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The Economics of Cacao Production in Kona

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Summary

This study uses an interactive spreadsheet model to estimate the economic costs and returns for producing cacao in Kona. The price and production data are *typical* for a 1-acre, mature cacao orchard in 2009; however, the economic model is flexible enough to accommodate a wide range of production systems with different cost structures and sizes of operation. In Kona, primary market demand is for wet beans. Two wet-bean costs and returns scenarios (one producing 100% Forastero and the other 100% Criollo) were selected for this publication, but the underlying computer model allows for many other production scenarios to be developed, such as any mix of cacao varieties sold in any combination of wet-bean, dry-bean, pod, and other cacao-related items. (Cacao dry-bean, pod, and by-product sales are converted into *wet-bean equivalents* to better evaluate comparative profitability of various cacao enterprises.)

Given the relatively small size of the market for cacao in Kona, a purely competitive, market-based price for cacao wet beans cannot currently be generated by market forces alone. The primary purpose of this economic analysis is to enable Hawai'i's cacao growers and processors to determine a price for wet cacao beans that will be fair to both farmer and cacao processor, allowing both enterprises to be profitable in the long run. A fair price will ensure the sustainability of local cacao production and processing.

To the extent that an adequate number of Kona cacao farmers collect annual data in this standardized format, useful performance benchmarks can be developed over time, and the "fair price" for wet beans can be adjusted periodically to increase accuracy. Cacao farm managers can also use this cost-of-production analysis to improve their economic decision-making and managerial control and planning.

Economic profit is expressed as a return to management and investment (i.e., *Management and investment income*). This economic measure is the residual after *all* labor and other production costs have been paid. The return to management, the return to owner equity, and all debt service payments (if any) are captured in *Management and investment income*. Hopefully, the economic *return* to the production of cacao will equal or exceed the *value* of the management and capital invested in the enterprise. Ultimately, however, each individual grower will need to decide if the actual profitability is "adequate." This economic analysis does not address concerns regarding financial feasibility, enterprise liquidity (cash flow), and solvency (debt structure), or after-tax benefits of the investment.

Situation

Cacao, the fruit of the cacao tree, can be sold in any of three unprocessed forms: pods, wet beans, or dry beans. From the farmer's point of view, selling pods is the easiest way to sell cacao. However, for the processor, purchasing pods entails the additional cost of labor to extract the wet beans, as well

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as the problem of disposing of the waste material after extraction and the risk of introducing postharvest plant disease. For the farmer, extracting wet beans requires extra postharvest cost and effort, and, being highly perishable, the wet beans require careful, timely handling. If the farmer were to continue one step further, to fermenting and drying the wet beans, the dry beans could be stored for lengthy periods and shipped long distances. However, the marketing then becomes problematic.[1] Alternatively, the farmer could consider vertical integration with the intent to manufacture and market a final, end-user product, such as chocolate. However, this option is far more complicated and expensive than simply extracting the wet beans, and, in any case, it is a completely different enterprise, well beyond the scope of this study. Other marketing possibilities include using the husks for soapmaking, drying and selling nibs, or exporting beans for chocolate manufacture on the U.S. mainland. Ultimately, most Kona growers will likely see their most attractive marketing option to be selling wet beans to a local processor who is willing and able to pay a higher price for local produce. That is the market assumed in this economic analysis.

Processors generally want to control the fermenting and drying activities themselves because the process of fermenting and drying has a significant impact on the quality of the final chocolate product. Therefore, processors prefer to purchase wet beans. In most of the world, this arrangement is not an option because growers and processors are located too far apart, and consequently the purchase of pods or dried beans is the more common model. However, Kona has the advantage that the cacao growers are located relatively near to the processors, enabling processors to purchase all of their cacao in the wet bean form.[2]

Most Kona farmers are growing the Forastero variety because it is hardier, generally easier to manage, and also produces a higher yield. Criollo, being somewhat less abundant, consequently demands a higher price. The two varieties have different flavor profiles, so they are not strict substitutes, and both are useful in the manufacture of chocolate.[3] Therefore, a costs-and-returns scenario is presented for the production and sale of wet cacao beans for both of the varieties. (The primary difference between the two scenarios is different marketable yields and market prices, resulting in different gross revenues.) The economic model accommodates any combination of Criollo and Forastero sold in any proportion of cacao pods, wet beans, and/or dry beans.[4]

Regardless of the form in which the cacao is sold, the average farm gate price must be high enough to provide an "acceptable" profit but low enough to allow chocolate processing to remain economically feasible. Ultimately, each grower will need to decide to what degree his or her expected profitability is indeed "adequate." Profit margins for both activities are relatively small, and in some years the margins might become so narrow that the farming and/or the processing enterprise may not be economically profitable in the short run. But in the long run, both partners in this symbiotic relationship must find their role to be economically viable.

Cost of production budgets can benefit a variety of potential users, including policymakers, extension agents, landowners, and investors. The intended audience for this study is existing and prospective cacao growers and processors in Kona. When used properly, an enterprise budget is a valuable farm management tool for producers. Growers who enter their own farm data will find the model useful for

- developing an end-of-the-year economic business analysis of their cacao enterprise
- projecting next year's cacao income under various production and marketing scenarios

[1]As the title of this study states clearly, this economic analysis is limited to analyzing the economics of cacao production (and marketing) in Kona on the island of Hawai'i. (Production implies marketing, because without a reasonable market production is not economic.) Cacao is an internationally traded commodity with world prices far too low to sustain production in the USA. Like Kona coffee farmers (and most other agricultural producers in Hawai'i), Hawai'i's cacao growers are not producing with the intent to compete globally with low-cost commodities of industrialized agricultural production. Hawai'i growers are neither low-cost nor low-quality producers. Their products compete on attributes other than price, such as quality, taste, variety, point of origin, etc., and their markets of choice will therefore be limited to niche markets, for the most part local.

[2]A cacao-growing operation that is vertically integrated would not, of course, sell cacao on the open market. Rather, the farm's wet cacao beans would simply be transferred internally to its chocolate production enterprise. If merely an accounting transaction, the grower's profit might not be realized until the time the value-added product is sold.

[3]Hereafter in this study, unless specified otherwise, reference to "cacao" or "beans" will be taken to mean "wet Criollo or Forastero beans."

[4]When including pods and/or dry beans, the user must provide appropriate market prices, conversion factors (such as the average weight of dry beans obtained from a pound of wet beans) and other postharvest cost coefficients in order to obtain an accurate estimate of enterprise profitability.

- considering the economic impact of business environment changes (e.g., regulatory, wage rate, or cacao price changes)
- determining the economic benefit of adopting new technology
- planning new or expanded cacao operations
- adjusting operations to improve efficiency, and
- controlling costs.

Given the inability of the small cacao market to reveal a competitive price, the primary intended purpose of this analysis is to help seller and buyer come to a mutually beneficial market price that will ensure a sustainable Kona cacao industry.

Methods

An analysis of *financial* feasibility, such as can be provided using a good cash-flow statement, considers the cash costs and the sources of required investment capital, but it does not reveal the actual *economic* profitability of an enterprise. By contrast, an economic feasibility analysis includes *all* costs, both cash and non-cash, but without reference to when specifically these payments are made or received in the production year, or to how the particular operation is financed. Economic feasibility focuses on longer-term profitability, risk, and sustainability strategies rather than short-term financial fluctuations or short-term survival tactics. In this study, economic profitability (the "bottom line") is expressed as the residual return to management and investment. *Management and investment income* is the amount left to the cacao enterprise's owner/operator after all costs (except the values of management and equity investment and any debt financing) are paid in full. The cost-of-production analysis stops at the farm gate, includes all growing and harvesting costs, and can include extracting and drying wet beans, as appropriate for particular marketing plans. This analysis does not estimate any possible costs of delivery because these will vary widely, depending upon the farm's location relative to the processor.[5]

Assumptions

A first step in determining the profitability of a particular cacao enterprise is to establish production and marketing parameters and make some important overall assumptions. How is the cacao enterprise organized? What is the real cost of labor, the single most important resource input? How many trees are there, how mature are they, and what is the expected replacement rate? What is the expected or actual marketable yield? What are the expected or current market prices and conversion factors for the various forms of cacao?

a. Cacao types

The three types of *Theobroma cacao* commonly grown are Criollo, Forastero, and Trinitario (a hybrid of the first two). These are not true subspecies or varieties, and seedlings usually do not grow true to type of the pod parent. Kona producers grow seedlings of Criollo and/or Forastero. While the two "varieties" share many characteristics and are grown in the same way, they nevertheless need to be treated somewhat separately to account for their different yields and prices. The program assumes all orchards are from 0 to 100% Forastero with the remaining balance in Criollo. By entering the percentage of Forastero, all other factors, such as percent of Criollo and all of the weighted average prices and yields,[6] are generated.

b. Tree count and land used

On some farms, cacao trees are scattered irregularly over

[5]The Excel spreadsheet economic model that is referred to throughout this study, reproduced in part on p. 10–12, is available as a free download from the University of Hawai'i's College of Tropical Agriculture and Human Resources website, at http://www.ctahr.hawaii.edu/freepubs, under "Cost of Production." This spreadsheet can be used on any computer that has the Excel program installed.

[6]The "yield" is the net *marketable yield* (i.e., actual wet-bean sales) and not necessarily the harvested yield and certainly not the biological-potential yield.

the property, sometimes intermixed with other fruit or nut trees that share similar growing requirements and that may offer horticultural benefits to the cacao trees, such as shade or wind protection. The grower will need to count how many cacao trees there actually are. When the cacao enterprise is organized as a conventional orchard of cacao trees (that is, spaced at regular intervals and not interplanted), the size of the orchard can be determined easily. (If one does not know how many trees there are per acre, the spreadsheet includes a routine that calculates the tree number, both orchard total and trees per acre, based on the tree spacing and the amount of land needed for other related activities, such as roads, packing work area, shed, etc.)

The example farm's tree spacing is 6 ft by 7 ft, with about 3.6 percent of the land being roadways, postharvest handling work area, and any other space directly related to the enterprise but not planted with trees. While the example farm uses 6x7-ft spacing, other layouts may be better suited to a particular operation. For instance, some managers prefer a 5x12-ft spacing arrangement because it allows machinery to travel more freely between the rows. When allowing 5 percent for the non-planted area, this arrangement results in only 690 trees per acre. Current practices strongly favor more densely planted cacao orchards, some with over 1200 trees per acre.

Having both an accurate tree count and a good estimate of the land area utilized by the enterprise are critical, because the program calculates revenue and costs per tree and per acre, as well as per pound of wet bean (or wet-bean equivalent) and for the whole farming operation. (If the actual planted area amounts to less than 1 acre of trees, the revenue and costs per acre will be projected.)

c. Labor

Kona cacao production is highly labor intensive. Qualified labor to perform the work is relatively scarce and expensive. Each of the growing and harvesting activities involves significant labor requirements. The *Operating costs* section that follows the *Assumptions* and the *Revenue* sections is organized by growing and harvesting activities. Each growing activity has its associated costs of labor,[7] machinery, and materials needed, and these remain the same regardless of the yield ultimately realized.

[7]Each time some amount of labor is called for, the program uses the wage rate entered in the *Assumptions* section.

By contrast, the costs of the harvesting and postharvest activities are a function of the amount of cacao actually harvested and prepared for market. Therefore, harvest and postharvest coefficients are multiplied by the yield.

An economic analysis accounts for all labor at its market value. All labor, whether hired or provided by the owner/operator or his/her family, is assumed to be "paid labor." In the example scenario the wage rate for typical "growing" labor is assumed to average $12.00 per hour plus 33 percent overhead or "benefits" (e.g., FICA and IRS withholding, worker's compensation, health insurance, etc.) Custom machine work usually includes the labor required to operate the machinery and equipment and is therefore already included in the relevant coefficient. A contract harvesting labor rate (likely different from the regular farm wage) is used to calculate the harvesting coefficients.

d. Wet bean equivalent

This analysis concentrates on the sale of wet beans for off-farm processing. However, the *Annual gross revenue* section includes the option for additional sales of dry cacao beans, cacao pods, and cacao by-products to be included. Any cacao sales (other than wet-bean sales) are converted into wet-bean equivalents, which will in effect increase (or decrease) the weighted average wet-bean price per pound. For example, a grower may choose to sell some of the cacao production as a value-added product and, after deducting associated costs to add this value, generate more income per pound than would come from selling the wet beans. This would to some degree increase the average wet-bean price per pound. Similarly, a grower (for some reason, perhaps convenience) may be inclined to sell cacao in a form (such as pods) at a lower wet-bean-equivalent price, and even after postharvest cost savings net less than when selling wet beans. This decision would to some degree lower the per-pound wet-bean equivalent price.

Annual gross income

The example cacao enterprise wet-bean revenue is simply the annual weighted average price per pound times the annual weighted average yield per tree multiplied by the total number of trees of all ages. Any sales of other cacao products would also be included here as wet bean equivalents and, as noted, would somewhat modify the annual average price for wet beans. The total annual orchard gross revenue is therefore 100 percent of the

income generated by the cacao enterprise. All production costs are expressed as a percentage of this total income figure. One can visualize these production cost percentages as the number of cents per dollar in sales needed to pay an operating or ownership expense.

Annual operating costs

Operating costs are all the costs directly associated with growing and harvesting the cacao crop. All expenses are expressed as costs per pound of wet bean and as costs per tree, per acre, and per whole enterprise (i.e., orchard). In the final column, each subtotal and total cost is expressed as a percentage of gross income.

a. Growing costs

These are categorized by each of the cacao growing activities. Each activity consists of three component expenses: (1) materials (the annual amount used for the whole orchard—except for fertilizer, which is per tree—at the average cost per unit of materials), (2) machinery (the annual time used for the whole orchard at the average rate per hour), and (3) hand labor (the annual time in "person minutes" per tree, except irrigation, which is in "person hours" for the whole orchard.) As noted above, the labor cost to complete each activity is computed using the average wage rate per hour, including overhead. Pruning is an exception to the three components per activity arrangement insofar as there is not a materials component cost.

Most of the growing activities are self-evident, but it may be worthwhile to comment on the way in which a few aspects of the material costs are calculated for the example scenario. *Fertilizers* are aggregated. For example, a common practice is to apply fertilizer, such as 10-5-20, three or four times a year, as well as dolomite once a year. The total cost of all fertilizers is then averaged on the basis of cost per acre, per tree, and per pound of wet bean. It is assumed that the fertilizer is applied by hand to each tree, but fertilizer might also be spread mechanically or applied dissolved in irrigation water.

The cost of water for *irrigation* is based on the current agricultural rate scale in Kona. In the example scenario, the cost for water is computed at the usage rate of $2.00 per thousand gallons of water. The total water cost per acre of $490 per year assumes 7 gallons of water per tree per week for 35 weeks per year which equals 245 gallons. Therefore, 1 acre with 1000 trees will require 245,000 gallons annually. At $2.00 per 1000 gallons, the annual water cost is $490. (In South Kona, many farmers must truck in their water, some at rates of $40 per 1000 gallons. The cost of irrigated cacao production is obviously prohibitive using water priced 20 times higher than the Kona agricultural rate.)

Pest control may at times become necessary, but it is not assumed to be a factor in this scenario's mature orchard. *Weed control* is not necessary with the well-developed canopy of a mature orchard, but in the example, it is assumed there will be some minimal weed control by hand and with mechanical mowing. *Pruning* does not involve any materials, only labor. Some pruning may be done as an aside during harvesting, but the labor included here is specifically for a separate pruning activity. *Periodic disease control* may be necessary, especially for the young trees, but it is not assumed to be a factor in the example cacao enterprise.

The "*other cost*" entry is simply a "catch-all" user-option in the model that can be used to include any cost(s) not explicitly covered by the above cost categories. Finally, although not relevant for the current wet-bean scenario, the model allows for inclusion here of any "*costs associated with other [cacao-related] sales.*"

b. Harvesting costs

These vary with the yield, so most farm managers prefer to view the cost of the various harvest and postharvest activities in terms of cents per pound of marketable yield. Once calculated, this coefficient can be used over time as yields fluctuate. The price-per-pound figure will need recalculation only with significant changes in average efficiency, such as may result from a sizable expansion of the operation, increased mechanization, improved picking or extracting efficiency, or a change in the harvest labor wage rate.

The actual harvesting cost can be expressed as average cents per pod picked. The pod-harvesting coefficient is calculated simply by dividing the hourly labor rate (assumed to be contract labor *without* overhead and benefits, valued at $12/hour) by the picking rate in pounds per hour (here assumed to be 100 pounds per hour.) The result is 12.0 cents per pod or $2.77 per tree. Since the conversion factor of pod to wet beans is assumed to be 0.255, pod harvesting costs 47.1 cents per pound of wet beans.

Postharvest costs (pod opening and wet-bean extraction, fermentation, and drying) are expressed in terms of cents per pound of wet beans. The wet-bean-extraction coefficient is calculated by dividing the hourly labor rate

(again assumed to be contract labor *without* overhead and benefits valued at $12/hour) by the extraction rate in pounds per hour (here assumed to be 75 pounds per hour.) The result is 16.0 cents per pound of wet beans.[8] The model automatically includes the additional costs of fermentation and drying in the annual harvesting costs if dry-bean sales are recorded in the *Gross revenue* section. As noted earlier, the cost to deliver farm product to a processor is not included here as a harvesting cost, but the possibility to do so is offered as a user-option later in the *Ownership costs* section.

Gross margin

The *gross margin* is the gross income minus the total operating (or "variable") costs, i.e., all the growing and harvesting costs. This figure represents the amount available to pay (1) all the ownership (or "fixed") costs and (2) any return to the owner/manager (i.e., *Management and investment income*). It approximates the return over cash costs, i.e., the *cash flow*, and is what farmers often but incorrectly call "profit." This figure might be called *accounting profit*,[9] but it is definitely not *economic profit* because it does not include the "non-cash" costs.

Gross margin is a good measure for comparing the economic and productive efficiency of similar-sized farms. More importantly, it represents the bare minimum that a farm must generate to stay in business. (Even if a farm in a particular year were to lose money overall, a positive gross margin would enable it to continue to operate, at least in the short run.) However, it is *not* as good a measure of a farm's actual profitability or long-term viability (as opposed to mere productive efficiency) as *Management and investment income* because it does not take into account the site-specific ownership costs, such as the cost of land, orchard establishment, and overhead.

Annual ownership ("fixed" or "overhead") costs

These costs are primarily the *annualized* costs for the productive resources: land, management, and the required capital investment (primarily for orchard establishment). Since capital resources last more than one

production cycle, they have to be amortized over their "useful lives." *Ownership costs*, as opposed to the *operating costs* we have been discussing up to this point, are the overhead costs that every individual owner/operator necessarily incurs. (Some of these costs, such as the land charges, will be incurred even if no production exists.)

Operating costs will be quite similar for every grower, given comparable managerial abilities. As noted earlier, the gross margin conveniently embodies in one figure all expected income, growing costs and harvesting costs, and is thus a very good indicator of comparative productive efficiency. By contrast, ownership costs will vary widely from one grower to the next for a range of reasons. Two growers of equal productive abilities will have similar gross margins, but for a variety of reasons these two growers could easily have quite different sets of ownership expenses. Consequently, the perceived profitability for each of these cacao enterprises would differ dramatically.

An economic analysis by definition includes all costs. But the wide variance in ownership costs from one farming operation to the next makes any generalization difficult. There is always a land charge associated with cacao production, but it varies widely among growers. A good proxy for access to 1 acre of good agricultural land in Kona is the cost of a 1-acre Bishop Estate land lease ($160 lease rent plus about $25 in property taxes equals about $185 per acre.)

There is usually a cost to delivery of cacao to the processor, but it will range from zero for an internal transfer to a high cost incurred for a more distant producer. No amount is entered in the example scenario, but of course

[8]A convenient base unit for paying at a piece-rate rather than an hourly rate would be a five-gallon bucket. One bucket holds about 38 pounds of wet beans.

[9]If one were also to deduct depreciation, the gross margin would then approximate "taxable income."

with good records one could easily use the actual average cost per pound to deliver wet beans in order to determine a farm-specific economic profitability.

Price and production (yield) risk cannot be eliminated. However, there are tools that enable one to manage risk effectively. For example, USDA revenue insurance ("Adjusted Gross Revenue—Lite") is a currently available, useful risk-management tool. It protects the grower from a debilitating financial loss from a substantial decline in yield and/or market price. The low cost of the AGR-Lite premium (over 50% of which is subsidized by the federal government) could be included in an enterprise budget as an ownership cost item. Liability insurance could also be included here, and together these should enable one to survive any catastrophic loss. While an insurance agent can easily calculate the premiums, farming circumstances and individual risk preferences and abilities to bear risk vary widely. Premiums for full coverage generally cost about 2 percent of the gross income. In some cases a manager may wish to include liability insurance as an option, but none is included in the example.

"Management overhead" includes office expenses, such as telephone and internet costs associated with doing business, as well as professional fees, even if limited only to accounting expenses for income taxes. If the enterprise is part of a larger farming operation, the orchard overhead cost will be that fraction of the whole-farm cost that can be allocated directly to the cacao enterprise. For the purposes of this economic analysis, a rough estimate of the accounting and office expenses to be attributed to growing and harvesting cacao is $200 and $100, respectively. But again, the cacao proportion of total managerial costs might be higher, in which case the specific dollar amounts would probably be higher.

The most significant capital investment is orchard establishment. Total planting cost is estimated at $35 per tree. It includes a nursery-grown seedling, minimal grading, and, if necessary, tree removal, purchase and installation of an irrigation system, digging holes, fertilizer for the tree, and the labor to plant the tree and grow it until there is some minimal production (at about two years). In the experience of some growers, this estimated planting cost may appear somewhat high.[10] However, extensive additional land improvements (major clearing and grading, brush disposal, drainage, additional soil amendments, and the planting of a cover crop) could further increase the per-tree cost by $5–10. Perimeter windbreaks, fences, and roads, if needed, would also add to the per-tree cost.

The initial cost to establish the orchard is amortized over a reasonable period. In the example, the time period is 25 years. The IRS depreciates all orchards for 10 years after the time they start producing a marketable yield. This amortization rate might be used in an after-tax financial assessment. However, a cacao orchard will be productive for at least 25 years, and this more realistic number better reflects management considerations and should be used for an economic analysis. The interest on capital investment (the return on owner equity plus debt service on any external financing) is part of the return to *Management and investment income* and is therefore not directly addressed here. A small percentage of the trees are replaced through normal mortality and attrition. The example scenario estimates the average annual replacement rate at 1 percent. In the example, this amounts on average to about 10 trees replaced per year. A lower rate will increase the overall profitability.

Management and investment income

Total cost includes all cash costs and all opportunity costs. Any return above total cost is *economic profit.* Since economic profit considers *all* costs, a manager would understandably be satisfied with business performance if the economic profit were equal to zero or better. Economic profit is the best measure of true profitability. It is also a measure of how attractive the enterprise is for potential investors and for potential new entrants into the business.

Although this theoretical concept of economic profit is accurate and correct, it can be somewhat confusing to hear that one should be satisfied with an "economic profit of zero." Furthermore, some find it difficult to grasp intuitively the meaning of a "negative economic profit." A more easily understood "bottom line" is the residual return to the owner/manager for management services and capital investment; that is, *Management and investment income*. (The owner/manager, to the extent that she or he is also an "operator," would of course also receive additional compensation for any of the manual farm labor personally provided.)

[10]Growers who keep comprehensive records can enter a better estimate based on their own experience when using the spreadsheet to calculate the economic profitability of their own cacao operation.

Sensitivity analysis

A simple break-even analysis is provided just after the *Management and investment income* is calculated. It shows what price, given the projected yield, would be required to just cover either *Operating* or *Total costs*, without any residual for *Management and investment income*. Breaking even (that is, covering costs but providing no return to management and investment) is a short-term survival tactic, but it is not sustainable for long. A shortcoming of the simple break-even price and yield calculation is that it considers only one point in a spectrum of possibilities.

A sensitivity analysis enables a grower to observe how a range of small changes in the most critical production variables affects profitability (*Management and investment income*). Most agricultural profitability is a function of price and yield. Cacao *yield risk* is somewhat ameliorated by irrigation and USDA revenue insurance, but it is still significant. The other risk variable of most concern in this study is the *price risk*. Ultimately, one's assessment of the cacao enterprise's overall risk comes down to one's confidence in the expected market price for wet beans. The sensitivity analysis considers how sensitive *Management and investment income* is to small changes in price and/or yield. It is a good way to evaluate the riskiness of the enterprise. After price and yield, *Management and investment income* is also especially sensitive to pod harvesting and extraction rates. These could be considered by using them as the variables of concern in the sensitivity analysis.

Results

The results of this study of the economic analysis of a cacao production operation are in the following spreadsheets, contained in the online file available at http://www.ctahr.hawaii.edu/oc/freepubs/spreads/Cacao$.xls:

*Cacao$ - Scenario A: 100% Forastero wet bean
*Cacao$ - Scenario B: 100% Criollo wet bean
*Cacao$ - Sensitivity Analysis

Discussion and conclusion

Based on data provided by representative Kona growers, a well-managed cacao enterprise that markets its production as wet beans generates a healthy gross margin. Cacao's growing costs and harvesting costs, as percentages of gross income, are within the expected range of other orchard crops. Ultimately the degree of profitability for any particular cacao operation, as measured by the

Management and investment income earned, will depend upon the amount of ownership costs incurred. A well-managed farming operation can fail economically if the ownership costs exceed the business' capacity to pay them. As one grower expressed his predicament, "I'm doing fine, making money, but my fixed costs are killing me." In essence, this grower is saying that his production is efficient enough and his short-term cash flow is OK, but he is operating at an economic loss, which, as we know, is not sustainable in the longer term. In short, while cacao wet-bean production is potentially profitable, one can fail to realize that potential if one's cost of capital,[11] land charge, required return on equity, exposure to agricultural risk, or overhead costs are too high. These are individual-specific determinants, well beyond the scope of this general economic analysis.

Horticulturally, the Criollo type is somewhat more risky because it is relatively more difficult to grow and its marketable yield is about 10 percent lower than that of the Forastero type. However, the current market price differential appears to compensate for the Criollo disad-

[11]The "cost of capital" is simply the weighted average of the cost of money borrowed and the cost of equity funds used to finance a capital purchase. For example, if one finances a purchase by borrowing 60% of the cost from a bank at 10% per year and by paying the balance with equity funds, for which one needs only receive a return of 3% per year, the cost of capital is (0.6 x 0.10) + (0.4 x 0.03) = 0.06 + 0.012 = 7.2%.

vantages. The 100-percent Forastero production scenario earns almost $100 more than the 100-percent Criollo, but this is not a significant difference. The dollar differential changes rapidly for every 1 percent increase or decrease in overall yield of Criollo. A smaller profit margin almost always increases the risk vulnerability of a business and thus also affects risk management concerns.

Having a reliable, progressive Kona buyer that has an innovative marketing plan reduces a producer's risk. And indeed, such an economically viable, socially responsible buyer is critical for a sustainable cacao industry on the island of Hawai'i. However, with one buyer and many sellers, the relationship is fundamentally monopsonistic.[12] And for an example of the potential market risk of monopsony, one need look no further than the recent predicament of Kona's macadamia nut growers' almost total reliance on sales to a single processor.

Profitability, as measured by *Management and investment income*, is most sensitive, as is usually the case in agriculture, to minor changes in market price and marketable yield. The sensitivity analysis demonstrates how quickly profitability changes with small changes in price and/or yield. Price and yield are the primary sources of risk for the grower. While these risks cannot be eliminated entirely, the risk management tools currently available to cacao growers in Kona enable one to manage catastrophic risk effectively at a very low cost. Good risk management enables a cacao grower to avoid what might otherwise be a financially devastating event and to survive a relatively unprofitable year or two.

After price and yield, cacao profitability is most sensitive to relatively small improvements in harvesting and extracting efficiency and the availability of labor to perform these tasks for a reasonable rate of pay. Although a sensitivity analysis is not presented for these variables, one can easily use the spreadsheet model to quickly answer "what-ifs?" and to appreciate how sensitive the overall enterprise profitability is to seemingly small changes in harvesting or extraction efficiency and/or cost. For example, a 20 percent increase in the harvesting cost cuts the gross margin almost in half, dramatically increasing the likelihood that the whole cacao operation will become economically unfeasible.

The Hawai'i cacao industry is young. All growers are relatively small-scale, and currently none are making a living solely by growing cacao. The *Management and investment income* for the 1-acre example farm is about $1,900. Without any debt service, this would be the return to management and owner equity. To this return the owner could add the value of all the paid labor, assuming that he or she performed these growing and harvesting tasks. This would provide a labor income of about $5,400 per acre. If one were to combine the value of labor, management, and equity investment, it is conceivable to generate a minimal, before-tax income of $35,000 per year with a 5-acre cacao enterprise. But at this time, no Kona operations are as large as 5 acres.

Cacao growers and processors have a symbiotic relationship that must constantly be nurtured by both parties. Cacao farming will be sustainable if sellers and buyers continue working together to reach a mutually agreeable market price.

[12]"In economics, a monopsony…is a market form in which only one buyer faces many sellers. It is an example of *imperfect competition*, similar to a monopoly, in which only one seller faces many buyers. As the only purchaser of a good or service, the 'monopsonist' may dictate terms to its suppliers in the same manner that a monopolist controls the market for its buyers." [from *Wikipedia*]. In terms of the Kona cacao industry, the monopsonistic relationship means a processor could offer the grower a price below the expected cost of production and in so doing likely benefit in the short run. Since cacao growers, like all orchardists, are unable to exit quickly from their industry, that is, move out of production of one tree crop into some other, more viable commodity, they will have to accept this low price, at least in the short run. But exit they will, cutting off the processor's life-blood.

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Photos are by Ken Love.

Spreadsheet for Scenario A

Assumptions: *Blue cells are the variables to modify, black numbers are calculated automatically.* — **Scenario A : 100% Forastero Wet Bean**

	Tree variety mix:	% of orchard planted in variety:	Ave. $/lb.	Yield / tree	
1	Forastero wet beans	100%	$1.80	5.60	lbs.wet beans
2	Criollo wet beans @~ 90%	0%	$2.00	5.04	lbs.wet beans
	Weighted ave. price ($/lb.) and ave. mature yield/tree =		*$1.80*	*5.60*	lbs.wet beans

	Age of trees:	% of mature yield	Number of trees	Yield / orchard	
3	Number non-bearing trees @	0%	10	0.0	lbs.wet beans
4	Number partially bearing trees @	30%	20	33.6	lbs.wet beans
5	Number partially bearing trees @	70%	20	78.4	lbs.wet beans
6	Number of mature trees @	100%	950	5,320.0	lbs.wet beans
7	Total trees & ave mkt. yield wet beans/orchard (lbs) =		1,000	5,432.0	

Yield wet beans/ average tree = 5.43 lbs.

8	Total acreage of orchard (ac.) =		1.0	13	Ave. # pods/ mature tree = 23.1
9	Trees /acre =		1,000	14	Ave. wt. of mature pod (lbs) = 0.954
10	Wage rate hand labor ($/hr.) =		$12.00	15	Pod => wet-bean conversion *f* = 0.255
11	Benefits (FICA, etc.) (%) =	33%		16	Wet => dry conversion *f* = 0.640

Tree density calculator:

1. Enter spacing (in feet): 6.0 x 7.0
2. Enter % of total land area required for roads, packing house, etc. : 3.6%
3. Enter total number of acres 1.0

Trees per acre = 1000 trees

Total trees = 1000 trees

I. Annual Gross Revenue:	%	Total units	$/unit:	¢/lb wet beans	$ /tree:	$ /acre:	$ /orchard:	% of gross
A. Wet beans (lbs. @ $/lb.) @	100%	5,432	$1.80	180.0	9.78	9,778	9,778	100.0%
B. Pods (no. pods @ $/pod @	0%	0	$0.10	0.0	0.00	0	0	0.0%
C. Dry beans (lbs. @ $/lb.) @	0%	0	$1.60	0.0	0.00	0	0	0.0%
D. Other cacao-related sales *(enter annual total for enterprise)*				0.0	0.00	0	0	0.0%
Price of "wet bean equivalent" => *$1.80*			I. Total Revenue =	180.0	9.78	9,778	9,778	100%

II. Annual Operating Costs:							
A. Annual Growing costs (w/ units):	*units*	*$/unit:*	*¢/lb wet beans*	*$ /tree:*	*$ /acre:*	*$ /orchard:*	*% of gross*
1 Fertilization	*Fertilization sub-totals =>*		*33.1*	*1.80*	*1,796*	*1,796*	*18.4%*
Fertilizer (lbs./tree)	1.4	$0.76	19.6	1.06	1,064	1,064	10.9%
Machinery (hours/orchard)	8.0	$25.00	3.7	0.20	200	200	2.0%
Hand labor (min./tree)	2.0	$15.96	9.8	0.53	532	532	5.4%
2 Irrigation:	*Irrigation sub-totals =>*		*16.4*	*0.89*	*889*	*889*	*9.1%*
Water (1,000 gals./ orchard)	245	$2.00	9.0	0.49	490	490	5.0%
Pumping (hours/ orchard)	0.0	$0.00	0.0	0.00	0	0	0.0%
Labor (hours/ orchard)	25.0	$15.96	7.3	0.40	399	399	4.1%
3 Pest control:	*Pest control sub-totals =>*		*0.0*	*0.00*	*0*	*0*	*0.0%*
Chemicals (gals./ orchard)	0.0	$10.00	0.0	0.00	0	0	0.0%
Machinery (hours/ orchard)	0.0	$10.00	0.0	0.00	0	0	0.0%
Hand labor (min./ tree)	0.0	$15.96	0.0	0.00	0	0	0.0%
4 Weed control:	*Weed control sub-totals =>*		*6.4*	*0.35*	*346*	*346*	*3.5%*
Chemicals (gals./ orchard)	0.0	$2.00	0.0	0.00	0	0	0.0%
Machinery (hours/ orchard)	8.0	$10.00	1.5	0.08	80	80	0.8%
Hand labor (min./ tree)	1.0	$15.96	4.9	0.27	266	266	2.7%

5	Pruning:			*Pruning sub-totals =>*	*10.3*	*0.56*	*559*	*559*	*5.7%*
	Machinery (hours/ orchard)	0.0	$5.00		0.0	0.00	0	0	0.0%
	Hand labor (min./ tree)	2.1	$15.96		10.3	0.56	559	559	5.7%
A.	Annual Growing costs: *(continued)* :	*units*	*$/unit:*		*¢/lb wet beans*	*$ /tree:*	*$ /acre:*	*$ /orchard:*	*% of gross*
6	Periodic disease control			*Diseae control sub-totals =>*	*0.0*	*0.00*	*0*	*0*	*0.0%*
	Chemicals (gals./ orchard)	0.0	$3.00		0.0	0.00	0	0	0.0%
	Machinery (hours/ orchard)	0.0	$10.00		0.0	0.00	0	0	0.0%
	Hand labor (min./ tree)	0.0	$15.96		0.0	0.00	0	0	0.0%
7	Other cost			*Other cost sub-totals =>*	*0.0*	*0.00*	*0*	*0*	*0.0%*
	Materials (amt./ orchard)	0.0	$0.00		0.0	0.00	0	0	0.0%
	Machinery (hours/ orchard)	0.0	$10.00		0.0	0.00	0	0	0.0%
	Hand labor (min./ tree)	0.0	$15.96		0.0	0.00	0	0	0.0%
8	Costs associated w/ other income			*Enter the annual orchard cost =>*	0.0	0.00	0	0	0.0%
				Total growing costs/ year =	66.1	3.59	3,590	3,590	*36.7%*
B.	Annual Harvesting Costs:		*¢ /*	*unit:*	*¢/lb wet beans*	*$ /tree:*	*$ /acre:*	*$ /orchard:*	*% of gross*
1	Harvesting (¢ /pod)		12.0	*¢ / pod*	47.1	2.77	2,772	2,772	*28.4%*
2	Extraction (¢ /lb. of wet bean)		16.0	*¢/lb.wet bean*	16.0	0.87	869	869	*8.9%*
3	Fermentation & drying	*None*	10.0	*¢/lb.wet bean*	n.a.	n.a.	n.a.	n.a.	0.0%
				Total harvesting costs/ year =	63.1	3.64	3,641	3,641	*37.2%*
				II. Total Operating Costs =	129.1	7.23	7,231	7,231	*74.0%*
				III. Annual Gross Margin =	50.9	2.55	2,547	2,547	*26.0%*
IV.	Annual Ownership Costs:				*¢/lb wet beans*	*$ /tree:*	*$ /acre:*	*$ /orchard:*	*% of gross*
A.	Land charge: (mortgage or lease rent & property taxes)			*sub-totals =>*	*3.4*	*0.19*	*185*	*185*	*1.9%*
B.	Delivery to processor	0.0	*¢/lb.wet bean*	*sub-totals =>*	*0.0*	*0.00*	*0*	*0*	*0.0%*
C	Risk management			*Risk Management sub-totals =>*	*3.6*	*0.20*	*196*	*196*	*2.0%*
1	Revenue insurance @	2.0%	of gross income		3.6	0.20	195.55	195.55	2.0%
2	Liability insurance @	0.0%	of gross income		0.0	0.00	0.00	0.00	0.0%
D	Management overhead			*Overhead sub-totals =>*	*5.5*	*0.30*	*300*	*300*	*3.1%*
1	Office expense			*Enter the total annual orchard cost =>*	1.8	0.10	100.00	100.00	1.0%
2	Professional services			*Enter the total annual orchard cost =>*	3.7	0.20	200.00	200.00	2.0%
E	Orchard establishment			*Orchard establishment sub-totals =>*	*0.3*	*0.02*	*15*	*15*	*0.2%*
1	Establishment cost @	$35.00	/tree amort.	25	0.0	0.00	1.40	1.40	0.0%
2	Annual replacement rate @	1.0%	of orchard		0.3	0.01	14.00	14.00	0.1%
				IV. Total Ownership Costs =	12.8	0.70	696	696	*7.1%*
				V. Total Cost of Production (*EXCEPT M&II)* =	142.0	7.93	7,927	7,927	*81.1%*
				VI. Management & Investment Income (M&II) =	38.0	1.85	1,851	1,851	*18.9%*

Simple break-even analysis:		*NOTE: Enter " T " to cover TOTAL production costs; enter " O " to only cover operating costs:*		T
Given the weighted average price of	$1.80	$/lb. of wet beans, the yield req'd. to cover TOTAL production costs		4.40
Given the actual marketable yield of	5.43	lbs. of wet beans/tree, wt'd. ave. price req. to cover TOTAL costs =		$1.46

Spreadsheet for Sensitivity Analysis

Sensitivity of Management & Investment Income per acre
to small changes in wet bean price per pound and marketable yield in pounds per tree.

1 *"Management & Investment Income"* = *annual sales minus all operating and ownership costs.*
Therefore, M&II is the total return to management & owner equity (& debt financing, if any.)
2 *"Price"* = the mean annual weighted average market price.
3 *"Yield"* = the mean annual weighted average marketable yield.

Forastero wet bean sales

Change in price and yield:

Enter the amount of change & select whether the change is to be in % or $ or #:				
+/-	2.00	%	change in yield (lbs./tree)	0.11
+/-	0.10	$	change in price ($/lb.) =	$0.10

Ave. lbs./tree =	5.43
Trees/ acre =	*1,000*
Prod. costs/ac. =	*$7,927*

Management & Investment Income per acre at various prices per pound & yields (in pounds) per tree:

Ave. price ($/lb.) =>	*$1.50*	*$1.60*	*$1.70*	*$1.80*	*$1.90*
5.00	-$431	$69	$569	$1,069	$1,568
5.11	-$268	$243	$754	$1,264	$1,775
5.21	-$105	$417	$938	$1,460	$1,981
5.32	$58	$591	$1,123	$1,655	$2,188
Ave. yield (lbs./tree) => *5.43*	$221	$765	$1,308	$1,851	$2,394
5.54	$384	$938	$1,492	$2,046	$2,601

Criollo wet bean sales

Change in price and yield:

Enter the amount of change & select whether the change is to be in % or $ or #:				
+/-	2.00	%	change in yield (lbs./tree)	0.10
+/-	0.10	$	change in price ($/lb.) =	$0.10

Ave. lbs./tree =	4.89
Trees/ acre =	*1,000*
Prod. costs/ac. =	*$7,840*

Management & Investment Income per acre at various prices per pound & yields (in pounds) per tree:

Ave. price ($/lb.) =>	*$1.70*	*$1.80*	*$1.90*	*$2.00*	*$2.10*
Yield: *4.50*	-$194	$256	$706	$1,156	$1,605
4.60	-$27	$432	$892	$1,351	$1,811
4.69	$139	$608	$1,077	$1,547	$2,016
4.79	$305	$784	$1,263	$1,742	$2,221
Ave. yield (lbs./tree) => *4.89*	$471	$960	$1,449	$1,938	$2,427
4.99	$637	$1,136	$1,635	$2,133	$2,632