Cooperative Extension Service
C/T/A/H/R
College of Tropical Agriculture & Human Resources
University of Hawaii at Manoa

AgriBusiness
March 2001
AB-14

The Economics of Producing Grafted Coffee Plants

Kent Fleming and Silvia Mauri, Department of Tropical Plant and Soil Sciences

Eighty-five percent of the land planted with coffee in Kona is infested with the Kona coffee root-knot nematode, *Meloidogyne konaensis*. Nematodes even in low numbers are very damaging to coffee tree roots, and it is estimated that infested farms are losing about 60 percent of their yield potential (Schmitt et al. 2001).

Nematicides are relatively ineffective in the soil conditions of Kona. Although removing all vegetation and leaving the soil fallow for a while can reduce nematode numbers, coffee subsequently replanted will soon become infected, and the nematode populations will increase again. The only practical solution now available for this critical economic problem is to remove infected coffee trees and replant with varieties resistant to nematodes. However, no strains of the preferred coffee variety in Kona, 'Guatemalan' (also called "Kona typica"), have been found to be resistant to the Kona root-knot nematode.

CTAHR researchers have recommended use of a nematode-resistant rootstock known as *Coffea dewevrei* (Serracin et al. 1999). Existing infected plants should be removed, and fields should be replanted with coffee scions grafted onto the resistant rootstock. Grafted plants may be purchased, or growers may graft their own. The recommended grafting method (and the one upon which this economic analysis is based) is a modification of the Reyna system, grafting coffee in the germination stage.

The economic model

The cost of producing field-ready grafted coffee nursery stock is calculated using an economic model of the production process. Understanding the cost of producing grafted plants will help producers determine whether it is more cost-effective to purchase grafted nursery stock or to produce their own grafted plants, or whether it is profitable to produce grafted coffee plants for sale to other coffee growers.

The example used to illustrate the method is based primarily on practices and experiences at the CTAHR Kona Research Station in Kainaliu, but the model is flexible enough to accommodate a wide range of modifications. Currently there are only a few private producers of grafted coffee plants, but their practices and experiences were also incorporated into this economic model. Growers should calculate their cost of production using their own production assumptions and input prices. The spreadsheet illustrated on pages 2–3 is available in Microsoft Excel 5 format on the CTAHR Web site at <www2.ctahr.hawaii.edu/oc/freepubs/spreads>.

Using the model

The model requires you to make a number of decisions. First, enter the number of acres of coffee trees desired, and select a planting density. This will help to determine the number of grafted plants required to meet your needs.

The model then requires you to make a decision on whether to produce one or two batches of plants per year. If two batches are produced, the capital items (such as the shadehouse and irrigation system) will be more fully utilized, and the fixed cost per grafted plant will be lower. In the example given here, enough grafted plants are produced to plant 4 acres at 680 trees per acre (approximately 8 x 8 ft spacing). The example system produces only one batch of nursery stock per year. (Note that the same final number of plants could be obtained by producing grafted plants for 2 acres and starting two batches per year.)

The next production decision is to choose between the "cell" or "tray" germination method. In the cell method, rootstock plants are started by sowing seeds in small plastic cells and subsequently transplanting the grafted plants into large bags and finally to the field. In the tray method, rootstock seeds are germinated in trays and then transplanted into rectangular plastic or paper containers (about 3 x 3 inches square and 7–9 inches

Published by the College of Tropical Agriculture and Human Resources (CTAHR) and issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Andrew G. Hashimoto, Director/Dean, Cooperative Extension Service/CTAHR, University of Hawaii at Manoa, Honolulu, Hawaii 96822. An Equal Opportunity / Affirmative Action Institution providing programs and services to the people of Hawaii without regard to race, sex, age, religion, color, national origin, ancestry, disability, marital status, arrest and court record, sexual orientation, or veteran status. CTAHR publications can be found on the Web site <http://www2.ctahr.hawaii.edu> or ordered by calling 808-956-7046 or sending e-mail to ctahrpub@hawaii.edu.

BASIC ASSUMPTIONS

1	Ultimate desired planting density (trees/acre)	680	6	Scion selection rate (% germinated seed used)	50%
2	Desired planting area per batch (acres)	4.0	7	Successful grafting rate	90%
3	Nursery batches per year (1 or 2?)	1	8	Grow-out rate (from successful graft to field)	90%
4	Use cells or tray for germination?	cells	9	Planted tree replacement rate (to bearing stage	12%
5	Successful rootstock seed germination rate	75%	10	Average wage rate for labor	$9.00
			11	Average labor overhead (e.g., FICA, etc.)	33%

OPERATING COSTS

		I. ESTABLISHMENT (~ 2 months):	No. / unit		Cost / unit		Req'd. units		Total cost	%
	A.	Planting rootstock:					*Planting rootstock subtotal =*		*909.94*	3.2%
	1	Rootstock seeds (*Coffea dewevrei*)			$0.10	/seed	**5,015**	seeds	501.47	1.8%
Yes	2a	Stubby cells (reuse 3 times)	1	seed/tube	$0.10	/tube	5,015	tubes	167.16	
Yes	3a	Vermiculite for germination	7.0	cu in/tube	$16.00	/bag	20.3	cu ft	81.26	
No	2b	Starter tray (reuse 10 times)	320	seeds/tray	$1.00	/tray	15.7	trays	0.00	0.0%
No	3b	Vermiculite for germination	432	cu in/tray	$16.00	/bag	3.9	cu ft	0.00	0.0%
	4	Labor to fill and place seed @	375	per hour	$11.97	per hour	13.4	hours	160.07	
No	5	Containers (reusable 3 times)	1	pl./contain.	$0.25	/contain.	3,761	contain.	0.00	
No	6	Artificial sterilized medium	80	cu inch/cont.	$16.00	/bag	174	cu ft	0.00	
No	7	Labor to fill and place seed @	150	per hour	$11.97	per hour	25.1	hours	0.00	
	B.	Planting scion:					*Planting scion subtotal =*		*546.77*	1.9%
	1	Scion seeds ('Guatemalan') @	2,000	/1 lb bag	$6.40	/1 lb bag	10,029	seeds	32.09	
	2	Starter tray (reuse 10 times)	320	seeds/tray	$1.00	/tray	31.3	trays	3.13	
	3	Vermiculite for germination	432	cu in/tray	$16.00	/bag	7.8	cu ft	31.34	
	4	Labor to fill and place seed @	125	per hour	$11.97	per hour	40.1	hours	480.20	
	C.	Growing maintenance:	60	days / nursery batch			*Growing subtotal =*		239.55	0.8%
	1	Water	20.0	gal/d/batch	$0.05	/gallon	60	days	60.00	
	2	Labor to water, etc., daily @	15	min/day	$11.97	per hour	60	days	179.55	
							Establishment subtotal =		**$2,483**	**8.7%**

	II. GRAFTING:	*Note:* ***3,761*** *rootstock seedlings at beginning of this stage*						
60	days / nursery batch	**No. / unit**		**Cost / unit**		**Req'd. units**		Total cost:
1	Grafting tools and supplies			$0.01	/graft	3,761	graftings	37.61
2	Labor to graft @	60	grafts /hr	$11.97	per hour	62.7	hours	750.32
3	Clips (use 3 times)	2,000	per bag	$200.00	per bag	1,254	clips	125.37
4	Water	20	gal/day	$0.05	/gallon	60	days	60.00
5	Labor to water, etc., daily @	15	min/day	$11.97	per hour	60	days	179.55
						Grafting subtotal =		**$1,115** **3.9%**

	III. TRANSPLANTING (Option):	*Note:* ***3,385*** *rootstock seedlings at beginning of this stage*						
		No. / unit		**Cost / unit**		**Req'd. units**		Total cost:
1	1 Bags	5	lb/bag	$0.25	per bag	3,385	bags	846.22
	2 Soil (unsterilized)	50%	of total req'd.	$15.00	cubic yd	62.7	cu yd	940.25
	3 Labor to collect soil @	14.2		$11.97	per hour	4.4	hours	52.84
	4 Soil sterilization			$5.00	cubic yd	62.7	cu yd	313.42 1.1%
	5 Artificial medium (potting soil)	50%	of total req'd.	$25.00	cubic yd	62.7	cu yd	1,567.08 5.5%
	6 Labor to fill bags @	75	bags/hr	$11.97	per hour	45.1	hours	540.23
	7 Labor to transplant @	30	plants/hr	$11.97	per hour	112.8	hours	1,350.57 4.7%
						Transplanting subtotal =		**$5,611** **19.6%**

IV. GROWING MAINTENANCE:	Note: 3,385 rootstock seedlings at beginning of this stage					
365 days / nursery batch	No. / unit		Cost / unit		Req'd. units	Total cost:
1 Fertilizer	0.50	lb/plant	$0.50	per lb	3,385 plants	846.22
2 Pesticides	0.50	oz/plant	$100	/gallon	3,385 plants	1,322.22
3 Water	20	gal/day	$0.05	/gallon	365 days	365.00
4 Labor to water, etc. daily @	15	min/day	$11.97	per hour	365 days	1,092.26
					Growing maintenance subtotal =	**$14,847** **52.0%**
	Note: 3,046 rootstock seedlings at end of this stage					
Note: Operating cost per grafted plant = $6.05					**Total operating cost =**	**$18,445** **64.6%**
Total labor cost per grafted plant = $1.57					Total labor cost =	$4,786 16.8%

OWNERSHIP COSTS

A. Management	25%	of time @	$30,000	per year			7,500	26.3%
B. Capital investment	*Life*	*Cost*	*Deprec.*	*Interest*	*Repairs*	*Tax/ins.*	*Annual cost*	
1 Shadehouse	10	$4,000	$400	10.00%	1.5%	0.5%	680	
2 Shadehouse sprinkler system	5	$1,000	$200	10.00%	1.5%	0.5%	270	
3 Outdoor nursery	10	$5,000	$500	10.00%	1.5%	0.5%	850	
4 Nursery sprinkler system	5	$2,500	$500	10.00%	1.5%	0.5%	675	
5 Machinery	7	$0	$0	10.00%	2.0%	0.5%	0	
						Annualized capital investment subtotal =	2,475	8.7%
C. Land (actual or imputed rent)	1.00	acre(s) @	$150	per acre			150	0.5%
Note: Ownership cost per grafted plant = $3.32						**Total ownership cost =**	**$10,125**	**35.4%**
Total cost per grafted plant = $9.38						**TOTAL COST =**	**$28,570**	**100%**

deep); the plants are grown in these containers, and then transplanted to the field. (This system is described in CTAHR's *Growing Coffee in Hawaii*, 2000.) A variation on the tray method is to sow the seeds directly in the containers, thus eliminating the costs of trays, starter media, and the labor for transplanting into containers from the trays. (Note: If this variation is used, enter zero under "Planting rootstock" for costs of trays, starter medium, and related labor; see steps 3a, 3b, and 4.)

In the process of producing grafted coffee plants for replanting, five basic assumptions affect success:

- the expected germination percentage of the rootstock seed
- the percentage of germinated scion that you expect to use
- the expected average rate of success in grafting scions onto the rootstocks
- the expected percent "grow-out"; that is, the percentage of successfully grafted plants that will make it to the field-transplanting stage
- the percentage of transplanted trees that will survive to the coffee-production stage, expressed as the expected necessary tree replacement rate.

Another basic assumption concerns the cost of labor: (a) the average wage rate, and (b) labor overhead (including legally required payments, such as FICA, and any employment benefits, such as health insurance) expressed as percentage of the wage rate. This "effective wage rate" is for the person/s doing the labor associated with growing the rootstocks, grafting scions onto them, and maintaining the grafted plants. If someone is hired to do this work, the amount is a cash cost. If the enterprise uses only family labor, the value of that labor is an opportunity cost. Because the purpose of this analysis is to determine the *real* cost (i.e., the economic cost) to produce grafted rootstocks, we include all opportunity costs as well as all cash costs. The value of the overall

management of the enterprise is included in the ownership costs. The value of the entrepreneurial effort to organize the enterprise (i.e., the return to risk) will be the difference between the total economic cost of production and the value of the plants.

Operating costs

The operating costs are all of the cash and noncash costs associated with

- establishment of the initial rootstock and scion material
- the grafting procedure
- transplanting of grafted material to bags (optional)
- maintenance of the plants during the grow-out phase.

The economic model assumes that the user will be familiar with the activities involved in each production step; therefore, production details will not be reviewed here.

Generally, the data required for the various variable cells in the spreadsheet on pages 2–3 should be self-evident. One should, however, be particularly aware that, as mentioned earlier, two different methods are allowed for in the calculation model: cell or tray germination. In the example we use, the cell method of germination is calculated. Therefore, the costs for cells and the appropriate amount of vermiculite are entered, and the costs associated with the tray method (trays, another amount of vermiculite, containers, and media) are zeroed out. If "tray" were to be entered in place of "cell" in the basic assumption of germination method, the latter costs would be calculated and the former would be zeroed out. The transplanting option is treated similarly.

Ownership costs

The ownership costs (sometimes referred to as the "fixed costs") are those associated with ownership of the enterprise. The management cost was discussed above. The annual cost of the capital investment is estimated by calculating the "DIRTI 5" (i.e., depreciation, interest, repairs, taxes, and insurance) for each capital item. The grafted rootstock nursery enterprise utilizes very little land area, but there is nevertheless a value to the land area required. The land may be specially rented for this enterprise, but it is more often the case that the land is already in the possession of the farming operation. In either case, an actual or an imputed rent should be included in the calculation of the total economic cost of production.

Results of the economic analysis

The enterprise illustrated in the example produces 3,046 trees in a year, enough to plant 4 acres at a density of 680 trees per acre (8 x 8 ft spacing) and to allow for 12 percent field losses from all causes. The cell method of germination was used, and only one batch of grafted trees per year was produced.

The example enterprise shows the total cost to be $9.38 per surviving plant. The operating costs per plant amount to $6.05 (65% of total cost), of which labor comprises $1.57 (17% of total cost). The ownership cost per plant is $3.32 (35%). Grafted coffee trees have recently sold for $10 each, providing a 62¢ per plant return to risk. If an owner-operator provided all of the labor, management, and entrepreneurial organization, the return to these resources would be $14,235 per year for the 4-acre farm in the example, or about $4.67 per plant.

All of the costs used in this example are current as of the date of this publication. Recently demand for rootstock seed has been high, while the supply of seed is extremely low. The estimated rootstock seed price (10¢ per seed) is perhaps higher than it eventually will be when more of the seed is being produced. The limited amount of rootstock seed is in turn constraining the supply of available grafted plants. However, as these supply situations improve and a commercial market develops for grafted plants, one would expect to see the price for grafted plants decrease.

Acknowledgments

The authors are particularly grateful to Marc Meisner (CTAHR, Kona Research Station), Apo Aquino (Greenwell Farms), Pepe Miranda (UCC Farms), and Kraig Lee, who are currently grafting coffee in Kona and generously shared their knowledge and experiences. This article was reviewed by CTAHR colleagues Virginia Easton Smith, H. C. Bittenbender, and Richard Bowen.

References

Bittenbender, H.C., and V.E. Smith. 2000. Growing coffee in Hawaii. Univ. of Hawaii, CTAHR.

Schmitt, D., F. Zhang, and M. Meisner. 2001. Potential for managing *Meloidogyne konaensis* on coffee in Hawaii with resistance and a nematicide. Nematropica 31. In press.

Serracin, M., D. Schmitt, and S. Nelson. 1999. Coffee decline caused by the Kona coffee root-knot nematode. Univ. of Hawaii, CTAHR, publication PD-16.