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Engineering for Productivity

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When Jack Shepherd asked me to speak to you about engineering for productivity, he suggested a generalist point of view which greatly relieved me. As a generalist, I figure, it allows me license to juggle facts as I need them. So here we go.

To engineer our tree for the future we have to ignore our model: the Hass. We must scrutinize our needs and recognize our limitations.

During the 1980s, avocados grew dramatically from a specialty item to a mainstream position in produce. During this decade, growers experienced the growing pains of the enormous plantings of the 1970s that burdened the industry and depressed returns. We sold crops in the 1980s that more than tripled the average 1970 crops.

These growing pains were not unique to the 1980s. In 1952, Jack Shepherd, while addressing the CAS annual meeting, drew a parallel of the market-breaking 1927 crop with the doomsayers of the expansion of the early 1950s. Jack used a quote from the 1926 Yearbook: "*It is a foregone conclusion that the Pacific Coast markets will be unable to consume the 1927 crop."* Jack went on to say, "It is interesting to note that the Pacific Coast markets consumed in one recent week of 1952 the equivalent of the 1927 crop." Jack, that 1952 crop, at current sales capacity, could be sold in a single day. I would venture to say that the 1927 crop could not supply demand for the duration of your address this afternoon.

During the 1980s, we also saw the majority of our trees at the peak of their performance. Young trees planted in the 1970s reached their prime of 10 to 15 years; while older groves, in general, declined in productivity from overcrowding and disease.

Tax breaks and drip irrigation spurred hillside development. The industry, then, was put in a precarious position to rely on a significant base of marginal to poor soils.

Many believe that a 600 million pound crop is just around the corner. It has been only a few years since a 900 million pound crop has been bandied about. I contend that in 1987 we saw the biggest crop of avocados that California will ever produce.

The 1987 crop averaged 7500 pounds per acre, totaling over 550 million pounds. We no longer have the production capacity to even come close to that crop. Bearing acres are slipping, trees are aging, pests and diseases are more rampant, and we rely on varieties that produce inadequately or sporadically.

California peaked at 75,000 acres 1988. Now indications are that current 68,000 acres may settle out in years to come at 60,000. Even at California's most efficient production, which was 8700 pounds per acre back in 1975 (whose achievement is highly unlikely), our maximum capacity now falls 30 million pounds short of the 1987 crop.

Not only are our groves aging, but according to a 1985 CAS survey, so are our members. Consider that the farming value of avocado ground is insignificant when a parcel is proposed for housing subdivision. And, with an average age of a grove owner exceeding 60 years, the security to cash in for the assets in the land tempts growers eyeing retirement. This speculative land value precludes the younger generation from taking on orchards.

Our California Avocado Commission (CAC) and our marketing organizations have excelled at spreading the gospel. This promotion has created growing demand. Supplies are decreasing and greater profits are assured in the short term. Unfortunately, there are other producers, namely Chile, Mexico, and Spain, certainly willing to fill the void. It is very conceivable that CAC could work itself out of a job, for growers will not finance foreign sales promotion.

This is not some future scenario. This is a status report. Our problem is that our industry has matured, yet our market has not. Our challenge, then, is to invigorate our production potential through varietal improvement. We must not only consider the introduction of new blood but further understanding and adaptation of current varieties. The technology is imminent; the motivation is not. Growers and packers are understandably complacent with the short term outlook of high fruit returns.

50 years ago, as reported in the CAS yearbook, Marvin B. Rounds of the University of California wrote, "*With the Fuerte as an ideal commercial fruit, the picture before us is that of a fruit of similar characteristics. Although this type of fruit is an ideal one, it is also a fact that if a dark-colored fruit is found which otherwise meets the requirements for a commercial avocado, it may prove of importance in some districts, especially if marketable at a time of the year when the markets are short of good avocados. There is evidence that a dark fruit can be sold in spite of the color handicap, if the fruit has quality and is backed up by a sales effort."* This was new thinking. This was a giant step away from the green, smooth, Fuerte model that drove avocado marketing and new variety acceptance. Conventional thinking then as now limits our ability to respond to opportunity.

Fifty years ago varietal development was zealously pursued by avocado growers. Their enthusiasm and energy generated the evolution of the industry. At that point in time, 96% of the fruit delivered to packing houses consisted of 10 varieties. The Hass incidentally was not among that 96%. Hass fell into the remaining 4% of the volume along with 95 other varieties.

The Hass originated in 1926. It took over 30 years to be accepted and fully 50 years to dominate the industry. Truly, the Hass had a tangle of varieties to struggle through, and it was restrained by the fashion of the industry in the prevalence of green and smooth characteristics. What allowed the Hass to float to the top? Undeniable quality, yes. But also it produced more fruit than the Fuerte. Productivity, now, will be the catalyst that will impel us to improve on the Hass.

Now, as before, new varieties are our link to a stabilized future. As Marvin B. Rounds spoke of the search for the "ideal commercial variety," so we have to hone our edge by a renewed effort in variety improvement.

We now face significant change in the avocado industry. The decline of the California avocado can be visualized. If we can scrutinize our opportunities and not be constrained by our conventional thinking, we can then describe what types of fruits will meet our needs and what type of tree we can engineer.

Disregard Hass for the moment. Forget color requirements. Ignore fruit size and tree size. Forget, even, growing fruit on *trees.* Open your mind and imagine unlimited possibilities. Let us define a goal for varietal improvement—not within our norms, but more broadly as "profitability through consumer satisfaction in a stable industry."

A few years ago, Bob Bergh stood up here and showed a slide of a Gwen tree less than two feet tall, less than two years old, growing 46 fruits. This was a fluke, yes, but it was also a glimpse of what may be possible. Imagine rather than ladders and picking poles, imagine *field cropping* avocados. This system may include 9000 plants to the acre in a strawberry-like planting, harvesting with a tomato combine and mowing like asparagus for rejuvenation.

Extrapolating the production per acre in a two year cycle from a plant this size would exceed 200,000 pounds to the acre. So what, if you spent $150,000 on plants and another $15,000 to prepare and plant that acre? So what, if you irrigated with $1,000 an acre foot water on land that rented for $2,000 for that acre and all of this with borrowed money? Your return on your investment at $.50 per pound would near 100%!

Is this far out? It is absurd; especially when you consider you could supply current demand on 2000 acres. But it is not as far out as a food security system that the federal government is researching. Our food supply consists of four to seven days supply on the grocery shelf, and further down the production line remains susceptible to weather, disease, and pests and transportation to the market.

Some years ago, it was demonstrated that fruit flesh could be cultured in the laboratory: no peel needed to protect the fruit, no seed needed to perpetuate the species; simply cells of fruit endlessly multiplying. This technology is in hand. The farm in this system would grow hardy, perennial plants, harvesting cellulose that would be reduced to a carbohydrate slurry and piped to central food manufacturing factories to feed the vats of food and fibre.

Don't discard our 9000 plants to the acre out of hand; stranger things are being considered.

Ever since avocado growers selected seeds to plant rather than rely on wild trees for their food, we have taken control of cultivation of the avocado. Grafting superior varieties to establish consistent qualities was a quantum leap forward. The latest step in this evolution has been the development of rootstocks that are adaptable to adverse conditions—most notably, root rot.

Throughout most of the last 75 years, we have taken advantage of chance seedlings like the Hass to improve our lot. Only in the last 30 years has there been a concentrated effort to breed varieties. These efforts have produced the Gwen and tens of thousands of siblings and progeny of such quality that had they occurred 50 years ago, the avocado would have remained generic and a single variety could not have surfaced. Dr. Bob Bergh's avocado breeding program has provided us with a collection of germ plasm

as has never been seen before in avocados. The stage is set for quality and production enhancement for our future.

Avocado growers have been contributing to a new angle of research under the direction of Dr. Michael Clegg at the University of California at Riverside. The initial work in his lab will provide genetic markers to create a map of avocado characteristics. The first use of these markers will be to confirm experimental crosses. For example, the Gwen was thought to be descended from the Nabal. It has already been demonstrated that the unique genetic fingerprints are so different that the Gwen and the Nabal are not closely related. Further, this genetic map will be used to screen avocado cultivars for desirable traits.

For instance, root rot research has identified as many as five distinct mechanisms that provide resistance or tolerance to the disease. By understanding where the genes responsible for these characteristics reside on the chromosome, we can select those that have one, or preferably a combination, of those traits. This scheme will shorten the selection process by years.

This science will ultimately give us better understanding of attributes and peculiarities of avocados: what constitutes frost and drought tolerance, root rot resistance, and tree size and fruit characteristics. Ultimately, we can dream of exchanging genetic material and design varieties to our ideal.

Concurrently, Dr. Carol Lovatt at UCR is investigating biochemical mechanisms of the avocado tree. We are finding out the processes that work for or against maximum cropping. Combined, these sciences will not only help us to manage trees more effectively, but to breed and select varietal types that possess desired traits.

Too often we are frustrated by crop loss. We can blame this on bad luck, on the whim of the weather, natural fluctuations, or idiosyncrasies of the tree. This is true, but we must admit that much of this loss has to be due to our lack of knowledge to control these factors economically. The success of growing the tropical avocado in arid California is evidence of enormous accomplishment in adaptation by cultivation. Our call, now, is to further control the quirks of the avocado.

Opportunities abound for the grower; markets are expanding, and acreage is receding. Seasonal gaps exist because we rely on a summer fruit to stretch year 'round. The biggest weakness that our industry has to building and maintaining markets is inconsistent supply, but this too is an opportunity.

Calavo estimates that in five years one out of five fruits they handle will be processed. Processed avocado eliminates the inherent risk of fruit loss in seasonal harvest and guarantees a satisfactory product. Fruit appearance and size is irrelevant when it comes to processing. From the grower's standpoint, his goal is delivering from his acre the maximum tonnage of flesh of suitable utility for the processor. So what, if the thick woody skin of a two pound fruit is riddled with thrips damage or if it is a thin skinned variety that bears like grapes? If the grower has a variety that produces well, he could ignore the cosmetics of the fresh market and target his production at the great potential of processed products.

Our industry is mature, our trees are past their prime, and so are many of our growers.

Land and water resources are scarce and foreign competition assumes our ready markets. Progress is only possible if we approach our obstacles and opportunities with an open mind.

We have never been in a better position to face these challenges. We are on a threshold of technological advancement that will give us extraordinary tools. Not in the least is the arsenal being assembled to improve our variety position. Let us use these tools to turn industry complacency into industry stability.

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