COMBINING TRADITIONAL VALUES OF COFFEE PRODUCTION WITH A MECHANICAL APPROACH

10TH ANNUAL SPECIALTY COFFEE ASOOCIATION OF AMERICA

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COFFEES OF HAWAII, INC.

INTRODUCTION

The reference point for this presentation is a 500-acre coffee plantation on the island of Molokai, Hawaii (latitude 21' 55", elevation 800-1000', rainfall 25-35" a year.) The trees were planted from 1991 until 1994. Today we are planning a 100-acre expansion.

This plantation development is a typical agriculture orchard investment, long term and not for the faint hearted. It is an expensive and risky investment to say the least. The risk factor is higher because we do not follow a proven pattern. There is no specific model to follow for this location and climate. Growing, processing and marketing needs to be adapted pioneered and changed to fit local conditions.

The proven patterns in regards to specialty coffee production may state*:*

- **minimal mechanization**
- **hand-picking of ripe beans**
- **low wind conditions**
- **high altitude**
- **gentle rains and cloud cover**
- **Typica varieties**
- **many other**

By necessity these proven patterns had to be ignored, addressed and overcome. This 500-acre plantation is:

- **completely mechanized**
- **100% mechanically picked**
- **located in a high wind area**
- **at 800-1000' elevation**
- **fully irrigated with few rains**
- **growing Catuai varieties**

Is it possible to produce "Specialty coffee" under these conditions? Perhaps, this presentation will at least open your minds to this possibility.

PHILOSOPHICAL ASSUMPTIONS

- ✓ Follow traditional proven farming and horticulture practices. (Tilling, compost earthworm's etc.)
- ✓ Follow traditional coffee processing methods. (Full fermentation, sun drying)
- ✓ The chain is only as strong as its weakest link. This goes for all aspects of an operation and of course the coffee will only taste as good as the weakest link permits.

MECANIZATION

LABOR AND PRODUCTIVITY

In a global environment of rising labor and production costs, mechanization can reduce costs. One must either pass on the rising costs or become more efficient for example, via mechanization. This can offset the trend towards higher labor / production costs.

- A more efficient worker can earn higher wages.
- Mechanization can provide cost benefits and allow coffee producers an opportunity to withstand a competitive market.
- Efficient mechanization seeks somewhat level production areas.
- Level land is usually drier than traditional mountain areas.
- These drier areas can be utilized for coffee production, especially with irrigation. Irrigation brings benefits such as fertigation, providing nutrients and moisture when needed. It allows for some flowering manipulation and more seasonal ripening. Drier areas have less leaf disease, except for leaf rust which occurs less in higher altitudes.

Typically labor cost run between 30 and 50% of a general farming operation. In the U.S. there are few surviving agriculture crops which are not mechanized or mechanically picked. Kona coffee is certainly an exception to this observation, as it is exclusively hand picked

LABOR COST IN HAWAII AND U.S. $/ HOUR

Years	HAWAII	CALIFORNIA	U.S.
1990	$6.76 -- $8.61	$6.34	$5.52
1998	$8.05 -- $10.32	$7.38	$7.61

Statistics of Hawaiian Agriculture, 1995&1997

To these labor costs 25-33% overhead cost has to be added.

WAGE AND OVERHEAD COSTS PER PERSON/HAWAII

Hourly	$10 ------ $15
Daily	$80 ------ $120
Monthly	$1600 ----- $2400
Annual	$19,000 --- $29,000

Efficiency of production is another essential requirement in today's competitive world. In Indiana, U.S., a Grain and Hog Farmer will farm 2000 acres and tend to 300 mother hogs with 4 people, *which amount to 1 person per 1000 acres, (Two people for the hog operation and two for the farm). That is an incredibly efficient agriculture operation. * Nash & Sons- Sharpville, Indiana

In coffee production we have not become as efficient. On Molokai, we farm 500 acres of coffee with 3 orchard tractors, which is about 150 acres per tractor. These tractors during the growing season operate 10 hr. days including Saturday and Sunday, for about 240 days putting on approximately 2400 hr. per season. This requires 5 full time employees or about 1 employee per 100 acres. In addition we utilize 2 full time employees in the machine/repair shop. Our dry mill operation utilizes 3 full time employees for about 200 days. In summary, for the growing season of about 240 days, we utilize 10 full time employees.

MANPOWER REQUIREMENTS DURING GROWING SEASON (500 ACRES)

Field Maintenance	Machine/Repair Shop	Dry Mill
5 full time employees	2 Full time employees 1 Part timer	2 Full time employees 2 Part timers
3 orchard tractors (150 acres per tractor) (Approx. 240 days)		(Approx. 200 days)

During the harvest season, (usually 100 to 125 days from August/September to December/January). We engage 6 harvesting machines operating with 15 drivers covering day/night shifts. It also requires 3 full time mechanics: 10 employees working on the wet processing; and an additional 12 in the drying facility. A total of approximately 35-45 extra employees are required for the harvesting season. This set up can process 5-10 million pounds of wet fruit per season.

MANPOWER REQUIREMENTS DURING HARVEST SEASON (100 –125 days)

Field Maintenance	Machine/Rep. Shop	Harvesting	Wet Mill	Dry Mill	Drying
1 Full time	3 Full time	15 Full time	10 Full time	8 Full time	12 Full time

MECHANICAL HARVESTING

There are opinions that specialty coffee can not be harvested with a machine.

Traditional higher altitude areas do not lend themselves well for mechanical picking due to the steeper topography. (Except for pneumatic hand shakers). Over the row mechanical harvesting can take place on slopes up to approximately 25% incline.

Over the row mechanical harvesting can be divided into two broad categories:

- **Hand harvesting assisted with mechanical harvesting during peak season.**
  (Approx. 500 acres per machine)
- **100% Mechanical picking .** (No hand harvesting)
  a) Aggressive one to two pass method (Approx. 350 acres per machine)
  b) Selective multiple pass method (Approx. 100 acres per machine)

These mechanical picking methods refer to **over the row harvesting machines**, such as Korvan, Jacto or Austoff. Mechanical harvesting will remove three types of fruit (cherry) simultaneously, a) overripe, b) ripe, c) underripe. Mixing these three types of fruits in processing would produce an inferior coffee. Therefore, separating these three type of fruits after harvesting must become a integral part of the harvesting procedure. A ripe cherry is a ripe cherry and cannot be distinguished from having been hand or machine picked. Current processing equipment available allows for the absolute separation of these three types of fruits via water flotation and the separation of green by its hard surface (pressure).

RIPENESS OF FRUIT (CHERRY) PICKED BY HARVESTING MACHINE

TYPE OF FRUIT (CHERRY)	BEAN COLOR	% OF PICK (WET WT. AVERAGE) *
Overripe – Raisin	Brown – Purple	15 – 30%
Ripe – Cherry	Red – Yellow	75 – 50%
Under ripe – Immature	Greenish	10 – 20%

* The percentage of pick will vary during the season. It will also vary from field to field.

HARVESTING APPROACH

Aggressive approach—Minimal passes

- One to two passes (one machine for 300-400 acres)

These harvesting machines can be equipped with large counterweights and heavy shaking rods. With full hydraulic power applied to the shaking mechanism this will result in a maximum stroke at the tip end of the shaker rod (4"). The shaker head can be set around 1000 to 1200 RPM. At this maximum setting everything including leaves can be taken off the tree. Depending on the situation, field condition, uniformity of ripening an aggressive harvesting approach may be the best alternative. However, if the season is spread out or the timing is off entering the field, the minimal passes approach may result in picking a high percentage

of unripe fruit or leaving unripe behind resulting in ground losses (mature later and fall to the ground).
This method will pick the most beans with the fewest machines at the lowest price per pound.

If the machine is used with a single pass approach during the peak of the season and is preceded and followed by hand picking, one machine may harvest 500 acres.
A two-pass approach with no hand harvesting assistance will require one machine for about 300 acres. An aggressive approach will harvest more acres quicker but may pick more green and leave more beans behind.

Selective Approach-multiple pass method

- Four to seven passes (one machine for 75-100 acres)

This method tries to selectively pick with less counterweights on the shakerheads using thinner rods. Using 4-7 passes at 1-2 week intervals simulating repeated handpicking, removing primarily red cherries. More machines are needed per acre and the picking costs are higher. However, a higher percentage of ripe can be removed. The selective approach uses five or ten pound counterweights. The counterweights can be adjusted in or out and will correspondingly adjust the stroke of the shaker rods (1/2" to 4"). Increasing or decreasing the shaker RPM will increase or decrease the aggressiveness of the shake (Korvan machine). Increasing or decreasing the forward motion (MPH) will contribute to the aggressiveness of the pick. The selection of the rod size or rigidness will also contribute to the selectiveness of the pick (3/8" or ½"). On Molokai we use a selective approach for harvesting.
With high labor cost in Hawaii it is not feasible to retrieve any beans that fall to the ground. Beans that fall to the ground are lost. We sweep them into the aisle and they get worked into the ground. There are several ground retrieval machines on the market for coffee which are still very labor intensive. For example almonds and other nut crops shake and retrieve their entire harvest from the ground very efficiently. This is combined with an elaborate ground cleaning, raking and vacuum approach. For coffee it would be better to genetically breed a tree better adapted to machine harvesting. It is better to focus on picking ripe cherry than retrieving raisins from the ground.

VARIABLES AFFECTING THE QUALITY OF THE PICK:

- Uniformity of ripening (ripening condition of fields)
- Shape and condition of the tree (pruning for machine)
- Capability to enter field at optimum time (ability to assess and scout ripening fields)
- Skill of operator (knowledge and training)
- Having enough machines
- HP and RPM of shaker head (600-1200 RPM)
- Lbs. of counterweights (5 to 35 lbs.)
- Distance of counterweight from center rod (controls stroke)
- MPH forward speed (.3 to 1.6 MPH)
- Diameter of rod and rigidness (3/8" or ½")

Two particular research areas could have an impact on coffee harvesting. In pineapple production, growers had a problem picking ripe fruit efficiently due to multiple flowering and far spread ripening. Research with nutrition manipulation and ethephon application in foliar sprays resulted in field by field flower synchronization. Imagine what this could do for coffee! In blueberries the "fruit removal force difference" between ripe and unripe fruit is maybe 4 - 5 to 1. In coffee it is only 2.2 – 1.1 to 1. In other words ripe beans adhere almost as well as unripe beans. The greater the "fruit removal force difference" the easier it would be to remove the ripe beans only. *(Evaluation of Fruit Removal Force; C.H.Crisosto, Hawaiian Sugar Planters Association and M.A.Nagao, Hawaii Agriculture Experiment Station.)

TREE SHAPE AND PRUNING FOR MACHINE

Pruning for the machine has to go hand in hand with successful harvesting. Multi branched coffees trees especially in -V- formation prohibit the shaker rods to touch the inside of the tree. The catch plates on the bottom of the harvester need to operate freely therefore a single trunk, clear of side branches is necessary. (Up to 16"-18"). Long hanging side branches need to be hedged back to allow access for the shaker rods. The height of the tree needs to be hedged off at about 12' to 14'. Internal pruning has to be done as well, to remove conflicting and multi-branching. (Time consuming). There should be not more than 10 000 uprights per hectare * (4545 /acre).

Hedging of terminal tips will induce internal branch division, which will provide for new growth within the old tree structure. This done successfully will minimize the need for stumping.

*Jose Romero- Oro Fino Farms, Brazil

COST OF MECHANICAL PICKING VS. HAND PICKING

Hand picking costs

In Kona a good picker can pick 5 to 6 bags of cherry per day, (500 – 600 lbs.). The pay was approximately $.30/lb. This amounts to $90-$180 per day, (Minimum wage = $ 8.32 x 8 hrs. = $ 66.56 / day). It is not realistic to find somebody to pick coffee at minimum wage and perform well. The approximate manpower needed per acre is 3 people. I understand Central America also uses approximately 3 pickers per acre.

Based on these examples and applying only minimum wage scale a 500-acre Hawaii plantation would require approximately 1000 to 1500 people per harvest season. At a minimum wage of $6.50 an hour plus overhead of 28%, the cost would be $8.32 and X 1250 employees = $10,400 a day X 110 day picking season = $1,144,000. This kind of harvesting cost is prohibitive; therefore mechanical picking is the only present alternative for us.

Machine picking costs

A new over the row harvesting machine Korvan, Jacto, Austoff costs between $100,00 -$130,000.

APPROXIMATE SEASONAL COST TO OPERATE OVER THE ROW HARVESTER

Depreciation + Interest	$25,000
Maintenance	$ 2,500
Fuel cost	$ 900
Labor (3 shifts day and night)	$20,000
Total Total (Approx. $400 a day 110 day season)	$48,400

As an approximate guide one machine can harvest from 500,000 to 1,000,000 to 2,000,000 lbs. of fruit per season, depending on the type of picking methodology and field conditions, etc.

- Cost per pound at 500,000 pounds/ pick/ season = $0.096 a pound
- Cost per pound at 1,000,000 pounds/ pick/ season = $0.048 a pound
- Cost per pound at 2,000,000 pounds/ pick/ season = $0.024 a pound

Comparing hand with machine harvesting costs makes it clear why machine harvesting might be the only alternative. There are other factors such as availability of labor regardless of cost. On Molokai for example the entire population is around 6000 people. 1000 to 1500 pickers could not be found.

I am convinced that "Specialty coffee" can be successfully mechanically harvested, provided it is done right and appropriate processing methods are integrated into the harvesting process.

MECHANIZED ORCHARD DEVELOPMENT AND MAINTENANCE

CONCEPTS

Mechanization is a concept that should be carried throughout the whole plantation layout and operation. A thirteen-foot implement can not fit in-between twelve-foot row spacing. Steep terraces do not accommodate machinery well.

"Broad shoulder terraces" do. The widest turn around radius of equipment determines the space requirements to turnaround. The method and volume used to carry harvested beans for example determines row length etc. For us, the harvesting machine dimensions, the operational length of drip tubing and the dimensions of standard orchard tractors determine spacing requirements.

On Molokai we use: 12 foot " in-between" row spacing; 2 foot "in-row "spacing; 1200 foot row lengths (two times 600' effective drip tube length); 1450 trees per acre.

"In-row" spacing is really determined by the ability to prune off excessive watershoots or conflicting branches. Closer planting does not automatically mean more yields. Apple growers, as well as most other orchard crops, prune to eliminate excess wood and may spray to abort excessive flowers to ensure fruit size and to ensure the ability of the plant to mature the forthcoming crop. (Related to alternate bearing)

Mechanization is not driving a tractor or large equipment. It is rather finding the minimum HP required to do the job. We are converting most spraying to ATV (all terrain vehicles) it is less expensive to operate and does not require the HP of a wheel tractor to operate and perform the task.

MECHANIZED ORCHARD TASKS

Tasks during Field Preparation (sequential)	Tasks during maintenance of Orchard
• *Tree and Brush removal • *Disking • *Broad shoulder terracing • Field layout • *Subground irrigation installation • Measuring, flagging * marking planting lines • *Deep ripping of planting lines • *Fertilizer application into rip line • *Rotovating of planting line • *Remarking of planting line • *Plastic and drip tube lying • *Planting of temporary sudax windbreak • Planting of Wiliwili and Norfolk Pines as permanent windbreaks. • *Planting of coffee *mechanical tasks	• *Irrigation and fertigation • *Granular fertilizer application • *Fouler Fertilizer application • *Liming or calcium application • *Composting and earthworm application • *Cultivation for weed control • *Hedging (of Hedgerows) • *Pruning of internal tree structure • *Skirting the underside of tree • *Mechanical sweeping under trees • *Incorporating organic material into soil • Insect monitoring • Soil and tissue sampling * mechanical tasks

GEOGRAPHIC CONDITIONS AND PLANT NUTRITION

CLIMATIC DATA

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This graph shows mild temperatures without much flactuation. Average rainfall varies around 25"- 35" inches per year with dry summers. Irrigation is a must especially with the high Pan Evaporation readings. The tradewinds can at times blow steadily at 15 to 25 MPH with higher gusts occasionally.

IRRIGATION

References are made in literature that coffee uses 800 to 1200 millimeters (32 to 47 inches) of water per year. This could translate into 3.6 inches of water requirements per month (43.2 inches a year). This scenario does not take into account the high "pan evaporation rates" in this dry and windy area. Interesting to note is that with the establishment of the permanent windbreaks the evapotransporation rate has decreased and the microclimate has changed significantly. Our annual water consumption is around 300 to 400 million gallons a year, which averages to about .8 to 1.1 million gallons a day. We irrigate about 2 to 4 inches per month depending on rainfall. We use irromenters and evapotransporation gauges to help determine moisture needs.

WINDBREAKS

It is essential to plant windbreaks in and around the coffee fields. Our permanent plantings in and around the coffee fields are Norfolk Island pine (Araucaria heterophylla) every 500 feet and Wiliwili (Erytrina varigata L.)

Every 108 feet. For the first two years Sudan (a sterile hybrid of Sorgum-Sudangrass) was planted between every coffee line.

NUTRITION ; COMPOST,GROUNDCOVERS AND EARTHWORMS

We compost all organic milling waste and other available organic materials. After the heat cycle of the compost is over we introduce earthworms into the compost and wait to see some worm activity. Then we broadcast the compost into the orchard. Any manure we can obtain is mixed in as well. Harvesting during wet weather can compact the soil. The greater the earthworm activity the better. It helps with loosening and texturing of the soil. We are looking for a drought resistant legume for the orchard floor. A good legume could add 40 to 90 units of Nitrogen per acre per year. We are experimenting with eight types of legumes and are still looking. Growing coffee in full sun requires higher inputs, it will grow faster and produce more sugar in the fruit. Interesting to note is that in Hawaii the sugar plantations in cloudy areas shut down operations first. The surviving ones are in high sunlight areas, (High light conditions for sugar cane will produce higher sugar content in the cane). I have no proof, but I believe that high sugar content in the coffee fruit will contribute to taste. Acidity levels might be affected by this as well. (This would make for an interesting research project.) The nutritional care of the plant is the most important element from my grower perspective. It is also expensive. (15 to 25 cents per tree per year = $200 to $350 acre a year.) The finer points of nutrition management are not necessarily how much N (Nitrogen), P (Phosphorus) or K (Potassium), to apply per acre, but understanding the relationships and desired ratios among nutrients.

NUTRIENT INTERACTIONS

The following nutrient information has been reported in published articles. When a nutrient was applied to a crop, certain nutrient levels in that crop were found to increase (go UP), other nutrients were found to decrease (go DOWN). Uncertain effects are indicated by a "?".

ADD Element	**	UP	DOWN	NO EFFECT
N	Nitrogen	N,Ca,Mg	P,K,Cu,Zn,Mn	B,Ca?
P	Phosphorus	P,Ca	Zn,Fe,Cu,K,Mg,Mn?	N,B
K	Potassium	K	Ca,Mg,N,Zn,B	P,Cu,Mn,Zn
Ca*	Calcium	Ca,N,Mn,Zn	K,Na,Mg	P
Mg	Magnesium	Mg,Zn,Mn	K,Ca,Mn,Cu(slight)	
N,P,B,Fe,Al,Na,Ca?				
B	Boron	B,K,Mn	Ca,P,Mg,Zn,Mn?	N,Cu,Zn?
Zn	Zink	Zn,K,Na,Cl	P,N,Ca,Mg,Cu,Mn?	B,N?,P?
Fe	Iron	Fe	Mn,Cu	
Mn	Manganese	Mn,Cu,Na,K?	K,Ca,ZnFe,B,Mg,Cu?	N,P,Ca,,B
		(adding Urea to Mn increases Mn levels more than Mn alone)		
Cu	Copper	Cu,K,Ca,Mg,Mn	Zn,Mn,Fe	,P,Ca,Mg,B
Zn+Mn		Zn,Mn,Na,Cl	N,Mg,Cu,Ca,K,P	
Ca+Mg			Mn	
KNO3	Potassium Nitrate	N,K,Fe,B,Cu,Na	P,Ca,Mg,Mn,Zn	(test on grapes)
SO4	Sulfate		Mo	
NH4	Amonia		Mg	

** table from UAP-Pacific *Ca increases Zinc utilization and decreases toxicity

From a grower perspective nutrition management is the most critical element to be managed. Nutrient and micronutrient levels show up in soil and tissue analysis, (which guides the fertilizer program). They certainly show up in the coffee bean and I believe that they influence roasting characteristics and taste, (more research is needed on this subject).

ALTITUDE AND SHADE

Coffee originated as understorage plant and will grows in lower light conditions. Higher altitudes have often lower light conditions and cooler temperatures. In Kona over 1500' elevation coffee takes 9 months to ripen after flowering. Lower elevations take 6 months to ripen after flowering. Light conditions with cloud cover or under shade trees may vary from 3000 to 4000 foot-candles. Full sun conditions in Hawaii measure 10,000-foot candles. In the "foliage plant business" artificial shade cloth of 70 and 80% is common. Leaves grow nicer in the shade. The plant in the shade also grows longer internodal spacing than in higher light. The plant adapts to the given light condition and makes an appropriate "shade leaf" or "sun leaf" The plant however cannot convert its shade leaf to a sunleaf. If the plant is moved into a different light condition the plant will abort the old leaves and grow new ones adapted to the new light condition. The nutrition requirements under shade are less and the plant grows slower. The more light the plant is exposed to the faster it grows however, it also requires correspondingly more care and nutrients (faster metabolism).

Coffee can grow in full light or shaded conditions. It is my opinion that it is harder to grow coffee in full sun light than under shade. It requires higher nutrient management without which the plant can literally crash in a short

time. Growing coffee in full sun will result in faster overall growth and can result in more sugar in the fruit. (Provided all inputs are there)

It is interesting to question the specific effects of high altitude on coffee. Is it higher night time/ day time temperature differential, is it "lower barometric pressure", is it slower metabolism, is it slower maturation, is it nutrition in relation to other factors? What accounts for a so-called harder or denser bean? In this regard it is interesting to examine the following table and commentary by Mike Sivitz.

BULK DENSITIES*OF ARABICA GREEN COFFEE BEANS OF COMMERCE (RANGE 650-800 Gm/l)

Recorded by Mike Sivitz

_ Grams/liter	Origin	Designation	Year
795	Ethiopia	Yergacheffe	1998
790	Kive	Africa	1998
782	Mexico-Chiapa	Tapachula	1997
776	Columbian Supremos	Armenia	1997
775	Sumatra-clean	Mandehleng	1997
774	Kenya AA	Africa	1976
774	Guatemala	Antigua	1976
768	Costa Rica	Jade Azul	1977
766	Costa Rica	Naranja	1976
766/758	Hawaii	Molokai	1997
763	Hawaii	Kauai	1998
760	Celebes	Kalosi	1976
752	Columbian	Exelco	1984
750	Zimbabwe	Africa	1984
720	Sumatra	with defects	1998
670/640	Brazil	Parana	1976

The test method is to take a 1 liter can (holds 16 ounces R&G coffee) and to fill and vibrate the green coffee beans until all are settled and level.

*This type of table was not published before, because there is a notable range in densities within each country of origin, as well as the density being influenced by bean size and their distribution, moisture, level of defects, crop year, natural or washed etc. HOWEVER in spite of these several variables, the altitude of growth appears to be a major contributor to the best tastes and highest densities. Since some growing countries have a broad range of elevation for crop growth, designating the country is not enough ; it is imperative to know elevation of growth and position of the country geographically within the Torrid ozone, as well as to whether it is in a maritime climate.

Sivitz states that this data may indicate that higher grown coffees with slower growth have higher density and therefore relate to better tastes. It is interesting to note that the listed Hawaiian coffees show above mid range density but are lower elevation grown.

I like to venture and say that good tasting coffee can be grown at different elevations, provided it is done well.

TRADITIONAL VALUES AND MECHANIZATION

At first hand traditional values may conflict with mechanization.

My definitions are:

- **Traditional:** -proven concepts or ways of doing things passed on over time.
- **Mechanization:** -a systems concept that deals with replacing repetitive time consuming hand labor with a machine.
- **Automation, robotization and computerization:** -deals with guiding mechanization without direct human brainpower.

If mechanization destroys the proven traditions then it may be bad. If mechanization frees human hands from repetitive, boring tasks and improves them then it may be good.

Example:

- Man hoeing the ground with a stick - Ox guided by man pulling a special stick through the ground - Horses pulling a steel plow - Tractor pulling a Teflon coated plow – GPS (Global Positioning System) guidance system steering a remote pulling device to plow the ground with multi bottom reversible plow.

- Color sorters via computerized eyes select defective coffee beans based on color and sort them aside. (No need for tedious hand labor).

The concepts have not changed but the methods have.

- A few more examples of Molokai mechanization / tradition:

- Composting and earthworm incorporation into soil. (beneficial)
- Row spacing to allow passage for tractors with appropriate implements. (instead of mule or horse)
- Tilling and mechanical sweeping for weedcontrol. (No hoeing or sweeping)
- Incorporation of organic material into soil. (No hoeing)
- Hedging and skirting. (No hand trimming)
- Apply fertilizer with irrigation, spray or machine. (No carrying by hand)
- Mechanical harvesting and transporting of beans. (No hand labor)
- Mechanical sorting in wet processing of bean types. (No hand sorting)
- Full fermentation of pulped beans. (follow tradition)
- Transporting of coffee with hoisting trailers. (No shoveling while unloading)
- Sundrying of coffee under mechanically movable roofs. (No hand pushing)
- Drying decks equipped with automatic rakes. (No handraking)
- Pruning with hydraulic power. (No hand saw)
- Drying decks equipped with solar heating pipes in concrete. (speeds drying)
- Sundrying decks accessible with movable vacuum. (No shoveling)
- Mechanical dryers as backup for “natural dry coffee”.
- **It is possible to adhere to the proven traditional ways of doing things, but substitute equipment and machinery to do it easier and faster. It is also possible to do these tasks more cost effective without sacrificing quality or performance.**