. Getting information, discovering what information farmers and agricultural business people need, is an important part of the communications function of our county Agricultural Extension staffs. From the people they talk to, we learn the problems and the needs. It is then the job of scientists to solve the problems and communications people to deliver the information.

SYMPOSIUM: FERTILITY PRACTICES AND SALT RESIDUES:

MANURES AND SLUDGES

P. F. Pratt
Chairman, Department of Soil Science and Agricultural Engineering
University of California, Riverside

The availability of N from manures and sludges depends on the amounts of NH_4 and organic N and on the rate of mineralization of the organic N. The NH_4-N in these materials is considered to be as available as the NH_4-N from mineral sources, such as $(NH_4)_2SO_4$. The unknown factor is the rate of mineralization of organic N. If mineralization rates are known, the rates of application of organic wastes can be adjusted to the needs of crops.

The availability of P and K and the secondary elements, Ca, Mg, and S, are much more available than the organic N. The trace elements in manures become available as the organic material decomposes and represent a balanced supply of these elements. In sludges the long-term problem is an excess of heavy metals and trace elements that might become a serious limit to the amounts of sludge that can be used on agricultural lands.

The salinity of manures and sludges must be considered as a limiting factor. A number of experiments with both types of materials have shown salt effects on plants at the highest rates of application. Adequate leaching to remove salts is essential in irrigated agriculture; but when manures and/or sludges are used, extra care must be taken to leach the salt from the root zone.

SEWAGE EFFLUENTS

Robert S. Ayers
Extension Soil and Water Specialist
University of California, Davis

About 2.4 million acre feet of sewage effluents are generated annually (1970). Seventy percent of this effluent is considered usable by agriculture (less than 1500 mg/l, TDS or EC below 2.25 mmho). However, as little as 175,000 acre feet (7.3%) is now reused (1970). If all the reusable effluent were used, it would represent about 5 to 6% of agriculture's needs.

Quality of sewage effluent depends greatly upon incoming quality of water to the domestic system. Domestic use adds about 300 mg/l, 0.5mg/l boron. Heavy metals usually drop out in sludge. Typical effluent is not usable for all crops, but is usable for a large number of selected crops.

State Department Public Health allows use for crops dependent on level of disinfection and type of crop.

Use of Reclaimed Wastewater	Allowable Coliform (MPN/100 ml)
Fodder, fiber and seed crops, pasture	primary treatment
Pasture (milking animals), landscape irrigation including golf courses	23
Processed food crops	23
Landscape irrigation including parks and playgrounds and impoundments	23
Recreational impoundments (water contact sports)	2.2
Fruit and vegetables	2.2

To design a completely satisfactory system to meet crop needs, health needs, and water quality and environmental needs, several things must be known:

WHAT ARE CONSIDERATIONS FOR EFFLUENT USE ON LAND

1. What is objective?

   Disposal
   Utilization
   Groundwater recharge
   Other

2. What is effluent quality and quantity?

3. What are soil characteristics in disposal/utilization area?

4. What is climate?

5. What are the crops or ground cover?

6. How much storage capacity?

7. What "fail-safe" installations are needed?

8. What is the best "system" after all above are known?

Sewage effluent can be useful to agriculture if water need is great enough and penalties of use are not too severe. Added level of salinity, boron, and nutrients to basin must be accommodated along with measures to alleviate or correct long-term salt balance problems.

NITROGEN FERTILIZERS IN RELATION TO WATER QUALITY

F. E. Broadbent
Professor, Soils and Plant Nutrition
University of California, Davis

Interest in the relationship between fertilizer management and water quality is centered largely on the possibility of nitrate escaping from soil and finding its way into surface waters and ground water. Similar questions arise in connection with the application of nitrogen-containing waste waters on land.

The fate and movement of nitrogen applied to soil, whether as fertilizer or in waste water, depends on many factors, not least among which are biochemical processes in soil.

Nitrification converts the positively-charged ammonium ions which are strongly adsorbed by the negatively-charged soil colloids and, on that account, relatively immobile into negatively-charged nitrate ions which move readily in the soil solution. Some acid is formed during nitrification; and over a long period, this may increase the quantities of calcium and magnesium which leach downward.

Denitrification results in conversion of nitrate to gases which escape from the soil. Although denitrifying bacteria reduce nitrate only in the absence of oxygen, the soil need not be anaerobic in order for denitrification to occur. The microsites in which denitrifying bacteria often live may be deficient in oxygen even in a soil regarded as well as aerated. Nitrification and denitrification may occur at the same time at different locations in a soil or at the same location at different times. Denitrification is favored by the presence of organic matter, which may come from the soil itself, from the roots of growing crops, or from the BOD component of wastewater. Denitrification causes a soil to become more alkaline; thus, it has the effect of counteracting nitrification in two different ways.

Controlled denitrification offers the possibility of minimizing the hazard of nitrate leaching, but more efficient usage of input nitrogen by crop plants is a more desirable alternative in situations where inputs can be limited.

Current experiments utilizing isotopically labeled nitrogen make it possible to follow input nitrogen as it moves in soil and undergoes various biological transformations. These experiments are expected to provide information useful in fertilizer management and water quality maintenance.

MANAGEMENT PRACTICES

Dwight C. Baier
Agriculturist, State of California Water Resources Control Board
Sacramento, California

Both the current energy crisis and the tightening of pollution controls are going to result in more use of manure and sludge as fertilizer on commercial crops. When the coastal cities have complied with State Water Resources Control Board controls, the generation of sludge will be in the order of thousands of tons daily.

Studies show that if these materials are applied to the land at rates that are in keeping with good fertility practice, undue pollution will not result. On the other hand, if the land is merely regarded as a means of disposal, the rates are likely to be so high that substantial pollution of the waters of the State may occur. From the standpoint of an agriculturalist who is charged with pollution control responsibilities, it is important that manure and sludge be applied by farmers at fertilization rates, rather than by city managers at disposal rates.

SYMPOSIUM: WATER CONSERVATION AND USE EFFICIENCY:

FERTILITY - WATER INTERACTIONS

J. Ian Stewart
Department of Water Science and Engineering
University of California, Davis

Genetic yield potentials of crop varieties remain largely unknown, but practical upper limits of yield display themselves empirically in the field. This occurs both in commercial farming and in research plots where maximum yields of given varieties are often known and surprisingly reproducible.

In the work reported, it is assumed crop yields significantly below known practical maximums reflect either environmental inclemencies or deficiencies. Our specific concerns are water and nitrogen deficiencies and their effects on yield.

Studies of corn and grain sorghum at Davis and wheat elsewhere show when water alone is limiting, yields decrease linearly with increasing seasonal evapotranspiration deficit, provided the periods of deficiency coincide with relatively insensitive crop growth stages. Rephrased, Yield Reduction versus ET Deficit functions for these grain crops are linear when ET deficits are optimally timed. On the other hand, when the deficits occur in relatively sensitive growth stages, yield reduction may be disproportionately great. The degree of this effect depends largely on the ET deficit history in prior growth stages, i.e., on the "conditioning" the crop has received.

Irrigation requirements depend on several factors. Primarily, these are the ET requirement of the crop in the given evaporative conditions, the rainfall during the growing season, the available soil water stored in the future root zone at planting time, and the efficiency of the irrigation system. If ET deficits are either inevitable due to limited irrigation water, or desired for any reason, the problem is to time them optimally as defined earlier. To accomplish this requires study of the relative sensitivities of crop growth stages to water deficits and study of the inter-workings of the crop-climate-soil-irrigation system factors above. While complicated, progress is being made toward prediction of these interrelations.

With respect to nitrogen (N) relations of crops, the following observations derive from two experiments with corn at Davis. The response of yield to N deficits may be represented as a linear decrease similar to that described for water. When total dry matter (grain + stover) is considered, the N content of the production loss about equals the fertilizer N deficit. Conversely, this indicates fertilizer N may be utilized at an efficiency approach 100% until maximum production is reached. Further N application either has no effect or may cause some yield reduction.

When predicting N fertilizer requirements, attention must be paid to (1) the production level sought or attainable, (2) the N content of the crop at that production level, and, (3) the N which will be obtained from the soil without fertilization. With water non-limiting, the expected production will be the known practical upper limit unless other factors are believed to limit yield. The total crop N requirement may then be estimated by multiplying expected production of grain and stover by their respective N contents (%) at maturity. These N contents appear to occur in rather narrow ranges. Grain N increases within its range with increasing N fertilization as would be expected. It remains to estimate the unfertilized soil N availability; and for this purpose, soil testing shows some promise. A second approach lies in empirically determining production on similar unfertilized fields grown with adequate water.

When water limits production, nitrogen relations change. The reduced yield means reduced N requirement, thus reduced fertilizer N requirement. However, the latter may be greater than anticipated because the drier soil regime results in reduced availability, i.e., reduced uptake of naturally occurring soil N. A simple experiment could be devised to provide all the information required for judging nitrogen needs of corn and, likely, other grain crops, both under adequate and limited water conditions. However, reasonable estimates are possible based on information about the upper limits of yield at different water levels, the partitioning of dry matter between grain and stover, their normal N contents at maturity, and the available N supply in the soil.

SOIL AMENDMENTS

Roy L. Branson
Extension Soils and Water Specialist
University of California, Riverside

Marketing of soil amendments in California is a sizable business as evidenced by the number of such products registered in Sacramento for sale within the State. By simplest definition, an amendment is a "non-fertilizer soil improver." The product may contain one or more elements essential for plant growth, but its action as a soil amendment is independent of the plant food it contributes.

Some amendments can have an effect on the movement of water into and through soils. Among these, gypsum is used in the greatest quantity by far. For the past several years, over one million tons of gypsum were sold annually in California for agricultural use, primarily as a soil amendment. Most of this was applied for reclamation of sodic soils, which commonly require an application rate of from 5 to 20 tons per acre.

Use of gypsum for reclamation is not restricted to agricultural areas. Some locations in California that are undergoing urban development are affected with excess exchangeable sodium and require treatment with gypsum or other suitable chemical amendments, such as calcium, chloride, sulfur, and sulfuric acid.

The chemical amendment used in greatest quantity on a national basis is lime, but little is used in California, mainly because the rainfall in important agricultural areas here has been too low to acidify soils excessively. Isolated cases of need for liming exist, however, in the State and are usually attributable to high uses of acidifying fertilizer.

Various amendments are marketed to alter the physical properties of soils and influence water movement. Sawdust and manures are examples of such materials, the amendment action of which involves enlarging the pore spaces of a soil by binding fine soil particles into aggregates or separating the soil particles further.

Exaggerated claims are made for some products marketed as chemical soil amendments. An important point to remember is that amendments are useful for correcting specific problems. Amendments are not panaceas or cure-alls for all soil conditions that might be desired.

EFFICIENCIES OF IRRIGATION PRACTICES

Albert W. Marsh
Extension Irrigation and Soils Specialist
University of California, Riverside

Historically, irrigation efficiencies have been low, but are improving as techniques and equipment become more sophisticated and as increased costs for both water and labor have induced growers to utilize more sophisticated equipment. Irrigation efficiencies are of different types and cover a wide range in value.

The total or gross irrigation efficiency is the percentage of the water diverted for irrigation use that is finally used by the crop in evapotranspiration. It can be expressed as $E = \frac{100\ Wc}{Wd}$ where Wc is water used by the crop and Wd is water diverted from the source. Israelsen[1] has stated that probably gross irrigation efficiencies in 1940 were less than 33%. Some of the figures he obtained ranged from 12 to 34%.

Gross efficiency can be separated into various components in order to understand better where the losses occur and how they can be improved. Israelsen suggests that as much as 38% of the water diverted may be lost in conveyance from the point of diversion to the field where it is used. This is based on the conditions existing in 1940 when most of the diversion was in open, unlined canals.

After arriving at the farm field, there are other losses that occur in the actual practice of irrigation. Field irrigation efficiency is defined as the fraction of water delivered to a farm field that is ultimately consumed for crop use. It can be expressed as $E_f = \frac{100\ Wc}{Wf}$ where Wf is the amount of water delivered to a farm field. Israelsen states that in a number of fields studied in Utah about 1940, the field efficiency averages ranged from about 35 to 45%. Most of these measurements were made with surface methods of application.

Field efficiency includes the losses by surface runoff, deep percolation and evaporation of water from wet soil surfaces. Of these, only surface runoff is readily visible, but sometimes is one of the smaller losses. Frequently, a substantial fraction of the water absorbed by the soil is lost by deep percolation and evaporation. Direct application efficiency is illustrated by the formula $E_a = \frac{100 \times Wf-Wr}{Wf}$ where Wr is surface runoff. More subtle losses related to storage efficiency are described by the formula $E_s = \frac{100 \times Ws-Wp-We}{Ws}$ where Ws is water absorbed by the soil, Wp is water lost by deep percolation and We is water lost by evaporation.

The losses principally related to the irrigation practices are those of surface runoff, deep percolation and evaporation. These can all be improved by adoption of better irrigation practices and particularly of improved irrigation movement. Losses of all types can occur with the most sophisticated irrigation practices if the irrigation management is inadequate.

---

[1] Israelsen, O. W. Irrigation Principle and Practices. John Wiley & Sons. Second Edition, 1950.

Surface runoff occurs mainly with surface methods of irrigation where it is difficult to apply the proper amount of water to the upper end of the field, obtain an adequate penetration of the soil within the field, and still eliminate or restrict surface runoff from the lower end of the field. Basin irrigation can control this to a great extent, but is not commonly used, is not readily adaptable to much of the terrain currently used for agriculture, and requires considerable labor, both in preparation and operation of the irrigation. Sprinkler and drip irrigation methods can be operated in a way to eliminate all surface runoff. But, examples are evident in the field where surface runoff does occur with either of these methods of irrigation if not properly managed. It is fairly common to see surface runoff with sprinkle irrigation, less so with drip irrigation.

Deep percolation can occur with any method of irrigation, but is more likely to occur with surface methods where the amount of water absorbed at any part of the field is difficult to control by management. This problem is caused in part by the physical difficulty of spreading water across the field without putting on more than may be wanted or needed. It is also caused by the fact that soils vary within a field and the amount of water absorbed is controlled almost entirely by the infiltration rates of the soil over which the water is spreading. Deep percolation below the root zone can occur both from over irrigation and from uneven distribution within the field. Deep percolation is possible with all present methods of irrigation, but is more easily controlled with sprinkler and drip irrigation than with surface irrigation. With sprinkler and drip methods, it should be possible, with good management, to limit the amount of deep percolation to that needed for salinity control.

Loss of water by evaporation from wet soil surfaces can be greater than generally suspected. With methods of irrigation that wet the entire soil surface, the amount of water lost by evapotranspiration is totally dependent upon climatic factors and forms the basis for most irrigation water requirement calculations utilized to the present time. With drip irrigation, which wets only a small fraction of the entire soil surface, a substantial amount of water normally lost by evaporation can be saved where canopy cover of the crops grown is less than 100%. Where the canopy cover is 100%, it makes little difference since transpiration from the leaves can account for most of the water used in evapotranspiration.

Now that we are faced with increased competition for limited water supplies and limitations on power used for lifting water, it is important that we look to means for increasing the efficiency. Distribution of water to and within fields in lined canals rather than unlined canals can eliminate much canal loss from deep percolation. Going one step further to enclosed pipelines can also eliminate evaporation and occasional canal spills. Much of this type of improvement has already taken place and more is being accomplished all the time. Better leveling and engineering of fields for surface methods of water application can improve the application efficiency with these methods. This can help to reduce the runoff losses from the lower end of the fields and help to reduce deep percolation losses by obtaining more nearly the required application amount. Sprinkler irrigation properly designed can eliminate most delivery losses and can distribute water uniformly without depending upon the infiltration rates of different types of soil. The limitation of sprinkler irrigation lies principally in management which sometimes permits surface runoff to occur and sometimes allows irrigation to extend to a point where deep percolation occurs unnecessarily. Better engineering of sprinkler irrigation systems, together with better management and maintenance, can improve the uniformity of distribution of water and, thus, reduce losses by deep percolation. Drip irrigation has the potential to greatly reduce the amount of water lost by evaporation from wet soil surfaces and, if properly managed, can reduce deep percolation and eliminate surface runoff.

Much can be accomplished to improve irrigation efficiencies through better equipment, better methods, and better management. No one of these items will do the job alone.

It takes a combination of good equipment plus an understanding management that can apply water when and as needed at a minimum of surface or deep percolation losses. It is within our power to irrigate with a gross efficiency of 70 to 80% compared with 25 to 30% thirty-five years ago.

EFFECTS OF SIDURON ON BERMUDAGRASS

John VanDam
Associate Agriculturist, Cooperative Extension
University of California, Los Angeles

The Problem: Common Bermudagrass (cynodon dactylon) is a frequent invader of creeping bentgrass (Agrostis palustris) putting greens; and because of its different color, texture, growth habit, and resulting putting characteristics, bermudagrass is considered a weed when encroachment does occur. Previous reports have indicated the herbicide Siduron (Tupersan) is phytotoxic to bermuda, whereas certain varieties of creeping bentgrass are quite tolerant of this chemical. It was the objective of this trial to evaluate the effect of various rates of Siduron on bermudagrass in a putting green seeded to Seaside bentgrass.

In the Spring of 1972, Siduron was applied at the rates of 6, 12, 18, 24 and 30 pounds active ingredient per acre. In the fall of 1972, the plots were split and the same chemical rates were applied to one-half the originally treated areas.

It was found that high rates of Siduron severly affected adventitious rooting of common bermudagrass. Newly formed stolons in plots treated with high rates of Siduron were shorter and had no viable roots present. There was no identifiable effect of any treatments to the creeping bentgrass.

WEAR TOLERANCE DIFFERENTIALS OF COOL-SEASON TURFGRASSES

Robert C. Shearman and J. B. Beard
O. M. Scott & Company
Portland, Oregon

The relative wear tolerance of seven cool-season turfgrass species was determined by four methods of evaluation for both sled (foot-like) and wheel (vehicular) wear injury. The four methods of evaluating wear tolerance differentials were (1) visual rating of wear injury, (2) percent total cell wall (TCW), (3) percent verdure, and (4) percent chlorophyll content per unit area remaining after wear treatment.

Manhattan perennial ryegrass was the most tolerant to wheel wear; Kentucky 31 tall fescue and Merion Kentucky bluegrass ranked second; Pennlawn red fescue and Italian ryegrass were intermediate; while Cascade chewings fescue and rough bluegrass ranked lowest among the species examined. The relative ranking for sled wear was slightly different from that of the wheel. Visual ratings indicated that Manhattan, Kentucky 31, and Merion were equally tolerant to sled wear. However, Merion was the most wear tolerant to sled injury, according to ratings based on the percent verdure remaining after treatment. Manhattan and Kentucky 31 ranked second and third, respectively; while, Cascade chewings fescue and rough bluegrass were essentially destroyed by the crushing and tearing action of the sled.

The wear tolerance differentiation among species for the four methods tested was in high agreement. However, percent verdue remaining was determined to be the preferred method for quantitatively evaluating wear tolerance differentials. It eliminated arbitrary decisions that were inherent in the visual rating system and involved fewer procedural steps than either the percent TCW or percent chlorophyll content determinations.

FACTORS INFLUENCING THE EXPRESSION OF *FUSARIUM* SPP. SYMPTOMS ON BLUEGRASS

Richard L. Baldwin[1] and Victor A. Gibeault[2]
[1]Associate Agriculturist, Cooperative Extension
Ventura, University of California
[2]Farm Advisor Ventura County and Environmental Horticulturist
University of California, Riverside

Fusarium blight of bluegrass occurs primarily as a very severe foot rot in California. Typical circular areas of dead grass up to 8 to 12 inches in diameter develop in the summer.

Trials in Southern California since 1971 indicate the disease is more severe under conditions of infrequent irrigation, high temperature, and high nitrogen. Kentucky bluegrass cultivars Park and Campus were found most susceptible. Common, Windsor, Merion, and Baron were moderately susceptible. Cougar, Fylking, Nugget, Pennstar, Prato, and Victa were least susceptible.

Of various fungicides tried, only bi-monthly application of benomyl at 2 ounces of 50% W. P. applied to 1,000 square feet of turf and watered in gave significant control.

IMPROVING KENTUCKY BLUEGRASS THROUGH HYBRIDIZATION

Gerald Pepin
Director of Research, International Seeds, Inc.
Halsey, Oregon

Kentucky bluegrass is the best known and most widely adapted cool season turfgrass. Although many types of bluegrass are now available, there is still considerable room for improvement over the existing varieties. Improvements in characteristics such as disease resistance, heat and drought tolerance, shade tolerance, and wear resistance would greatly ease the problems now faced by those interested in growing fine bluegrass turf. As continued improvement by selection of naturally occurring off-types is becoming very difficult, some turfgrass breeders are turning to hybridization as a possible new method of improving the bluegrasses.

Hybridization is a plant breeding technique whereby two carefully selected parent varieties are crossed in order to combine the best characteristics of both into a single new variety. By using hybridization, it is theoretically possible to combine a large number of desirable characteristics into one variety.

Only recently has hybridization been utilized successfully in bluegrass improvement. The varieties Adelphi, Bonnieblue, Majestic, and Galaxy are the only hybrid varieties now available; and all were developed at Rutgers University in New Jersey. Although there are still problems to be solved in perfecting bluegrass hybridization, it is likely that more and more improved bluegrasses will be developed by this technique in future years.

COOL SEASON SPECIES AND VARIETY ADAPTATION CHARACTERISTICS

Victor A. Gibeault
Environmental Horticulturist
University of California, Riverside

Cool season turfgrass species are widely used throughout California; and in the past few years, numerous varieties of certain cool season grasses have been released from breeding programs. It was the objective of a series of trials to evaluate performance characteristics of the new varieties on 15 on-site locations in several plant climate zones of California.

Up to 40 varieties were selectively established in replicated plots on golf courses, parks, athletic fields, lawns, etc., from San Diego to Chico. The plots were maintained the same as the surrounding functional turfgrass on each site. Evaluations included turf scores (monthly visual appearance ratings based on a 0-10 system), disease ratings, and other data when appropriate. Results on species/variety survival, rust susceptibility, weed competition, and Fusarium roseum susceptibility are of particular interest.

SEEDING RATE OF PERENNIAL RYEGRASSES FOR TURF IN THE SAN FRANCISCO BAY AREA

[1]Kenneth Gowans, [2]Edward Johnson, [3]Dean Donaldson, and [4]Victor A. Gibeault
[1]formerly Farm Advisor, Bay Area
[2]Farm Advisor, San Mateo County
[3]Farm Advisor, Napa County
[4]Environmental Horticulturist, Riverside

In the past few years, the use of the newer varieties of perennial ryegrass has increased markedly for permanent turf in the cool season zones of California. Suggested seeding rates vary from two to in excess of 10 pounds per 1000 square feet. It was the objective of this trial to evaluate various seeding rates of seven commonly used perennial ryegrass varieties in terms of turfgrass establishment and subsequent performance characteristics.

The varieties Manhattan, Pennfine, Lamora, NK-100, NK-200, Pelo and common perennial ryegrass were seeded at the rates of 1, 3, 6 and 9 pounds per 1000 square feet in a replicated randomized factorial design experiment at the U. C. Deciduous Fruit Field Station in San Jose. Conducive management practices were followed throughout the trial period. Observations included tiller counts per unit area and visual evaluations of density of stand. Visual recordings of cutting quality and insect susceptibility were also made.

AN ALTERNATE METHOD OF PUTTING GREEN MANAGEMENT

John H. Madison, Jack L. Paul, and William B. Davis
University of California, Davis

Continually increasing traffic on putting greens creates problems which have been treated by mechanical and chemical means. Increased ability to handle more traffic by these means appears limited. A simplified program reported here retains present mowing and irrigation practices and substitutes for all other management activities a program of frequent light topdressing. Topdressing sand is used as a carrier for seed, nutrients, and pest control chemicals. Topdressing eliminates formation of a discrete thatch layer, so there is no need for mechanical manipulation of the green with an accompanying increase in weediness.

This report discusses topdressing composition and use and the effects of such a program on playability, thatch development, pests, and labor requirements. Present results indicate that a simplified program based on frequent topdressing presents an economical alternative to traditional management programs.

PLANTS ADAPTED FOR ORNAMENTAL PLANTINGS IN SALT WATER EXPOSURES

Donald F. Rodrigues
Ventura College
Ventura, California

Adverse coastal soil and climatic conditions present a unique challenge to the horticulturist or landscape planner. Most ornamental plant recommendations for California coastal conditions seldom take into consideration complex geographic patterns, micro-environmental considerations or plant adaptation factors. The focus of this study was to investigate the suitability and availability of plant species and to evaluate their adaptability to various coastal situations. A reconnaissance of the Southern California coastal belt was conducted to confirm preliminary academic investigations. The conclusions of this study resulted in a selected plant list for various coastal exposures.

PRIMARY COMMUNICATION . . . THE TALKING EARTHWORM

[1]R. L. Luckhardt and [2]Dan Solomon
[1]Collier Carbon & Chemical Corporation, Los Angeles
[2]Audiovisual Director
Council of California Growers, San Mateo

A "Soil Studies Kit", designed to teach the rudiments of soil structure and plant nutrition to upper elementary youngsters, was premiered at the California Plant and Soil Conference in Fresno, Thursday, January 31.

The kit, which contains a sound filmstrip starring three animated earthworms, a Teacher's Guide, plastic pots, seeds, fertilizer packets, and a sterile growing medium for classroom use and experimentation, was produced for the California Fertilizer Association by the Council of California Growers.

The premier was a part of a larger presentation dealing with agricultural communications by Dan Solomon, Council of California Growers, Audiovisual Director, and R. L. Luckhardt, Director of Technical Services for Collier Carbon and Chemical Company.

AUDIOVISUAL TECHNIQUES IN COMMUNICATING SOILS EDUCATION

Robert N. Wallen
Chairman, Business and Social Science
Mendocino College, Ukiah

In recent years technology has flourished at an ever-expanding pace. Educators have been given a multitude of tools that can promote learning far beyond our current level. First, consider the cassette audio tape which permits the student to complete an entire laboratory assignment in the field in an audio-tutorial framework. Students move to predetermined stations responding to instructions on the tape and printed material. This teaching innovation permits the instructor to work with small groups; and it allows the student to work at his own pace. The second technique involves the use of the video-tape on either cable, or air broadcast, once the video-tape has been produced. The advantages of the video-tapes are many. First, one can prepare a visually oriented lesson by including 16 mm, 35 mm slides, and well-prepared visual graphs and diagrams. After production is complete, the extra cost is reimbursed many times through continual use. Most television stations are cooperative in production and airing of the programs.

ENVIRONMENTAL AWARENESS WORKSHOP AS A COMMUNICATIONS MEDIUM

Ray Morales
Chairman, Department of Civil Engineering
California State Polytechnic University, Pomona

The Environmental Awareness Workshop was created as a result of the concern for the difficulty encountered at the communication interface between historically isolated technical and social disciplines bound by common concerns and directed to a common objective: such as, optimal consideration for environmental equilibrium while satisfying societal needs. The function of the workshop is to articulate these concerns and the needs of various disciplines with the demands exerted by societal needs and to make this information available in language that is most easily assimilated and utilized. This description of function identifies the workshop as a tool for communication.

Many leaders of the water, energy, food, and fiber industries feel that they have similar concerns and responsibilities for the solution of pressing environmental issues, or any other member of our earth community, and that the proper approach for resolving these issues may be that of effective communication, i.e., a program for mutual awareness. The clarification of the interrelated producer-consumer-public responsibility for supply-use-demand and responsibility for the related environmental effects should be a simple enough task as should be the task of pointing out that deterioration of the environment is a direct function of the priority given to a demand for services or products affecting environmental systems. However, how can the critically needed effort by industry and the consumer-public to understand and assume their respective responsibilities be encouraged? Several interested individuals thought that some degree of orientation could be achieved perhaps by a program whereby these interdependent segments could become aware of their interdependence and common objectives.

The Environmental Awareness Workshop is a program that was designed to establish a dialogue of awareness and understanding between the public, the consumer, and the producer. The program attempts to accomplish this by directing its efforts to providing information, exposure, and contacts with industry to that segment of the public that can most effectively communicate with a sizable audience: the classroom teacher whose main function is to enlighten a captive audience. Conversely, the program provides an opportunity for industry to directly communicate with a representative group of the consumer public and to recognize some of the public concerns and needs. To this end, the program provides a consortium of experts that make their expertise, facilities, and materials available to a select audience, such as classroom teachers, so that this vital information may be utilized as classroom material to stimulate objective discussions of critical issues, such as problems of environmental concern.

CROP QUALITY AND HUMAN HEALTH

B. S. Schweigert
Department of Food Science and Technology
University of California, Davis

Crops, particularly cereals, have had a great deal of attention from food scientists and nutritionists in view of the key contribution these foods make to the diet of man and animals of economic importance. Very small improvements in nutritive value, such as protein content, of the major cereals in the diet of man (rice, wheat, corn, sorghum, or barley) can have a much greater impact on the nutritional well-being of man than major fortification programs, which often receive far more public attention.

The significance of major research efforts to improve the protein and lysine content of cereal grains through breeding programs will be reviewed with particular attention to the criteria of nutritive quality changes and the evidence of usefulness of such modified crop varieties for developing cereal-based foods for man and the potentials for further research in this field.

The significance of the use for various foods in relation to human health goes far beyond nutritive value and quality attributes, such as functional properties for developing appropriate cereal-based products for various cultures. The possible occurrence of naturally occurring toxicants is a key example. In the case of the cereals, we think primarily of enzyme inhibitors and other changes in the value of such foods for man, such as if aflatoxins should develop during storage of such foods due to mold growth.

Finally, we need to consider the total utility of our cereal-based foods in that there is an increasing concern among nutritionists that the use of too large quantities of highly refined foods may reduce providing trace minerals and other essential nutrients for man as compared to the unrefined food products. We have limited evidence that this is a concern, but it is something to keep in perspective in terms of the total health aspects of various dietary patterns.

FERTILIZATION AND QUALITY OF CITRUS

T. W. Embleton, W. W. Jones, and R. G. Platt
University of California, Riverside

Many factors of citrus fruit quality are affected by fertilization, some favorably - others unfavorably. The effects of N, P, and K on orange quality are summarized in Table 1. Most of the effects of raising the N level in orange trees are adverse. Thus, under most circumstances, the N level should be no higher than that necessary to maintain maximum fruit yield.

The influences of N, P, and K on grapefruit quality are similar to those on orange. Limited research in California indicates that the N effects on grapefruit are not as great as on the orange.

N and P have little practical influence on lemon quality. However, an increase in K has many favorable influences on lemon quality, including an increase in fruit size, smoother fruit with thinner peels, and greater juice percentage, and a greater amount of acid per ton of fresh fruit. This latter influence is particularly important in fruit that enters juice-marketing channels.

Table 1. Fruit Quality Effects Associated With an Increase in N, P, or K in orange trees.[1]

	N[2]	P[2]	K[2]
Fruit size	--	-	++
Time to color break	+	+	+
Regreening of Valencias	++	+	+
Rindstaining of navels	++		
Peel thickness	++	-	+
Coarseness of peel texture	++	-	+
Creasing	-	+	--
Fruit splitting from K deficiency			-
Percent juice in fruit	--	+	--
Percent soluble solids in juice	o	-	-
Percent acid in juice	+	-	+
Ratio, solids to acid	-	+	--
Vitamin C in juice	-	--	++
Pounds acid per ton of fruit			++

[1]For most of the above factors, an increase in the element in question from the deficient to adequate level for fruit set will give a stronger effect than an increase within or above the adequate range.

[2]Key to symbols: + indicates a positive relation; - indicates a negative relation; ++ or -- indicates a strong effect; o indicates no change or inconsistent relation; the absence of a symbol indicates data is not available.

THE IMPACT OF BREEDING AND ENVIRONMENT ON CEREAL QUALITY

C. O. Qualset
Department of Agronomy & Range Science
University of California, Davis

Widely different yields and quality of cereal grains are realized from year-to-year or place-to-place even within a rather small agricultural region. Wheat provides an excellent example of the complexity of the genotype-environment problem. For many years now, market classes of wheat grain have been recognized, primarily on the basis of the ultimate usage of the grain for human consumption. Quality has been defined mainly on the basis of its properties for industrial uses and not so much for its nutritional value to humans or animals. The recognition of market classes has served to standardize the quality characteristics of the crop because of climatic similarities within a region. However, in California, the situation was never clear because wheats of widely differing quality were grown throughout the state and the quality varied considerably. More recently, new varieties, developed in Mexico, have virtually replaced all of the old California varieties because of their stripe rust resistance and high grain yielding ability. This introduced a new and completely unknown situation with respect to quality and classification according to market class. White-grained wheats had been grown in California; and the new varieties are mainly red-grained. Some of these wheats have soft texture in one environment and relatively hard texture in another. They are all wheats with spring growth habit that are planted in the fall or winter months. The grain has often been sold in the soft red winter market class because of variable quality and because no "soft red spring" category existed.

These difficulties in defining the crop for marketing indicate the need for evaluating the quality characteristics of new varieties when grown over a wide range of environments. A study of this type was conducted with 10 wheat varieties at 4 locations in the Central Valley of California for 3 years. Quality evaluations were done at the USDA Western Wheat Quality Laboratory in Pullman, Washington. Common wheats have two main uses: the largest usage is for breadmaking and a smaller amount is used for pastries and crackers. Breadmaking requires moderately high protein content with good quality gluten.

For pastries, low protein flour is desirable. Seventeen characteristics relating to those two major usage categories were evaluated. Almost without exception, the following results were found for these characters: (1) Highly significant varietal differences; (2) years and locations interacted significantly; and (3) varieties did not interact with years or locations separately, but the varieties x locations x years interaction was highly significant. These results suggested that genotype x environment interaction was important for wheat quality and that it is not possible to allocate varieties to locations on the basis of their quality characteristics. Further, these results imply that regional quality characteristics cannot be predicted, at least for the three areas studied (Sacramento Valley, Sac-SJ Delta, and San Joaquin Valley). The situation is improved by considering the performance of the variety with the best quality - in this study, INIA 66 was most desirable for breadmaking. None of the varieties had very good pastry quality. The major determinant of quality was flour and grain protein content. Since INIA 66 usually had the highest protein content of all varieties in any particular environment, it was more likely to have acceptable quality than the remaining varieties. Therefore, one way of reducing the complex genotype-environment interaction problem is through development of varieties that have acceptable quality even in "low-protein" environments (for bread types); and such varieties are expected to have outstanding quality when grown in "high-protein" environments. The relationship of bread loaf volume to grain protein content provides another saving factor regarding genotype-environment interaction. This relation was positive and significant for all varieties. The slopes of the regression lines were similar for the varieties, with the exception of Siete Cerros 66, Super X, and Nainari 60, which generally had unacceptable breadmaking properties. When these regression lines are established with sufficient accuracy, an indication of the breadmaking quality is given by the protein content; and this provides an aid to marketing. The relation for pastry quality was not so clear in this study. A strong negative relationship is expected with cookie diameter and grain protein. This is observed when good pastry varieties are grown in a wide range of environments. The regression coefficients for 8 of the 10 varieties were negative; only one was significantly different from zero. The deviations from regression were very large; and grain protein content was virtually useless as an indicator of pastry quality. This relation will have to be investigated again using varieties more acceptable for pastry uses.

Some of the environmental factors, such as moisture, temperature, and plant nutrition, have been studied extensively in relation to wheat quality. Only limited data are available in California regarding management variables. In one study conducted for 2 years at Davis, 7 varieties were grown at varied nitrogen levels up to 400 pounds per acre. Addition of N above 150 pounds per acre did not result in economic yield increases; and protein content was improved only about one percentage unit. Thus, it appeared that N fertilization would not have a large effect toward reducing genotype-environment interaction for quality. Additional research in this area is badly needed.

Nutritional quality has been of increasing concern during recent years; and improved amino acid balance is the prime target for improved quality. The amino acid lysine must be provided to humans and monogastric animals through the diet. For human use, it is the first limiting amino acid in wheat flour. Attempts have been made to identify sources of high lysine for use in breeding wheats of improved quality. Variation has been found, but it is not highly heritable, based on preliminary studies. It has been found that lysine content, like technological quality characters, also exhibits genotype-environment interaction. When considered on a whole grain basis, the interactions are similar to those found for protein content; however, when expressed as a percentage of protein, the interactions are much smaller. This relation does not hold completely though because there is a general decrease in lysine in the protein as the protein content is increased in the grain. This suggests that different kinds of proteins (probably soluble albumins) are produced in high-protein wheats or in all wheats grown at high-protein environments.

It is important to characterize the functional proteins in great detail, including physical properties, amino acid content, and possibly amino acid sequence in order to develop varieties having increased portions of those proteins or protein fractions that have desirable effects on nutritional quality. Breeding for specific components may provide a means of stabilizing quality over environments and, at the same time, provide the plant breeder discrete selection criteria for complex traits, such as wheat quality. Some efforts have been made in this direction. An example is the characterization of some of the components of gliadin proteins by D. D. Kasarda and co-workers at the USDA Western Regional Laboratory at Berkeley. They have found that certain alpha-gliadin proteins are present or absent depending on the variety. The alpha gliadins have been characterized with respect to amino acid composition and even to some extent the amino acid sequence of certain components. The importance of these results to the plant breeder are obvious; and another aspect has to do with human disease. Celiac disease causes malabsorption of nutrients in the small intestine by destroying epithelial cells. People predisposed to celiac disease cannot eat wheat products because of a toxic factor in wheat. It has been determined that certain peptides of the alpha-gliadin fraction of gluten proten are responsible for this disease. Since there is genetic variability for gliadin proteins, it may be possible to breed a wheat variety that is nontoxic to celiac patients.

The complex role of breeding and environment on cereal quality is no way minimized by these remarks. It seems obvious that greater understanding of environmental factors affecting plant growth and biochemical factors affecting quality are urgently needed.

FRUIT QUALITY AS AFFECTED BY FERTILIZATION AND MATURITY

L. L. Claypool
Professor of Pomology
University of California, Davis

In this discussion "quality" is used to denote attractiveness to the consumer, whether the commodity was used fresh or in some processed form. Health and food value factors, already discussed, will not be considered. Attractiveness to the consumer is associated primarily with appearance, flavor and texture. Quality standards for fresh or processed fruits are usually based solely on appearance factors, but other factors may occasionally be used as well.

For the purposes of this discussion, I will separate fruit tree nutrition as it relates to fruit quality into three categories:

1. Appearance abnormalities associated with nutrient deficiency, excess, or imbalance.

2. Nutrient deficiency symptoms affecting foliage or other vegetative parts, but no fruit symptoms visible.

3. Nitrogen nutrition.

The first category includes fruit distortion, such as from boron deficiency and boron and copper excess. Such fruit would not normally reach the market because of the obvious nature of the disorders. On the other hand, bitterpit, a physiological disorder of apples thought to be associated with Ca/Mg relationships, would likely be found in fruit on the market as symptoms may not be detectable at harvest.

Deficiencies in category '2' are likely to adversely affect fruit flavor if photosynthetic capacity is significantly reduced, thus lowering soluble solids. Fruit size, also a potential quality factor, may be reduced as well.

Relationships between nitrogen nutrition and fruit quality are of far greater interest than relationships previously noted. Some of the quality effects are highly subtle. Massive applications of nitrogen have been applied annually by some orchardists with varying effects on fruit quality. Delay in maturity and reduction in red color development with increased N are two of the better known quality effects related to nitrogen. Some of the more subtle effects include the following: a) Lower flavor associated with low soluble solids resulting from overcropping made possible by high N regime. May be complicated by competition for carbohydrates between maturing fruit and new vegetative growth, the latter forced by high N; b) Variable maturity of fruits on different trees, of fruits on different parts of the same tree, or of different parts of the same fruit. Irregular ripening of apricots where the stem end of the fruit is much greener than the stylar end is an example of a quality problem to the canner; c) Changes in chemical composition of fruit having quality implications. Softening of canned apricots associated with low pH is one example. Low pH is correlated with low N, but high N while elevating pH causes irregular ripening. Discoloration (browning) of canned freestone peaches associated with high anthocyanin in the flesh is another example. High N indirectly relates to the problem because apparent maturity based on fruit shape and exterior appearance is delayed more by high N than is pigment formation. No doubt other subtle quality effects will be demonstrated for nitrogen and other nutrients as well.

Maturity, whether affected by nutrition or not, poses increasing quality problems to our fruit industries. Advancing maturity is associated with fruit softening. Softer fruits are more easily damaged by impacts. Mechanization of fruit harvest and subsequent handling procedures increases the potential for impact damage. Improvement in uniformity of maturity by nutritional and other chemical control can do much to aid in ultimate fruit quality.

ALFALFA QUALITY - ITS PRODUCTION AND UTILIZATION

Vern L. Marble
Extension Agronomist
University of California, Davis

Alfalfa is the most important high-quality forage in California. It furnishes 40% of the nutrient requirements of dairy cattle, who consume 70 to 80% of the crop. Approximately 40% of the total money spent in dairy operations is alfalfa. Plant breeders are improving alfalfa quality through breeding for higher leaf percentages, redesigning stem structures with less lignified xylem cells, increasing disease and insect resistance that cause preharvest leaf drop, improved protein content, improved digestibility, and elimination of the negative nutritional factors, such as saponins, etc. While this work will eventually result in improved quality in alfalfa, greater affect can be made in quality by manipulation of maturity and in controlling factors that affect quality, such as leafiness, green color, contamination with foreign material, and condition of the hay when baled. When these factors are controlled, the palatability and digestibility of alfalfa hay are inversely related to its maturity. As the length of time between cuttings is increased, the maturity increases, lignification proceeds, and digestibility to cattle is decreased.

The ultimate quality of alfalfa is controlled by the producer primarily by decisions he makes regarding: 1) harvest frequency; 2) management practices that influence weediness; 3) area of production and soil type; 4) hay-making practices; 5) choice of a variety.

Research conducted 20 years ago with antique varieties indicated that the optimum yield/quality compromise was 10% flower. A higher quality was produced at bud stage maturity, but yield was reduced 15, weediness increased 200, and harvest costs 33%. Cutting at 50% bloom decreased quality significantly, reduced harvest costs 13%, and only increased yield 1%. Research initiated in 1971 has challenged the validity of the yield and quality assumptions. Using five varieties of distinctly different growth habits, this research has revealed that varieties differ in their response to cutting frequency, that varieties continue to increase in yield up to and past 50% flower, that quality decreases with increasing maturity, that weediness begins to increase at 10% flower and comprises up to one-half the yield at more immature harvest stages, and that root reserves and, hence, vigor of the alfalfa regrowth decreases sharply as the cutting interval is shortened from 50% flower. Ranger, a leafy, fine-stemmed variety considered unadapted to California, continued to increase in yield and was the highest yielding variety when allowed to go to the 75% bloom stage, with a quality equal to or better than adapted varieties cut at 10% flower.

These results place in question the validity of variety evaluation with varieties of widely differing dormancy types harvested at the same time. Moreover, from a producer's point of view, it does not seem wise to cut at 10% bloom or less without buyers paying a premium for increased quality produced at the expense of decreased tonnage, increased weediness, and shorter stand life.

Sampling in the hay markets indicate that visual estimates (federal grade) of alfalfa quality are unreliable for judging maturity. A chemical procedure has been developed by U. C. Davis that can predict the quality of alfalfa hay, requiring only two analyses, a dry matter and a modified crude fiber determination. U. C. research has established relationships that reliably predict estimated net energy, total digestible nutrients, and digestible protein values from these two analyses. Combined with visual analysis to sort out unpalatable lots, chemical analysis accurately predicts digestibility and provides a method for determining the quality of hay offered for sale.

Feeding trials reveal that at a uniform stage of maturity, alfalfa produced on clay or clay loam soils was shorter, leafier, and higher in protein and digestibility than alfalfa grown on soils of coarser texture. Alfalfa that was raked and baled under dry conditions lost 30% of production and up to 50% digestibility. A rain of 0.63 inches reduced alfalfa efficiency to produce gain by 14%. Dehydrating increased efficiency by 21% when compared with field-cured alfalfa. Alfalfa harvested at comparable maturity stages will be higher quality in the spring and fall than in the summer. Alfalfa harvested in the bud stage and 10% bloom stage was, respectively, 31 and 11% more efficient in producing gains than lower quality hay cut in the 50% bloom stage.

Increased efficiencies in digestibility for hay cut in the late bud and early bloom stage must be balanced against decreased yield, shorter stand life, and decreased income for the producer. A system now exists that will allow the identification of superior alfalfa and the establishment of a pricing system so the purchaser can compensate for the production of higher quality alfalfa.

QUALITY MAINTENANCE IN FRESH PRODUCE DURING STORAGE AND HARVEST

Werner J. Lipton
Market Quality and Transportation Research Laboratory
ARS, USDA, Fresno, California

Quality of vegetables has two components, the intrinsic quality, i.e., flavor, odor, or nutritional value, and condition, i.e., the presence or absence of bruising, decay, or other defects. Both components directly affect the value of our vegetables, but maintenance of condition, particularly as condition is affected by handling practices between harvest and shipment, is an appropriate topic for this conference.

Physical injury to vegetables after harvest is the major cause of direct and of indirect losses because injured tissue readily decays. Damage prevention must start at harvest and must be a prime concern of all who handle fresh vegetables or melons.

Decay prevention is another major need. Decay can be minimized by prompt cooling of produce after harvest, by adequate sanitation of field boxes or bins, and by decontamination of wash water and of sorting and packing lines.

Water loss also must be minimized because wilted vegetables are unsightly and nutritionally inferior. Wilting of vegetables can be retarded by shading them during transit in open trucks and while they are waiting to be cooled or processed, and finally, by prompt cooling.

Excessively low or high temperatures in the field also can reduce the postharvest quality of vegetables and melons. Chilling-sensitive crops that have been chilled in the field should either not be shipped, or they should be shipped only if the chilling exposure has been brief. Sunburn and other disorders caused by exposure to solar radiation can be minimized by misting, sprinkling, or by whitewashing, as appropriate for the crop.

Careful handling and proper temperature management at the production end can help maintain vegetables in good condition throughout the marketing chain; and these practices often provide a bonus by maintaining the nutritive value of the product.

POTPOURRI IN BREEDING

Frank W. Zink
Research Specialist in Vegetable Crops
Agricultural Experiment Station
University of California, Davis

A mosaic disease of Lactuca sativa L. is described and the causal agent identified as turnip mosaic virus (TuMV). Extensive infection reduces the yield appreciably or may destroy entirely the value of the crop. A survey of L. sativa cultivars indicated that TuMV susceptibility is restricted to downy mildew, Bremia lactucae Reg., resistant crisphead types: Calicel, Calmar, Calmaria, E-4, Imperial 410, Imperial Triumph, Montemar, Monterey, Valrio, Valtemp, and Valverde. Resistance to mildew in these cultivars stems from a Lactuca serriola L. collection (P. I. 91532); strong circumstantial evidence indicates that TuMv susceptibility in L. sativa was introduced into the mildew-resistant progenies derived from P. I. 91532.

Resistance to TuMV and mildew are each controlled by a single dominant allele designated as Tu and Dm. The TuMV-susceptible allele, tu, is linked with the mildew-resistant allele, Dm. In the repulsion phase, the crossover value was 12.5% $\pm$ 1.6. Forty-three lettuce cultivars resistant to one or more mildew races in Israel or the Netherlands were assayed for reaction to the California mildew race(s) and to TuMV. The crisphead cv. Avoncrisp was both mildew and TuMV resistant. Twenty-seven butterhead type cultivars, two leaf type, one cos type, and one Latin type were resistant both to the California race(s) of mildew and to TuMV.

The inheritance of resistance to California race(s) of downy mildew was studied in the TuMV resistant cvs. Bourguignonne, Meikoningin, Proeftuin's Blackpool, Red Salad Bowl, Salad Trim, Ventura, and P. I. 164937. Resistance in cvs. Bourguignonne, Red Salad Bowl, and Salad Trim is conferred by a single dominant allele. This is the same allele found in the TuMV-susceptible cultivars derived from P. I. 91532. Resistance in Meikoningin is controlled by a single dominant allele different from the one derived from P. I. 91532. Allelism tests indicate that the two alleles are independently inherited. Proeftuin's Blackpool and Ventura each have two dominant alleles for resistance that are different from the single dominant allele derived from P. I. 91532. Allelism tests of Proeftuin's Blackpool and Ventura indicate resistance is conferred by the same two dominant alleles. The two alleles in cvs. Proeftuin's Blackpool or Ventura and the single allele derived from P. I. 91532 are independently inherited. Resistance in P. I. 164937 is conferred by two dominant alleles, one of which is the same as the single dominant allele derived from P. I. 91532.

SALT TOLERANT CROPS?

Emanuel Epstein
Professor, Department of Soils and Plant Nutrition
University of California, Davis

In California and other arid and semi-arid regions in the West and elsewhere in the world, salinity is a severe problem both actually and potentially. Success in coping with this problem could make large contributions to the production of food and fiber, worldwide. It could increase the crop production potential of soils already affected by salinity and provide insurance against the contingency that our future ability to raise crops may be impaired through salinization of soils and waters in irrigated areas, nearly all of which are subject to this hazard.

In a sense, salinity may be looked upon as an aspect of environmental pollution. Much has been written in recent years on various esoteric pollutants and their inhibitory effects on plant and animal life. But, it is seldom realized that by far the most significant inhibitory substance plants may encounter in soils is salt; and that it affects larger areas than any other toxic substance. Part of this salinity exists naturally; additional areas have been affected through man's activities, mainly irrigation with water that is itself saline.

The conventional way of dealing with this problem has been to reclaim the soil by leaching to remove the salt, that is, to transfer it elsewhere. In other words, the approach has been to suit the soil to the crops. We have underway a project in which we take a different tack, namely to suit the crop to the soil.

Virtually all economic crop plants are sensitive to salt. This does not, however, imply that plant life is incompatible with high concentrations of salt in the medium. Witness the phytoplankton of the oceans, the halophilic bacteria, and halophytic land plants - those indigenous to the sea shores, salt water marshes, and saline desert soils. The problem is that so far there exist virtually no plants combining high value as crops with a high degree of tolerance to salt.

Is there evidence that salt tolerance is under genetic control and, therefore, amenable to genetic manipulation? The answer to this question is: yes, as indicated in surveys of the available evidence (1, 2, 3). The point was made "that much is to be gained by an energetic pursuit of the possibilities of breeding for salt tolerance(3)." Evidence obtained in Davis has since given support to this conclusion. Our work also includes a program on the physiology of salt transport and toleration by plants.

The existence of salt tolerant species or strains of plants, on the one hand, and of marked, genetically controlled differences in salt tolerance, on the other, presents a challenge and an opportunity. It opens the prospect of developing plants which combine high value as crops with a high degree of resistance to the damaging effects of salinity.

In view of the fact that fairly low levels of salinity can be severely injurious to many plants, even modest success in this direction would amount to a valuable contribution to world agriculture. Since no large-scale, concerted effort of this kind has so far been made, it is quite possible that such an effort, well conceived and energetically pursued, may result in better than merely modest success. Recent experiments in Davis will be described and discussed.

Supported by the National Science Foundation and National Sea Grant Program, United State Department of Commerce.

1. Epstein, E. 1963. Selective ion transport in plants and its genetic control. Desalination Research Conference Proceedings. National Academy of Sciences - National Research Council Publication 942. Pp. 284-298.

2. Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons, New York.

3. Epstein, E. and Jefferies, R. L. 1964. The genetic basis of selective ion transport in plants. Ann. Rev. Plant Physiol. 15: 1969-1984.

EXPERIENCES IN HYBRIDIZING BARLEY VIA THE BALANCED TERTIARY TRISOMIC SYSTEM

Robert W. Matchett
Barley Breeder, Northrup King and Company
Woodland, California

The successful commercial use of any hybrid crop species is dependent on a number of factors. Certainly of most importance is the overall genetic system utilized in producing the hybrid seed. The system must give a reliable and economical source of male sterile individuals to serve as the female parent of the hybrid.

Because barley is a relatively low income crop (until this year) and because the ratio of seed planted to seed harvested is greater for barley than for other hybridized crops, such as corn and sorghum, the system must allow for the production of crossed seed in abundance - and do it economically. Since barley is also a widely cultivated species, it is necessary that this genetic system operate consistently over a wide range of environments and under different management practices.

In addition to the above prerequisites, but possibly not as biologically demanding, is the requirement that the genetic system for producing hybrid seed be relatively simple and adaptable to full mechanization.

The system in barley for producing hybrids, which I will discuss at this 1974 California Plant and Soil Conference, meets the above demands with the exception of now being a simple system adaptable to full mechanization. Our research efforts are designed to develop this genetic mechanism for hybridization to the extent that we are able to produce a hybrid barley which will insure a profit for both the grower and the seed producer.

The system we are developing for hybridizing barley is the Balanced Tertiary Trisomic system as "engineered" at the University of Arizona in 1966.

A balanced tertiary trisomic plant (BTT) is one which contains an extra chromosome, a translocated one, derived from a heterozygous translocation. Properly chosen, this extra chromosome will establish a linkage for the genes Ms and A, related to male sterility and genetic sorting, respectively. The trisomic genotype is set up in such a manner that the normal diploid chromosomes are ms ms a a and the extra chromosome is Ms A. This BTT is both fertile and green.

Upon selfing a BTT, pollen grains with the extra chromosome fail to function, thus leaving only ms a type pollen grains as the functional type. Eggs of both types survive; and upon fertilization, give Zygotes that are both BTT (approximately 30%) and diploid (approximately 70%). The BTT's are fertile green and self perpetuating while the diploids are albino and die.

In order to obtain a supply of male sterile plants, it is necessary to cross male sterile green plants ms ms A a X BTT plants ms a ms a + Ms A which will give 50% ms ms a a albinos and 50% ms ms A a male sterile greens. Seed of the latter type is used to both repeat the cross just made, to produce more male sterile plants, and is also used as the female parent of the commercial hybrid. A seeding rate adjustment must be made in that case where the albinos appear in this scheme.

Not only must this scheme work on paper, but, more importantly, in commercial production, also. Past experience leads us to believe that the system as outlined will work.

Barley, as developed by early man, evolved into an autogamous species exhibiting rather low degrees of cross pollination.

Even so, hybrid seed has been produced successfully in both California and Arizona. Some commercial seed production fields in California have yielded over 2800 pounds of cross-pollinated seed per female acre.

Cross pollination is one of the major and yet unsolved problems for many environments. Through selection and breeding within genetically diverse populations containing male sterility, lines are being developed which possess good seed-setting ability upon outcrossing.

Not of least importance, of course, is the factor of heterosis. Does sufficient hybrid vigor exist to make barley hybrids economically attractive?

Heterosis and combining ability studies at public institutions have revealed some encouraging yield data on hybrids. Our own yield data gathered over numerous locations for a period of three years makes us optimistic regarding the yield potential we think exists to be exploited in hybrid barley.

In conclusion, Northrup, King is optimistic about the future of hybrid barley; but at the same time realizes that some basic breeding research is still very much necessary before the Balanced Tertiary Trisomic system for producing barley hybrids becomes a reality.

HOW TO AND HOW NOT TO MINE
THE VAST GENETIC POTENTIAL OF TREE FRUIT NUT SPECIES

Paul E. Hansche
Associate Professor, Departments of Pomology and Genetics
University of California, Davis

Analyses of measurements on thousands of offspring arising from matings among hundreds of parents in each of several tree fruit and nut species indicate that the rate of genetic improvement obtainable in the commercially important traits in these species is less than one-half that usually obtainable in agronomic species. They further indicate the cost per unit of genetic improvement in these species is between 100 and 10,000 times the cost of improvement of agronomic species.

However, if the generation length of tree fruit and nut species could be reduced to one-fourth their usual length and if the size of these trees could be reduced to one-fifth their usual size; then the cost per unit genetic improvement would be reduced by about 90% and the attainable rate of genetic improvement would be increased by four fold.

Genetic dwarfs that reduce the size by four-fifths and more are common in these species. Furthermore, the technology required to eliminate seed dormancy and sufficiently reduce the period of juvenility to shorten the generation length in these species to one-fourth their current lengths seems well within our grasp.

Therefore, it is proposed that the potential benefits to variatial improvement programs of genetic dwarf tree fruit and nut species with short generation lengths is sufficiently large to warrant serious efforts to develop the technology required.

BREEDING THE SUGAR BEET -
THE SWEETER THEY ARE, THE BETTER OUR FALL

James D. Schulke
Plant Breeder, Spreckels Sugar Company
Salinas, California

Until 1973, breeding and genetical work on sugar beets in America has been performed by sugar company and USDA personnel. The industrial breeders primarily work to perfect varieties grown under contract by their respective companies; and the USDA scientists have generally been assigned disease-resistant projects. Yet the genetical tools available in sugar beets suggest that it might be an excellent species for university scientific work.

Since 1950, two large changes have been made in sugar beet varieties. They include a switch from open-pollinated varieties to multigerm hybrids and, then, to monogerm hybrids. Sugar content has declined through this period, but data show that, genetically, the new varieties have generally been superior. The yearly fluctuation in the sucrose content of a sugar beet crop may be somewhat predictable by tasting the sugar content of some fruit crops. This suggests that some environmental factor occurring in a certain year has a large influence on sugar accumulation in plants.

In California, sugar beets are planted somewhere during 10 different months and also harvested over a 10-month period. Many topcross hybrids have shown a wide adaptation throughout the State. Two- or three-way crosses involving inbred lines, however, have frequently shown distinct genotype x location interactions. From some of the data, it is suggested that the determining factor for this interaction occurs during the first 6 or 8 weeks of the plant's life.

JOJOBA - FOLKLORE AND AGRONOMIC POTENTIAL

D. M. Yermanos
Professor, Department of Plant Science
University of California, Riverside

Jojoba (pronounced "hohoba") has been known for a long time as a browse plant and as a source of liquid wax with many potential uses. Its natural habitat is the Sonoran Desert of Mexico and the southern parts of California and Arizona between latitudes 25° and 31° North, and elevations of 2000 to 4000 feet.

The similarity between jojoba wax and sperm whale oil in chemical composition and rheological properties makes jojoba wax a potential substitute for the 50 million pounds of sperm whale oil annually used in the United States. Jojoba seed contains about 50% wax, which, for most industrial processes, can be used without any refining. The wax has a high viscosity index, high flash and fire points, and a rather pleasant odor. It takes up larger amounts of sulfur than will sperm whale oil without turning dark in color and remains unaltered by repeated heatings to high temperatures. Because of its properties, jojoba wax is considered to be a valuable raw material in the manufacture of lubricants, pharmaceuticals, cosmetics, floor waxes, and candles.

Jojoba survives extreme daily fluctuations of temperature, ranging from 15° to 115° F. and is extremely draught resistant. Two avenues appear to be open for the commercial production of jojoba seed: (a) harvesting the existing natural populations and (b) establishing new cultivated stands of jojoba.

Initial trials for harvesting the wild populations indicate that 4 to 6 pounds of seed can be harvested per hour by hand. In spite of higher efficiency of harvesting expected with experience and with simple harvesting devices, manually harvested jojoba seed would produce wax which would have to sell for a considerably higher price than sperm whale oil. Under cultivation and with mechanized harvesting, however, it appears that jojoba wax could be produced at a highly competitive price. Research work is now underway in the University of California in Riverside to evaluate the potential of jojoba as a new crop for California agriculture.

NEW CONCEPTS OF MINIMIZED LEACHING

Leon Bernstein
Plant Physiologist
USDA Salinity Laboratory, Riverside

Experiments were carried out in forty, five-feet deep (2 ft. i.d.) greenhouse lysimeters between 1967 and 1973. Lysimeters were filled with Pachappa sandy loam soil with tensiometers for determining water depletion and ceramic cups for extracting soil water samples by suction at one-foot depth intervals. Drainage was collected by gravity flow or suction through filters. Alfalfa was harvested approximately monthly in experiments of two to three years' duration.

In the first experiments, the effects of 1.0 and 2.0 mmho/cm irrigation waters were compared at various leaching percentages (LP's) that produced maximum salinities in the lower root zone ranging from about 4 to 26 mmho/cm. Increasing the concentration of the soil water in the lower soil zone to 14 mmho/cm had no effect on yield; but a further increase in salinity of the lower root zone to 26 mmho/cm decreased yield by 15%. Yields with the 2.0 mmho/cm irrigation water were consistently lower by 10% than with the 1.0 mmho/cm water which produced the same yield as the 0.4 mmho/cm control water. Thus, an increase in salinity of 1.0 mmho/cm in the soil water of the upper root zone had about the same effect as a 20 mmho/cm increase in the soil water of the lower root zone. It is concluded that alfalfa responds to the different salinities in a root zone in proportion to relative water uptake from each level of salinity.

An experiment in which irrigation frequency was varied showed that major increase in salinity occurred at, or immediately below, the depth to which major water use was limited. These changes in salinity profiles had no effect on yield. Also, when minimal leaching (LP's of 3.1 and 6.2 with the 1.0 and 2.0 mmho/cm waters, respectively) was done evenly in all irrigations, yields were 9% lower than when leaching was concentrated in every third or sixth irrigation. Thus, even when steady-state salinities of 26 mmho/cm had developed in the lower root zone, achieving the necessary leaching every two months (every sixth irrigation) was as effective as regular leaching in every irrigation.

Sodium and chloride concentrations in the harvested alfalfa were similar at all LP's with a given irrigation water, but increased significantly with increasing salinity of the irrigation water. Thus, salt uptake, like growth, was responsive to the minimal salinity in the upper root zone determined by the salinity of the irrigation water, but not to the maximum salinity in the lower root zone as long as salt balance was maintained. When leaching was discontinued in one experiment, salinity in the root zone rose to a maximum of 35 mmho/cm, providing an estimate of the maximum soil water salinity achievable by alfalfa roots. This figure, which can also be estimated from salt-tolerance data, can be used in calculating leaching requirements for maintaining steady-state salinity with minimum leaching. For crops of low and moderate salt tolerance, leaching requirements are, therefore, reduced to about 25%, and for highly tolerant crops to 40%, of the previously recommended values. Satisfactory yields at low LP's indicate great potentials for increasing irrigation efficiency, decreasing the volume of drainage water, and for minimizing salt load in river systems by maximizing the harmless precipitation of salt in the soil and by minimizing salt pickup from irrigated lands.

Reference: Bernstein, Leon and Francois, L. E. 1973. Leaching Requirement Studies: Sensitivity of Alfalfa to Salinity of Irrigation and Drainage Waters. Soil Sci. Soc. Amer. Proc. 37: 931-943.

SALT AND THE COLORADO RIVER

W. Don Maughan
California Water Resources Control Board
Sacramento, California

The Colorado River supplies nearly all of the irrigation water supplies to Southern California. Its salinity has been increasing ever since development began in the basin. The river is almost totally controlled with a "storage capacity - annual runoff" ratio of more than 4 to 1. Projections are that the water will continue to get saltier, unless effective remedial measures are taken.

Two main causes of the salinity are natural saline springs and irrigated agriculture. Since 80% of the water in Southern California comes from the Colorado River, and 75% is used by agriculture, the problem is of major concern. Natural ground water basins that are being partially recharged with Colorado River water are threatened with potential degradation with salts.

The Colorado River salt problem must be solved if its water supplies are to be used indefinitely. Used on an interim basis, it must be closely monitored. The basic solution must come from a basinwide approach involving the seven western states through which it flows. The State Board is also reactivating the Agricultural Water Quality Advisory Committee to assist the Board in implementing plans to deal with the salt balance problem.

IMPLICATIONS OF NEW RESEARCH FINDINGS ON POLLUTION CONTROL

Dwight C. Baier
California Water Resources Control Board
Sacramento, California

Both federal and California state law require that the quality of irrigation return flows be regulated. The staff of the State Water Resources Control Board (SWRCB) is now studying procedures to develop a rationale for setting limits on salts in such return flows. The seeds of the answers appear to lie in the recent research on leaching fractions as they affect mass emissions of salts. The dilemma for government is what regulations are needed to force irrigators to be more efficient. Industry participation in the decision-making process is being sought in the form of a reactivated Agricultural Water Quality Advisory Committee; and technical advice is being received from the University of California, Committee of Consultants.