INTRODUCTION TO THE SYMPOSIUM

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During the past five years, mechanized growing and harvesting of certain fruit and vegetable crops made tremendous gains. Within the next five years several additional crops will probably be mechanized. The degree of mechanization varies with the area and with the crop. Factors such as climate, varieties, cultural practices, machine development, labor supply and whether the crop is grown for fresh market or processing, all have influenced the present status of mechanization.

Specialists working with both fruits and vegetables from Eastern and Western United States were invited to speak at the Symposium. Their interests as related to mechanization were in production, breeding, engineering and processing. They were asked to summarize and interpret the research findings in their specialties. Mechanization concepts, and principles of mechanization were discussed using crop examples. The impact and interactions of mechanization on the fruit and vegetable processing industry as to quality, economics, and sociology were also explored.

Dr. Roy Bainer, Dean of the College of Engineering at the Davis Campus of the University of California set the stage for the Symposium by outlining the history of the development of mechanization in agriculture.

Looking toward the future, projections by the speakers were that cultural practices will continue to change, becoming more efficient as new varieties and machines are developed. Rates of fertilization will advance as plant populations increase, but probably not at the same speed. Sprinkler irrigation will come into its own as the need for perfect seedling emergence and complete chemical weed control becomes apparent. Improved sprinkler systems will be developed, along with better selective herbicides. Chemical plant regulators will be used to control plant growth, fruit set, and ripening. Farm operations will become larger, and will require massive investments for sophisticated equipment. To handle this equipment, the skills of farm laborers will have to be raised as their numbers diminish.

MECHANIZATION IN AGRICULTURE

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The strong position of the United States in today's world is largely due to a prospering mechanized agricultural industry-an industry that produces the nation's food and fiber in abundance with around 6 per cent of the nation's working force on the production line. The millions released from producing the necessities of life are freed to other industries, services and professions, thereby contributing to America's remarkable industrial expansion and the prevailing high standard of living.

Progress in agricultural mechanization during the past 60 years is unparalleled. It has no been matched in our history or in any other major area. McKibben suggest that the rapid evolution in mechanization in the United States is the "result of a combination of favorable circumstances-a combination unique in the World's history and one which probably will not appear again." He lists 26 elements of this combination. Included are such factors as: a stable and equitable government; a system of free enterprise; a rapidly increasing population occupying new land; a surplus of clear level land well suited to mechanization; a shortage or infrequent surplus of agricultural labor; a rapidly expanding and effective industrial development; an abundance of natural resources; and a remarkable development of transportation facilities.

California has been one of the leading contributors to agricultural mechanization. This has been due to many high labor input crops produced in the state and a general shortage of dependable labor to meet peak demands. Furthermore, transportation charges to markets, which are 2 to 3,000 miles away, have gradually increased over the years. Anything that was done to reduce production costs assisted in maintaining a competitive position with other producing areas.

To meet peak labor demands in the past, it was necessary to import labor. Many of the Chinese brought in following the gold rush to build the transcontinental railroad found employment in agriculture when the railroad was completed. Laborers from the Philippines came to work in the fruit, lettuce and asparagus fields. Nationals from Mexico were used for general field work, including the thinning of sugar beets and harvesting of beets and tomatoes. American Indians were brought in from the southwest reservations during World War II to harvest sugar beets. On the other hand, only a relatively few of the negroes who came in from the South to work in the shipyards accepted employment in agricultural production following the war.

Over the past 50 years, the University of California has developed an outstanding agricultural research staff on the Davis campus to assist in the solving of many problems facing California agriculture. Much of the success of this group is the result of an interdisciplinary approach to problem solving. As a typical example, agricultural engineering has had cooperative projects with practically every department from agronomy to zoology. Furthermore, many of the commodity groups have given financial assistance for research in their areas.

Following World War II an inventory was taken by the Department of Agricultural Engineering of the progress to date in agricultural mechanization. By that time, the production of cereal crops, forage crops, sugar beets and cotton was well on the way toward complete mechanization. It was immediately evident that if engineering was to continue in its important role in rounding out the total picture, research work had to be initiated involving the mechanization of vegetable, vine and tree crops. As a consequence, certain crops, because of their relative importance, were selected for study. In the vegetable area, asparagus, lettuce and tomatoes were considered. Under the vine classification, attention was directed toward raisin and wine grapes. Prunes, olives, peaches and walnuts were selected for the initial studies on tree crops. In all cases the engineers were joined by plant scientists in the various areas. In situations involving processing, the food scientist participated in the program. Later, projects were initiated involving citrus harvesting, forced air cooling of fresh fruit, electronic color sorting, and packing houses.

One of the most significant events in the history of agricultural mechanization occurred in California in the summer of 1854. In that year, the Moore-Haskell combined harvester-thresher was transported from Kalamazoo, Michigan, via Cape Horn to San Francisco and then overland to Mission San Jose where it successfully harvested 600 acres of wheat. Due to faulty lubrication, this machine caught fire and burned along with the field of grain in 1856. Within the next few years, however, several companies were building combines in California for use on the Pacific coast. It was not until the 1920's that the combine was accepted in the winter wheat belt. The irony of the story is that Michigan, the birthplace of the combine, finally accepted it about 1936 – 100 years after its invention.

The principal reasons for substituting capital for labor (machines for men) are based upon economic factors or the availablility of labor. Oftentimes it is a combination of the two. The introduction of the mechanical cotton picker into California is an excellent example of the place economics played in the acceptance of the machine. By 1949, 16.2 per cent of California's 1,268,000 bale cotton crop was harvested by machine. A study, made by Hedges and Bailey, of 63 machines used by San Joaquin Valley cotton growers showed a relative cost of $45.00 per bale for hand picking vs. $25.76 for machine harvesting. The latter costs took into consideration: labor, overhead and operating cost, field waste and reduced sales value due to reduction in quality of the machine-picked cotton. Needless to say it wasn't long thereafter before the bulk of the California crop was picked by machine.

The rapid adoption of the mechanical cotton picker brought about a serious labor problem for the raisin and wine grape producers. Grapes and cotton are grown in the same general area. We were informed by a delegation of grape growers that the labor that normally picked cotton came in two or three weeks early to pick the grapes. Since there was no more cotton to pick, many of the laborers they had counted on to pick grapes didn't come into the area. As a result, they requested work be started immediately on a mechanical grape harvester. A research program, involving agricultural engineering and viticulture, was initiated. A machine has been developed and licensed for commercial production.

The adoption of a mechanical tomato harvester was a direct result of labor shortage. The labor shortage resulted when the Secretary of Labor banned the importation of foreign labor. The tomato industry of the State faced a serious problem because approximately 85 per cent of the tomatoes for processing were normally picked by nationals from Mexico.

It was fortunate for the industry that the University had launched a long range research program to mechanize the harvesting of tomatoes some 10 years before the ban on importing foreign labor. As a result, a system, somewhat imperfect at the start, became available at about the right time. The research behind it was truly interdisciplinary. It involved plant breeding, food science and technology, agricultural engineering and finally a local manufacturer, and farmers and processors who were willing to risk their future on mechanizing the crop.

If labor in good supply were available today, it is almost certain that we would not have faced the problem and would still be picking tomatoes by hand. The important end result was the saving of an industry for California. Processors were considering the shifting of their operations south of the border where labor was plentiful. This would have resulted in a loss of an annual income to the State of around one-half billion dollars.

Similar situations existed during World War II. The mechanization of sugar beet production is another example. Ten years prior to the war, the University in cooperation with USDA started a program in mechanization. In 1938, the program was accelerated by a sizeable grant from the U.S. Beet Sugar Association. Work was well underway by the time we became involved in the war. In 1942, the sugar beet acreage in California dropped from 170,000 to 70,000 acres. Growers, in anticipation of a shortage of labor, simply did not contract for their full acreage. At this rate of decline, one more year like 1942 would have resulted in no beet sugar being produced in the State. Growers accepted processed seed that approached single germ units and the crude commercial harvester available by 1943 and the processors accepted the poorly topped beets. The result was the harvest was fully mechanized by the end of the war and a multimillion dollar industry was maintained within the State.

During the war, labor shortages showed up in many areas. Mechanical bale and sack loaders were developed. The high cost of sacks and the subsequent handling of sacked grain was an important factor in forcing bulk handling of grain. The introduction of direct combining and artificial drying of rice just prior to the war enabled this industry to triple the acreage during the years of the conflict without a marked increase in labor. By then this industry was producing rice with an input of approximately 7-1/2 man-hours per acre as compared to around 900 in the Orient.

The first attempts to shake prune and walnut trees mechanically took place when so many of our able-bodied men were in the armed forces or engaged in war industries. Out of this experience came rigid-boom, inertia-type tree-shakers and self-propelled catching frames. Three men working with the above-mentioned equipment can harvest 50 to 60 prune trees per hour. Recent modifications in this type of equipment are being used this year in the peach harvest.

Two crops where prototype harvesting machines have been developed but not put into use are asparagus and lettuce. So far, growers have been successful in recruiting sufficient labor. Little interest is generated in mechanization when labor is plentiful and the price of the product is good. Should conditions change, interest in mechanization would be generated overnight. Incidentally, the latest sensing element development for determining the density of lettuce heads is by gamma ray bombardment. This method will also give a measurement of the diameter of the head.

In closing, I would like to remind you that the adoption of mechanization is closely associated with economics, and the availability of labor. The main thing is for the subject matter divisions to have new developments ready for the extension staff to to carry to the field when conditions are right for acceptance.

Literature Cited

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MECHANIZATION OF FRUIT HARVEST IN THE EASTERN UNITED STATES

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No one knows when mechanization of fruit harvest began in the United States. It is documented, however, that machine patents were approved for a fruit gatherer in 1899 (9), a mechanical tree shaker in 1927 (1) and a collecting unit similar to today's models in 1931 (24).

Regardless of when serious research and development of mechanical harvesting of fruits commenced, few would question that more progress has been made during the past decade than in all previous history. Innumerable agricultural engineers, horticulturists, food scientists, farmers, equipment manufacturers, and economists have contributed to the wealth of information and know-how which has made mechanical harvesting a practical reality for several fruit crops.

The acceleration of research and development activities has resulted from many factors, but primarily from (1) the increasing costs and (2) the decreasing availability of harvest labor. These factors are well documented, and merit no further discussion here.

Time and space will not permit complete credit to all who have contributed to progress in mechanical harvesting. Any such oversights are unintentional. This presentation will review some of the past and present programs of mechanized fruit harvest in the eastern United States, and will consider some of the present problems and future needs for effective harvest mechanization.

As indicated by Claypool (6), the practical feasibility of mechanical harvesting revolves around (1) plant health and longevity,