The Economics of Wetland Taro Production in Hawaii

G. R. Vieth, B. W. Begley,
and W. Y. Huang

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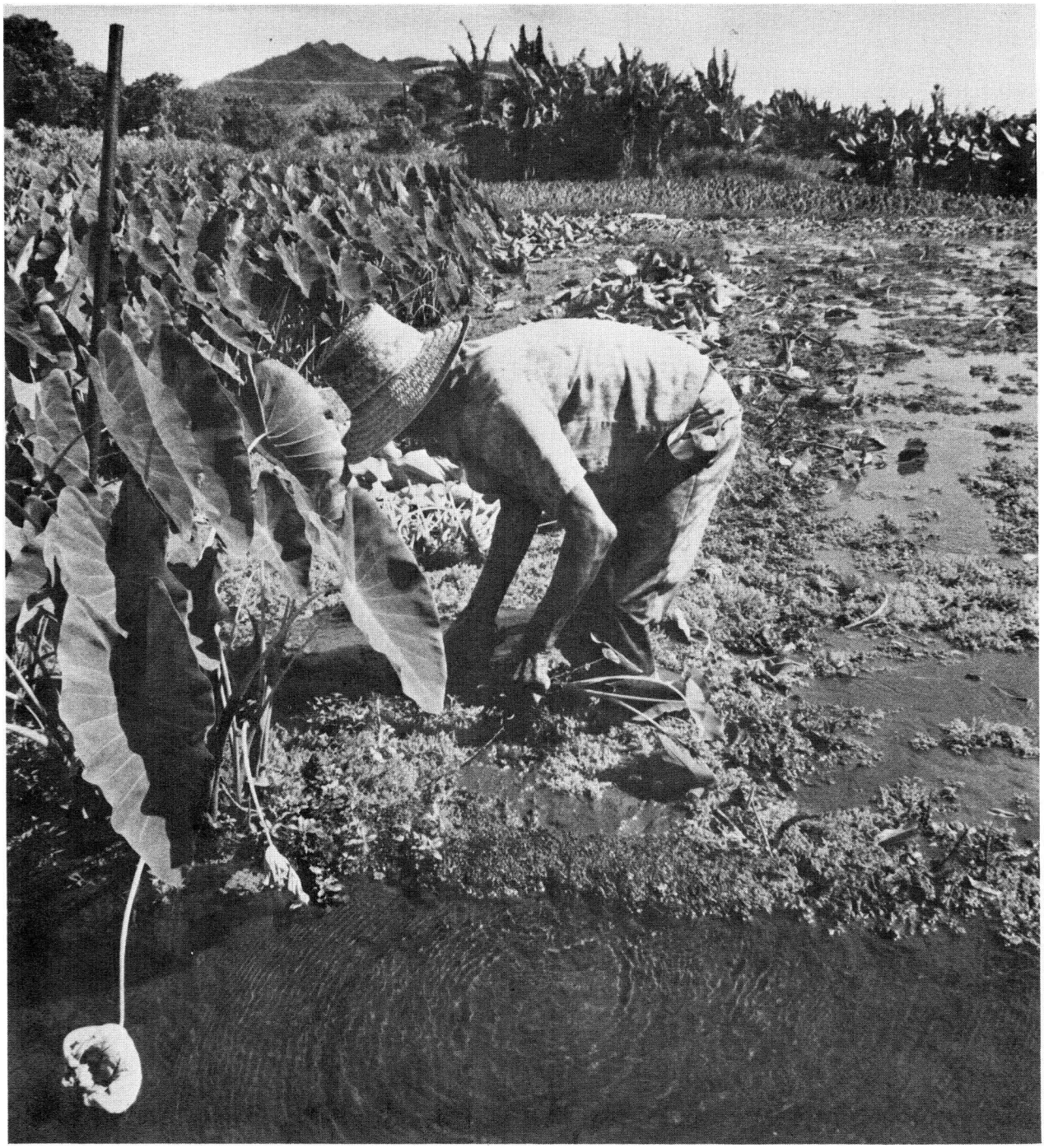

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ACKNOWLEDGMENTS

Special thanks are due to each of the growers interviewed on the Islands of Kauai, Maui, and Hawaii, and also to Dennis K. Ikehara, Hawaii Cooperative Extension Service, Kauai County, and Ramon de la Peña, Hawaii Agricultural Experiment Station, Kauai Branch.

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ERRATA

Page 2, Appendix Tables;

Delete;

"A-1 Kauai: Typical Taro Producer Using Hand Tiller .11"

It should read;

"A-1. Kauai I: Typical Taro Producer Using Hand Tiller .11"

Page 16, Table B. Charges for using machinery,

	Total costs	**Hourly:**
Delete;	*($/yr)*	
It should read;		($/hr)

THE ECONOMICS OF WETLAND TARO PRODUCTION IN HAWAII

G. R. Vieth, B. W. Begley,
and W. Y. Huang

INTRODUCTION

Though cultivated in most tropical and subtropical areas of the world, taro is particularly important in the Pacific region because it has been, and still is for many island groups, a staple food.[1] Together with seafoods, taro constituted the staff of life for the native Hawaiians and was grown using quite sophisticated production techniques (*5*). The acreage under taro cultivation today is a far cry from the thousands of acres of taro that dotted the landscape when Captain James Cook first visited Hawaii in the 18th century. But taro remains an important crop in certain areas that have been appropriately referred to as "valley bottoms," and this paper focuses on production in these areas.

Wetland taro (*Colocasia esculenta*) production in the State of Hawaii is examined in terms of five typical systems of production that reflect the differing locations and levels of mechanization used in the growing of taro in three major production centers in the State. Descriptions of these systems were developed from interviews with Hawaii taro farmers in 1976.

[1] A concise description and explanation of the differences between taro and other members of the Araceae family is given in Plucknett (*8*). Plucknett, de la Peña, and Obero (*9*) is a basic reference for the origin, geographical distribution, and botany of taro.

Figure 1. Taro fields, or patches as they are called in Hawaii, in Hanalei Valley on the Island of Kauai.

OVERVIEW OF TARO PRODUCTION IN HAWAII

In 1900, there were approximately 1300 acres in taro production in Hawaii, grown under both wetland and dryland production methods (*4*). At the time of our survey in 1976, production was reduced to under 500 acres of commercial taro (*11*), with less than 20 acres being grown using dryland methods. The bulk of wetland taro raised today is processed into poi. In February 1978, however, the area under dryland taro production was being systematically expanded to produce a type of taro particularly suited for processing into taro chips.

The approximately 130 farmers who still raise taro in the State are concentrated in the four river valleys of Hanalei, Keanae, Wailua, and Waipio on the Islands of Kauai, Maui, and Hawaii. Thirty-three (slightly less than 40 percent) of the growers were interviewed. These included most full-time growers, as well as a representative sample of part-time growers. While two-thirds of those interviewed were over 50 years of age, some sons of Japanese taro growers in particular and some younger Caucasians also were included in the survey.

Taro is a plant that needs ample water. The Waipio, Hanalei, Keanae, and Wailua valleys are all located close to high mountain areas that provide a year-round water supply for the taro patches. However, the flow of water varies throughout the year, with excesses in winter often resulting in heavy flooding and shortages in summer leading to drought. Maui frequently has water shortages in summer, and in Waipio Valley on the Island of Hawaii, high temperatures during times of reduced water flow lead to the creation of an ideal environment for disease.

THE COST-OF-PRODUCTION STUDY

Purpose

Cost-of-production surveys are conducted in an attempt to determine costs and returns faced by the "typical" producer of a commodity. The surveys highlight the situation of producers within the industry in a quantifiable way and are an aid to those making policy or management decisions.

A cost-of-production study is used for policy-making when the information is interpreted and applied to the state of production or the structure of an industry. This information might be used, for example, to make decisions concerning pricing and subsidization policies. Studies that are designed for this purpose are usually initiated at the request of public officials or agencies.

As a management tool, cost-of-production studies are used when there is a need to identify important or potentially important management problem areas. Also in the category of management tools are studies that provide standards or identify critical areas of cost that farmers or Extension personnel can compare against individual per-

formance. In this study, for example, the data show that a high proportion of time is spent weeding and harvesting. It would appear, then, that concentrated efforts to make greater use of herbicides and investigations of the potential of mechanization to reduce hand-harvesting are warranted. Studies that are designed for management oriented purposes are usually initiated at the request of farmers or groups of farmers.

Need for Caution

The user of a cost-of-production study for either policy formulation or management decision making must proceed with caution. Specifically, the policy oriented user must recognize that "typical" cost and return figures give a general picture of the industry. The figures do not indicate how individuals relate to the average or typical, nor how they will react to recommendations or policy measures. On the other hand, administrators keen to increase efficiency by making better use of land, labor, or capital in a particular industry must recognize that cost-of-production studies for specific commodities are limited by what costs and returns are taken into account or actually measured. Finally, the figures themselves must often be treated with a great deal of caution.

Measurement Problems: Working from Memory

In addition to the caution that must be exercised in making inferences from broad cost-of-production figures to individual farmers' costs, a user also must consider the limitations resulting from measurement problems and computational procedures when working with data from small, often part-time, growers. Many of these farmers do not keep detailed records of their expenses or work hours; as a consequence, when asked specific questions on quantities of chemicals used or hours spent weeding, they use a "best guess," rather than actual, recorded figures.

It is important to keep the "memory factor" in mind, since a respondent may unintentionally have biased estimates of costs (inputs) and returns (outputs). This problem is particularly applicable to nonpurchased inputs such as family labor. For a crop such as taro with a long growing season, it may be very difficult to remember how many times and for how long each time an operation–such as weeding–has had to be carried out over the course of 12, 15, or 18 months. Additionally, the number of times any particular taro patch has to be weeded varies a great deal from year to year. Reality also suggests that when taro growing is a way of life as it still is for some producers, rather than strictly a business, a farmer and his family may spend more hours weeding, planting, or harvesting than would be the case if labor was hired on an hourly basis.

Usefulness of Cost-of-Production Studies

Despite cautions to those using these studies, and despite problems that arise because of the deficiencies inherent in the figures themselves, cost-of-production studies are useful tools for the policy maker or the manager of a farm.

Cost-of-production studies help to quantify what farmers are doing, show variations within the industry, highlight critical cost areas, and provide some standards against which individuals can measure their own performance. This cost-of-production study is not the first on taro in Hawaii (*1,7*), but it is the first taro production study in which a significant number of taro farmers were interviewed in all major production areas of the State. The authors believe it represents a first attempt to describe inputs and outputs at the production phase for a heterogeneous, rather than homogeneous, group of farmers in Hawaii.

Average vs Typical Studies

There is a distinction between "average" and "typical" costs of production. As the term suggests, to derive average figures the researcher simply takes all of the data on equipment, labor, chemicals, and other inputs, and divides the total in each category by the number of respondents. When aggregating responses, therefore, odd figures emerge that do not make much sense. For example, if there were three respondents, one using a tractor and disc, the second using a hand tiller, and the third using manual methods, averaging would result in each having one-third of a tractor and disc and one-third of a tiller as the equipment used for tilling the land.

Certain assumptions are implied when using averages. First, the physical production environment is assumed to be the same for all producers. Second, it is assumed that all producers use the same technology or cultural practices. Third, equal access to capital, markets, and input suppliers is assumed. Finally, it is assumed that all producers have similar economic motivation.

Concerning taro growers in Hawaii, the validity of these assumptions is questionable. The data suggested that rather than having one single "average," there were groups of producers using similar technology or production methods in different areas. Consequently, rather than use averages, we used "typical" costs of production for groups of farmers in the different locations.

PROCEDURES USED

Interviews with 33 wetland taro growers were conducted in 1976. The growers were equally divided among three areas: Hanalei Valley, Island of Kauai; Keanae-Wailua Valleys, Island of Maui; and Waipio Valley, Island of Hawaii. Respondents were asked questions concerning their cultural practices, input usage, costs and returns, and physical and socioeconomic production environments.

The data on cultural practices, inputs, and costs and returns were then summarized into five "typical" production models that are presented in Appendix A. Costs were calculated by determining the unit's physical inputs and multiplying these by the appropriate prices or per-unit costs.

Special note should be made of the methods used to calculate charges for labor and machines. The charge for labor involving use of machinery was $5.50 per hour; all other labor was valued at $3.00 per hour. The labor figure of $3.00 is slightly above the minimum wage, and the charge of $5.50 is what a machine operator can be hired for in rural areas of Hawaii. However, wage rates not only vary from island to island but even from farm to farm, and the individual user of this study is invited to substitute his own figures and prices to more accurately represent the cost of his specific inputs. The charges for machine usage were calculated on a per-hour basis and include charges for interest, depreciation, and operating costs. These are presented in Appendix B.

THE PRODUCTION ENVIRONMENT

As mentioned earlier, taro is produced in a number of wet river valleys and a few "upland" areas in Hawaii, with much of it produced in the four valleys in which interviews were conducted. "Upland" or dryland taro is produced under natural rainfall and irrigated, but not flooded, conditions. The taro in the Hanalei, Keanae, Wailua, and Waipio valleys is produced under flooded, or "wetland," conditions. This study concerns "wetland" taro production, and further reference to taro in this paper will indicate "wetland" taro.

Though cultural practices do differ between and within producing areas, several common categories of cultural practices can be identified. These are: land preparation for planting, preparation of planting material, planting, weeding in the patch, fertilizing, weed control on the dikes, and harvesting. The number of hours devoted to each and the inputs in the performance of these general cultural practices vary widely both among valleys and within valleys. Since all possible variations of location, cultural practices, and inputs cannot practically be considered, five model situations were determined to be "typical" or representative. The criteria for selecting five groups, or models, were: location, level of technology, usage or nonusage and amount of usage of selected production inputs, and size of the patches. Two models were selected for Kauai (Kauai I and II), two for Hawaii (Waïpio I and II), and one for Maui.

Location clearly separated Waipio Valley on Hawaii from Keanae and Wailua on Maui and Hanalei on Kauai. Technology distinguishes one model from another, particularly in models that are located on the same island. For example, the technology level of Kauai Model I includes a hand tiller whereas that of Kauai Model II includes a 30 hp tractor. Waipio Model II includes a hand tiller whereas Waipio Model I includes no mechanical tillage. Waipio Models I and II include four-wheel drive vehicles whereas the other three models all include pickup trucks.

Finally, in terms of size of area cultivated, Maui is quite different from Kauai or Hawaii. Patches on Kauai and Hawaii are roughly the same size, while patches on Maui are considerably smaller.

CULTURAL PRACTICES

Cultural practices and costs involved in the production of wetland taro can be discussed in terms of the following broad categories: land preparation, planting, weed control, fertilization, harvesting, and delivery. Costs of each operation in each model are set out in Table 1.

Table 1. Comparison of costs of producing wetland taro (dollars per acre per crop cycle and percentage)

	Kauai I[a]		Kauai II[b]		Maui[a]		Waipio I[c]		Waipio II[a]	
	($)	(%)	($)	(%)	($)	(%)	($)	(%)	($)	(%)
Land charge	31.25	1.7	31.25	1.6	175.00	4.4	60.00	3.1	60.00	3.4
Land preparation	120.00	6.5	221.52	11.4	440.00	11.1	273.00	14.2	172.50	9.8
Planting	192.00	10.5	192.00	9.9	240.00	6.0	210.00	11.0	210.00	12.0
Weed control	292.64	15.9	292.64	15.1	1,883.58	47.3	367.92	19.2	307.92	17.5
Fertilizer	392.50	21.4	392.50	20.2	447.00	11.2	112.00	5.8	112.00	6.4
Harvesting	600.00	32.6	600.00	31.0	699.00	17.6	399.00	20.8	399.00	22.7
Delivery	25.86	1.4	25.86	1.3	0	0	250.00	13.0	250.00	14.2
Other expenses	183.30	10.0	183.30	9.5	94.65	2.4	246.60	12.9	246.60	14.0
Total costs	1,837.55	100.0	1,939.07	100.0	3,979.23	100.0	1,918.52	100.0	1,758.02	100.0
Labor charges	1,302.00	70.7	1,284.00	66.2	3,095.50	77.8	1,324.50	69.0	1,122.00	63.8
Total costs (excluding labor)	535.55		655.07		883.73		594.02		636.02	

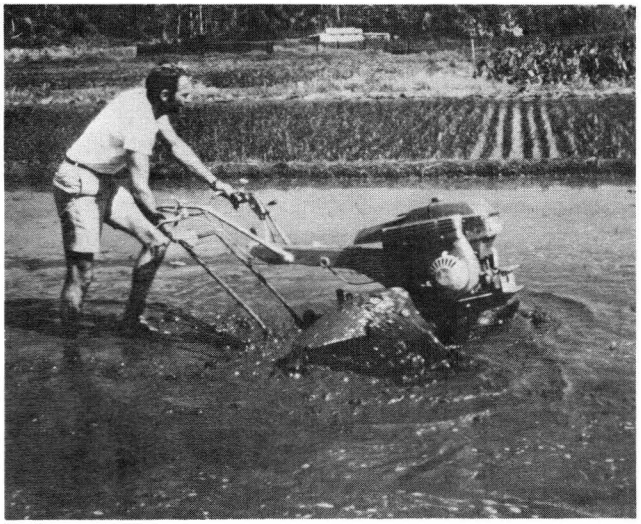
[a] Hand tiller (rotary cultivator).
[b] Riding tractor and equipment.
[c] No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

Detailed figures for the costs and returns on each of the five models are presented in Appendix A.

Land Preparation

Land preparation practices vary considerably among taro growers. In general, farmers on Kauai till their patches three times whether they use a rotary cultivator or a riding tractor. Those who use the tractor require fewer hours. However, they have higher costs for the tillage operation due to higher equipment costs (Table 2). Producers on Maui generally use a rotary cultivator and till three times. In contrast to comparable farmers on Kauai (Kauai I), their land preparation costs are much higher. The major reasons for this difference is that Maui growers report that in addition to tilling, they require 50 hours of labor to hand clean their patches. Waipio Valley growers may or may not till, depending upon the soil conditions. Those who do not till (Waipio I) incur a higher land preparation cost ($273.00 as opposed to $172.50) because of the cost of labor required to hand clean the patches.

Growers on all islands indicate that they level their patches before planting. Land preparation costs range from a low of 6.5 percent to a high of 14.2 percent of total costs. High cost can be attributed to the labor-intensive, no-mechanical-tillage operation.



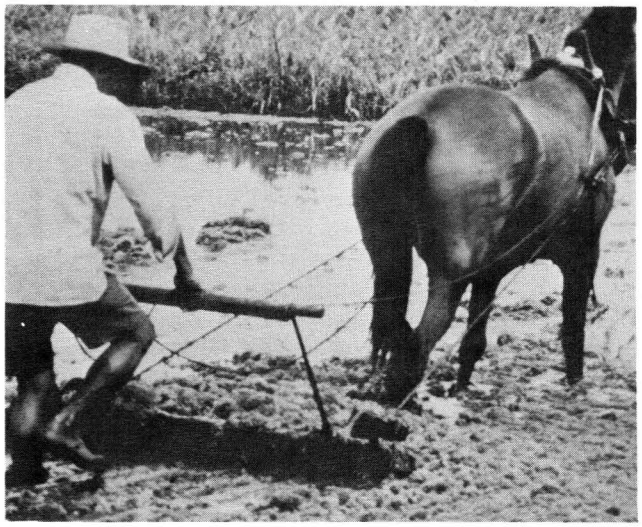


Figure 2. Prior to planting, taro patches are tilled and levelled to minimize weed growth. Tilling turns weeds under, and levelling drags mudpiles below the level of the water, thereby drowning weeds. Mechanization, animal power, and manual methods with the farmer smoothing the surface of the patch using a wooden board, are all used in Hawaii, particularly in the levelling stage. In the photos above, a rotovator is used to turn over the mud (top) and a horse drags a levelling board in an animal-powered operation (bottom).

Table 2. Comparison of land preparation costs

	Land preparation	
	Dollars per acre per crop cycle	Percentage of total costs
Kauai I[a]	120.00	6.5
Kauai II[b]	221.52	11.4
Maui[a]	440.00	11.1
Waipio I[c]	273.00	14.2
Waipio II[a]	172.50	9.8

[a] Hand tiller (rotary cultivator).
[b] Riding tractor and equipment.
[c] No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

Planting

Practices used in preparing planting material—which requires care and benefits from experience—and planting are standard among all producers. Though there are differences in the estimated hours required for this operation, the variations in costs among areas are not as great as with other practices (Table 3). The total labor charge ranges from a low of $192 to a high of $240.

Table 3. Comparison of planting costs

	Planting costs	
	Dollars per acre per crop cycle	Percentage of total costs
Kauai I[a]	192.00	10.5
Kauai II[b]	192.00	9.9
Maui[a]	240.00	6.0
Waipio I[c]	210.00	11.0
Waipio II[a]	210.00	12.0

[a] Hand tiller (rotary cultivator).
[b] Riding tractor and equipment.
[c] No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

Weed Control

Weeding, both in the patch and on the dikes, is done by hand in all five models. Though a chemical herbicide has been cleared for spraying in taro patches, this is not yet in general use. The "typical" number of in-patch weedings required is four per crop cycle in all cases.

There is general consistency in the figures for weed control in all cases except Maui (see Table 4). Weed control costs range between 15.1 and 19.2 percent of total costs. On Maui, cost of weed control jumps to 47.3 percent, and this expense is the biggest single factor causing costs on Maui to be double those of the next highest "typical" group of producers.

Table 4. Comparison of weed control costs

	Weed control costs	
	Dollars per acre per crop cycle	Percentage of total costs
Kauai I[a]	292.64	15.9
Kauai II[b]	292.64	15.1
Maui[a]	1,883.58	47.3
Waipio I[c]	367.92	19.2
Waipio II[a]	307.92	17.5

[a]Hand tiller (rotary cultivator).
[b]Riding tractor and equipment.
[c]No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

Serious concern about weed control is reflected in the responses of Maui taro growers, who list weeds as their most serious problem. The intensity with which weed problems are tackled is borne out by the fact that 35 percent of the time spent on weed control on Maui is devoted to mowing the banks. Weed control on the dikes is accomplished in all models by spraying, but on Maui both spraying and mowing are used.

Figure 3. Weeding is one of the most labor-demanding activities in the production of wetland taro in Hawaii.

Fertilization

Fertilization practices are similar among growers on Maui and Kauai, but different for those in Waipio Valley (Table 5). The "typical" farmer in Waipio applies approximately one-third as much fertilizer as those in other areas. This results in a much lower cost for fertilization in the Waipio models. The low application rate may be a reaction by Waipio growers to severe disease problems affecting their crops.

Table 5. Comparison of fertilizer costs

	Fertilizer costs	
	Dollars per acre per crop cycle	Percentage of total costs
Kauai I[a]	392.50	21.4
Kauai II[b]	392.50	20.2
Maui[a]	447.00	11.2
Waipio I[c]	112.00	5.8
Waipio II[a]	112.00	6.4

[a]Hand tiller (rotary cultivator).
[b]Riding tractor and equipment.
[c]No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

Growers confronted with yields severely reduced by disease may deliberately cut back on fertilizer inputs. On the other hand, the low fertilization rates may contribute to the disease problem and in fact exaggerate the situation. Plants that are not adequately fertilized may be less vigorous and, therefore, more susceptible to disease infestation.

Harvesting

Harvesting, as well as weed control, requires a lot of time and is physically demanding. Harvesting ranges from a low of 17.6 percent of costs on Maui to a high of 32.6 percent in the Kauai model, with an overall average of about 25 percent of total costs (Table 6). The time spent harvesting is dependent on two factors: sacks harvested per hour and yield per acre per crop. On Maui and in the Waipio Valley, growers claim they can harvest an average of one and one-half 80-pound sacks per hour; while on Kauai, farmers assert that two 80-pound sacks are harvested per hour. However, differences in harvesting rates for 80-pound sacks on Maui or Waipio and Kauai may reflect more conservative estimates on the part of Maui and Waipio farmers.

Harvest figures are adjusted to exclude time preparing planting material—making seed as it is called—an operation that takes place at harvest time. Yields reported are 400 and 250 80-pound sacks for Kauai and Maui, respectively, and 200 100-pound sacks for Waipio.

Table 6. Comparison of harvesting costs

	Harvesting costs	
	Dollars per acre per crop cycle	Percentage of total costs
Kauai I[a]	600.00	32.6
Kauai II[b]	600.00	31.0
Maui[a]	699.00	17.6
Waipio I[c]	399.00	20.8
Waipio II[a]	399.00	22.7

[a]Hand tiller (rotary cultivator).
[b]Riding tractor and equipment.
[c]No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

Disease can seriously affect yield, time spent harvesting, and total return. During our survey, the disease situation was serious in Waipio. Losses of 50 percent of normal yield were common, and in some instances farmers did not harvest entire patches because of extensive disease damage. Disease also was reported by farmers in other areas, and it usually reduced yields by approximately 10 percent. However, there were instances where losses in areas other than Waipio were as high as 50 percent. In general, it was reported that disease was a much more serious problem in summer than in winter.

Figure 4. On Kauai, labor during harvesting accounts for approximately 50 percent of the 355–380 hours needed to take a crop from the stage of field preparation to the stage of being ready to be trucked to the miller. On Maui, harvesting accounts for 175–200 hours, or roughly 19 percent of the total labor used. The physical demands of this operation are very much in evidence.

Though a long steel or wooden pole may be used to lever the corm from the mud, the pulling, rough cleaning, and trimming are all carried out by hand. On Kauai, in particular, the taro is loaded onto a "boat" or flat-bottom wooden container and hauled to the bank for bagging.

Delivery

The methods of delivery vary greatly among the areas. Maui growers have their taro collected at the farm gate at no charge, while growers in Waipio haul their own bags out of the valley. Delivery costs are minor except for the Waipio taro farmers, where delivery accounts for approximately 14 percent of total costs (Table 7). In Waipio, taro has to be hauled out of the valley up a steep road where use of a four-wheel drive vehicle is mandatory by law. To compensate for transportation problems, farmers in Waipio are paid $1.25 extra per 100-pound sack.

Table 7. Comparison of delivery costs

	Delivery costs	
	Dollars per acre per crop cycle	Percentage of total cost
Kauai I[a]	25.86	1.4
Kauai II[b]	25.86	1.3
Maui[a]	0	0
Waipio I[c]	250.00	13.0
Waipio II[a]	250.00	14.2

[a]Hand tiller (rotary cultivator).
[b]Riding tractor and equipment.
[c]No tillage.
Source: Appendix Tables A-1, A-2, A-3, A-4, and A-5.

RETURNS

The gross returns generated by a productive enterprise are dependent upon two factors: quantity, and price of the output. In the case of taro, the price is approximately the same for all farmers. Therefore, the differences in the figures that appear in the first row of Table 8 are primarily the result of variations in yields. For example, the gross returns (per acre per crop cycle) for the two Waipio Valley models are much lower than for the others. This is because the Waipio growers were experiencing severe disease problems in 1976 when the survey was conducted. Farmers indicated that losses from diseases ranged up to 75 percent or more with an average loss of approximately 50 percent.

The importance of labor in the production of wetland taro can be seen in Table 8. If all costs except labor charges and interest on working capital are deducted from the gross returns, the remaining returns range from approximately $2,000 to over $3,000 per acre (line 3 of Table 8). These figures can be viewed as returns to labor, management, and working capital. However, if specific charges of $5.50 and $3.00 per hour are made for labor (calculated on the basis of using and not using machines, respectively), the residual figure then varies from a low of about $−600 to a high of more than $2,000 per acre. These figures are given in line 5 of Table 8. This residual can then be interpreted as a

Table 8. Returns from wetland taro (dollars per acre per crop cycle)

	Kauai I	Kauai II	Maui	Waipio I	Waipio II
1. Gross returns	$3,840.00	$3,840.00	$3,360.00	$2,650.00	$2,650.00
2. Minus costs (excluding labor charge)	535.55	655.07	883.73	594.02	636.02
3.	$3,304.45	$3,184.93	$2,476.27	$2,055.98	$2,013.98
4. Minus labor charge	1,302.00	1,284.00	3,095.50	1,324.50	1,122.00
5. Residual[a]	$2,002.45	$1,900.93	$-619.23	$ 731.48	$ 891.98

[a] The residual is the return to management and working capital. Working capital is that money that is "tied up" in inputs, such as fertilizer and weed spray, during the crop cycle. The return to working capital is approximately $125 per acre per crop cycle. This figure was calculated by assuming that the producer has one-half of $2,000 tied up for 15 months with an interest charge of 10 percent per year.

return to management and working capital.

The high labor charges shown in line 4 of Table 8 arise because labor accounts for a high proportion of the total inputs necessary for wetland taro production. The high labor cost may be partially influenced by the fact that in some areas farmers are predominantly part-time growers and may not consider the opportunity cost of their labor. (The notable exception to this is Kauai, where the majortiy of the producers interviewed were full-time growers.)

In essence high labor inputs probably simply reflect the fact that taro demands constant and regular attention—particularly in the case of weeding—in the course of its life cycle. The labor charges involved in growing taro range from a low of 66 percent of all costs in the Kauai II model to more than 77 percent in the Maui model (see Table 1). These differences in labor utilization are partly due to diverse cultural practices and partly due to the fact that the same operation takes longer in some instances.

SUMMARY

Wetland taro production is labor intensive. Whether or not farmers put a charge on their own or family labor, the reality is that if labor had to be paid, not less than 66 percent of total costs would be accounted for by labor. The major labor-consuming operations are weeding and harvesting. At the present time farmers do not use herbicides in controlling weeds within the patch, so weeds must be pulled by hand. In the first 6 months, various weeds can compete quite successfully with young taro. So until the broad taro leaves shade out the weeds, farmers have to work assiduously to keep ahead of weeds, which can quite easily get out of control. Harvesting during the pulling, trimming, and sacking phases is all done by hand. Skill and experience can no doubt speed up harvesting, but disease and small taro corms add hours to the harvesting operation. Though note has been made of the seriousness of disease in Waipio and the resulting loss of revenue, one of the farmers in Kauai mentioned that it took 8, and not 4, hours to harvest eight 80-pound bags because of bad "guava seed" (an internal hard rot of the corm) in the taro.

The "typical" Maui grower appears to use much more labor than "typical" growers in other areas. Maui producers indicate that weeding charges comprise almost half of their total costs; this is supported by two observations. First, their patches and dikes are remarkably clean; and second, they consistently list weeds as their major production problem.

Variable inputs for operations other than weeding are similar for Kauai and Maui growers, except that Maui growers generally indicate that their labor inputs are greater for each operation. Whether this is because the acreage each farmer has in taro production is smaller (patches are about one-fourth in size those of other areas), because the majority of producers are part-time, or whether other factors are involved is a question for further investigation. The usual acreage used for taro production on Maui is 3 acres, less than half as much as other areas. Patches on Maui are typically a tenth of an acre, while those on Kauai are approximately half an acre, and those in Waipio are just over one-third of an acre. Though it may not directly affect the actual hours spent weeding or preparing the patches, farmers on Maui, in general, live closer to their taro patches than those on Kauai. This contrasts with Waipio, where the bulk of growers live several miles from their patches and drive four-wheel drive vehicles in and out of the valley.

Although labor demands of taro production are high and there are other negative factors associated with taro farming (e.g., the physical discomfort of working the mud, the serious problems associated with root rot, and too much or too little water), at least half a dozen well-educated sons of taro planters, as well as some Caucasian newcomers, have returned to or begun taro farming in recent years.

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APPENDIX TABLES

Table A-1. Kauai I: Costs and returns per acre per crop cycle for typical taro producer using a hand tiller[a]

	Inputs	Value per unit	Labor charge	Other costs	Total costs
	(Units)	*($)*	*($)*	*($)*	*($)*
Land charge	1 acre	31.25		31.25	31.25
Land preparation					
Till (3 times) (hand tiller)	12 hr	3.00		36.00	
(labor)	12 hr	5.50	66.00		
Level (labor)	6 hr	3.00	18.00		120.00
Planting					
Prepare material (labor)	40 hr	3.00	120.00		
Plant (labor)	24 hr	3.00	72.00		192.00
Weed control					
In patch (4 times) (labor)	80 hr	3.00	240.00		
On dikes (spray 7 times)					
Material–Dalapon	14 lb	2.10		29.40	
Equipment–knapsack sprayer	7 hr	.32		2.24	
Labor	7 hr	3.00	21.00		292.64
Fertilizer (3 times)					
Material–16-16-16	1000 lb	250.00/T		125.00	
–7-30-20	1000 lb	280.00/T		140.00	
–10-20-20	1000 lb	255.00/T		127.50	
Labor	15 hr	3.00	45.00		392.50
Harvesting (2 bags/hr)					
Labor	200 hr	3.00	600.00		600.00
Delivery to agent					
Pickup truck	2 hr	7.43		14.86	
Labor	2 hr	5.50	11.00		25.86
Other expenses					
Miscellaneous transportation					
Pickup truck	10 hr	7.43		74.30	
Labor	10 hr	5.50	55.00		
Maintain ditches (labor)	18 hr	3.00	54.00		183.30
Total costs					$1,837.55
Returns/Yield: 400 (80-pound bags) @ $9.60					$3,840.00

[a]The typical producer in this model farms 8 acres and takes 15 months to raise a crop. Equipment: hand tiller (6 hp), knapsack sprayer, pickup truck (¼-ton), miscellaneous (hoes, machetes, sickles).

Table A-2. Kauai II: Costs and returns per acre per crop cycle for typical taro producer using a tractor[a]

	Inputs	Value per unit	Labor charge	Other costs	Total costs
	(Units)	*($)*	*($)*	*($)*	*($)*
Land charge	1 acre	31.25		31.25	31.25
Land preparation					
Till (3 times) (tractor)	8 hr	11.96		95.68	
(disc)	8 hr	1.50		12.00	
(labor)	8 hr	5.50	44.00		
Level (tractor)	4 hr	9.74		38.96	
(labor)	4 hr	5.50	22.00		221.52
Planting					
Prepare material (labor)	40 hr	3.00	120.00		
Plant (labor)	24 hr	3.00	72.00		192.00
Weed control					
In patch (4 times) (labor)	80 hr	3.00	240.00		
On dikes (spray 7 times)					
Material–Dalapon	14 lb	2.10		29.40	
Equipment–knapsack sprayer	7 hr	.32		2.24	
Labor	7 hr	3.00	21.00		292.64
Fertilizer (3 times)					
Material–16-16-16	1000 lb	250.00/T		125.00	
–7-30-20	1000 lb	280.00/T		140.00	
–20-20-20	1000 lb	255.00/T		127.50	
Labor	15 hr	3.00	45.00		392.50
Harvesting (2 bags/hr)					
Labor	200 hr	3.00	600.00		600.00
Delivery to agent					
Pickup truck	2 hr	7.43		14.86	
Labor	2 hr	5.50	11.00		25.86
Other expenses					
Miscellaneous transportation					
Pickup truck	10 hr	7.43		74.30	
Labor	10 hr	5.50	55.00		
Maintain ditches (labor)	18 hr	3.00	54.00		183.30
Total costs					$1,939.07
Returns/yield: 400 (80-pound bags) @ $9.60					$3,840.00

[a]The typical producer in this model farms 8 acres and takes 15 months to raise a crop. Equipment: tractor (30 hp), disc, pickup truck (¼-ton), miscellaneous (hoes, machetes, sickles).

Table A-3. Maui: Costs and returns per acre per crop cycle for typical taro producer[a]

	Inputs	Value per unit	Labor charge	Other costs	Total costs
	(Units)	*($)*	*($)*	*($)*	*($)*
Land charge	1 acre	175.00		175.00	175.00
Land preparation					
Till (3 times) (hand tiller)	20 hrs	5.25		105.00	
(labor)	20 hrs	5.50	110.00		
Cleaning (labor)	50 hrs	3.00	150.00		
Leveling (labor)	25 hrs	3.00	75.00		440.00
Planting					
Prepare materials (labor)	50 hr	3.00	150.00		
Plant (labor)	30 hr	3.00	90.00		240.00
Weed control					
In patch (4 times) (labor)	320 hr	3.00	960.00		
On dikes (spray 14 times)					
Material–Paraquat	3.5 gal	40.00		140.00	
Equipment–knapsack sprayer (hand)	42 hr	.21		8.82	
Labor	42 hr	3.00	126.00		
Mow (28 times)					
Equipment–lawn mower	196 hr	.31		60.76	
Labor	196 hr	3.00	588.00		1,883.58
Fertilizer (3 times)					
Material–10-20-20	2800 lb	255.00/T		357.00	
Labor	30 hr	3.00	90.00		447.00
Harvesting (1.5 bags/hr)					
Labor	233 hr	3.00	699.00		699.00
Delivery (collected at farm gate)					
Other expenses					
Miscellaneous transportation					
Pickup truck	5 hr	7.43		37.15	
Labor	5 hr	5.50	27.50		
Maintain ditches (labor)	10 hr	3.00	30.00		94.65
Total costs					$3,979.23
Returns/yield: 350 (80-pound bags) @ $9.60					$3,360.00

[a] The typical producer in this model farms 3 acres and takes 15 months to raise a crop. Equipment: hand tiller (6 hp), pickup truck (¼-ton), lawn mower, knapsack sprayer, wheelbarrow, miscellaneous (hoes, machetes, sickles).

Table A-4. Waipio Valley I: Costs and returns per acre per crop cycle for typical taro producer doing no tillage[a]

	Inputs	Value per Unit	Labor charge	Other costs	Total costs
	(Units)	*($)*	*($)*	*($)*	*($)*
Land charge	1 acre	60.00		60.00	60.00
Land preparation					
Cleaning (labor)	75 hr	3.00	225.00		
Level (labor)	16 hr	3.00	48.00		273.00
Planting					
Prepare material (labor)	50 hr	3.00	150.00		
Plant (labor)	20 hr	3.00	60.00		210.00
Weed control					
In patch (4 times) (labor)	100 hr	3.00	300.00		
On dikes (spray 6 times)					
Material–Paraquat	1.2 gal	40.00		48.00	
Equipment–knapsack sprayer	6 hr	.32		1.92	
Labor	6 hr	3.00	18.00		367.92
Fertilizer (1 time)					
Material–16-16-16	800 lb	250.00/T		100.00	
Labor	4 hr	3.00	12.00		112.00
Harvesting (1.5 bags/hr)					
Labor	133 hr	3.00	399.00		399.00
Delivery	200 bag	1.25		250.00	250.00
Other expenses					
Miscellaneous transportation					
Four-wheel drive vehicle	15 hr	8.94		134.10	
Labor	15 hr	5.50	82.50		
Maintain ditches (labor)	10 hr	3.00	30.00		246.60
Total costs					$1,918.52
Returns/yield: 200 (100-pound bags) @ $13.25					$2,650.00

[a]The typical producer in this model farms 8 acres and takes 15 months to raise a crop. Equipment: four-wheel drive vehicle, knapsack sprayer, miscellaneous (hoes, machetes, sickles).

Table A-5. Waipio Valley II: Costs and returns per acre per crop cycle for typical taro producer using a hand tiller[a]

	Inputs	Value per unit	Labor charge	Other costs	Total costs
	(Units)	*($)*	*($)*	*($)*	*($)*
Land charge	1 acre	60.00		60.00	60.00
Land preparation					
Till (2 times) (hand tiller)	14 hr	3.00		42.00	
(labor)	14 hr	5.50	82.50		
Level (labor)	16 hr	3.00	48.00		172.50
Planting					
Prepare material (labor)	50 hr	3.00	150.00		
Plant (labor)	20 hr	3.00	60.00		210.00
Weed control					
In patch (4 times) (labor)	80 hr	3.00	240.00		
On dikes (spray 6 times)					
Material–Paraquat	1.2 gal	40.00		48.00	
Equipment–knapsack sprayer	6 hr	.32		1.92	
Labor	6 hr	3.00	18.00		307.92
Fertilizer (1 time)					
Material–16-16-16	800 lb	250.00/T		100.00	
Labor	4 hr	3.00	12.00		112.00
Harvesting (1.5 bags/hr)					
Labor	133 hr	3.00	399.00		399.00
Delivery	200 bags	1.25		250.00	250.00
Other expenses					
Miscellaneous transportation					
Four-wheel drive vehicle	15 hr	8.94		134.10	
Labor	15 hr	5.50	82.50		
Maintain ditches (labor)	10 hr	3.00	30.00		246.60
Total costs					$1,758.02
Returns/yield: 200 (100-pound bags) @ $13.25					$2,650.00

[a]The typical producer in this model farms 8 acres and takes 15 months to raise a crop. Equipment: hand tiller (6 hp), four-wheel drive vehicle, knapsack sprayer, miscellaneous (hoes, machetes, sickles).

Table B. Charges for using machinery

	Purchase price	Annual use	Annual ownership costs (interest and depreciation)[a]	Annual operating costs[b]			Total costs	
				Repairs and maintenance	Fuel	Lubrication	Annual	Hourly
	($)	*(hr)*	*($/yr)*	*($/yr)*	*($/yr)*	*($/yr)*	*($/yr)*	*($/yr)*
Tractor (30 hp)	9,000	100	971.00	150.00	65.70	9.86	1,196.56	11.96
Disc	600	60	61.00	28.80	0	0	89.80	1.50
Hand tiller (6 hp)	2,500	50	225.00	21.00	14.40	2.16	262.56	5.25
	2,500	100	225.00	42.00	28.80	4.32	300.12	3.00
Knapsack sprayer	80	45	9.62	5.00	0	0	14.62	.32
	80	100	12.21	8.33	0	0	20.52	.21
Lawn mower	120	470	34.00	36.00	67.70	10.15	147.85	.31
Pickup truck[c]	4,000	15	40.00	30.00	36.00	5.40	111.40	7.43
	4,000	100	267.00	200.00	240.00	36.00	743.00	7.43
		(300)	(800.00)					
Vehicle (four-wheel drive)[c]	6,000	100	418.00	200.00	240.00	36.00	894.00	8.94
		(300)	(800.00)					

[a] Annual ownership costs = $[P(1 + R)^M - S]/[(1 + R)^M - 1)/R]$; where P, R, S, and M are purchase price, interest rate, salvage value, and life in years, respectively.

[b] Repairs = (purchase price) X (percentage total repairs in wear-out life)/(expected life).

Fuel = 0.06 X (PTO hp max) X (price of fuel) X K X (annual use in hours); where K = 1 for gasoline.
= 0.73 for diesel

Lubrication = 0.15 X (annual fuel cost).

[c] It was assumed that the pickup truck and four-wheel drive vehicle would be used for a total of 300 hr per year although the use for taro production was less. Ownership costs are prorated to reflect this.

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