Mechanization in the Coffee Orchard

(Some Generalities followed by specific examples)

As often told, Coffee is the second largest traded commodity after oil. Estimated 25 million families depend on coffee cultivation and are located between Tropic of Cancer and Capricorn. Maybe 11 million hectares are devoted to coffee cultivation. Labor was always a major factor being solved with slave labor in the historic past. Today many areas offer coffee employment however in some instances it still resembles slave labor conditions, as lack of housing, transportation and lack of social benefits are concerned. Child labor sounds terrible, however many young people want to work and often falsify their papers to be able to earn some money during the coffee harvest.

Even today, coffee is still a predominant hand crop. Mechanization is relative new to coffee cultivation and harvesting. Many coffee farms are located in difficult terrain. Mechanization is difficult or impossible in some of these Mountainous areas.

Worldwide the trend is to replace hand labor with machinery, no matter what crop involved. There is a trend for coffee cultivation to move from steep mountain areas, into more flat areas such as the Bolaven Plateau in Laos at 1300 meter elevation or the Cerrado Plains in Brazil or the Highlands in PNG or the Atherton Tablelands in Queensland. These locations are all around 1300 meter+ elevation. Excellent coffee growing areas and suitable for mechanization.

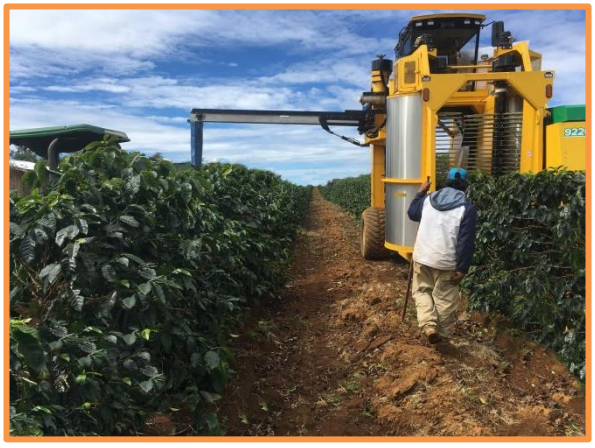
Hawaii with high labor costs is using machines where possible. Kona due to steep terrain is still using migrant hand labor.

The most expensive coffee task is harvesting. As a single task, harvesting costs are maybe double all other costs combined. In addition harvesting labor is short in many areas having to rely on migrant workers. In the Bangalore area of India, some farmers could not harvest the coffee crop on account of labor shortage.

Hawaii, Australia, parts of Brazil and other areas are working with harvesting machines not just to reduce cost but to have the means to harvest the crop, as often competition for harvesting labor creates shortages especially during the harvest period.

In addition to self-driven harvesting machines there are other means to speed up the harvest with hand held shakers, pneumatic shakers and tractor pulled harvesters.

It is essential that with machine harvesting **appropriate Wet Milling equipment** is employed to sort the harvested beans into the 3 different categories: Ripe, Over Ripe and Under Ripe beans.



A first in South East Asia. An Oxbo machine harvesting on the Bolaven Plateau. Day and night operation supporting hand harvesting.

In Queensland Australia a Korvan machine is harvesting coffee. 30% Over Ripe, 60% Ripe and 10% Under Ripe.

Agromachine "Vertical Green Bean Separator".
Photo: Pascoal D'Andrea

Good Green Bean Separation and Over Ripe Separation with flotation are critical to get the best cup results. With today's processing machinery it is possible to remove any immature green to less than 2%. Many people doubt that Specialty Coffee can be produced using harvesting machines.

It has been proven beyond doubt, that Specialty Coffee can be produced with mechanical harvesting.

Requirements for coffee mechanization

1. A self-driven harvester can handle a 22% incline however terrain needs to be reasonably modulated.
2. Rock removal is necessary, as machines do not mix with rocks. This applies to harvesting as well as orchard maintenance.
3. Field layout needs to conform to machine spacing requirements. Turn around areas, including field entry and exit needs to be to specifications.
4. Supporting roads need appropriate dimensions.
5. Drainage provisions and erosion control is essential for a sustainable operation.
6. Good groundcover plantings are important.
7. Machines save labor but need qualified maintenance and access to parts.
8. If irrigation is required infrastructure needs to compliment machinery.
9. Windbreak or shade trees need planting to coexist with machinery.
10. Shorter, more compact coffee varieties are more suitable for mechanical harvesting.
11. Mechanization and machine selection are area specific and can be selected for topography and soil conditions.

Components needed to complement each other

Climate: In the case of the Bolaven Plateau there is a distinct dry season starting in the fall with the onset of harvest. This greatly helps with harvesting and it also helps to unify flowering. Ideally flowering will happen after a dry period, followed by rainfall in the spring (March, April). Consolidated flowering makes machine harvesting much easier on account of red cherries being ripe at the same time

Fertility: Interesting to note that the Cerrado Plateau in Brazil needed considerable amounts of Calcium upon development for agriculture production. The same has proven with numerous soil tests on the Bolaven Plateau. The Hydrogen-Calcium ratio needs to be reversed with the application of considerable amounts of Calcium Carbonate. The typical manure application does not help with this.

Uniform Flowering: Areas where flowering and ripening happens throughout the year do not lend themselves for mechanical harvesting. Flowering manipulation through various means, can reduce the number of flowerings to three or less which makes mechanical harvesting easier and reduces the amount of immature green.

Varieties: Shorter varieties lend better for machine harvesting. The Lao Experiment station in cooperation with CIRAD (French Experiment Center) have produced good rust resistant varieties base on Catimor crosses. On the other hand a local cooperative is producing Typica coffee (not rust resistant) getting premium prices in Japan.

Example of Mechanical Coffee Development on the Bolaven Plateau, Lao, PDR

DanKuhnCoffee.com (Coffee Consultant)

Coffee development 1.2 year after transplanting. Photo: Sandesh D.R.

Sequential Coffee Development

1. Field Preparation / Rock Removal

Modified steel plates pulled by tractors can handle large and small rocks. Very large rocks need two tractors. Front blades on tractors are a great tool.

Dozer with rock rake for pushing rocks and leveling of high spots.

The rock picker can pick rocks up to 1.5 feet (maybe 2 feet) in diameter. The rocks can only be picked up on the surface and need a harrow (for the smaller rocks) to bring them to the surface.

Rocks up to 1.5 feet can be handled with a Rock Rake. Surface rocks are winrowed from two sides and picked up by the Rock Picker.

Large rocks need a backhoe or other digger for removal. Ripping with the dozer can bring most rocks to the surface.

2. Field Preparation / Marking and Deep Ripping

Tree logs can be used as land levels, provided they are heavy and on angles

Hydraulic marking arms on a 6 foot wheel base "Row Crop Tractor" makes field marking easy.

Spacing: 12 feet between rows (3.6 meters) and 3 feet (.91 meter) in the row.
This will allow access for the Harvesting Machine and access for a Narrow Tractor (5.5 feet wide) between mature coffee rows. Taller varieties have wider in-row spacing.

Ripping to 1 meter depth helps with tap-root growth. Good root development is essential for sustainability. Ripping also fractures the top layers, helping with drainage. The open furrow helps with getting calcium and phosphorus into the deeper layers, as they are difficult to move in the soil horizon.

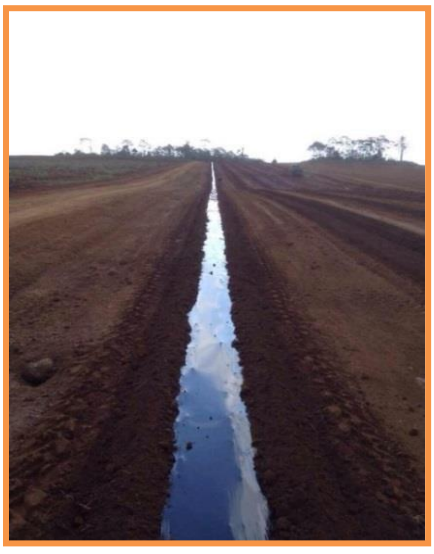
3. Pre-Plant Fertilizer and Rotovating

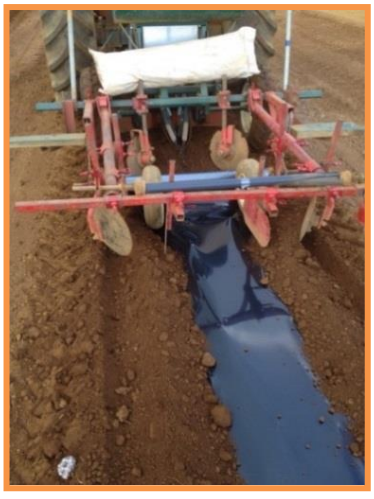
In this location, calcium and phosphorus was missing. Applying Calcium Carbonate and Dolomite (for magnesium) made all the difference. The calcium is dropped on 12 foot center into the two furrows. To understand the nutritional make up, "Soil Sampling" is a must.

Rotovation is done two times. First, to work in the initial pre- plant fertilizer. Second, the ground is marked again and fertilizer is applied and worked in again, followed by final marking prior to mulch laying.

4. Mulch Laying and Planting

Plastic mulch has several advantages. It reduces the initial weed pressure. It also contains moisture, which is important if there is a dry season. Temperature measurements show that plastic contains soil temperature, which is important if temperatures approach 0 degree Celsius (frost damage). Even a small temperature difference can make the difference between damage or not.





The mulch-laying machine has a fertilizer attachment as well. A small amount of NPK is applied at the exact planting line. There are a combined 3 fertilizer applications under the plastic, lasting up to one year.

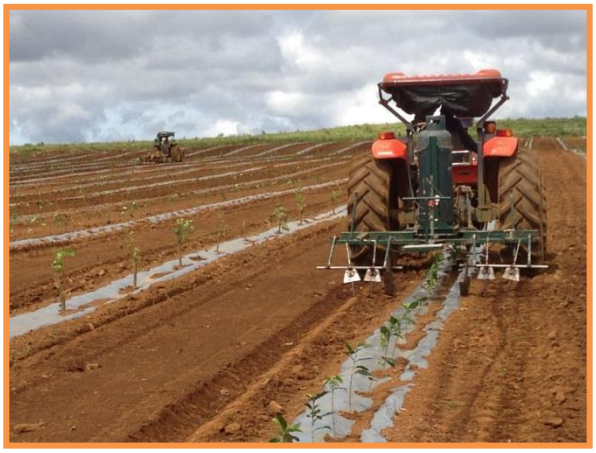
If the seedlings are grown in plastic bags, the bottom 1 inch has to be cut off, to remove any circling or j-roots.

Because the ground has been ripped and rotovated and amended with fertilizer there is no need for making big planting holes. Planting is rapid.

Better than plastic bags are “Dibble Tubes”. Dibble Tubes will self- prune roots on the bottom and j root or circular roots cannot develop. Note the white roots in this example which is desired.

5. Field Maintenance

Some fundamentals: Weed-control is a major factor. To keep weeds under control it is essential to eliminate small weeds before they make seeds. Letting weeds go to seed brings 4 to 1 (or 7 to1) time required to eliminate the weeds subsequently. It will take 4 years to eliminate weed seeds as they will germinate over time.



Flaming with propane burners will eliminate small weeds easily, without the use of herbicides. Movable shields to protect the plastic.

Sweepers are great when weeds are small.

To keep fertilizers from volatization , it needs to be incorporated ASAP.

Initial fertilization in the rip line lasts for one year or more. After roots develop outside the plastic, subsequent fertilizer can be applied. It is important to check soil and tissue conditions to utilize fertilizer efficiently.

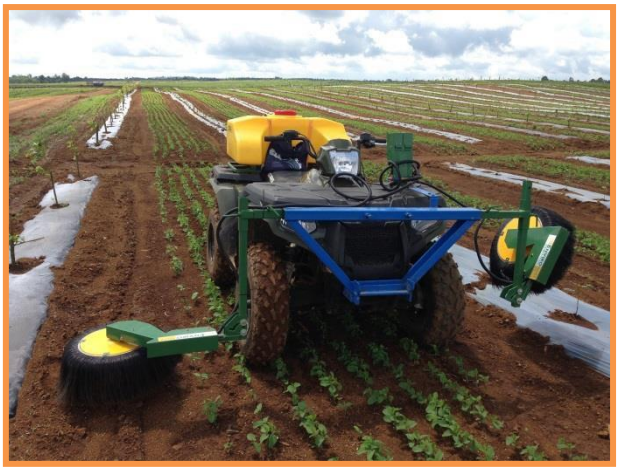
Spraying “amino acid” and other “micro- nutrients” after planting will help with a good plant start. It also can help during frost and any other stress condition.

A 3 point platform can help in the early stages of weed-control, especially around the planting hole and close to the side of the plastic.

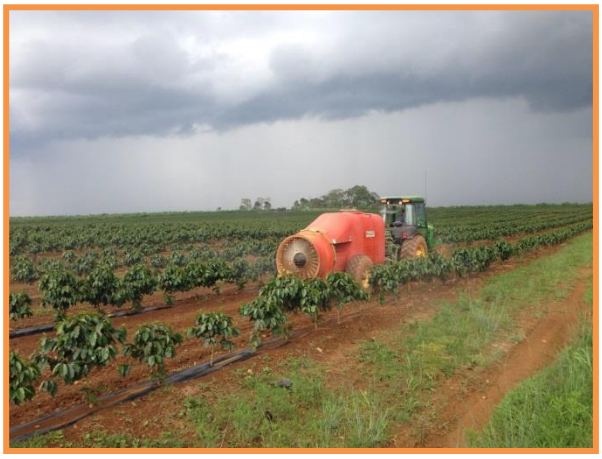
As long as the ground is open the heavy orchard disc is the best tool for weed-control. It is fast and easy to use. Because of the weight, it has hydraulic wheels to lift of the ground.

Manual pruning and removal of lower branches at about 1 year.

It is difficult to control emerging weeds in Arachi pintoi. A weed wiper can be adjusted above the Arachis plants and wipe the taller weeds with “Round Up”. This is a New Zealand machine used in pasture management.



Low volume spray heads use very little spray material and can be attached to any vehicle. To minimize herbicide use, spray in critical areas only. Narrow strip next to plastic. ATV’s have good application, especially in muddy terrain, because they are light and have 4 wheel drive.

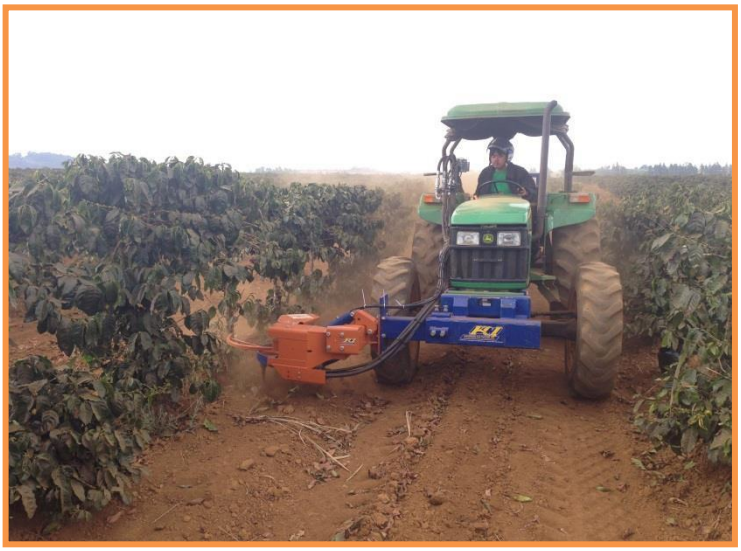


Air-blast sprayers deliver superb coverage with reduced spray material. To increase distribution efficiency, a Hydrostatic electric attachment is cost effective. This can be retrofitted.
The sprayer is used for foliar application, insecticide and fungicide spraying. The “Narrow” tractor has an air-conditioned cab, ideal for spray application as it protects the driver.

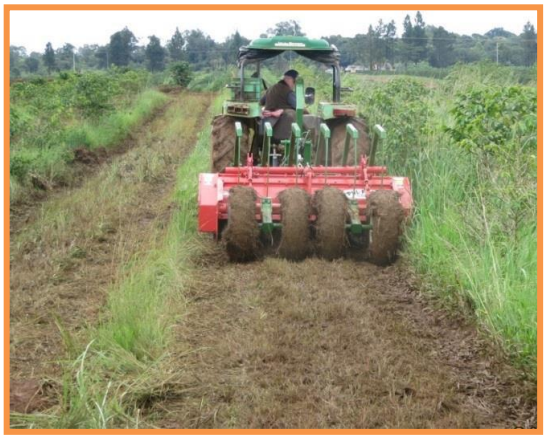
2 seats in front of small tractor for spot spraying of herbicides.

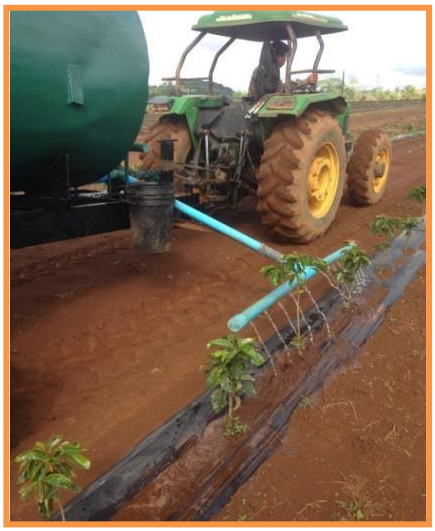
Hydraulic driven skirter attached to the front hitch. Cuts lower branches 16 – 18" " off the ground for Harvesting Machine operation. Note the 94 HP Narrow Tractor with hydraulics in the front and back.

This French vineyard trimmer can be used for hedging and to keep the coffee contained and uniform. The multifaceted adjustability can help with the two sides and the two tops and can be adjusted on the go. It can be equipped with either knifes or saw- blades for heavier cuts.



Front mounted side cultivator. Will move between trees and move in or out when trigger is touched. The machine operates hydraulically and does an excellent job replacing hand weeding in the row and around the trees.

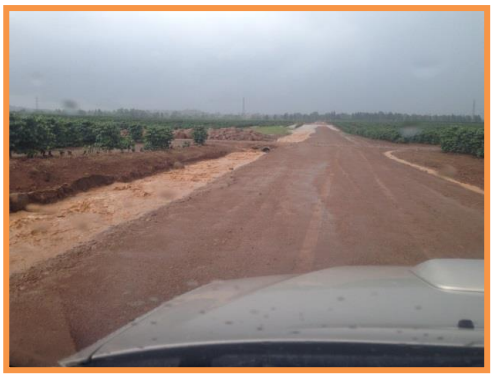




Shredder for mulching vegetation and trimmings.
Watering during the dry season.

6. Waterways and Drainage

With 3 to 4 meters of rain per year makes drainage important. The water has to go somewhere.
7 to 8 months with heavy rain and 4 months without any rain makes for some interesting oposites.

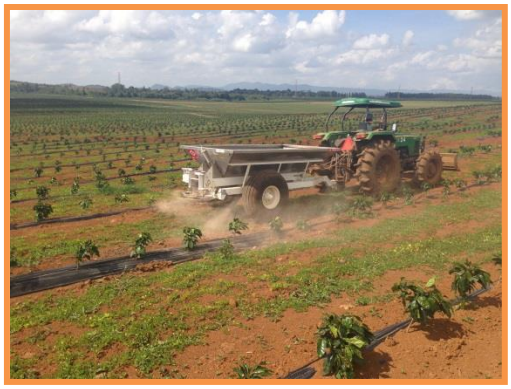


Any low spot will fill with water and kill the coffee. All low s pots have to be drained or filled and sloped for drainage.
Waterways need to be planted with Bermuda-grass for erosion control. Annual rainfall 3 to 4 meters.

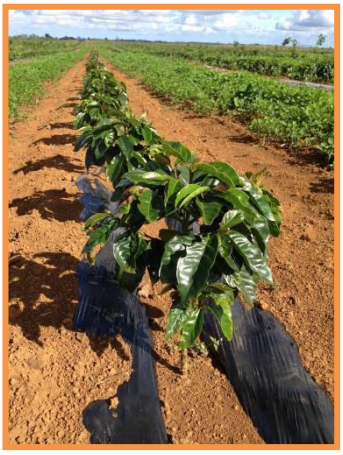
7. Plant Response after Transplanting

Two weeks after planting, no loss of leafs

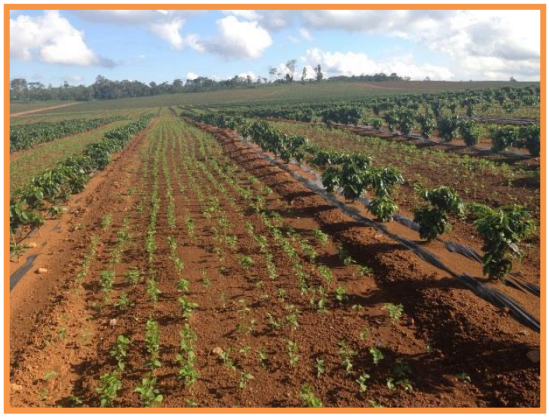
One month after planting. Good growth response. Arachis pintoi for ground-cover



Three months after planting, coffee is growing well. Fertilizing Arachis with spreader.



Eight months after planting.



Eight months after planting

One year after planting with good ground cover - Arachis pintoi (miniature peanut)

First major flowering at two years of age. About 18 to 24 flowers per cluster.

For each node, there are flowers (not always). In this case, there are about 20 to 24 flowers per cluster. There are also leaf buds where new leaves are emerging from.

Coffee at two and half years, with maturing cherries.

At 2 years 10 months, the first harvest delivering 8.4 tons cherry per ha. Besides the maturing harvest there is new growth and buds for next year's crop. It is necessary to take care of two needs; the maturing harvest and new growth with new flowers for the following year's harvest. Like grapes, coffee makes flowers only one time on the same wood, requiring continued new growth for sustainable harvests.

Trees are 2.5 year of age, prior to first harvest.
Nutritional "make up" is in good order, indicated by new growth and shine on the leaves.

Coffee is a "**Female Crop**" requiring **TLC** (Tender Loving Care)

Dan Kuhn is a Coffee Consultant. (DanKuhnCoffee.com)
He worked in various countries with coffee development.
The last 3 years he spent on the Bolaven Plateau with this project

All photos by Dan Kuhn unless noted