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PRESIDENT'S ADDRESS

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LOS ANGELES

Ladies and Gentlemen:

The California Avocado Association has now completed its seventh year. During this time we have built up an organization of 450 enthusiastic members. The avocado industry in Southern California has had a phenomenal growth since the organization of this association. It is not my purpose today, however, to enter into a discussion of what our association has done in the past. That subject has been fully and ably presented by my predecessor in some of his annual addresses. In brief, however, I will say that we have collected valuable data concerning the different varieties of avocados and their adaptabilities to the climate of Southern California. A large amount of work has been devoted to the task of selecting from a large list some of the better varieties for propagation here. In fact, we have successfully performed the preliminary work which is essential to the success of any new horticultural industry.

No industry, however, can look forward to an indefinite period of prosperity without maintaining a department for systematic research. This is especially true of horticulture. It is not desirable or even possible for any horticultural industry to remain permanently in any definite and fixed condition. The horticulturist is continually meeting new and increasingly complex problems. The improvement of varieties, the maintenance of soil fertility, the study of plant diseases, insect pests and injurious fungi, and the adjustment of conditions to ameliorate the hazards due to climatic changes must always occupy a prominent place in any successful horticultural industry. Continuous and systematic research is the only means whereby such problems can be successfully met and solved. The time has arrived when this industry should be operated on a strictly scientific and business basis. It is my purpose to discuss in this paper some of the scientific aspects of the avocado and leave the business side until the business meeting later in the day.

One of the most important problems with which horticulturists are concerned is the improvement of varieties. No field offers greater opportunity for scientific research and no field has yielded more interesting and valuable results. An immense amount of work has been done to improve other fruits and vegetables, and remarkable results have been obtained. In the case of the avocado, however, one of the most important foods in the world, practically no effort has been made to improve the existing varieties. This work will be undertaken some time, and it seems to me that our association should inaugurate the movement now. It is in line with the progressive policy of this association.

In order to improve the avocado there are many points to be considered, such as the size, shape and color of the fruit; nature of the skin; condition of the pulp; size and

condition of the seed; character, precociousness and prolificness of the tree; keeping qualities of the fruit after being picked; length of time the fruit hangs on the tree; susceptibility of the fruit and tree to soil and climatic conditions; and the chemical composition of the edible portion.

The improvement of the chemical composition of the avocado is one of the subjects to which I desire to call your special attention today. As an example of the change in the chemical composition of an agricultural product by long systematic work, reference might be made to the sugar beet. Nearly a century ago a German chemist analyzed the ordinary garden beet and found that it contained from 4% to *5%* of sugar. By a long process of careful analysis of beets and selection of seeds, the percentage of sugar was gradually increased. In 1840 the beets from these selections contained about 6% sugar; in 1860 about 8%*;* in 1890 about 12%. In 1918 the sugar beets of Southern California averaged about 19% sugar. In other words the sugar content of the beet has been increased four fold, and the whole beet sugar industry has been made possible by this scientific work on changing the chemical composition of the beet.

Analysis of the avocado shows it to be rich in fat, protein and mineral salts. The fat content in the better varieties is all that can be desired. It is neither necessary nor desirable to increase the percentage of fat. On the other hand, it is especially desirable to increase the content of protein which is also one of the essential articles of diet. It is difficult to imagine a more extravagant or a more wasteful method of producing protein than to produce it in the form of beef, pork and mutton. It is only a matter of time, as population increases, until such foods will be entirely out of question except possibly for a very small minority of the human race.

Further investigation will be necessary to definitely determine whether the protein of the avocado is a complete protein food or not. It may be necessary to supplement it with a certain amount of protein from eggs, dairy products or other protein foods. However, it is an important source of nitrogenous food which is one of the essential constituents of the human diet.

The comparatively few analyses which have been made of the avocado at maturity by Chace and Jaffa show a wide variation in the protein content, not only in different varieties, but in different fruits of the same variety, as shown in the following table:

Variety	Per Cent Protein
Taft	1.22 to 3.14
Sharpless	1.13 to 1.92
Spinks	1.50 to 2.70
Fuerte	1.25 to 2.32
Puebla	1.62 to 2.30
Lyon	2.12 to 4.37

Other varieties show similar results. The maximum variation in these few analyses amounts to nearly 300%, while the maximum variation in any one variety is more than 150%.

With an orchard of mature trees containing 66 trees per acre and producing 300 pounds of edible portion per tree, the amounts of protein produced by these different varieties on each acre are as follows:

Variety	Pounds of Protein Per Acre
Taft	244 to 628
Sharpless	226 to 384
Spinks	300 to 540
Fuerte	250 to 464
Puebla	324 to 460
Lyon	424 to 874

The differences in these amounts are very significant, and it is evident that by growing the better strains of the different varieties the increase in the yield of protein food on a large acreage would be enormous.

The following individual analyses show high protein content:

Variety	Per Cent Protein
Azusa	2.91
Caribou	2.92
Gage Seedling	2.98
Taft	3.14
Blakeman	3.19
Hertrich Seedling	3.33
Seedless Ganter	3.34
Challenge	3.43
Oakley No. 3	3.54
Oakley No. 4	3.67
Oakley No. 1.	3.81
Lyon	4.37

Without discussing these results any further it is evident that we should have and can have avocados with 5% or more of protein. Under the conditions outlined such avocados would produce each year 1000 pounds or more of protein per acre of ground, which is probably from 20 to more than 100 times as much protein as can be produced

in the form of beef, depending upon the conditions under which the cattle are raised.

Having established the importance of increasing the protein content of the avocado, the question arises as to how the work can be accomplished. The problem is not exactly parallel with that of increasing the amount of sugar in the sugar beet, and it is probable that considerable time will be required before satisfactory results can be obtained, but there is no reason to doubt the feasibility of such an undertaking. One way to produce such results would be to plant seeds, but as avocados do not come true from seeds, this would probably be a long and tedious work.

Bud selection is the most feasible and the quickest method of producing these results. In this connection I want to refer you to a bulletin on the "Improvement of Plants through Bud Selection" by A. D. Shamel of the U. S. Department of Agriculture, which was issued last year by the experiment station of the Hawaiian Sugar Planters' Association. No one can read this bulletin without being impressed with the tremendous importance of bud selection in any horticultural industry. There is no doubt that the size and condition of seeds, as well as the size and quality and the chemical composition of fruits and vegetables can be controlled to a large extent by bud selection.

Shamel calls attention to the many excellent strains of apples which have originated as bud mutations. The same is true in the case of peaches, some of which have even produced nectarines. Important bud variations occur also in the prune, pear, grapes and other fruits. Seedless strains are frequently produced as bud mutations from the seedy varieties.

The investigations of Shamel indicate that the Washington Navel orange is a bud variation of the Selecta variety in Brazil. At least 14 different strains of the Washington Navel orange have originated in Southern California as bud mutations and have been propagated. Some of these strains are of a very inferior quality. Twelve strains of Valencia oranges have been produced; also seven strains of the Marsh grapefruit, some of which are seedless. There are eight strains of Eureka lemons.

Shamel calls attention to the fact that about 25% of Eureka lemons are known as the shade tree variety, producing a low yield of inferior fruit. Many other examples might be given, but these are sufficient to show that systematic and intelligent bud selection is of fundamental importance in any horticultural industry. The fact that a tree of any variety is a good bearer is not sufficient reason for propagating all of its buds.

In regard to the avocado there is abundant evidence of bud variation. The variations in the shape of the fruit, size of the seed and condition of the pulp in any variety are probably due in a measure to bud variation. The large variations in the protein content of any variety as well as large variations in the fat content are probably influenced by bud variation. Mr. Rideout reports a Ganter tree which always bears fruit black in color on one of its limbs. This is evidently a true bud mutation.

A very careful and exhaustive investigation should be made of the avocados in Southern California to determine the extent of bud variation, and to determine how far these variations are due to environmental conditions and to what extent the variations are inherited, in order that some comprehensive plan for the improvement of the avocado may be inaugurated. If these investigations show that the variations in the

chemical composition are due to bud variations and that these variations can be reproduced by bud selection, then the U. S. Department of Agriculture should provide a competent chemist to accompany Wilson Popenoe to points in Mexico and Central and South America where the better varieties of avocados are to be found, in order that similar investigations may be made at these points.

This suggestion is not made with a view of criticizing in any manner what has already been done. Popenoe's explorations represent a magnificent and colossal piece of work, which will be of inestimable value to the avocado industry in Southern California. It would have been unwise to undertake a systematic and extensive chemical investigation of avocados in these countries until the better varieties had been definitely located. In order to reap the full benefit of Popenoe's extensive work by bud selection, however, it may be necessary, not only to analyze the different varieties, but to analyze the fruit from different branches of the same tree. The most desirable strains of the different varieties can be determined only by such investigations.

Before leaving the subject of increasing the protein content of the avocado, I want to quote from an article published in *Science,* Jan. 20, 1922, by A. F. Woods of the University of Maryland. He says, "There has never been a time when the need for agricultural research of the first order was as great as it is today." He emphasized the fact that, under the present conditions of population, it is not only essential to make two ears of corn grow where only one grew before, but that it is just as essential to increase the nutritive value of the products produced.

Having defined what should be done, the next question is who should undertake the work. A careful investigation of the existing varieties in this state and in different countries where the better varieties of avocados are to be found will be an important step in such an undertaking. Our own association can do much, and we can rely upon the County Farm Bureau, the State University and the U. S. Department of Agriculture for valuable assistance, but inasmuch as there are many other problems of great importance to be investigated and inasmuch as the expense of establishing and operating the plant and organization necessary to make such work permanent will be of considerable magnitude, it seems to me that the most feasible plan would be to undertake the work through either a state or a national experiment station.

President Raymond A. Pearson of Iowa State College of Agriculture and Mechanic Arts, in an address on "A National Policy for Agricultural Research," delivered at the Conference on the Agricultural Situation called by the President of the United States in January of this year, called attention to the many problems which are continually presenting themselves to agriculturists, and said, "A sound and efficient Agriculture calls for more research." He showed that such work cannot be carried on successfully by individuals on account of the expense incident to the establishment and operation of the necessary organization. He said, "There should be a well defined national policy in reference to agricultural research because such research relates to questions of fundamental national importance, and the value of such research to the whole nation has been proved. A program of agricultural development, therefore, must include provisions for an expanded scientific investigation through state and national departments of agriculture, and through agricultural colleges and universities."

One of the points emphasized at that congress was the importance of establishing adequate experiment stations throughout the country. There is great need for an experiment station to study the subtropical fruits which are being introduced into Southern California in large numbers. At a recent convention of pear growers held at the University of California, a resolution was passed calling upon the legislature for a special appropriation to carry on a major project on the breeding of better varieties of fruits in California. They called attention to the fact that California leads the nation in the production of fruit and to the fact that at present there is no extensive plan under way for producing new and better varieties of fruits. We should make a similar appeal to the State or National Government and urge the immediate establishment of an experiment station in this vicinity for the study of subtropical fruits.

Among the problems which such an experiment station, with the assistance of this association, the County Farm Bureau, the State University and the United States Department of Agriculture should investigate are:

1. The improvement of the existing varieties of avocados through bud selection.

2. The introduction of larger and more satisfactory varieties of the Mexican race of avocados.

3. The development of new varieties of avocados from seeds—especially hybrids of Mexican and Guatemalan varieties.

4. Diseases of the avocado, injurious insects and fungi.

5. Irrigation problems:

a. The maximum drought which the different varieties of avocados will stand in different soils without injury should be determined.

b. The effect of excessive irrigation on the trees and on the production and quality of the fruit should be determined.

c. The importance of allowing the trees to dry out in the fall should be emphasized. It is thought by many growers that trees are rendered less hardy by irrigation in the fall on account of the new foliage which is produced. Recent investigations on hardiness, however, show that the drying out process has a tendency to produce certain colloid materials in the tree which greatly increase its hardiness.

6. The falling of fruit before it matures.

7. The tendency of trees to bear in alternate years.

8. Influence of climatic conditions:

a. The effect of humidity on the different varieties of avocados should be determined.

b. An effort should be made to lessen the hazards due to cold weather by encouraging the development of hill land, and by the devising of more efficient and more economical orchard heaters or other apparatus for the protection of orchards.

9. The keeping qualities at the ordinary temperature and the effect of cold storage on the different varieties of avocados.

10. Possibilities of by-products.
11. Vitamin content and nutritive value of the avocado.
12. The physical condition of the soil best adapted to the growing of avocados.
13. Root stock best adapted to the growing of avocados.
14. The maintenance of soil fertility.

The maintenance of soil fertility is one of the most important and one of the least understood problems with which horticulturists are concerned. In this connection I want to quote again from the address of Raymond A. Pearson at the President's Conference. He said that soil fertility is the most important of our national resources and emphasized the importance of its conservation, and added that we gather crops very much as we harvest lumber. We make use of what we find without much reference to the needs of future generations.

Avocados remove much larger quantities of mineral matter and nitrogenous matter from the soil than do other fruits. These materials must not only be returned to the soil from year to year, but must be in a condition to be assimilated by the trees. Practically no attempt has been made to solve the fertilizer problem for avocados. It is more than likely that the tendency of avocados to bear in alternate years and the tendency of the unripe fruit to fall at times are due, in a measure, to the fact that the tree is undernourished. Fruit trees have stored in them each fall a certain amount of reserve material for their growth in the spring, but this reserve material has not been shown to contains any large amount of available nitrogen. It is very doubtful if avocado trees in ordinary soil and with ordinary treatment can fully recuperate from year to year the large amounts of mineral and nitrogenous matter which are removed with the fruit. Its failure to produce fruit in any year may represent the normal performance of an undernourished tree. Furthermore, an undernourished tree is an easy prey for all the enemies of the horticultural world.

Professor Henry D. Hooker, Jr., of the University of Missouri, in an address on "Horticulture as a Science" at a recent meeting of Southern Agricultural Workers in Atlanta, Georgia, and published in *Science, April* 14, 1922, calls attention to the possibility of increasing the setting of apples by the application in the spring of quickly available nitrogenous fertilizer. He further says, "Fruit setting is only one step in fruit formation. The process begins with the formation of fruiting wood and involves in succession fruit bud differentiation, bud development to the time of blossoming, pollination, fruit setting and fruit development. The failure or limitation of a crop may be occasioned by the interference with any one of these successive processes." He then calls attention to the fact that, while the application of nitrogenous fertilizer in the spring is favorable to the setting of fruit, it is unfavorable to bud differentiation. The application of fertilizer then may do more harm than good, depending on the time when it is applied. "This work," he says, "reopens for investigation the entire orchard fertilizer problem which was thought to have been solved in the last few years by experiments with sodium nitrate in the orchard." He calls attention to the fact that each problem connected with horticulture requires special study and special treatment. "The use of fertilizers to correct the alternate bearing habit of apple trees," he says, "is as distinct

from their use in increasing the set of fruit as spraying peaches for San Jose scale is from spraying to control scab."

Noyes, Martsolf and King of the Mellon Institute for Industrial Research have recently carried on an investigation on "Cultivation and Nitrogen Fertilization," published in April of this year in the *Journal of Industrial and Engineering Chemistry.* This work was undertaken for the benefit of the grape growers of the state of New York, and it was found that one application of nitrate fertilizer was practically lost each year on account of the time it was applied to the soil. They showed that inorganic nitrates which are added to the soil are made available largely through bacterial action, and emphasized more than had been done before the importance of bacteria in the soil. In summing up, they said, "It is very important that agriculturists put into practice systems of soil management which will be favorable to the multiplication of desirable soil bacteria; and that cultivation, organic matter and a soil less than moderately acid are essential for desirable bacterial action." In closing their paper they said, "The ratios of oxygen, carbon dioxide, organic matter, bacteria, fungi, plant food, etc., for the optimum growth of any plant are unknown." This is evidently a fruitful field for further research. An effort should be made to determine the fertilizers best adapted to the growing of avocados, as well as the time when they should be applied to the soil.

A study should also be made of the influence of various fertilizers on the resisting power of avocados to cold weather. It is well known that some fertilizers make trees more hardy, while others produce the opposite effect. An exhaustive investigation should be made of this subject. A thorough study should be made of the influence of cover crops on the production of avocados. It has been shown that the protein content of some agricultural products can be increased by the addition of certain fertilizers at the proper time. W. F. Gericke of the University of California published an article in *Science,* November 20, 1920, on "The Increase of Protein Content by the Addition of Soluble Nitrates to the Soil." It had been known for a long time that wheat grown on the Pacific coast contains less protein than wheat grown at other places in the United States. For many years this was thought to be due to climatic conditions. Gericke's experiments, however, showed that the protein content of the wheat could be increased from 8.6 per cent to 15.2 per cent by the addition of ammonium nitrate and sodium nitrate to the soil. The increase of protein was materially influenced by the time when the nitrates were applied to the soil. It is probable that the climate has something to do with the amount of fertilizer to be applied and the time when it should be applied, as bacterial action is greatly influenced by climatic conditions. It is purely a question of making the plant food available at the proper time. This work suggests the possibility of increasing the protein content of the avocado by the application of the proper fertilizer at the right time.

These are some of the problems which the avocado industry must meet. As these problems are solved, the quality of the avocado will be improved and its nutritive value increased; and the avocado tree will become more hardy and more prolific. The influence of this work will be felt in all countries where the avocado is grown, and the avocado will become more and more important as a factor in increasing and perpetuating the food supply of the world. If the California Avocado Association takes the initiative in solving these important problems, and becomes instrumental in the establishment of either a state or national experiment station in Southern California

where research on subtropical fruits may be permanently established, it will have performed an important service to this state and to the world; and the avocado industry in Southern California will become a permanent and profitable industry in the face of ever increasing obstacles.