# Kealoha Plantation: Optimizing Coffee and Macadamia Nut Production

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**ABSTRACT**

The subject matter in the Kealoha Plantation case is optimizing coffee and macadamia nut production on the Kealoha family farm. The Kealoha Plantation case is a case used to encourage students to utilize basic quantitative skills such as numerical statistics, modeling, and simulation. Through the use of these quantitative methods, students will engage in simple business and sensitivity analysis involving revenue, costs, and profits.

## KEALOHA PLANTATION

### Introduction & Background

After Michelle Kealoha's father passed away, she decided to leave here job as a purchasing agent at gourmet coffee company in Portland to move back to her childhood home on the island of Hawaii. Her aging mother needed her and there was also the question of what to with the 837 acres that belonged to the Kealoha family since the Kingdom of Hawaii private land division in 1848.

The family had grown sugar on most of the land, excluding from cultivation only the 38 acres that surrounds the family home, where Michelle and her mother now live. This non-sugar land, in the upper and cooler elevation, offers a panoramic view of the 30 miles of coastline and has been filled up over the years with a small vineyard and orchards of tropical and subtropical fruits. Michelle and here mother were in agreement that the 120 year-old family house and surrounding acres will remain as Michelle's father and his father's father left them. What should be done with the remaining 799 acres was not nearly as clear.

The sugar industry produced many fortunes and Michelle's ancestors managed to share in a little of this wealth. The century of sugar's swaggering success ended in the 1960's, however, and Hawaiian sugar plantations have been closing steadily ever since. Michelle's father resisted the inevitable for too long, unfortunately, and much of the family's capital disappeared in vain efforts to bolster his stubbornness. Once he finally gave up on sugar, Michelle's father no longer had the heart to try any new enterprises and so had, a few years before his death, leased the 799 acres to five different neighbors for their use as cattle pasture. These combined leases produced $48,600 per year but were negotiable each year.

### Hawaii Real Estate

The Kealoha's were given title to their land in recognition of their royal lineage and service to the Kingdom. Land values had generally been in a steady upward movement for a century and a half, with accelerating spikes in the 1960's, after Hawaii was admitted as the 50th state, and in the 1980's when a rapid growth in Japanese investment caused property values in the islands to almost double. In 1991, however, the real estate bubble burst and the value of Kealoha land was now about 70% of what had been in 1991. There were signs the market had bottomed but some analysts were predicting that the downward trend would continue indefinitely, especially on the outer islands beyond the commercial center of Oahu.

### Agricultural Possibilities

Informal inquires has been made to Michelle's father before his death buy off-island corporations interested in acquiring the Kealoha land to expand their coffee and/or macadamia nut production. No per-acre price had been determined, but Michelle knew that these prices would reflect currently depressed real estate conditions. Michelle's mother was encouraging Michelle to sell the land and get out of the agriculture business. She blamed the collapse of sugar for the bitterness and depression that had preceded and perhaps precipitated Michelle's father's death.

Michelle's experience in coffee retailing had left her more optimistic than her mother about the future of agriculture. Since others were making money in tree crops, she thought she might be able to do so to. Two local bankers had

encouraged her to believe she would be able to mortgage land to raise capital to develop orchards. She was not sure if she should plant all the 799 acres in trees, but she thought the possibility deserved to be studied.

Pastureland for cattle was always in demand, so it is possible new leases with current tenants could be negotiated. Still, cattle prices are low and unlikely to rise soon, so raising lease rents substantially is out of the question. Length of the lease with the current leases that would terminate at various times, if such a strategy seemed productive. Much of the Kealoha land is suitable for growing coffee and macadamia nuts, two crops already well established in the islands.

**Coffee Production**

Michelle did her homework and determined that the costs of purchasing, transporting and planting 250 new coffee trees per acre would be 1800 per acre. Maintenance costs would be about 300 per acre for the first year and increase 15% per year, as the growing trees required increasing of fertilizer. Cost would level off at maturity at year seven. Production would begin in year four and increase each year to maturity in year seven. In year four, acres in trees at the ideal elevation would produce 1000 pounds of raw beans (called "cherry") per year. At maturity, these acres would produce 5500 pounds per year.

The price for coffee cherry tended to fluctuate dramatically. Cost of harvesting and delivering the crop would be about $0.30 per pound. The ideal elevation for coffee production was from 300 to 800 feet. At elevations above 800 feet, the production could be expected to decrease at a rate of about 10% for each additional 100 feet of elevation. Michelle's land began at 500 feet and sloped steadily upward to 1500 feet so she suspected that at least some of this land might be suitable for growing coffee.

**Macadamia Nut Production**

The price paid to farmers for macadamia nuts tend to be more stable than that paid for coffee. Unfortunately, however, macadamia nut trees mature more slowly, not reaching first production until year seven and not achieving maturity until year twelve. The cost of purchasing, transporting and planting 50 new macadamia nut trees per acre would be $1250 per acre. Maintenance cost would be about $225 per care for the first year and increase 10% per year until they stabilized when the trees were mature in year 12.

Production would begin in year seven and increase each year to maturity in year 12. In year seven, acres would produce 500 pounds of nuts-in-shell per year. At maturity, these acres would produce 7000 pounds per year. Cost of harvesting, husking and delivering the crop would be $0.32 per pound. Michelle found statistics about the price paid for macadamia nuts to farmers in the past from the USDA.

The ideal elevation for macadamia nut production was from 700 to 1200 feet below 700 feet and above 1200 feet, production could be expected to decrease at a rate of about 15% for each additional 100 feet of elevation.

**Combined Coffee and Macadamia Nut Production**

Because yields would vary by elevation, though cost remained the same, Michelle thought it might be best to plant coffee at some elevations and macadamia nuts at others. Once she began considering the option, it occurred to here that she might combine the two crops on some of the same acres, planting the two types of trees side by side. If coffee and macadamia nuts were inter-planted she could begin harvesting coffee at year four, earning income from acres where the macadamia nuts were still continuing to mature.

Inter planting could be done by planting coffee in the open spaces between the macadamia nut trees planted 50 trees to the acre on 30-foot centers. Since these trees did not fill in for 12 years that open space could be used to produce coffee. These inter-planted coffee trees would have to be cut down and removed as the branches from the macadamia nut tree grew and became competitive for space. The cost for removal of a mature coffee tree would be $3 per tree.

The thought of planting coffee in the spaces left open by the young macadamia nuts led Michelle to consider the possibility of planting these trees at a 15-foot centers and so 100 macadamia trees per acre. If she did this she would receive twice the revenue per acre from seven through twelve as she would receive from a normal 50 trees per acre planting. In year 12, however, she would be faced with the cost of removing half of the trees to allow the maturing macadamia nut branches room to fill in the space they needed to reach maximum production. The cost of removal of 12-year old macadamia nut trees would be $14 per tree.

Michelle realized that in addition to these removal costs here production in year thirteen would be cut in half. Production would not return to this level again for three years as the remaining trees branched out to fill in the space. If mature macadamia nut trees were left at spacing of 100 per acre, however, their health would deteriorate so that by year 13 the rate of nut producing would likely fall at a steady pace of about 10% per year there after.

**Michelle's Decision Problem**

There are many different ways to use the Kealoha land. Michelle needs your help to determine which option would give her and her mother the best profit in the long run (20 years). She wants you to make an analysis of her problem and then provide her with a recommendation based on your results.

## TEACHING NOTE & CASE QUESTION

The best way to use the Kealoha land for the next 20 years is the case's main question. Michelle's options included: continue to lease the land, plant only coffee trees, plant only macadamia nut trees, plant a combination of coffee trees and macadamia nut trees, inter-plant coffee trees and macadamia nut trees (30-foot), plant twice the amount of macadamia nut trees and remove half the trees at maturity (15-foot), or plant twice the amount of macadamia nut trees and leave them (15-foot).

**Case Objectives**

The first objective is to determine maximum, mean, minimum and standard deviation price for coffee and macadamia nuts in order to estimate the profits from the agriculture business the students need. The standard deviation should be noted as a means to measure risk. The second objective is the modeling and calculation of revenues, costs, and profits for each option over 20 years. For example, the revenues for the second option: grow coffee only on all of the 799 acres could be calculated using the formulas below.

Year 1 *Revenue*
*=((CoffeePrice-CoffeeHarvestingCost)*CoffeeProduction-CoffeeMaintenanceCost-CoffeePurchasingCost)*#OfAcres*

Year 2-20 *Revenue*
*= ((CoffeePrice-CoffeeHarvestingCost)*CoffeeProduction-CoffeeMaintenanceCost)*#OfAcres*

Students may experience some difficulty in creating the formulas for the different options, but the true value of the formulation lies in the sensitivity analysis that follows these formulas.

**Analysis**

After calculating the max, average, and min profit over the specified time period, the results can be graphed to examine the concepts of dominance and trade-offs between each potential crop or crop combination. Students should recognize that the inter-planting of coffee and macadamia trees dominates the rest of the options. They should also be able to see that there are no explicit trade-off points.

**Redefining assumptions**

Instructors should push students to further examine the case by making there own assumptions. Variables such as coffee and macadamia nut price, maintenance costs, production costs, etc. could be changed or made uncertain by developing underlying distributions. By introducing these uncertainties into the model the instructor can lead the students into the topics of further sensitivity analysis and finally simulation.

**References**

United States Department of Agricultural. 1999 Annual Production Report [Online]. Available: http://usda.mannlib.cornell.edu/reports/nassr/field/crop_production_12.11.9

Wood, Houston, Personal Interview, Fall 1999.