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The Economics of Commercial Wetland Taro Production in Hawaii

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Taro is an important staple throughout the world, but taro, and especially wetland taro, is a particularly important crop in Hawaii because of the long historical tradition of growing taro in Hawaii and because of the deep Hawaiian cultural associations with the plant. The demand for taro in Hawaii exceeds the domestic supply, and there appears to be growth potential for the industry. However, the economics of this crop are as complicated as those of any other agribusiness enterprise. An economic model of wetland taro production for poi processing is developed in order to estimate typical and specific economic profitability. An analysis of the break-even price and yield and an analysis of the value of and return to various productive resources helps one to interpret the cost of production results. No attempt is made to quantify other positive attributes of wetland taro production, such as the crop's significant cultural and historical importance.

Commercial taro production in Hawaii can be categorized as either wetland or dryland taro, the former being cultivated like rice in the flat, wet lowlands and the latter being raised like corn in the drier uplands. (Yokoyama, *et al.*, 1989) The taro used for poi production is the wetland variety, and this paper is limited to the economics of commercially producing this type of taro. The root, or corm, of wetland taro, in addition to being processed into poi, can be cooked fresh and eaten directly. Some varieties of wetland taro are grown for their leaves, rather than for the corm. The leaves are nutritious and also important culturally, especially for making *laulau*. The cultivation of wetland taro for leaf production is similar to the cultivation of taro for poi production, and these plants may be grown in adjoining taro patches. However, for the purposes of this economic study, taro leaf production is considered to be a separate enterprise from taro corm production.

Wetland taro has enormous cultural importance in Hawaii, perhaps more so than for any other food in the Hawaiian diet. There are many legends about taro production, and taro prepared in various ways is essential to any traditional meal. It has a particularly strong symbolic value for those who grow it. Great pride is taken in growing and harvesting "perfect" taro and giving it to friends. This cultural importance provides a small but lucrative fresh taro corm market; however, almost all commercial wetland taro corm production is marketed to the poi processors. For the purposes of this study, the value of the corm for fresh market sales and for culturally significant gift-giving (approximately 5% of the total yield), is acknowledged but ignored from an economic point of view. The economic value of wetland taro production is assumed to be the **marketed yield**, the amount of corm actually sold to poi processors.

Situation

In 1993 the Hawaii Agricultural Statistics Service (HASS) reported that 175 farms had a total of 550 acres in taro production in 1992. Of this total taro acreage, 305 acres were in wetland taro production, and 2/3 of this wetland taro acreage was on Kauai. The average statewide 1992 farmgate price was reported to be 44.1 cents per pound and the average yield for taro used in processing taro was almost 20,000 pounds per acre. (HASS, 1993) The more well-known wetland taro producing regions in Hawaii are Kauai's Hanalei Valley, the valleys along the east Maui coast, and the Waipio Valley on the Island of Hawaii. The current study is based

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on field work done in the Waipio Valley.

Unfortunately, the HASS statistics do not allow one to calculate the average size of a wetland taro operation, but typically, taro farms are small, family-operated farms, with three to seven acres in wetland taro production. Wetland taro is raised in a paddy, referred to as a *lo'i*, and is about 10,000 square feet in area or a little less than a quarter of an acre. However, in addition to the actual growing area, a considerable amount of land area is also required for the infrastructure, such as the complex irrigation system and the surrounding banks and levies.

Demand for taro in Hawaii is greater than the supply, and Hawaii must import taro. There is additional land in Hawaii which is potentially suitable for wetland taro production. However, in spite of this current situation of limited supply and substantial demand, the poi market price for wetland taro corm is not high enough to assure that all commercial production of wetland taro for poi processing will necessarily be profitable, that is, will provide an equitable and satisfactory return to a taro grower. One must calculate the production costs and returns to determine if a particular operation growing wetland taro for poi processing could be financially viable.

Methodology

An economic model of wetland taro production was synthesized based on field work in the Waipio Valley. The computerized model has two parts: (a) **operating** cost and returns, in cents per pound of taro and in dollars per acre *per harvested crop* of taro (Table 1), and (b) **ownership** costs and returns, on a cents per pound, as above, and in dollars per acre and per farm on a *per year basis* (Table 2). In these tables, which are the actual printouts of the calculations, italicized figures or text indicate variable data entries; upright figures and text indicate calculated results or fixed categories.

Table 2 annualizes the per crop cycle costs and returns generated in Table 1. If the crop cycle for taro happened to be exactly one year, then the per acre costs and returns in parts (a) and (b) would be identical. However, the wetland taro crop cycle (from planting to planting) is 15 to 16 months. If it were 16 months, the yield per acre *per year* would be 12/16 or 75% of the yield per acre *per crop cycle*.

Production practices in these tables are typical of the better producers in the Waipio Valley, and the operating input costs are typical rather than average. A detailed description of the various production practices is beyond the scope of this economic fact sheet and would be better addressed in a horticultural fact sheet. However, it is important to note that wetland taro is generally propagated with *huli*, the top part of the ma-ture taro plant. Huli can be purchased for about 18¢ each or cut off from the top of the corm at harvest. The com-puter program calculates the number of huli required based on the proposed plant spacing within and between rows. If a price is entered for seed in the planting section of the program, it is assumed the grower purchases huli. If a price is not included, the amount of harvest time is automatically increased appropriately to account for the extra time required to make the amount of huli needed.

The ownership arrangements are also meant to reflect a typical situation. Most poi taro land happens to be leased, but the model allows any ownership structure. All wetland taro production is extremely labor intensive, but there is some room for limited mechanization, such as rototilling. The farm portrayed as typical in this study hires some rototilling services, but the model accommodates the whole range of production possibilities, from no mechanization (all manual labor) to a relatively high level of mechanization.

The "bottom line" for the operations component of the model is *gross margin*, the gross revenue minus all of the operating costs. The ownership component's "bottom line" is *economic profit*, the gross margin minus the value of all of the ownership resources (i.e., the management, capital and land resources) and an estimate of the riskiness of the enterprise.

Economic profit is the best measure of farm profitability because it includes *all* costs, not simply cash costs, as does "accounting profit," a more commonly used measure of profitability. In the long run we would expect economic profit to equal zero because all "out-of-pocket" costs would have been included and all productive resources (including "unpaid" labor) would have received a return equal to their value. We would therefore expect significantly positive economic profitability to attract other producers into the industry.

Most farmers do not consider the full value of their labor, management and owner equity. They often think of their "profit" as the residual of their farming effort. However, in calculating the economic profit, we must consider the value of all productive resources. The return to the farmer is the return to his labor, management, and owner equity. If these returns are at least equal to their values, then the taro operation can be considered to be "profitable."

Results

The model consists of two linked spreadsheets, one which calculates the operating costs and another which calculates the ownership costs. The

TABLE 1. CALCULATION OF OPERATING COSTS

GROSS REVENUE, Σ:	Quantity/acre	in units of	@ $/unit =	Gross revenue/crop = ¢ per pound	$ per acre	% of gross revenue
1992 TYPICAL yield & price	**23,000**	pounds	$0.431	**43.1**	**$9,913**	100.0%

OPERATING COSTS, Δ (by activity):		Quantity/acre	in units of	@ $/unit =	Operating costs/crop = ¢ per lb.	$ per ac.	% of gross
A. Pre-harvest costs:		Note: Pre-harvest labor/hr.		$10.00			
1 **Land Preparation =**					**3.7**	**$849.20**	**8.6%**
a Labor to clear patch		28.30	hours	$10.00	1.2	283.00	2.9%
b Fertilizer: Lime, if necessary		0.00	bags	$13.00	0.0	0.00	0.0%
c Labor to machine till		4.36	hours	$10.00	0.2	43.60	0.4%
d Labor to machine rough level		4.36	hours	$10.00	0.2	43.60	0.4%
e Machinery operating costs		8.70	hours	$30.00	1.1	261.00	2.6%
f Custom rototilling		0.00	hours	$95.00	0.0	0.00	0.0%
g Labor to hand level		21.80	hours	$10.00	0.9	218.00	2.2%
2 **Planting (given spacing) =**	27	16	inches		**1.3**	**$305.00**	**3.1%**
a Seed (huli) @ sq.ft./plant of	2.8	15,488	huli	$0.00	0.0	0.00	0.0%
b Labor to raise & plant seedlings		30.50	hours	$10.00	1.3	305.00	3.1%
3 **Fertilization =**					**3.7**	**$850.45**	**8.6%**
a Fertilizer: 15-15-15		22.00	bags	$14.80	1.4	325.60	3.3%
b Fertilizer: Super Phosphate		1.30	bags	$0.94	0.0	1.22	0.0%
c Fertilizer: Muriate of Potash		26.10	bags	$11.71	1.3	305.63	3.1%
d Labor to apply fertilizers		21.80	hours	$10.00	0.9	218.00	2.2%
e Mechanized Operations		0.00	hours	$20.00	0.0	0.00	0.0%
4 **Pest Control =**					**13.2**	**$3,035.45**	**30.6%**
a Herbicide: Round-up		0.57	gallons	$85.00	0.2	$48.45	0.5%
b Labor to spray herbicide		39.20	hours	$10.00	1.7	392.00	4.0%
c Labor to hand weed		240.00	hours	$10.00	10.4	2,400.00	24.2%
d Labor to machine mow		6.50	hours	$10.00	0.3	65.00	0.7%
e Fungicide: Ridomil		0.00	pounds	$14.39	0.0	0.00	0.0%
f Other pest control expense		0.00	pounds	$0.00	0.0	0.00	0.0%
g Other pest control expense		0.00	pounds	$0.00	0.0	0.00	0.0%
h Labor to apply other pesticides		0.00	hours	$10.00	0.0	0.00	0.0%
j Mechanized Operations		6.50	hours	$20.00	0.6	130.00	1.3%
5 **Irrigation =**					**0.5**	**$120.00**	**1.2%**
a Water		0.00	acre inches	$0.00	0.0	0.00	0.0%
b Labor to apply water & maintain system		12.00	hours	$10.00	0.5	120.00	1.2%
6 **Operating interest @ APR**	10.0%	6.67%	per crop on	$5,160	**1.5**	**$344.01**	**3.5%**
A. Total pre-harvest cost =					23.9	$5,504.11	55.5%
B. Harvest costs:		Note: Harvest labor/hr. =		$8.00			
1 **Harvesting, grading & packing =**					**7.9**	**$1,827.95**	**18.4%**
a Labor, w/ huli @ bags/hr. =	1	193.60	hours	$8.00	6.7	1,548.80	15.6%
b Labor, w/o huli @ bags/hr. =	3	31.30	hours	$8.00	1.1	250.40	2.5%
c Bags, @ 80 lbs./bag =		288	bags	$0.10	0.1	28.75	0.3%
d Mechanized Operations		0.00	hours	$10.00	0.0	0.00	0.0%
2 **Shipping =**					**0.8**	**$175.57**	**1.8%**
a Labor to transport to market/shipping pt.		7.00	hours	$8.00	0.2	56.00	0.6%
b Mechanized Operations		7.00	hours	$10.00	0.3	70.00	0.7%
c Commissions & excise tax		0.50%	of gross revenue		0.2	49.57	0.5%
d Freight, storage & other shipping costs		0.00		$0.00	0.0	0.00	0.0%
B. Total harvest cost =					8.7	$2,003.52	20.2%
TOTAL OPERATING COSTS OF PRODUCTION, Δ (A+B) =					**32.6**	**$7,508**	**75.7%**
GROSS MARGIN (Gross revenue minus operating costs, Σ - Δ) =					**10.5**	**$2,405**	**24.3%**

program was written in Excel 4.0 on a Macintosh computer and is freely available to anyone who has access to a similar system or who can import an Excel 4.0 file into a preferred spreadsheet program. A printout of the complete results from part 1 of the program (operating costs) is provided as Table 1 above. Table 2, on the next page, provides the results from the second part of the program (ownership costs.) The summaries presented

TABLE 2. CALCULATION OF OWNERSHIP COSTS

WHOLE FARM ASSUMPTIONS:

Crops per year	*0.75*	Value of mgmt. (% of gross)	*5.0%*	Term debt/asset %	*20.0%*
Productive acres	*4.50*	Opportunity cost of money	*6.0%*	Term interest rate	*10.0%*

GROSS MARGIN, μ	Lbs./acre/crop:	Lbs./acre/year:	Lbs./farm/year	¢/lb. sold/yr.	$/acre/year	$/farm/year	% of gross:
Gross Revenue, Σ:	**23,000**	**17,250**	**77,625**	**43.1**	**$7,434.75**	**$33,456**	**100.0%**
Operating costs, Δ:				**32.6**	**$5,630.72**	**$25,338**	**75.7%**
A. Total pre-harvest costs =				23.9	4,128.08	$18,576	55.5%
B. Total harvesting costs =				8.7	1,502.64	$6,762	20.2%
GROSS MARGIN, μ (Σ - Δ) =				**10.5**	**$1,804.03**	**$8,118**	**24.3%**

OWNERSHIP COSTS, Ω:	(per farm per year basis)			¢/lb. sold/yr.	$/acre/year	$/farm/year	% of gross:
1 Management resource:				**2.6**	**$446.09**	**$2,007**	**6.0%**
a Management	$33,456	gross income	5.0%	2.2	371.74	1,673	5.0%
b Office overhead	$33,456	gross income	*1.0%*	0.4	74.35	335	1.0%
c Other management costs		*Enter farm total under "$/farm"=*		0.0	0.00	0	0.0%
B. Capital resources:				**5.7**	**$975.11**	**$4,388**	**13.1%**
1 Depreciation (est.) on	$23,000	investment					
a. Machinery & equip.	*$18,000*	investment @	*14.3%*	3.3	572.00	2,574	7.7%
b. Bldg. & improve.	*$5,000*	investment @	*5.0%*	0.3	55.56	250	0.7%
c. Growing plants	*$0*	investment @	*0.0%*	0.0	0.00	0	0.0%
2 Interest expense on	$4,600	loan	10.0%	0.6	102.22	460	1.4%
3 Opportunity cost on	$18,400	equity	6.0%	1.4	245.33	1,104	3.3%
C. Land resource:				**1.1**	**$191.67**	**$863**	**2.6%**
1 Property taxes	*$20,000*	assessment	*1.00%*	0.3	44.44	200	0.6%
2 Property insurance	*$100*	premium		0.1	22.22	100	0.3%
3 **Leasehold:**							
a. Purchase of lease	*$0*	cost or mkt val.	*10*	years remaining on lease			
b. Depreciation of lease		@ rate of	10.0%	0.0	0.00	0	0.0%
c. Interest expense	$0	loan	10.0%	0.0	0.00	0	0.0%
d. Opportunity cost	$0	equity	6.0%	0.0	0.00	0	0.0%
e. Lease rent/prod. acre/ye	*$125*	/ac.+ % of gross @	*0.0%*	0.7	125.00	563	1.7%
4 **Freehold:**							
a. Purchase price	*$0*	cost or mkt value					
b. Interest expense	$0	loan	10.0%	0.0	0.00	0	0.0%
c. Opportunity cost	$0	equity	6.0%	0.0	0.00	0	0.0%
D. Price/yield risk factor:		$33,456	*2.0%*	**0.9**	**$148.70**	**$669**	**2.0%**
TOTAL OWNERSHIP COSTS, Ω (A+B+C+D) =				**10.2**	**$1,761.56**	**$7,927**	**23.7%**
TOTAL COST OF PRODUCTION (Δ + Ω) =				**42.9**	**$7,392.28**	**$33,265**	**99.4%**
ECONOMIC PROFIT, π (μ - Ω) =				**0.2**	**$42.47**	**$191**	**0.6%**

BREAK-EVEN ANALYSIS: Gross margin =μ; economic profit = π			μ /acre/yr.=$0 when:	π /acre/yr.=$0 when:	
In order to cover operating & total costs, μ & π, respectively, must be >= $0:					
given the current ave. yield of	**17,250**	lbs/acre/year, the break-even wt ave PRICE =	**32.6**	**42.9**	¢/pound.
given the current ave. price o	**43.1**	¢/lb., the ave annualper acre break-even YIELD =	**13,064**	**17,151**	lbs/ac/yr

in Tables 3 and 4 of the following section are easier to read, however, the detailed results of Tables 1 and 2 have two important uses. First, the transparency of the spreadsheet approach allows one to determine exactly how each of the costs were calculated. And secondly, the detail enables a current or prospective taro grower to see what kinds of data are needed in order to calculate the profitability of a specific taro operation. With the appropriate data growers can use the economic model, either with an extension agent or on their own, to calculate enterprise profitability and to consider the economic impact of proposed or anticipated production or marketing changes, that is, to answer strategic "what if?" questions.

TABLE 3. SUMMARY OF OPERATING COSTS

Summary of Operating Costs (per Crop Cycle) for the Production of Wetland Taro Corm

GROSS REVENUE	Lbs./crop cycle	Price (¢/lb.)	Revenue ($/acre)	% of gross
Typical yield per crop	23,000	**43.1**	**$9,913**	**100.0%**
OPERATING COSTS:		**Cost (¢/lb.)**	**Cost ($/acre)**	**% of gross**
A. Pre-harvest costs: Labor @ $10/hr.				
1 Land Preparation		3.7	849.20	8.6%
2 Planting		1.3	305.00	3.1%
3 Fertilization		3.7	850.45	8.6%
4 Pest control		13.2	3,035.45	30.6%
5 Irrigation		0.5	120.00	1.2%
6 Operating interest		1.5	344.01	3.5%
Total pre-harvest costs =		*23.9*	*5,504.11*	*55.5%*
B. Harvest costs: Labor @ $8/hr.				
7 Harvesting, grading, & packing		7.9	1,827.95	18.4%
8 Shipping		0.8	175.57	1.8%
Total harvest costs =		*8.7*	*2,003.52*	*20.2%*
TOTAL OPERATING COSTS		**32.6**	**7,507.62**	**75.7%**
GROSS MARGIN		**10.5**	**2,405.38**	**24.3%**

Discussion and conclusions

Table 3 summarizes the detailed calculations of Table 1. The gross revenue per pound of taro is simply the price of taro per pound. The gross revenue per acre is this price per pound multiplied times the pounds of taro actually marketed per acre per crop cycle. The methodology section explained how the particular price and yield figures were selected.

Operating costs are the costs for each of the various production and harvest activities. The total cost of production is primarily of interest relative to the gross income from taro sales. The gross margin helps to relate these two figures. The gross margin, the gross revenue minus the total operating costs, is the amount remaining after paying for the input costs and for labor. Therefore, the gross margin can be thought of as the amount left to pay the ownership costs.

The cost of production can be represented in various ways, but perhaps the most popular expression is in terms of what it costs to grow a pound of taro. In Table 3 above we can see that in 1992 taro farmers typically received about 43¢ for a pound of taro. Valuing their pre-harvest labor at $10.00 per hour and harvest labor at $8.00 per hour, including self-employment tax and health insurance, it cost them almost 4¢ per pound (of the taro marketed) to prepare the land for planting. It cost a little over one cent per pound of product to plant the taro, almost 4¢ to fertilize the crop, over 13¢ for pest control (primarily weed control), a half a cent to maintain the irrigation system, and a cent and a half for interest on the operating costs. The total pre-harvest growing costs amount to 24¢, over half of the 43¢ received for the pound of taro corm. Harvesting costs add almost 9¢ more, for a total of 32 and a half cents per pound, about three quarters of the amount received per pound of taro. The gross margin is only 10 and a half cents, about one quarter of what was received for the taro. This amount is what is left to pay the ownership costs.

Gross margins will be fairly similar across various sizes of taro farms which have similar levels of farm management. However, the ownership (or "fixed") costs can vary substantially from farm to farm, depending upon a wide range of factors, such as ownership and debt structures and economies of scale. If the ownership costs can be controlled, the farm can be profitable. But since the taro farm typically is small to begin with and since the gross margin is fairly small, we can expect profitability is very sensitive to the size of the operation. We can turn to table 4 on the next page to evaluate the ownership costs in the same way we expressed the operating costs.

Management is valued at about two and a half cents per pound of taro sold. The value of the capital resources is almost 6¢ and the value of the land resource is just over 1¢. There is some risk involved in being an entrepreneur. The riskiness of an operation is difficult to quantify, but we must nevertheless include a contingency factor to compensate for the likely variability in price and/or yield. The

TABLE 4. SUMMARY OF OWNERSHIP COSTS

Summary of Annual Ownership Costs for the Production of Wetland Taro Corms (from Table 2)

GROSS REVENUE		¢/pound	$/acre/yr.	$/farm/yr.	% of gross
0.75 crops per year	17,250	43.1	$7,435	$33,456	100.0%
4.50 productive acres	Lbs./acre/yr.				
OWNERSHIP COSTS:		¢/pound	$/acre/yr.	$/farm/yr.	% of gross
A Management resource		2.6	446	2,007	6.0%
B Capital resources		5.7	975	4,388	13.1%
C Land resource		1.1	192	863	2.6%
D Price/yield risk factor		0.9	149	669	2.0%
Total Ownership costs =		10.2	$1,762	$7,927	23.7%
Total Operating costs =		32.6	$5,631	$25,338	75.7%
TOTAL COST OF PRODUCTION =		42.9	$7,392	$33,265	99.4%
ECONOMIC PROFIT =		0.2	$42	$191	0.6%

estimate used here may be low, and for planning purposes, an individual grower may wish to increase it to reflect personal experience. This entry can be interpreted as saying that the proceeding analysis of a typical taro growing situation is a good estimate, but that there exists a good chance that the price and/or yield could drop by 2%.

The total ownership costs per pound therefore amount to a little over 10¢, consuming nearly the entire gross margin and leaving only a small fraction of a cent as the economic profit per pound. However, we must remember that an enterprise which generates any economic profit at all is "adequately profitable" in the common sense of "profit." Recall that an economic profit of at least zero means that all cash operating costs have been paid and that all productive resources, such as labor, management, and the owner's capital investment, have received a return at least equal to their value.

But how profitable is "adequately profitable?" In other words, how much taxable income would an owner-operator of this enterprise of 4.5 productive acres of taro, earn in a year? An obvious result of this research is the highly labor intensive nature of wetland taro production. To put labor hours into perspective, a full time industrial worker is assumed to provide 2,000 hours of labor annually. A typical farmer works 2,500 hours per year. The total number of labor hours in our example farm, is 2,162, or about one full-time operator, especially when time for management is included. The total annual income is thus $23,027 (the total *return* to labor and management, $21,923, plus the *value* of the capital equity, $1,104.)

In conclusion, it must be stressed that the results of this study were not deducted from a survey of all producers. The figures are not based on averages but rather on what the author believes to be typical of better managers. The production model was synthesized from an in-depth analysis of a few selected farms with the intent of providing producers with a structured approach for the financial analysis of a wetland taro enterprise.

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The "agribusiness community" is defined broadly to include agricultural producers and all of those who directly support them: legislators, policy-makers, relevant government agency personnel, agricultural lenders, consultants, educators, chefs, food wholesalers and processors, and the many others who provide the necessary infrastructure for sustainable agricultural production in Hawaii.

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