Third in an agricultural research centennial series

WINNING THE WEST
. . . *with agricultural engineering*

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AGRICULTURAL ENGINEERS, today as 100 years ago, deal in survival—a harsh word, but the economic reality that has helped California become a world leader in farm technology, and the national leader in farm production.

The University of California's Agricultural Experiment Station has been a partner in this progress of agriculture. Private farmers and farm innovators, and UC's researchers have traded ideas back and forth over a century in developing machines and farming systems adapted to our rich, sometimes harsh, but extremely varied environment.

Back a century ago, agriculture began to flower in California—gold brought the settlers here but it was agriculture that kept them when the gold ran out. By the late 1800s, California had become important in the world grain trade, because of seaports, good land and climate, and mechanical pioneers who got the grain out of the long sweeping fields of the Central Valley.

It was a grain harvester, a Hiram Moore harvester-thresher brought from Michigan in 1854, that touched off the farming revolution in the Far West. The equipment, patented only five years after McCormick introduced his reaper, had not been widely accepted in its home state. But western need and ingenuity made it work in California. And like many inventions that followed in the next 100 years, it produced "know-how" that spread back across the other states.

When the transcontinental railroad opened the central states to outside markets, California lost her early lead in grain. By 1899, 64% of the state's farm income came from vine, tree, vegetable, sugar beet, cotton, and rice crops. These crops have all brought endless challenges to the field of agricultural engineering.

In rice, the use of stationary threshers prevailed until about 1929. As a result of Experiment Station studies in Yolo County, combines were introduced for threshing down the windrow. Later, to open the irregular rice fields without running over part of the crop, the header, or cutting mechanism, was moved from the side to the front of the combine. This, too, caught on across the country. Further studies in Sutter County in the 1930s introduced artificial drying to improve crop quality by reducing sun-checking and rice grain breakage.

The year 1929 saw aircraft seeding rice fields, and ever since then, U.C. agricultural engineers have been involved in aircraft equipment design, particularly in development of better spray nozzles and spreaders for pesticides, fertilizers, and seed.

So complete was rice mechanization that, at the time of a 1948 Experiment Station study, the California crop required only 7.5 man hours of labor per acre. The comparable figure then for hand labor production in Japan was 900 man hours.

Faster field curing of alfalfa hay retains nutritional feeding values for livestock, and was shown possible by U.C. engineers with a farmer-devised mower-crusher in the 1930s. Thresher cylinder changes made by the engineers improved the separation of seed and its quality in bean and flax crops. Cotton—an industry that had seen some 900 machine patents—became mechanized in the late 1940s and early 50s. Experiment Station researchers had shown that: (1) machines could pick a bale for almost half the cost of hand labor, which was also becoming scarcer; (2) better, more uniform plant stands could be obtained by using cotton seed de-linted chemically; (3) increasing plant populations from 10,000 to 60,000 per acre crowded fruiting nodes higher off the ground for better picker recovery, and also demonstrated that cotton could be planted to a stand with no thinning; and (4) flame jets could be used to control growth-robbing small weeds and grasses.

Today U.C. engineers are working on improved systems for once over "stripper" harvest, and temporary storage of cotton in giant field stacks so harvesting can go on when ginning capacity backs up.

California never has grown much corn, but it was a U.C. idea to put a snapper-roll cornhead on a standard grain combine to harvest corn. This cost-saving device soon spread back to the corn belt.

The wet and boggy Delta led to the development of the tracklayer tractor for farm, field, forestry, dam, and road construction—even for war purposes. The first Holt and Best tractors at the turn of the century were steam powered, but eventually were equipped with internal combustion engines. One of the little-heralded, but very significant Experiment Station achievements, starting in 1921, was the designing of a *good* engine air cleaner to cope with the dry, dusty conditions of California and the West. This device has saved untold millions of dollars in engine repair costs—for the motoring public everywhere, as well as for agriculture.

Two areas of work, in sugar beets and canning tomatoes, illustrate the expansion of research across scientific disciplines. In the case of sugar beets, seed had to be changed genetically. The multi-germ seed formerly in use sprouted several plants from each seed ball. This called for 20 to 30 man hours per acre of backbreaking, short handle hoe blocking and finger thinning. Emigrants from Russia, Drs. F. V. Savisky and his wife, Helen, working in U.S. Department of Agriculture laboratories in Utah, in 1948 discovered two important mono-germ sugar beet inbred lines. By 1954 they had the first mono-germ seed ready for release and paved the way for spaced, precision plantings.

Before this development, however, U.C. Davis engineers provided two interim advances. First they developed a process for segmenting multi-germ seed balls into units approaching mono-germ. Within three years segmented seed was used on 900,000 acres nationally, at a saving of 9 million man hours in thinning. The second improvement, an abrasive process called decortication, reduced seed to an average of 1.5 germs per cluster and replaced segmented seed until mono-germ took over.

The manpower shortage in World War II reduced beet production from 170,000 acres to 70,000 in a single year, and the crop threatened to disappear. Heavy inputs of hand labor still were used to pick up the plowed-out beets, slash off the tops, then toss the beets into trucks. Then the shift began toward mechanical harvesting, which today, with mono-germ seed, precision planting, and a synchronous thinning machine developed at Davis, has completely mechanized sugar beet production in the United States.

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hopper vectors which had fed on the plants exposed previously to vectors injected with sterile broth. The reisolated bacterium had the same morphology, size, cultural, and physiological characteristics as the original isolate. The bacterium is gram-positive, rod-shaped, 0.4–0.6 μm wide, 1.0–2.0 μm long, and nonmotile. It grows well at a temperature range of 20 to 32°C with an optimum of 29 ± 1°C. On agar medium the colonies are white to white-gray in color, slightly convex, circular with entire margins, and have a smooth, shiny texture. The bacterium is a faculative anaerobe and produces acid but not gas from glucose. Tests for production of indole and methyl-red were negative.

These experiments have demonstrated that a gram-positive bacterium is the etiological agent of Pierce's disease in grapevines, and not a virus, as previously believed. The organism has been successfully cultured on artificial media. By using the leafhopper vector injected with the cultured and purified bacteria, the disease symptoms can be consistently reproduced in healthy grapevines and the same organism reisolated from clean leafhoppers fed on these plants and on naturally infected plants from the field. An attempt to isolate and to culture the bacterium from diseased plant tissues did not succeed, for reasons presently unknown. The characteristics of this bacterium, which in nature is apparently confined to its vectors and to the xylem vessels of its host plants, plus its morphological, cultural, and physiological features, suggest that the Pierce's disease agent is a distinct plant-pathogenic gram-positive bacterium heretofore unrecognized. Studies to determine the taxonomic position and characteristics of the Pierce's disease bacterium are in progress in the Department of Plant Pathology, at U.C., Davis.

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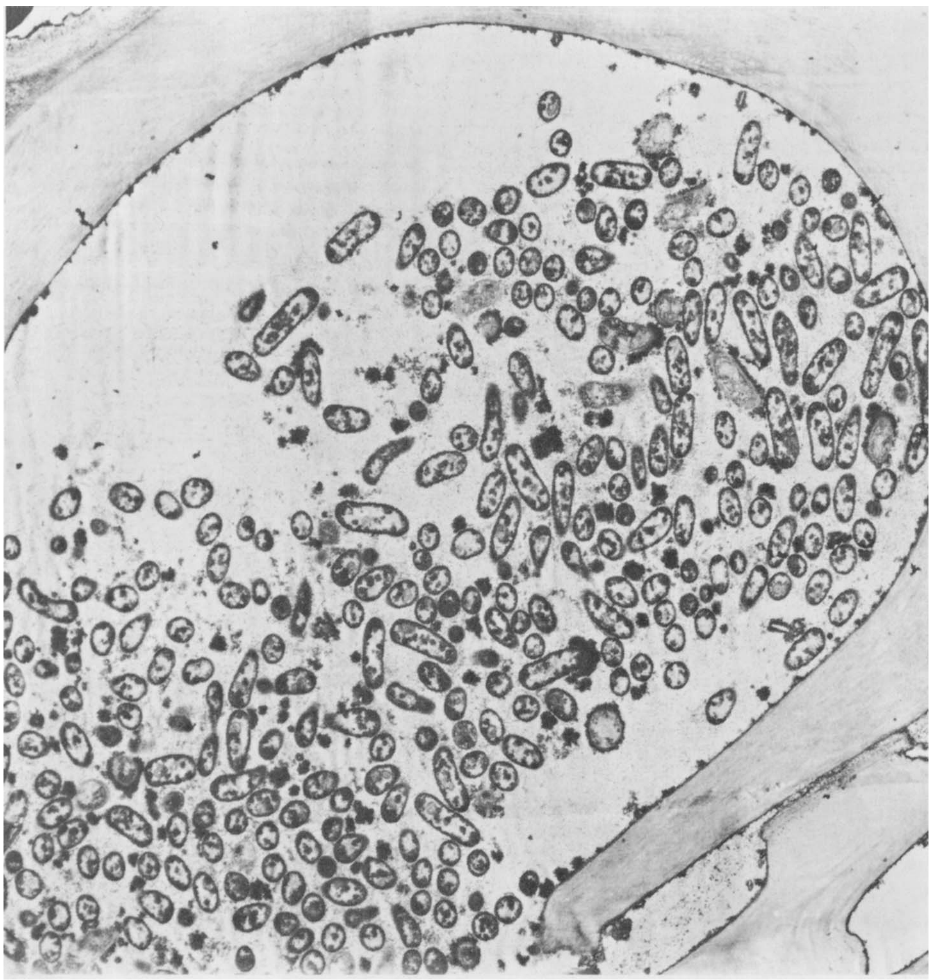

Photo 2. Electron micrograph of a transversely sectioned vessel from a leaf of a plant experimentally inoculated with the Pierce's disease bacterium. The vessel lumen is partially filled with the causal bacteria. X 5000.

WINNING THE WEST

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The tomato story demonstrates even broader research involvement. Eighty-five per cent of this crop was being picked by Mexican nationals, until that practice was drastically restricted by Congress in 1964. Fortunately, a long-range mechanization research program had been launched in 1950, and the first machine prototypes were proving their worth.

The U.C. once-over harvester design of Coby Lorenzen is incorporated in a majority of the machines now in use. But its success depended upon plant scientists breeding a tomato plant that could set and ripen most of its fruit at one time; on food scientists who determined how to process this new tomato; and on farmers and processors working with Cooperative Extension personnel to find out how to grow and handle the crop. And it was U.C.'s G. C. Hanna whose seedstock has served as the parentage for virtually all varieties in common use internationally.

The final major achievement in the tomato project was the shift from hand-picking into 50-lb capacity field lugs, to machine harvesting into 1,000-lb bins, and finally, into bulk trailers, each holding more than 10 tons of fruit.

Tree fruits, grapes and nuts, are shaken and picked in a minute or less by machines. Raisin grapes are shaken from their vines, spread on paper on the ground to dry, then picked up by machine.

Besides eliminating the human drudgery of many farming tasks, mechanization in some crops has permitted harvesting in cooler evening or nighttime hours, benefiting both workers and crops. Harvesting also can be timed more closely to the maturity peak of the crop.

There are, and will be, arguments about whether these improvements are a boon to the public at the expense of human labor displaced from old jobs. The engineer, of course, must concern himself with all human needs. Some of his efforts are in problem solving responses, and others are the added outgrowth of problem solving. But the adoption of new technology depends upon economics. Since mechanization usually adds to the costs of processing, or increases problems of quality or quantity, new practices usually are adopted only when their absence would mean a food or fiber shortage.

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