NOVEMBER 2012 ORCHARD WALK

Labor Management in Modern Orchards and Opportunities for Mechanization

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The most important thing you can do to manage your labor-related risks in tree fruit production is to commit to simple, narrow, accessible and productive orchard systems (SNAP). When established with the right genetics in the right location, these systems set you up for high early yields and high and yields of high quality fruit from the top of the tree to the bottom of the tree over the life of the orchard. Transitioning to high density narrow architectures orchards will put growers in the best position to take advantage of new labor reducing technologies as they are developed. Orchard operations that have at least a portion of their acreage planted to SNAP blocks are more competitive for labor, contract services and warehouse relationships. The labor that is hired can be successful with less skills and experience. Blocks trained to these systems are both people and machine user friendly. And interestingly, sunlight and humans have about the same reach – light becomes limiting and arms run short after penetrating a canopy to a depth of about 1 meter.

It has been shown repeatedly that orchards with high density and simple plantings are more attractive to workers if all other things are equal. This means that if you are known to be a fair to good employer and your wages are competitive, you will be more attractive to a worker if you have at least some of your blocks planted to SNAP systems. In 2012, there are more jobs than people so the agricultural worker is in the driver's seat. Having said that, bad employers will be bad employers and regardless of system, they will be or should be on the bottom of everyone's list.

Where do you want to work?



Labor –related risks

Labor –related risks in tree fruit production are many but perhaps the most important are 1) getting the job done 2) getting the job done on time and 3) getting the job done correctly. Basic best practices and labor relation guidelines are usually sufficient to get the right people for the right job at the right time. Things like be respectful, be kind, ask for input, pay competitive wages, have incentives in place, be open to negotiation, identify leaders and expect greatness and know when it shows up are required modes of operation. Things have changed. The economy has changed what employees need from employment and employers need to work smarter to attract the right people for the right job at the right time. A common thread in the global fruit growing community is labor shortages and increasing labor costs. From South Africa to South America, from the South Pacific to Asia, Europe to the Americas, we are all in this together. Under these conditions, we need to go above and beyond. We may need to pay more than our neighbors, we need to ensure that people can earn as much as possible in the least amount of time, we need to ask them what it will take to keep them there and committed to quality throughout the season and be sincere in trying to deliver at all possible. Engage workers in the process of growing fruit – explain why XYZ needs to happen, why it needs to happen a specific way and why it needs to happen within a specific time period. Don't confuse how with why… they are not the same. And now more than ever we need to dedicate time and effort to recruitment and communication by people within the specific workforce population(s).

So, we can regulate and educate and move people all around the globe but at the end of the day, this will not lead to a win-win. It is time to engineer solutions to our labor-related risks. I believe with available and emerging genetic selections and horticultural practices, we are on a shared path to change the way we grow and harvest perennial tree crops. *"We have invested in and succeeded with high density narrow systems and we now need the engineering solutions to optimize the system and our investment" – Scott McDougal, McDougal and Sons, Wenatchee, WA.*

Mechanization

With new shortages and demographic trends, there is renewed interest in developing engineering solutions for perennial tree fruit production. There is a lot of time and money being spent in both the public and private sector to develop machinery, automated systems and tools. Small market size limits the number and size of companies working on our behalf and it limits the amount of money available to take a product through research and development to commercialization. Fortunately, there are individuals and small companies willing to take the risk and expend the energy to undertake the process. As I scan the R and D arena in both the public and private sectors, I see more effort directed at tools for simple narrow canopies than for tools that would be a good fit in 3D trees. There are systems being developed that won't see the light of day because of lack of robustness, poor design and most importantly poor return on investment. The adoption of technologies for mechanization requires a positive return on investment, proven reliability and local serviceability. Successful integration of the technology requires a desire to make it work, rigorous evaluation and the right fit between people, machine, orchard system and task.

When surveyed about mechanization, North American fruit growers ranked mechanical harvest as the number one need for mechanization. Thinning, pruning and mowing followed mechanized or augmented harvest. Growers also report that while you need a positive return on your capital equipment it might not always be found in increased efficiencies. In the case of mechanical thinning, pruning and harvest, there is value in removing ladders from the operation and that value can be captured in being able to cast a wider net for employees and from mitigating the risks associated with ladder injuries.

System Clarification: SNAP, fruiting wall, narrow canopy, high density, simple etc.….
The apple architectures that I work in to validate the following technologies fit in this range:
Canopy thickness - 20 - 70cm, tree height 2.7 to 3.5m, row spacing 3-3.5m.
Tree spacing 0.75 – 2.5m depending on system. Less than 2.7 m row spacing is tight for equipment.

MOBILE PLATFORMS

Platforms have been around for several decades but for the most part the European labor crisis in the mid 60's was the event that really got work underway. Since then, platforms are built, sold, bought and used for primarily 2 reasons. SAFETY AND EFFICIENCY

Platforms have 2 jobs: They position workers in the canopy without ladders and they set a block up for further mechanization. Almost regardless of the high density system, if you use a platform to thin, prune, train, tie etc., then at least the top portion of your tree is set up for additional mechanization. This will allow for mechanical thinning, mechanical pruning and perhaps augmented harvest.

Platforms come in a wide range of sizes and costs. Platforms that have multi use design and function are the most desired because prices for commercial platforms are high and increasing. Examples of multi use include: DBR Conveyor Concepts, Van Doran – Auvil, John Deer prime mover and several European harvest assist system with removable bin handlers. Platforms can be home made, over the row, self-steering, laser guided, tractor pulled etc. You name it and it has been done or will be done.

Removing ladders and putting the right people on a mobile platform requires smart management. You need to have a near perfect fit to obtain the efficiencies you need, you cannot cause ergonomic harm, you must carefully select the right number of people and the right people to work together and you need a pay system that gets the job done, gets it done on time and correctly. I have many tales of two platforms. Integration is critical and more people have failed than succeeded.

PLATFORM EFFIENCIES

Apple – high density, tall, narrow systems

Activity	Efficiency gain platform over ladders
Pruning	+ 25-40%
Tree Training	+ 40-60%
Bloom Thinning	+ 20-35%
Green Fruit Thinning	+ 20 -25%
Pheromone Placement	+ 75%
String Tying	+ 65-116%
Trellis Construction	----------

REASONS FOR USING PLATFORMS		REASONS FOR NOT USING PLATFORM	
Reason rated "very important"	Frequency	Reason rated "very important"	Frequency
Increased worker productivity	33	Purchase price too high	110
Improved worker safety	22	Maintenance and repair costs too high	44
Ease of operation	18	Limited availability	28
Purchase cost is recoverable	19	Orchard architecture not suitable	152
Improved quality of work	21	No improvement in productivity	62
		Steep slopes	82

Gallardo et al 2010

MECHANICAL PRUNING

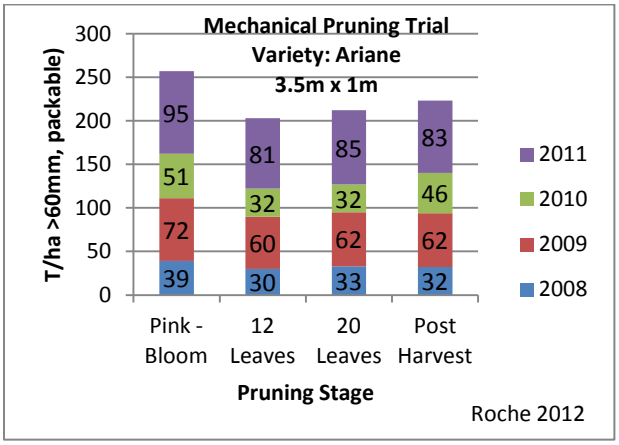
In recent years, Europe has been experimenting and at some level adopting mechanical pruning in fresh market apple production. Pruning times being evaluated are bloom, 8 and 12th leaf and dormant. Sickle bar and circular saws are both used with a slight preference to sickle bar in blocks where there is little or no wood over 3cm. In blocks with the more than occasional piece of wood larger than 2.5 - 3cm, the circular saw is preferred.

French physiologist Roche suggests that pruning a new shoot at the 12th stage results in a proliferation of inflexible spurs, enhanced floral induction and a long lasting fruiting zone. Dormant pruning by hand

might be needed to remove sagging branches, forgotten branches and competing branches (0-30hrs/ha/year). The pink to 20-leaf strategy begins in year 3 or 4. Mechanical pruning using this strategy saves 80-100 hrs. /ha/year and can increase one workers productivity from 8ha to 12ha.

Matt Whiting, WSU Prosser conducted mechanical pruning in UFO cherry block in 2012 at dormant stage. Replicated studies indicate 90% gained efficiency when compared to ladders and loppers.

As of 2012, I know of no commercial orchard in the PNW that has adopted mechanical pruning in apples. A handful of orchardists are evaluating the practice on a small scale. A search for hard data amplifies that this practice be field validated in our respective climates.



MECHANICAL THINNING

Finding labor reducing technologies for fruit thinning is critical and ranks right behind harvest. Hand bloom thinning and hand green fruit thinning is labor nightmare and very expensive. The need for a large number of people over a short window = high risk.

Mechanical thinning got its start in stone fruit with rather rudimentary rope thinners. Today we have PTO powered string thinners and handheld systems. The two PTO string thinners, the Darwin and the Bonner are non-selective thinners that can be used across all species and are most effective and useful where there is sufficient cord to bloom contact. You can with good to excellent results and a “dialed in” level of thinning if you manage the strategy well. The tractor driver is a variable and one that needs to be sorted out. A plus with mechanized thinning is that it can be carried out in all sorts of weather including rain and light snow.

New to the market is the INFACO Electroliv or Electroflor and a soon to be named product out Washington via china. The handheld devices are still a non – selective thinner but when you put it in the hands of a person, you add selectivity to the process. The other advantage of the handheld is you can penetrate canopies that are 3D and complicated.

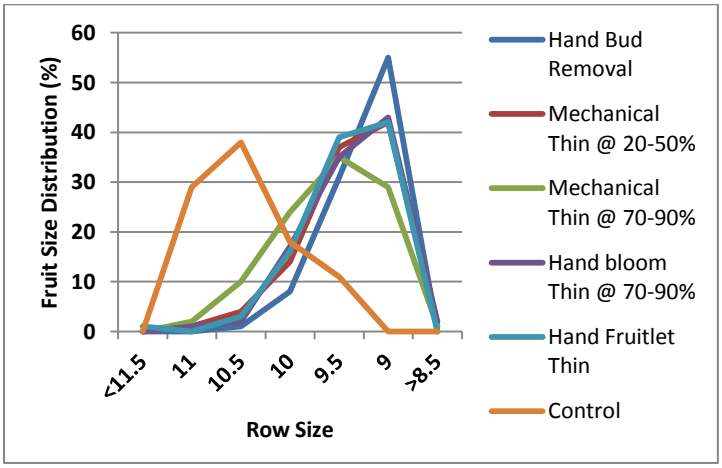
STONE FRUIT

These tools have documented success in nectarines, peaches and apricots trained to a planer system where cord to bloom contact its good. The best conditions for stone fruit is in systems where most of the wood is either stiff or tied to wire. Whippy shoots are difficult to thin and odds are you will either strip them or not thin them. Seventy replicated and demonstration trials in commercial orchards in the USA have shown that bloom thinning and bloom thinning with mechanized string thinners improves fruit quality, percent of fruit in first pick, size and return bloom in stone fruits. Hand bloom thinning in PNW runs between $800 and $1200 / acre. Mechanical thinning costs $55-60/acre. Added savings are captured in reduced follow up green fruit thinning times by 25-65%. In stone fruit there is a fear of late frosts, but without chemical options and the returns of bloom-thinned fruit, mechanical thinning is easy to pencil out.

CHERRIES

The arrival of new prolific sweet cherry varieties and early Darwin and Bonner trials in sweet cherry led to the development and validation of the handheld. There is very small acreage of cherries planted to planer canopies so right off the bat we knew these machines would not move the needle. In addition, Darwin/Bonner trials often resulted in over thinning and blank wood. Results were mixed across varieties when thinning was conducted at bloom but results when treated at bud swell were positive. Dormant timing is "easier" on the grower and we were able to dial in the amount of buds we wanted to remove better than we were at dialing in bloom removal.

Cherry trials with the hand held INFACO have shown mixed results in some varieties but overall, it is safe to say that hand held devices will be adopted and become a useful tool in managing crop load in the most prolific cherry varieties grown in the US. Below is fruit distribution curve for Sweetheart on Mazzard.



APPLES

Apple growers have been hesitant to use mechanical thinners because of concern for fireblight, over thinning, non-selectivity, potential king bloom loss and reported leaf tearing. Early trials and demonstrations worked out the many variables that can be dialed in when using the Darwin or Bonner in apples. What we have learned in apples thus far: 1) a mechanical string thinner where cord to flower contact is good, is an effective thinning tool in apples, 2) the variables of cord placement and cord number are less important than spindle speed and tractor speed, 3) as number of strings increase, the level of thinning severity increases 4) as spindle speed increased, the removal of the number of blossom clusters increased and the number of blossoms per spur declined as spindle speed increased, 5) spindle speeds of 180–210 rpm provided the best overall thinning response and minimized injury to spur leaves,5) fireblight can be transferred from tree to tree but in PNW temperatures at bloom reduce the risk of active infections.

Cropload Management in Granny Smith
Lewis, Schmidt 2010-2016

Treatments: 1) every year – chemical thinning, 2) every year – mechanical thinning and 3) alternate year – chemical thinning and mechanical thinning.

Key findings and questions:

- Comparing thinning data of chemical (CT) vs. mechanized thinning (MT) should not be the sole focus; MT can be dialed up or down to be as aggressive or gentle as the operator wishes based on bloom, crop history etc.; actual data are more a function of tree architecture & operator technique than anything else
- The question is how aggressively can we mechanically thin and for how many consecutive seasons without hurting yields of target fruit? CT treatments in this study should be considered more as an industry standard/control
- MT produced ½ box size larger fruit than CT in 2011;
- MT has reduced fruit set more than CT in the first 2 years, but is it too much?
- MT return bloom was almost twice that of CT, suggesting that injury to trees from MT was more than compensated for by benefits of reduced cropping; long term yield trends will tell the story

MECHANICAL HARVEST

Fully mechanized tree fruit harvesters are on the minds and drawing boards in public and private sector engineering and / or horticulture labs around the world. Several attempts have been made to fully mechanize harvest of apples and pears since the 60's. Most machines have had a large industrial robotic

arm and either a suction, cutting or hand end effector. These projects have failed to make it out of the lab because of it is too big, too expensive, isn't fit for duty outside in the elements … or they can't find or pick an apple.

A step in the direction is human in the loop or augmented harvest platforms. These are used extensively in Europe and are now being evaluated in the US. They come in all kinds of configurations, sizes, capacities, complexities and prices. Labor savings can be realized when you remove ladders and put the bin filling or the bin in close proximity to the picker. Basically they deliver a bin or box to the pickers, pickers fill the bin from bags, conveyors or vacuum tubes from the ground or from the platform. All require workers to find the fruit and pick the fruit. Our tests have shown that 35-40% of the time is devoted to these actions in a modern orchard of 3D trees. In 2D trees the amount of time is reduced by 50% when compared to 3D trees. European producers report minor increase in labor efficiency or productivity on small orchards of mixed varieties and strains. I point this out because in the PNW we tend to have large blocks of single varieties and strains so our need for efficiency is different that most of European orchards. The best use of this technology in the PNW is to focus on the top 1/3 of the tree.

In the United States we have 3 equipment manufactures gearing up to offer human in the loop harvest assist machines capable of handling apples within industry quality tolerances.

Van Doren / Auvil / Lattau Machine "OP" Self propelled

This is a multi use machine that can be used as a platform for other tasks throughout the year. It is designed for 4 platform pickers, 2 ground pickers, 2 sorters and one driver/rover for a total of 9 people. This machine shuttles over the empty bin and picks it up and lowers bin-filling mechanism in the rear. Fruit is picked in "short" picking bags and the four pickers on the machine deliver fruit to a sorting conveyor where culled fruit is dropped through a shoot to the ground. The 2 pickers on the ground self sort and put fruit directly in the bin. In most varieties, pay is by the piece. Cullage is ~ 8-10 bins per acre where wind and / or sunburn is not a major factor. Where wind is a major factor in fruit finish, cullage can be as high as 20 bins/acre. While these numbers are high, it is of great financial benefit to not put this fruit in a bin, send to warehouse, pay the in charge, apply MCP etc. (they just need more shade cloth). Bruising on all varieties where the machines are used is within industry tolerance <5% and <3% downgrade. Efficiency varies according to variety and type of pick but overall, this company is realizing a gain in efficiency from 20-50%. Core technology: dry bin filler. Price estimate - $250K US.

Picker Tech / Oxbo (Swoosh Technologies / Oxbo) Self propelled

People pick from ground and from the platform. This machine is a single use vacuum tube machine with a water tank decelerator and vision based defect sorter on board. It straddles empty bins and has dual bin filler for both sorted and culled fruit. It is not designed and cannot be configured for other tasks throughout the year. The machine carries 4 - pickers and one driver/ rover. The pickers pick fruit by hand and place in vacuum tubes. In 2011 efficiencies were difficult to determine with observations reporting in the 20% range. Bruising and general fruit damage was an issue throughout the 2011 season.

After identification of where impacts were occurring and mitigation at the sites, bruising was reduced to within the high end of industry standards. This machine did not operate in apples during 2012 season. Major design and function changes are on the drawing board.
Core technology – vacuum tube. Price: estimate - unknown.

DBR Conveyor Concepts “DBR”

The DBR is a vacuum based tube system with dry decelerator and bin filler. It is designed for 4 pickers and one tractor driver/rover. Two pickers can pick from the ground and 2 from the platform or 4 from the platform. In 2011 bruising was greater that industry tolerances in all varieties except Braeburn and late Fuji. In 2012, fruit handing was within tolerance in all varieties when operating within normal range. Design and function continues to evolve. Efficiencies varied but overall we can gain about 25%. Pennsylvania reported 40% gain with similar model. Core technology – dry decelerator. Price: estimate - $90-100 US

HORIZON TECHNOLOGIES – What’s going on and who is doing what.