New Technologies and Innovations in Agricultural Economics Instruction

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Software on the Cost of Anthurium Production and Its Use in Teaching and Extension

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I. Introduction

In the mid 1980's the Hawaiian anthurium flower industry was decimated by Xanthomonas campestris pv. dieffenbachiae (Xcd), a bacterial blight of nthuriums. Several years of research have generated a number of effective, although expensive, solutions for controlling, though not eliminating, the blight. These solutions include: replacing open shade cloth structures with more expensive climate controlled greenhouses; breaking the chain of contamination by changing the method of plant propagation from cuttings to tissue cultured plant material; sterilizing tools used in harvesting and cultivation; and using sanitation, quarantine, and isolation techniques as a means of prevention. It became apparent that many variables needed to be considered simultaneously, making it difficult to use any one set combination to estimate the cost of anthurium production. In order to quickly assess the cost and return of various alternative combinations a computer software was developed. This software could then assist the individual grower in selecting which would be the most affective growing practices to implement.

II. Methodology

In order to achieve the above objectives the task was divided into three stages. First, various technical coefficients for the cost of production were obtained. Second, a spreadsheet tablet was developed which included all necessary information on the cost of production and defined the relationship between production cost and various farm inputs. The final stage was the further development of the software in order for it to be more user friendly for farmers and bankers.

The data used to estimate various technical coefficients was obtained from a survey of 18 anthurium growers in Hawaii County. A questionnaire was developed in order to obtain the necessary information concerning establishment, operational and overhead costs, as well as to collect information regarding production. The survey began in October 1990 and was completed in March 1991.

The participants in this survey were divided into four groups according to farm size and technology being applied. Under shade cloth, the first three groups are represented by the following farm sizes: two to five acres, six to fifteen acres, and farms larger than fifteen acres. The fourth group consists of farms utilizing roof structures. Only one farm surveyed had the entire operation under roof, while three other farms employed both technologies.

A spreadsheet on the cost of production combining various technologies was developed and tested during the 1991 Anthurium conference. Development was then continued using Pascal computer language to produce the present software.

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III. The Anthurium Software

This program, ANTHURIUM, was designed to provide farmers with an easy way to compare and evaluate the cost effectiveness of various blight controlling measures. Through this analysis, farmers were also able to better understand some important economic principles related to anthurium production.

ANTHURIUM is based on the underlying cost of production conditions that existed in the State of Hawaii in 1990. Various assumptions underline the program.

1 LAND COSTS Land rent is not included in the calculations because in Hawaii costs vary considerably according to location; therefore, net farm income would need to be adjusted for the land rent.

2 CAPITAL ASSETS All assets have the same life span; therefore, one can sum the total capital expenditure and divide it by the total approximate life span. This assumption was included for the purpose of simplicity and will be eliminated in future versions.

3 FIXED TECHNOLOGY There will be no change in technology or technical coefficients in the near future.

4 PLANT MATERIAL Tissue culture plants are used only in the beginning of farm operation and thereafter the cutting methods are used.

5 PLANT PRODUCTION CYCLE The anthurium plant is assumed to reach full production in the end of the second year and all plants are replaced by the end of the seventh year of farm operation.

ANTHURIUM illustrates the effects of selected production and management decisions on farm income. There are 15 decision variables in ANTHURIUM encompassing different possible blight control strategies and differences in business practices employed from one farm to another. Essentially, there are two types of decisions growers make. The first set, made less frequently, are related to the initial decision making stage and represent decisions that, once made, are not easily changed, such as structural costs and irrigation systems, which then determine plant population. The second set of decisions are made more frequently and can be varied through management practices and business environments. Included in this group are percentage of tissue culture plants used, hourly wages, interest rates, flower price, number of flowers per plant, and the percentage of plants lost due to blight. The remaining elements affecting the cost of production are more uniform from farm to farm and are kept as constants in the program.

In order to conduct sensitivity analysis, relationships between the net farm income and decision variables were specified. It was hypothesized that there is a positive relationship between net farm income and both farm size and flowers per plant, and that there is a negative relationship between net farm income and the following quantities: percentage of tissue culture plants used in establishing the farm, percentage of plants lost, and wages. These functional relationships are specified as follows:

Net farm Income per acre (I) is a function of farm size (Z), the number of flowers produced per plant (F), percentage of tissue cultured plants (T), percentage of tissue cultured plants lost due to diseases (DT), percentage of plants propagated through cuttings which are lost due to diseases (DC), and wages per hour (W). This relationship is presented in equation (1).

$$I = f(Z,F,T,DT,DC,W) \quad (1)$$

The *sensitivity index* can be defined as the ratio between the relative change in net income and the relative change in a decision variable. More precisely, if q denotes a specific decision variable and all other variables remain constant, the sensitivity index relative to q is a function of q and can be defined as

$$SI_q(q_0) = \lim_{\Delta q \to 0} \frac{\Delta I / I(q_0)}{\Delta q / q_0} \quad (2)$$

Here $I(q_0)$ denotes the net income at $q = q_0$, holding all other variables constant. Therefore, if I is differentiable at q_0,

$$SI_q(q_0) = I'(q_0)^* q_0/I(q_0) \qquad (3)$$

In order to approximate each sensitivity index in closed form, a regression analysis was done for each decision variable. A linear regression was performed for net income relative to all variables, except size, with the resulting correlation coefficient r-squared lying between .95 and 1 in all cases. A logarithmic regression was done for income relative to size, for sizes between 4 and 14 acres, with r-squared having a value of .917. These are reasonable values for Z since the default size value, or average farm size of those farms surveyed, was 8 acres. Net income as a function of size for values between 4 and 14 is approximated by

$$I(z) = 715^*ln(z) + 1636.5 \qquad (4)$$

For farm sizes larger than 14, income as a function of size is best approximated as linear and will not be included here. Therefore, the sensitivity index relative to size, for example, for farm sizes between 4 and 14, is given by

$$SI_Z(z) = 715/(715^*ln(z) + 1636.5) \qquad (5)$$

Moreover, it is easily verified from equation (5) that this sensitivity index ranges in value from .272 at z=4 to .203 at z=14, with $SI_Z(8)$ being approximately .22. In other words, a one percent increase in farm size from the default size of 8 acres results in less than a .23 percent increase in net income. Furthermore, relative changes in farm size away from other values result in similar minimal changes.

The range and default values for the remaining variables, as well as the equations for net income, are given in Table 1.

Table 1. Range and Default Values for Variables in the Model.

Variable	Range	Default Value	Equation
F	2 - 3	2.4	I(F) = 6887*F - 13329
T	0%-100%	50%	I(T) = -23.3*T + 4368
W	\$4-\$9	\$6.50	I(W) = -1176*W +10844
DT	0%-100%	7.5%	I(DT) = -12*DT + 4102
DC	0%-23%	17%	I(DC) = -466*DC+11119

Table 2. Sensitivity Indexes for Each Variable.

Variable q	SI_q	Range for SI_q	$SI_q(d)$ for default d
F	$SI_F(F)$=6887*F/I(F)	31.00- 2.80	5.16
T	$SI_T(T)$=-23.3*T/I(T)	0.00- 1.15	0.37
W	$SI_W(W)$=-1176*W/I(W)	0.77-40.42	2.39
DT	$SI_{DT}(DT)$=-12*DT/I(DT)	0.00- 0.42	0.05
DC	$SI_{DC}(DC)$=-466*DC/I(DC)	0.00-26.25	2.47

Table 2 provides the results regarding the sensitivity index for each variable. It is easily seen from the Table 2 that relative changes in either the percentage of plants initially propagated through tissue culture or the death rate of such plants result in minimal changes in net income. Indeed, this is expected, as the effects from initial plantings become less significant over time. However, as row three indicates, if hourly wages are as high as $9, a 1% decrease in hourly wage will result in a 40% increase in net income. On the other hand, if the hourly wage is a more realistic $6.50, a 1% change in wage will result in a change in net income of approximately 2.39% in the appropriate direction. Similarly, 1% changes about the default values for F and DC result in changes in income of 5.16% and 2.47% respectively. However, these results are somewhat more significant since, unlike wages, these quantities can be improved through extra care in blight prevention. Thus, if the farmer can improve the average number of flowers per plant from 2.4 to 2.64, a 10% increase in production, a 50% increase in net income will result.

Employing this index the program was used to evaluate the impact of specific changes on net farm income. The different sets of projected output can then be compared using annual cost and return to management per acre. The relative importance of various expense and revenue items can be considered independently while other variables are kept constant. Therefore, the grower has a better understanding of its impact. The higher the sensitivity index the more importance the variable plays in farm profitability. An index greater than one indicates that the solution is sensitive and less than one is insensitive to the change. Certain decision variables such as the number of flowersper plant have a major affect on profitabilitywhile the initial cost of the irrigation system has only a minor affect.

IV. Application

Workshops were then conducted to demonstrate and familiarize users with the program format, possible applications, and how to process their data in order to become comfortable using it in evaluating the profitability of both present and proposed farm operations. Figure 1 illustrates the software decision menu after having input various decision values, in this case the default values. Once the decision values have been input, the user is given summary information regarding cost breakdown and projected return, as is illustrated in Figures 2 and 3. Figure 2 illustrates the cost breakdown screen for the third year of production, given the default values in Figure 1. Figure 3 represents the annual projected cost and return screen for the first ten years of operation, again given the default values in Figure 1.

Using the decision menu, the user may easily change the values of one or more variables in order to investigate the significance of each aspect of the operation. Figures 4 and 5 illustrate the results of a 10% increase in flower production. A comparison to Figure 3 above shows the expected annual return is indeed increased by 50%, as was hypothesized by the sensitivity index relative to flowers above.

Figures 6 and 7 illustrate the effects of a 10% decrease in the death rate for cuttings. Again, comparison to Figure 3 shows a 25% increase, as was predicted using the sensitivity index relative to DC.

ANTHURIUM COST OF PRODUCTION USING SHADE

FOR: XYZ'S FARM

SHADE - Cost/square foot	$ 0.46 incl. labor & materials
Farm Size	8.0 acres
Cost of Irrigation System	$ 3078.00 per acre
Plant Population	25,000 plants per acre
% of Tissue Culture Plants	50.0 % tissue culture plants
Tissue Culture Plant Cost	$ 1.5
Cost of Plant from Cutting	$ 0.65
Current Hourly Wages	$ 6.50 per hour
Current Interest Rate	10.0 %
Price per Flower	$ 0.55 per flower
# Flowers per Plant per Yr	2.40 flowers per plant
Percent of Plant Loss	
Tissue Culture	7.5 %
Cuttings	17.0%
Pay Back Periods	12 years

Figure 1. Decision Menu Default Values

	Per Acre	Per Farm
Annual Investment Cost	7067.50	56539.99
Annual Return on Investment	2928.01	23424.08
Overhead Cost: Repairs, Taxes, etc.	589.80	4718.40
Operating Cost	5786.67	46293.39
Plant and Material Cost	6250.47	50003.76
Total Cost	22622.45	180979.63

Figure 2. Cost Breakdown Summary Default Values

Plant Age	Gross Income	Annual Cost	Net Income	Accumulative Return on Land & Mgt.
Third year	27514	22622	4892	4892
Fourth year	28200	23754	4446	9338
Fifth year	29590	24941	4648	13986
Sixth year	31138	26188	4949	18345
Seventh year	32690	27498	5192	24127
Eighth year	27484	28873	-1389	22738
Ninth year	34300	30316	3983	26721
Tenth year	37124	31832	5292	32013
Annual Return to land and Management per acre				$ 3201

Figure 3. Annual Cost and Return Summary Default Values.

	Per Acre	Per Farm
Annual Investment Cost	7067.50	56539.99
Annual Return on Investment	2943.45	23547.58
Overhead Cost: Repairs, Taxes, etc.	589.80	4718.40
Operating Cost	5786.67	46293.39
Plant and Material Cost	6401.07	51208.60
Total Cost	22788.49	182307.95

Figure 4. Cost Breakdown Summary at F=2.64.

Plant Age	Gross Income	Annual Cost	Net Income	Accumulative Return on Land & Mgt.
Third year	29846	22788	7058	7058
Fourth year	30519	23928	6591	13649
Fifth year	31913	25124	6788	20437
Sixth year	33601	26381	7220	27658
Seventh year	35285	27700	7585	35243
Eighth year	29033	29085	-52	35191
Ninth year	35991	30539	5452	40643
Tenth year	39966	32066	7901	48544
Annual Return to land and Management per acre				$ 4854

Figure 5. Annual Cost and Return Summary at F=2.64.

	Per Acre	Per Farm
Annual Investment Cost	7067.50	56539.99
Annual Return on Investment	2897.71	23181.68
Overhead Cost: Repairs, Taxes, etc.	589.80	4718.40
Operating Cost	5559.96	44479.69
Plant and Material Cost	6282.73	50261.81
Total Cost	22397.70	179181.57

Figure 6. Cost Breakdown Summary at DC=15.3%.

Plant Age	Gross Income	Annual Cost	Net Income	Accumulative Return on Land & Mgt.
Third year	28245	22398	5847	5847
Fourth year	29068	23518	5551	11398
Fifth year	30476	24683	5782	17180
Sixth year	32050	25928	6122	23302
Seventh year	33652	27225	6428	29930
Eighth year	27387	28586	-1199	28531
Ninth year	34924	30015	4909	33440
Tenth year	38129	31516	6613	40054
Annual Return to land and Management per acre				$ 4005

Figure 7. Annual Cost and Return Summary at DC=15.3%.

Concluding Comments

Anthurium software has been utilized by most of the anthurium growers in the state of Hawaii. It has proven to be easily implemented by the growers to fit their specific farm environments. Moreover, the results demonstrate to the growers that small increases in flower production and small decreases in the death rate result in large increases in net income. This justifies the extra effort required to control the blight and improve management practices. Furthermore, with minimal programming knowledge, Anthurium software can be updated to fit changes in technology and the economic environment. The program can also be adjusted to fit other floriculture crops such as orchids, gingers, heliconias, etc. Anthurium is designed to enhance the teaching of sensitivity analysis in a classroom environment. In addition, it could easily be utilized to teach various economic and business principals such as break-even, investment analysis, partial budgeting, etc.