Cooperative Extension Service
C/T/A/H/R
College of Tropical Agriculture & Human Resources
University of Hawaii at Manoa

Soil and Crop Management
July 2001
SCM-3

Impacts of Organic Inputs on Taro Production and Returns

Susan C. Miyasaka[1], James R. Hollyer[2], and Linda J. Cox[3]

[1]*Department of Tropical Plant and Soil Sciences,* [2]*Agricultural Development in the American Pacific Project,* [3]*Department of Natural Resources and Environmental Management*

Interest in less use of agricultural chemicals in crop production—and in use of alternatives to them—is growing. These alternative production methods are often referred to as "sustainable agriculture." In supporting nonchemical or low-chemical approaches, consumers may state a preference for foods grown with organic inputs, while environmentalists point out that pesticides and inorganic fertilizers can have harmful, long-term effects on ecosystems. In response to these conditions, agricultural producers may believe that organic inputs have potential, but they want more detailed cost-benefit information before changing their production practices.

A field experiment was conducted (by author S.C.M.) to evaluate organic inputs in taro production. Due to loss of the land lease, the experiment had to be concluded after only two crops. Therefore, some questions on the best nonchemical practices for taro production remain unanswered. The experiment did, however, reveal some aspects of switching to organic inputs that should be considered by consumers, environmentalists, and growers who are interested in the use of organic inputs in agriculture.

The field experiment

In addition to assessing the effects of organic inputs on taro yield and crop quality, another purpose of the experiment was to see if organic inputs resulted in any control of corm rot. The generally standard practices of dryland taro production in Hawaii result in taro yield losses due to corm rot estimated to range from 25 to 36 percent. A single application of the fungicide metalaxyl near planting time is the only approved agrichemical way to control corm rot, but this method is undesirable to those who wish to reduce chemical inputs. Another goal of the experiment was to control weeds by applying mulch rather than herbicide.

Taro (*Colocasia esculenta*) variety 'Bun Long' was grown twice in rainfed, upland conditions in 1996–98 using six treatments. None of the treatments used fungicide to control corm rot. Two treatments used the standard practices of applying inorganic fertilizer and preemergence herbicide; of these, one was supplemented with additional soil amendments. Four treatments used chicken manure as fertilizer and mulch for weed control; of these, one added compost, while another included soil solarization, intended to kill or weaken soil pathogens sensitive to heat. More details of the treatments are given in Table 1.

The experiment was conducted at Onomea on the Hamakua Coast of Hawaii island at about 300 feet elevation in the Hilo silty clay loam soil. Before planting, the site was plowed and lime was tilled in (2.7 tons/acre calcium-carbonate equivalent; 80% crushed coral and 20% dolomite). Treble superphosphate was banded in lines at 600 lb/acre to prevent production differences due to phosphorus deficiency.

The taro was grown from *huli* having 0.2 inches of upper corm and 12 inches of lower petiole. All plots received a total of 600 lb/acre nitrogen (N) as either inorganic fertilizer or dried chicken manure. In the inorganic fertilizer plots, N was broadcast at planting and once monthly for 5 months using a commercial fertilizer blend (23-0-36). In the manure plots, dried chicken manure (4-4-2) was applied once after planting, except for the solarized treatment, where the manure was added before planting.

In the supplemented inorganic fertilizer treatment, calcium and alfalfa meal were banded near the planting rows and tilled in. In the supplemented manure treatment, commercial macadamia nut compost was tilled in before planting each crop.

In the pre-planting soil solarization treatment, dried chicken manure was tilled in to increase heat generation, and the plots were covered with clear plastic. After solarization, the plastic was removed, and the plots were

Published by the College of Tropical Agriculture and Human Resources (CTAHR) and issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Andrew G. Hashimoto, Director/Dean, Cooperative Extension Service/CTAHR, University of Hawaii at Manoa, Honolulu, Hawaii 96822. An Equal Opportunity / Affirmative Action Institution providing programs and services to the people of Hawaii without regard to race, sex, age, religion, color, national origin, ancestry, disability, marital status, arrest and court record, sexual orientation, or veteran status. CTAHR publications can be found on the Web site <http://www2.ctahr.hawaii.edu> or ordered by calling 808-956-7046 or sending e-mail to ctahrpub@hawaii.edu.

tilled before planting.

For weed control, inorganic plots had herbicide applied before planting, while mulched treatments had either silage mulch or wood mulch applied after planting.

Agronomic results

The major difference in taro yield was between mulched and non-mulched (bare-soil) plots. Weed control was adequate in all treatments, but fresh corm yield and the percentage of corm dry matter were significantly greater due to mulch effects.

Soil samples taken after each harvest indicated that soil organic carbon, total N, and exchangeable calcium and magnesium were greater in mulched plots. Plant nutrient concentrations were within the recommended range in all treatments, but mulching increased leaf concentrations of magnesium and boron.

The second year was drier than the first, and several months of inadequate rainfall during the time of greatest water need resulted in lower yield and percentage corm dry matter. The greater effect of mulch on improving taro yield and quality during the second, drier year indicated that mulch reduced soil moisture loss and increased plant water uptake. While most experiments in arid and semiarid regions show that mulching increases soil moisture and plant growth, our experiment revealed that mulching can also increase plant growth in a humid, subtropical region, and it suggested that taro yield is sensitive to short periods of dry weather.

In the first, wetter year, corm rots affected 21 percent of corms in mulched plots compared to 8.2 percent in bare-soil plots. Mulch may have increased surface soil moisture and conditions favorable to disease development, but despite increased corm losses due to disease, mulching still increased net yield. Soil solarization did not increase soil temperature sufficiently to affect most soil fungi or result in any noticeable effect on the incidence of corm rot.

Economic results

Growers who want to produce taro commercially must get a price for their taro that is high enough to pay for all the inputs. We used "partial budgeting" to determine the cost of each of the production practices that were field-tested. Only costs that changed among treatments were included. The labor cost used was $10.52 per hour, and the marketable yield used was the average yield of both years' crops for each treatment. The price used was $0.53 per pound, which was the average farmgate price for 'Bun Long' corm in 1998.

While all the organic input treatments increased yield relative to the control treatment (see Table 1), the returns from these increases did not cover the increases in cost. Getting an input at a lower cost or using less of the input could reduce the total input cost. At the same time, selling the taro grown using organic inputs at a higher price could increase the net return.

A reduction of 50–75 percent in the cost of inputs would be necessary before net returns of the treatments tested would exceed that of the control. For example, macadamia nut compost, the most costly organic input, can be purchased at a lower, bulk rate to reduce its cost by 27 percent, but the net return would still be negative. Or, if the farm price of taro rises to between $0.79 and $2.37, an increase of 49–347 percent over the average price for 1998, the net returns of the other treatments would exceed that of the control. Research in Nigeria and the Philippines also found that the cost of organic inputs in the situations studied was not covered by increased returns.

Conclusions

We found that organic soil amendments increased taro yield. But due to the high cost of those organic inputs, the increased yield did not result in larger profits but in losses. Long-term benefits, including reduced soil erosion and improved soil structure, are possible with the continued use of mulches and compost. Unfortunately, this experiment could not be continued to measure long-term benefits.

Producers who wish to substitute organic inputs for inorganic ones will likely have to decrease input costs by looking to economies of scale, mechanization, and changes in field practices. Also, labor costs could be reduced to less than the $10.52 per hour used here if producer or family labor could be used. A long-term commitment to alternative production practices such as those we tested is needed in order to make a transition from the present standard dryland taro production practices. "Organic" certification, for example, requires at least 7 years of no chemical use.

Assuming that using organic inputs results in a better, more sustainable use of agricultural lands, consumers could support improved sustainability by paying

Table 1. Inputs and costs, average marketable yield, gross crop value, and net return for dryland taro production alternatives.

Treatment	Labor	Subtotal	Total cost	Market yield[A]	Crop value[B]	Net return
	hours/acre	$/acre	$/acre	lb/acre	$/acre	$/acre
Inorganic (control)			$ 1,471	4,965	$ 2,631	**$ 1,160**
A-1 fertilizer		$ 479				
Labor to broadcast fertilizer	39	$ 410				
Goal® (oxyfluorfen) herbicide[C]		$ 35				
Labor to apply herbicide	52	$ 547				
Inorganic, plus amendments[D]			$ 3,040	5,891	$ 3,122	**$ 82**
"A-1" fertilizer (23-0-36)		$ 479				
Labor to broadcast fertilizer	39	$ 410				
Calcium and alfalfa pellets		$ 1022				
Labor to spread pellets	52	$ 547				
Goal® (oxyfluorfen) herbicide	35					
Labor to apply herbicide	52	$ 547				
Manure[E]**, wood-chip mulch**[F]			$ 11,772	7,966	$ 4,222	**–$ 7,550**
Chicken manure		$ 2,797				
Labor to broadcast manure	157	$ 1,652				
Wood-chip mulch		$ 2,351				
Labor to aerate mulch	1.6	$ 17				
Labor to spread mulch	471	$ 4,955				
Manure, silage mulch			$ 8,552	7,644	$ 4,051	**–$ 4501**
Chicken manure		$ 2,797				
Labor to broadcast manure	157	$ 1,652				
Silage mulch		$ 1,536				
Labor to spread silage mulch	244	$ 2,567				
Manure, silage mulch, compost[G]			$ 17,435	8,021	$ 4,251	**–$ 13,184**
Chicken manure		$ 2,797				
Labor to broadcast manure	157	$ 1,652				
Silage mulch		$ 1,536				
Labor to spread mulch	244	$ 2,567				
Macadamia-husk compost		$ 3,928				
Labor to incorporate compost	471	$ 4,955				
Manure, solarization, silage mulch			$ 11,763	7,982	$ 4,230	**–$ 7,533**
Chicken manure		$ 2,797				
Labor to broadcast manure	157	$ 1,652				
Silage mulch		$ 1,536				
Labor to spread mulch	244	$ 2,567				
Plastic mulch		$ 3,074				
Labor to spread plastic	13	$ 137				

[A]Fresh weight corm yield at 11 months after planting; average of two crops.
[B]Calculated based on average farmgate price of $0.53 per pound for 'Bun Long' taro corm.
[C]Oxyfluorfen sprayed on the soil after planting at 0.5 lb/acre active ingredient.
[D]Supplemental 0.1 oz calcium and 0.16 oz alfalfa meal per pound of soil, banded near the planting row and tilled in.
[E]Dried chicken manure sold commercially in bags tilled in before each crop at 26 and 39 days, respectively, before planting.
[F]Wood-chip mulch at 22.3 and 8.8 tons/acre; silage mulch applied at 8.9 and 12.7 tons/acre to the two crops, respectively. Silage mulch was purchased and wood mulch was prepared on-site by adding dried chicken manure to wood chips in a ratio of about 1:70 three months before planting and turned weekly.
[G]Macadamia-husk compost tilled in at 80.3 and 58 tons/acre for the two crops, respectively.

higher retail prices. This type of market development is also a long-term commitment. Consumers will need to become educated about the justifications for the high-cost inputs needed, at least initially, for these types of production systems. This education may take resources that agricultural producers find hard to provide. For example, consumers may want to meet the farmer and learn exactly how the crop was grown, which might take too much of the producer's time to be cost-effective.

Environmental stewardship is an investment that requires a long-term commitment from both consumers and producers. Consumers in Hawaii may feel they cannot afford higher prices for foods grown with organic inputs, although education may make them more willing to pay somewhat higher prices. Producers, to ensure profitability, must be committed to their operation for several years in order to realize the expected benefits of using organic inputs. But some producers may find long-term land leases hard to obtain. In addition, they may not be able to endure short-term losses due to high input costs as they work to lower costs and develop markets that bring higher prices. An investment in environmental stewardship may not fit into the lifestyle of everyone, although as federal regulations increase, these investments in the environment by agricultural producers may not be voluntary. Possibly, subsidies to ensure that producers can withstand the short-term losses could be initially provided to producers willing to make a long-term commitment to organic or low-chemical production.

More detailed information about the agronomic research, in the form of an article from the agricultural journal *Field Crops Research,* can be obtained by contacting the first author. For contact information, call CTAHR or visit our Web site at <http://www2.ctahr.hawaii.edu>. Further information on taro production can be found in CTAHR's *Taro, mauka to makai; a taro production and business guide for Hawaii growers* (1997, 108 pp.).