AN ECONOMIC ANALYSIS OF HEAD CABBAGE AND DRY ONION PRODUCTION IN THE STATE OF HAWAII

William L. Collier and Jack R. Davidson

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AN ECONOMIC ANALYSIS OF HEAD CABBAGE AND DRY ONION PRODUCTION IN THE STATE OF HAWAII

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INTRODUCTION

About 86 percent of the head cabbage produced in the State of Hawaii is grown in Kula, Maui, and 13 percent on Hawaii. The Island of Hawaii's production is primarily located in the Waimea (Kamuela) area with small additional acreages in Volcano and other scattered areas. Small acreages on Oahu and Kauai account for the remainder.[1]

In Kula the head cabbage growers plant small acreages of dry onions as a speculative crop. This is their main alternative crop enterprise at present. This is why dry onions have been included in this study which is primarily concerned with head cabbage.

Approximately 83 percent of the state's production of dry onions is grown in the Kula and the Omaopio (Lower Kula) areas on Maui. Hawaii produces about 3 percent and the remaining commercial production is located on Oahu.[2]

During 1965 and 1966 detailed physical and economic information on head cabbage and dry onion operations was obtained by interviewing the individual farm operators. This was part of a general survey of production practices and costs for vegetable operations in Hawaii.

A total of 18 head cabbage growers in the Kula area were interviewed in the summer of 1966. They grew about 85 percent of the head cabbage acreage in Kula at the time of the survey. Eleven growers were interviewed on Hawaii during the summer of 1965. They grew about 53 percent of the head cabbage acreage in Waimea (Kamuela) and 73 percent of the acreage on the rest of the island.

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[1] Statistics of Hawaiian Agriculture, 1965, Hawaii Crop and Livestock Reporting Service, pp. 18-27.

[2] Ibid., pp. 18-27.

Figure 1. View of a head cabbage farm in Kula, Maui, showing the various fields, some just plowed, some with head cabbage at different stages of growth, and some already harvested.

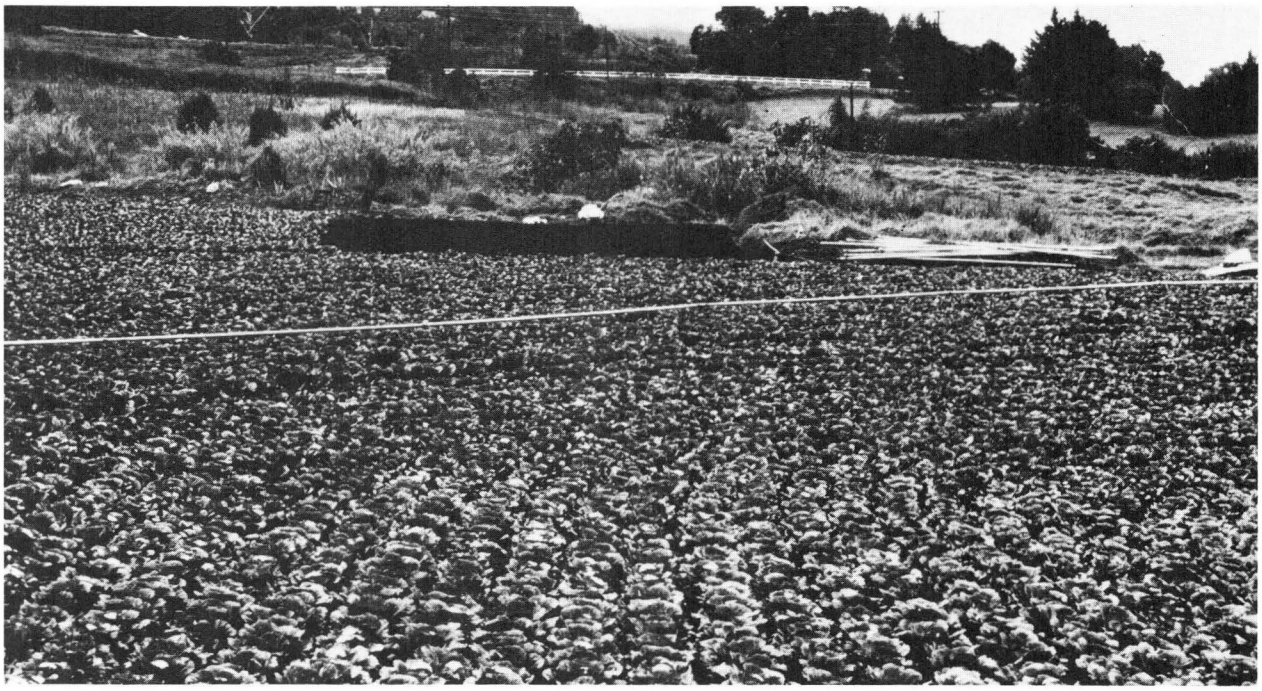

Figure 2. A single field of head cabbage in Kula, Maui.

Table 1. Size distribution of head cabbage growers by acreage per year, Kula, Waimea (Kamuela), Volcano, and Others on Hawaii, Hawaii vegetable crop survey, 1965 and 1966[a]

	0.0 to 3.9 ac/yr	4.0 to 9.9 ac/yr	10.0 to 14.9 ac/yr	15.0 to 24.9 ac/yr	25.0 to 34.9 ac/yr	35.0 to 44.9 ac/yr
Kula, Maui:						
No. of growers[b]	1	6	5	5	4	3
Average ac/yr of h. cab.	3.0	7.0	12.0	17.0	26.0	41.0
Average ac/yr of all veg.	9.0	9.0	14.0	18.0	28.0	42.0
Waimea (Kamuela), Hawaii:						
No. of growers[c]	2	5	1	0	0	0
Average ac/yr of h. cab.	2.0	8.0	13.0	-	-	-
Average ac/yr of all veg.	52.0	41.0	31.0	-	-	-
Volcano, Hawaii:						
No. of growers[d]	2	1	1	0	0	0
Average ac/yr of h. cab.	1.0	8.0	12.0	-	-	-
Average ac/yr of all veg.	22.0	44.0	31.0	-	-	-
Others on Hawaii[e]:						
No. of growers[f]	6	1	0	0	0	0
Average ac/yr of h. cab.	2.0	7.0	-	-	-	-
Average ac/yr of all veg.	10.0	11.0	-	-	-	-

[a] Source: Hawaii vegetable crop survey, 1965 and 1966; and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Six of these 24 farmers were not interviewed; one in the 0.0 to 3.9 group, three in the 4.0 to 9.9 group, one in the 10.0 to 14.9 group, and one in the 25.0 to 34.9 group.

[c] Three of these eight farmers were not available for interviews; two were in the 4.0 to 9.9 group and one in the 10.0 to 14.9 group.

[d] Only one of these five growers was interviewed about head cabbage. He was in the 4.0 to 9.9 size classification.

[e] Others on Hawaii include farmers located in Honokaa, Keeau, Mt. View, and Pepeekeo, Hawaii.

[f] Two of these seven farmers were not interviewed; both were in the 0.0 to 3.9 group.

The survey on Maui also included 12 producers who grew approximately 42 percent of the island's dry onion acreage. One dry onion grower in Kona was interviewed. He was the only commercial dry onion producer on Hawaii at the time of the survey.

The following report examines costs of production and the production practices used for these crops. The survey findings are the primary source of data. These findings have been checked against and supplemented with information from the published research and the experience of University of Hawaii personnel of the Hawaii Agricultural Experiment Station and the Hawaii Cooperative Extension Service.

CHARACTERISTICS OF THE HEAD CABBAGE AND DRY ONION PRODUCTION AREAS

All three of the main producing areas covered in this report (Kula, Waimea, and Volcano) are situated on the slopes of mountains. Kula and Waimea (Kamuela) are at 3,000 feet, and Volcano is at approximately 4,000 feet. Average rainfall over a three-year period was between 30 and 45 inches per year for Kula, 30.5 inches per year for Waimea (Kamuela), and 112 inches per year for Volcano. The average temperatures over this same time span were 64.2° F. in Kula, 64.2° F. in Waimea (Kamuela), and 60.4° F. in Volcano.[3]

Size Distribution

Table 1 gives the distribution of the growers of head cabbage in each area by size of operation in acres per year. A complete description of the growers' other crops and acreages is presented in Appendix A. The tables show that Kula has rather large head cabbage farms, while Hawaii has relatively small ones. Also, Kula head cabbage farmers tend to specialize in this crop except to grow relatively small acreages of dry onions and other miscellaneous crops, while the growers on Hawaii produce a wide variety of crops, and head cabbage is usually not the predominant one. The Waimea (Kamuela) farmers growing head cabbage diversify even more than those in Volcano or the other areas on Hawaii. The average acreages of head cabbage per year are about the same for Volcano and Waimea (Kamuela) but tend to be smaller for the other localities.

Table 2. Size distribution of dry onion growers by acreage per year in Kula and Omaopio (Lower Kula), Maui, Hawaii vegetable crop survey, 1966[a]

	0 to 1.9 ac/yr	2 to 3.9 ac/yr	4 to 5.9 ac/yr	6.0+ ac/yr
No. of growers[b]	7	8	6	2
Average ac/yr of dry onions	1.0	2.0	5.0	9.0
Average ac/yr of all veg.	12.0	15.0	13.0	26.0

[a] Source: Hawaii vegetable crop survey, 1965 and 1966; and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Of these 23 onion growers, only 12 were interviewed; five in the 0 to 1.9 group, four in the 2 to 3.9, two in the 4 to 5.9, and one in the 6.0+ group.

The distribution of growers producing onions by acres per year is shown in Table 2. Other crops and acreages of these farmers are given in Appendix B. Only farmers on Maui are included because there is only one farmer on Hawaii. Judged by the small acreage in dry onions as compared with acreage in the other crops grown by these farmers, dry onions are a minor crop, especially among the head cabbage growers. There are only two farmers (in the 6.0+ ac/yr group) that depended heavily on dry onion production.

Due to weather, crop failures, disease, and insect infestation, the farmer may not maintain his usual or desired planting schedule. Furthermore, the farmers may revise their plans depending on prospective prices. Therefore, these acreages presented here are estimates based on available data and knowledge. In general, these tables indicate the range of acreages grown by location of the head cabbage and dry onion producers.

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[3] U.S. Department of Commerce, Climatological Data, Summaries 1963, 1964, and 1965.

PRODUCTION PRACTICES OF THE INTERVIEWED HEAD CABBAGE FARMERS

In Kula, the time between seeding the cabbage and completing the harvesting averaged 105 days in the summer and 130 days in the winter. On Hawaii, the length of the growing season was a week or two longer. Half of the farmers in the group called others on Hawaii did not even plant head cabbage in the summer because the weather is too hot for the crop.[4]

Seedbed. All of the growers used a seedbed to start their head cabbage seedlings. Normally on Maui, the seedlings remained in the seedbed for five weeks in the summer and six weeks in the winter. The seedbed period in Waimea was the same as in Kula but appeared to be one or two weeks shorter for the rest of the island of Hawaii. This operation used from 4.3 to 7.2 percent of the growers' total labor and was about the same in each location (see Tables 3 and 4).

Field Preparation. In Kula most of the growers plowed their field once, then either disked or harrowed several times. A few of the farmers then leveled their fields. Finally, they cut the irrigation lines or furrows. One-half of the interviewed growers fumigated their soil. In Waimea farmers relied mainly on disking their fields a number of times before transplanting. The rest of the growers (others on Hawaii) plowed and disked or harrowed their fields.

Transplanting. On Maui the growers usually planned to set out from 1/4 to 3/4 of an acre of their seedlings one time per week or ½ to 1½ acres one time every two weeks throughout the year. They could not always maintain this planned schedule because of unfavorable weather conditions, especially in the winter.

On Hawaii the growers in Waimea planned on setting out from 1/8 to 1/2 acre of seedlings one time every two or three weeks. Most of the rest of the interviewed growers on Hawaii planned on transplanting seedlings into 1/8 to 1/4-acre fields every two or four weeks. One farmer transplanted one acre of seedlings one time per month for seven months.

Transplanting is done by hand and was, in most areas, the second largest labor-using activity, requiring from 16 to 28 percent of the total labor used per acre (Tables 3 and 4). The Kula farmers appeared to have a more efficient transplanting operation than do the Hawaii farmers.

Fertilizing. On Maui the growers applied fertilizer at the same time they transplanted their seedlings. One-half of these operators also applied one side-dressing of fertilizer during the growing period (Tables 3 and 4).

Most of the growers in the group, others on Hawaii, sidedressed one or two times besides a preplant application. Consequently, more hours per acre were used by these farmers for fertilizing than by farmers in Kula or Waimea.

Irrigating. All the interviewed growers in Kula irrigated their head cabbage during the summer. Only two-thirds irrigated in the winter. Normally, the crop was irrigated once per week in the summer and approximately once every 20 days in the winter, depending on the weather. For this reason labor requirements per acre

[4]The group, others on Hawaii, includes the interviewed growers in Volcano, Honokaa, Keeau, Mt. View, and Pepeekeo.

Table 3. Labor use per acre of head cabbage by representative growers in Kula, Maui; Waimea (Kamuela), Hawaii; and Others on Hawaii; Hawaii vegetable crop survey, 1965 and 1966.

Labor-using activity	Kula		Kamuela (Waimea)		Others on Hawaii	
	Hours used	Percent of total labor used	Hours used	Percent of total labor used	Hours used	Percent of total labor used
Establishing the stand:						
Seedbed	12.0	6.3	10.0	5.2	16.0	7.2
Field preparation	9.0	4.7	4.0	2.1	6.0	2.7
Transplanting	33.0	17.4	53.0	27.6	43.0	19.4
Sub total	54.0	28.4	67.0	34.9	65.0	29.3
Cultural operations:						
Fertilizing	8.0	4.2	7.0	3.6	32.0	14.4
Cultivating (weeding)	24.0	12.7	16.0	8.3	13.0	5.9
Spraying	11.0	5.8	14.0	7.3	14.0	6.3
Irrigating	20.0	10.5	13.0	6.8	0.0	0.0
Sub total	63.0	33.2	50.0	26.0	59.0	26.6
Harvesting and handling	73.0	38.4	75.0	39.1	98.0	44.1
Total hours of labor	190.0	100.0	192.0	100.0	222.0	100.0

Table 4. Winter labor use per acre of head cabbage by representative growers in Kula, Maui; Waimea, (Kamuela), Hawaii; and Others on Hawaii; Hawaii vegetable crop survey, 1965 and 1966

Labor using activity	Kula		Kamuela (Waimea)		Others on Hawaii	
	Hours used	Percent of total labor used	Hours used	Percent of total labor used	Hours used	Percent of total labor used
Establishing the stand:						
Seedbed	9.0	5.4	10.0	5.4	11.0	4.3
Field preparation	9.0	5.4	4.0	2.1	6.0	2.3
Transplanting	33.0	19.9	53.0	28.3	42.0	16.4
Sub total	51.0	30.7	67.0	35.8	59.0	23.0
Cultural operations:						
Fertilizing	8.0	4.8	7.0	3.7	50.0	19.5
Cultivating(weeding)	24.0	14.5	16.0	8.6	25.0	9.8
Spraying	10.0	6.0	14.0	7.5	33.0	12.9
Irrigating	3.0	1.8	8.0	4.3	0.0	0.0
Sub total	45.0	27.1	45.0	24.1	108.0	42.2
Harvesting and handling	70.0	42.2	75.0	40.1	89.0	34.8
Total hours of labor	166.0	100.0	187.0	100.0	256.0	100.0

Figure 3. Several fields of head cabbage which illustrate the slope of the fields in Kula, Maui. These fields are near the Kula Sanitarium.

Figure 4. A field of dry onions in Omaopio, Maui.

were greater in the summer than in the winter (Tables 3 and 4). The Waimea farmers watered less regularly than the Kula farmers, and the others on Hawaii did not irrigate. One-half of this latter group did not grow head cabbage in the summer because it is too hot and dry. The others depended on rainfall. Because the Kula growers irrigated more often, they used more labor for this operation than those in the other two locations (Table 3).

Spraying. Depending on disease and insect problems, the growers in Kula usually sprayed their fields three or four times during the period from transplanting to the finish of the harvest. They used either mist blowers, boom sprayers, or knapsack sprayers. The Hawaii growers sprayed more frequently, though the rate varied widely among the individual farmers.

Weeding. Weeding was done only once per crop in Kula. Part of this operation was done by hand and part with a garden tractor. In Waimea the farmers used a cultivator on the weeds in the cabbage crop from one to four times. This was sometimes combined with the sidedressing operation. The remaining growers (others on Hawaii) weeded their fields by hand.

Herbicides were used by 10 of the 18 interviewed Kula growers to supplement weed control. They were mostly the larger-scale growers. Very few head cabbage growers in Waimea used herbicides, but one-half of the others on Hawaii applied herbicides.

Labor requirements for weeding in Kula were approximately 12.7 percent (summer) and 14.5 percent (winter) of the total man hours per acre for growing the crop.

Harvesting and Handling. The harvest period lasted from one week to one month and was by far the most labor-consuming operation. This is a hand operation and used from 34.8 to 44.1 percent of the total labor required for producing head cabbage (Tables 3 and 4).

Total Labor Used Per Crop. To grow a crop of head cabbage the representative grower in Kula used 190.0 hours (summer) and 166.0 hours (winter); the representative farm operator in Waimea used 192.0 hours (summer) and 187.0 hours (winter); the representative farm operator of the others on Hawaii used 222.0 hours (summer) and 256.0 hours (winter) (Tables 3 and 4). Since the representative hours used per acre for the others on Hawaii was based on the records of only the three growers who produce in the winter time, while the 256.0 hours per acre is based on all the interviewed growers, the winter labor use is a better indication of the labor required to produce cabbage.

PRODUCTION PRACTICES OF THE INTERVIEWED DRY ONION FARMERS

None of the vegetable growers on Maui or Hawaii continuously crops dry onions. Rather, dry onions are planted one or two times in the winter or the spring. The cycle from seeding to completion of the harvest of a dry onion crop requires an average of 180 days or about six months. In the following discussion growers have been grouped into representative low-labor and high-labor producers in order to more adequately show the differences in production practices. There are nine interviewed farmers in the low and three in the high labor-using group.

Seedbed. One grower seeded his field directly in the winter, while all the other growers used a seedbed to start their seedlings. Normally, the seedlings were kept in the seedbed for 60 days, then transplanted to the field.

Field Preparation. Usually the fields were first plowed, then disked or harrowed, and finally irrigation furrows were cut. Only 3 of the 12 growers fumigated their soil before transplanting the seedlings.

Transplanting. The growers in the Omaopio area (Lower Kula) set out 2.0 to 3.0 acres of seedlings at each transplanting while those in Upper Kula set out 1.0 acre per time. The growers in Upper Kula are also the head cabbage producers. On Hawaii, the single producer's schedule was similar to the growers' in Omaopio.

A transplanting operation may take from one day to three weeks. The average was four to five days. An average of three to four people was employed by the growers in this operation. Transplanting required 15.4 to 18.4 percent of the labor used in producing onions and was the second highest labor-using activity (Table 5). The low labor-producers averaged 62.0 hours per acre for this operation while the high-labor producers averaged 104.0 hours.

Fertilizing. Eight out of the nine growers represented by the low-labor producer applied fertilizer either as a preplant application or as a sidedressing, and the ninth did both. Two of the three growers represented by the high-labor producer used both methods and took more labor time to apply the fertilizer. This group used three times the amount of man hours used by the low-labor producers (Table 5).

Irrigating. The five growers located in the lower and drier Omaopio (Lower Kula) area irrigated much more frequently than did the seven in Upper Kula. The growers in Omaopio averaged one watering every five to six days. In Upper Kula, growers watered an average of once every 42 days. Two did not irrigate their crop.

Two out of the three high-labor producers and three out of the nine low-labor producers were located in Omaopio.

Spraying. As was the case with irrigation, the growers in Omaopio (Lower Kula) sprayed more often than the Upper Kula growers. The farmers in Omaopio sprayed one time per week while the Upper Kula growers sprayed an average of once every one and one-half months. Because a greater proportion of the high-labor producers were located in Omaopio, the representative labor hours for spraying by these high-labor producers in Table 5 was ten times that by the low-labor producers.

Besides this, three types of sprayers were used to spray the fields: knapsacks, mist blowers, and boom sprayers. Depending on the type of equipment, the amount of time required to spray one acre of dry onions varied greatly among the farmers. Of the 12 growers, 3 used knapsacks, 4 used mist blowers, and 4 used

Figure 5. Dry onions being harvested in Kula, Maui.

Figure 6. An irrigation system in a field of dry onions in Mana, Kauai.

Table 5. Labor use per acre of dry onions by representative low- and high-labor producers, Kula and Omaopio, Maui, Hawaii vegetable crop survey, 1966

Labor-using activity	Low-labor producer		High-labor producer	
	Representative hours used	Percent of total labor used	Representative hours used	Percent of total labor used
Establishing the stand				
Seedbed	17.0	5.1	14.0	2.1
Soil preparation	6.0	1.8	16.0	2.4
Transplanting	62.0	18.4	104.0	15.4
Subtotal	85.0	25.3	134.0	19.9
Cultural operations				
Fertilizing	4.0	1.2	19.0	2.8
Cultivating (weeding)	68.0	20.2	68.0	10.1
Spraying	5.0	1.5	50.0	7.4
Irrigating	14.0	4.2	16.0	2.4
Subtotal	91.0	27.1	153.0	22.7
Harvesting and handling				
Harvesting	40.0	11.9	99.0	14.7
Handling	120.0	35.7	287.0	42.7
Subtotal	160.0	47.6	386.0	57.4
Total hours of labor	336.0	100.0	673.0	100.0

boom sprayers mounted on trucks. A knapsack sprayer takes an average of 6 hours per acre per spraying, a mist blower 2.3 hours per acre, and a boom sprayer .7 hour per acre. Four out of the five dry onion growers in Omaopio used a boom sprayer. Even though it is more expensive, the number of times they spray makes it expedient to use such equipment.

Weeding. The farmers weeded their fields from two to three times per crop. This operation took from 10.1 to 20.2 percent of the total hours of labor per acre of dry onions and was the highest labor user of the cultural operations.

Seven of the 12 farmers also used herbicides to control weeds. Usually they applied herbicides one time per crop.

Weeding requires a large amount of hand labor, but it is an essential operation. On order to grow a good crop of dry onions, the weeds must be controlled. This is especially true in the early stages of growth because dry onions are slow growing and easily harmed by weeds.[5]

Harvesting. Growers in the Upper Kula and Omaopio areas harvested the dry onions an average of four times per crop. They had from one to eight people pulling the onions. As shown in Table 5 this operation required an average of 40.0 hours per acre for the representative low-labor producer and 99.0 hours per acre for the representative high-labor producer. The difference in man hours is due to the number of pullings per crop and the length of each harvest.

Handling. This operation required from 35.7 to 42.7 percent of the total labor hours. Handling was by far the most labor-consuming of all the dry onion operations. Several stages are involved in the handling process. After the onions are pulled, they are allowed to dry on the fields or under roofs which protect the onions from rains and from the strong, direct sunlight that causes sunburning and greening of the bulbs. After the leaves and roots are dried, the tops are cut off in order to leave a short neck, and the roots are clipped off near the base of the bulbs.[6] Once this is completed, the onions are allowed to cure, usually by spreading the bulbs out in the sun and letting them dry for 3 to 15 days, depending on the weather. Finally, the onions are graded and bagged for marketing.

The difference between the low-labor producer's 120.0 hours per acre and the high-labor producer's 287.0 hours per acre for handling was due to the trimming of the onions. The high-labor producer used many more man hours to top the bulbs.

Total Labor Used Per Crop. Although the percentage breakdown of man hours for low- and high-labor producers was fairly similar for most of the operations, the total labor used per acre was only 336.0 hours per acre for the low-labor as compared with 673.0 hours per acre for the high-labor producer. The similar percentages indicate that the methods of production are similar, but one group of growers uses more labor hours to perform each operation. However, the low-labor producer's representative hours were based on information from nine interviewed growers while the high-labor producer's were based on information from only three growers. Consequently, the low-labor producer's hours are much more representative of dry onion growers on Maui.

[5]Homer C. Thompson and William C. Kelly, Vegetable Crops, McGraw Hill Book Company, 1957, p. 356.

[6]From a personal communication with Mr. Yukio Nakagawa, Associate Specialist in Horticulture, Hawaii Cooperative Extension Service.

CALENDAR OF OPERATIONS

An important task for a farm manager is to select his crops and to organize his planting schedule so that he effectively utilizes his available labor and other resources. Only in this way can he maximize his net revenue.

Table 6 is a calendar of operations for a representative head cabbage grower in Kula, Maui. Kula was used as a basis for the calendar because it is the center of head cabbage production in the state. The calendar shows the various operations by month and their demand on labor, land, materials (fertilizer, insecticides, etc.), and machinery. Also a distinction has been made between summer and winter operations when it is appropriate. By using this calendar, a grower has a guide for planning his labor use and for scheduling the various operations. Of course, the exact timing of spraying, irrigating, and weeding will depend on the weather.

Table 7 is a calendar of operations for a representative dry onion grower who is a low-labor producer in Kula and Omaopio (Lower Kula), Maui. Since the low-labor producers are more representative of the growing situation, the calendar has been based on their operations. The calendar indicates the demand for the farmer's resources and should help a manager plan his labor use and schedule his operations. No attempt has been made to distinguish between summer and winter conditions for the dry onions crop becausemost of the growers plant in the winter or the spring, and harvest in the summer.

Figures 7 and 8 illustrate graphically the labor use by months for each crop, emphasizing the months of low and high labor use. For example, in dry onion production over one-half of the total man hours must be used in the final month, while in head cabbage growing a fairly constant amount of labor was used over a three-month period. If a farmer grows both head cabbage and dry onions, he must plant his operations so that at the time of onion harvesting his head cabbage demand for labor is relatively low.

Table 6. Calendar of farm operations for a representative grower producing 23,700 pounds (summer) and 22,300 pounds (winter) of head cabbage per acre per crop, Kula, Maui

Month	Operation	Man hours per acre	No. of men	Acres	Power hours per acre	Type of power and equipment	Materials and notes
	Seedbed:[a]						
	Soil preparation, planting, and pre-plant fertilizer application	2.0	1	-	-		.5 lb. of seed
1	Irrigating					Hose	
	(6X summer)[b]	(3.0)	1	-	-		
	(2X winter)	(1.0)	1	-	-		
	Spraying (1X)	.2	1	-	-	Knapsack sprayer	A nominal amount
	Weeding (1X)	7.0	2	-	-	By hand	
Total 1st month	Summer	12.2			-		
	Winter	10.2			-		
	Seedbed (5 days-summer)[c] (12 days-winter)						
	Irrigating					Hose	
	(1X summer)[b]	(.5)	1	-	-		
	(1X winter)	(.5)	1	-	-		
2	Spraying					Knapsack	
	(1X winter)[b]	(.2)	1	-	-	sprayer	A nominal amount
	Plowing (1X)	5.6	1	1.0	5.6	Tractor and plow	
	Disking or harrowing (2X)	3.5	1	1.0	3.5	Tractor and disk or plow	

Table 6 (cont.)

Month	Operations	Man hours per acre	No. of men	Acres	Power hours per acre	Type of power and equipment	Materials and notes
2 (cont.)	Cut furrows (1X)	1.5	1	1.0	1.5	Tractor and double mold-board plow	
	Fumigate the soil (1X)	1.5	1	.5	-	Applicator	Telone 40 gal/ac
	Applying a herbicide	.7	1	.5	-	Hand applicator	Vegedex 22½ lbs/ac (granular)
	Preplant fertilizing	5.6	1	.5	-	By hand	1500 lbs/ac of 8-20-5 (X-4)
	Transplanting	33.0	3	.5	-	By hand	
	Irrigating (4X summer)[b]	(6.4)	1	3.0	-	Sprinkler	
	(1X winter)	(1.6)	1	3.0	-		
	Spraying[d] (1X summer)[b]	(2.3)	1	3.0	-	Mist blower	Endrin 1 pint/ac/spray and phosdrine 1 pint/ac/spray
	(1X winter)	(2.3)	1	3.0	-	Mist blower	
Total 2nd month	Summer	60.6			10.6		
	Winter	56.0			10.6		
3	Irrigating (4X summer)[b]	(6.4)	1	3.0	-	Sprinkler	
	(1X winter)	(1.6)	1	3.0	-		
	Spraying[d] (2X summer)[b]	(4.6)	1	3.0	-	Mist blower	Endrin 1 pint/ac/spray and phosdrine 1 pint/ac/spray
	(1X winter)	(2.3)	1	3.0	-		
	Fertilizer sidedressing (1X summer)[b]	(6.5)	1	.5	-	By hand	650 lbs/ac of 8-20-5
	Weeding and cultivating (1X)	14.6	2	.5	-	Garden tiller and hoe	Part is done by hand w/ a hoe and part w/ a garden tiller
Total 3rd month	Summer	32.1			-		
	Winter	18.5			-		

Table 6 (cont.)

Month	Operation	Man hours per acre	No. of men	Acres	Power hours per acre	Type of power and equipment	Materials and notes
4	Summer (15 days):[e]						
	Fertilizer sidedressing (1X winter)	6.5	1	.5	-	By hand	650 lbs/ac of 8-20-5
	Spraying (1X summer)[b]	(2.3)	1	3.0	-	Mist blower	Phosdrine 1 pt/ac/spray
	(2X winter)	(4.6)	1	3.0	-		
	Irrigating (2X summer)[b]	(3.2)	1	3.0	-	Sprinkler	
	(2X winter)	(3.2)	1	3.0	-		
	Harvesting (3X summer)	73.0	3	.5	-	By hand	474 bags
Total 4th month	Summer	78.5			-		
	Winter	14.3			-		
5	Winter (10 days):[f]						
	Harvesting (3X winter)[b]	70.0	3	.5	-	By hand	446 bags
Total 5th month	Winter	70.0			-		
Total for Crop	Summer	188.4			10.6		
	Winter	169.0			10.6		

[a] The inputs for the seedbed are the amounts that will produce enough seedlings to transplant into a one acre field.

[b] The brackets indicate that the operation utilizes different amounts of inputs for the summer and the winter seasons.

[c] In the summer the seedbed operation extends 5 days into the second month while in the winter it lasts for 12 days in the second month.

[d] Seven farmers used mist blowers; 6 farmers used boom sprayers 3.6X (summer) and 3.3X (winter) @ .82 hr/ac/spray; and 4 farmers used Knapsacks - 4.6 X @ 7.1 hrs/ac/spray.

[e] The summer crop operations are finished after 15 days in the fourth month.

[f] The winter crop operations are finished after 10 days in the fifth month.

Table 7. Calendar of farm operations for a representative low-labor producer growing 19,000 pounds of dry onions per acre per crop, Kula and Omaopio, Maui

Month	Operation	Man hours per acre	No. of men	Acres	Power hours per acre	Type of power and equipment	Materials and notes
	Seedbed:[a]						
	Soil preparation, planting, and pre-plant fertilizer application	2.3	1	-	-		1 lb/seedbed (for 1 ac.) of seed
1	Spraying (2X)	.3	1	-	-	Knapsack sprayer	A nominal amount
	Irrigating (5X)	.7	1	-	-	Hose	
	Weeding (1X)	6.0	1	-	-	By hand	
Total for 1st month		9.0			-		
	Seedbed (cont.):						
2	Spraying (2X)	.3	1	-	-	Knapsack sprayer	A nominal amount
	Irrigating (5X)	.7	1	-	-	Hose	
	Weeding (1X)	6.0	1	-	-	By hand	
Total for 2nd month		7.0					
	Plowing (1X)	4.0	1	1.0	4.0	Tractor and disk or mold-board plow	
3	Disking or harrowing (1X)	1.2	1	1.0	1.2	Tractor and disk or harrow	
	Cut furrows (1X)	3.0	1	1.0	3.0	Tractor and double mold-board plow	

Table 7 (cont.)

Month	Operation	Man hours per acre	No. of men	Acres	Power hours per acre	Type of power and equipment	Materials and notes
3 (cont.)	Transplanting	62.0	4	1.0	-	By hand	
	Applying herbicide (1X)	.4	1	1.0	-	Boom sprayer	Randox (CDAA) 1½ gals/ac or dacthol W-75 10-14 lbs/ac
	Spraying (1X)[a]	.5	1	1.0	.5	Boom sprayer	Diazinon 2 lbs/ac/spray Maneb 2 lbs/ac/spray
	Irrigating (1X)[b]	1.6	1	1.0	-	Sprinkler system	
Total for 3rd month		72.7			8.7		
4	Weeding (1X)	22.7	3	1.0	-	By hand	Diazinon 2 lbs/ac/spray
	Spraying (1X)[a]	.5	1	1.0	.5	Boom sprayer	Maneb 2 lbs/ac/spray
	Irrigating (1X)[b]	1.6	1	1.0	-	Sprinkler system	
Total for 4th month		24.8			.5		
5	Fertilizer sidedressing (1X)	4.0	1	1.0	-	By hand	1130 lbs/ac of 8-20-5 or 10-10-5
	Weeding (1X)	22.7	3	1.0	-	By hand	
	Spraying (1X)[a]	.5	1	1.0		Boom sprayer	Diazinon 2 lbs/ac/spray Maneb 2 lbs/ac/spray
	Irrigating (1X)[b]	1.6	1	1.0	-	Sprinkler system	
Total for 5th month		28.8			.5		

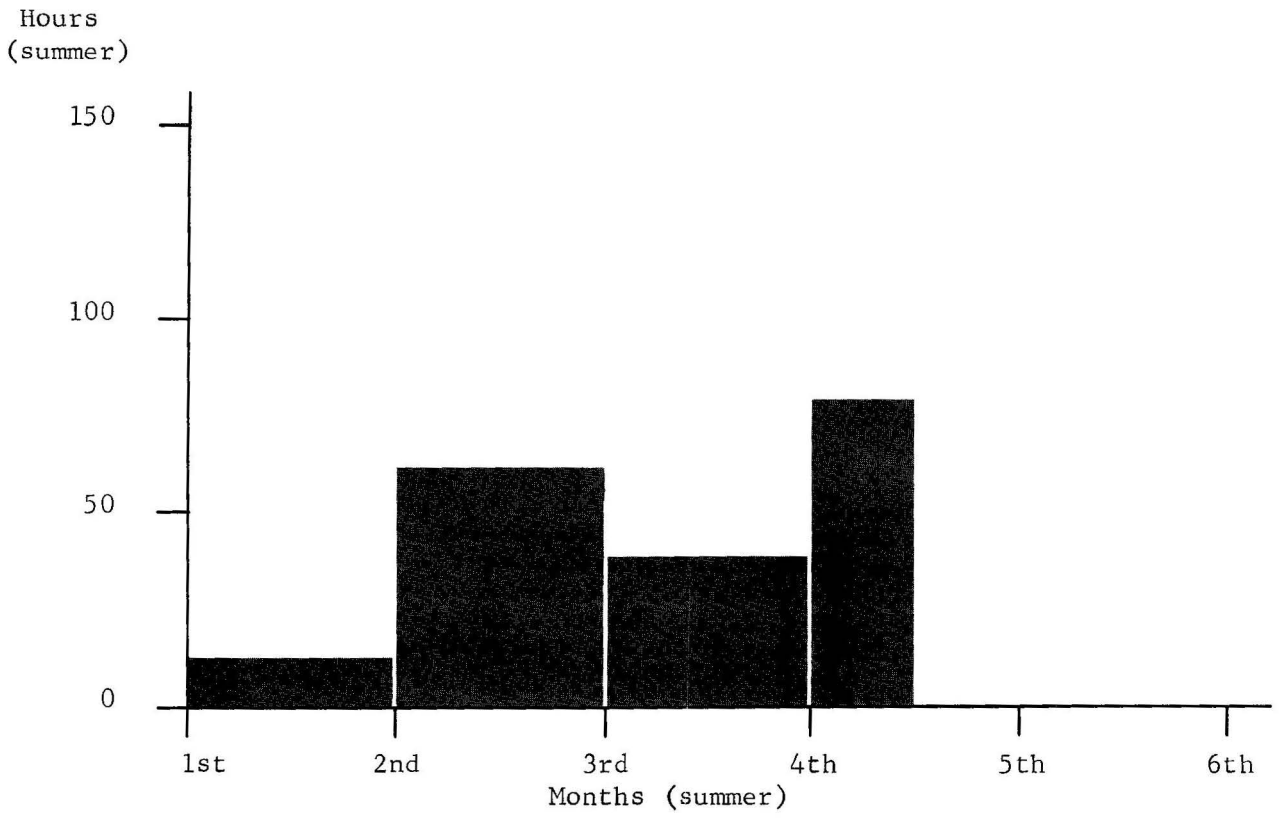
Table 7 (cont.)

Month	Operation	Man hours per hour	No. of men	Acres	Power hours per acre	Type of power and equipment	Materials and notes
	Weeding (1X)	22.7	3	1.0	-	By hand	
	Spraying (1X)[a]	.5	1	1.0	.5	Boom sprayer	Diazinon 2 lbs/ac/spray Maneb 2 lbs/ac/spray
	Irrigating (1X)[b]	1.6	1	1.0	-	Sprinkler system	
6	Harvesting (4X)	40.0	2	1.0	-	By hand	
	Topping (trimming) and curing	59.0	3	1.0	-	By hand	
	Grading and bagging	60.0	3	1.0	-	By hand	380 bags
Total for 6th month		183.8			.5		
Total for crop		326.1			10.2		

[a] Four farmers used boom sprayers, three used mist blowers (1.3 hrs/ac/spray), and two used knapsacks (4.8 hrs/ac/spray). The four who used boom sprayers were taken as the representative situation for this calendar.

[b] An average of eight farmers: five in Kula (1X/42 days) and three farmers in Omaopio (1X/5.5 days). The Kula rate was taken as representative and used in this calendar.

Figure 7. Typical schedules of labor use per acre per crop by month in the summer and the winter for a representative head cabbage grower in Kula, Maui, Hawaii vegetable crop survey, 1966



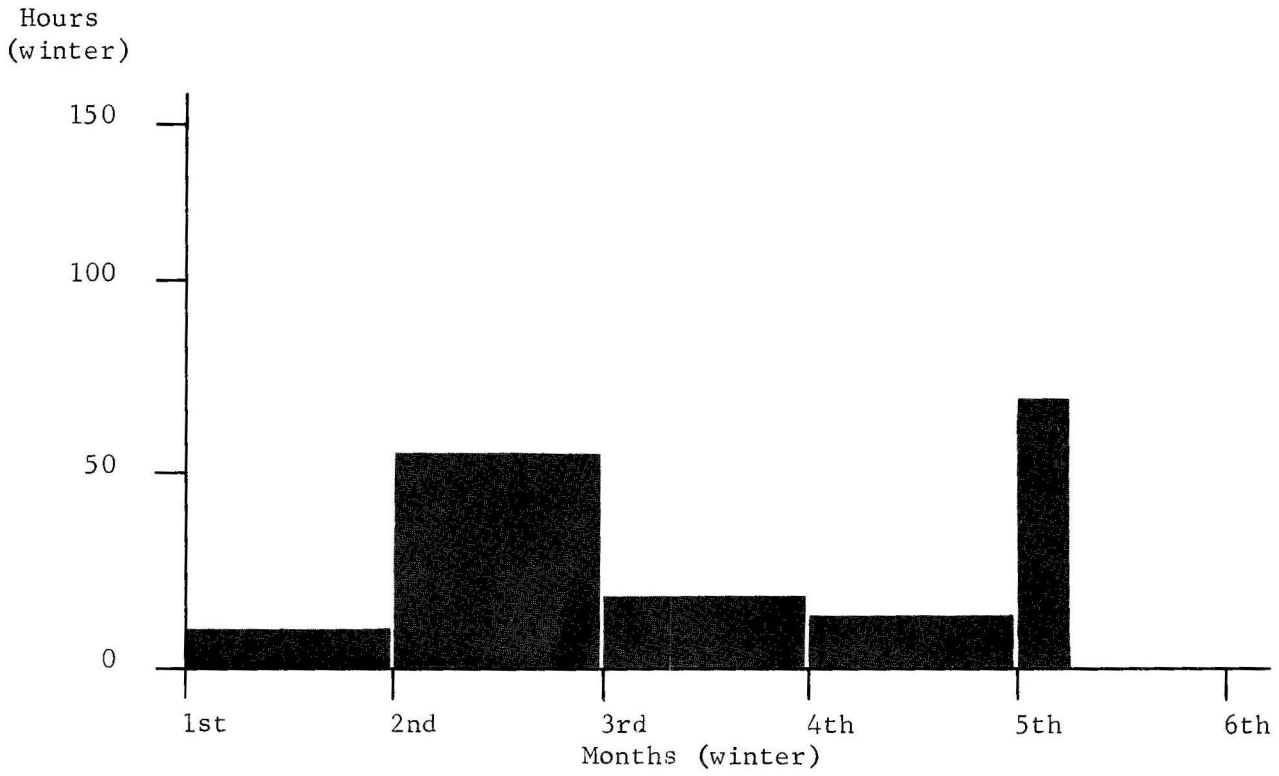
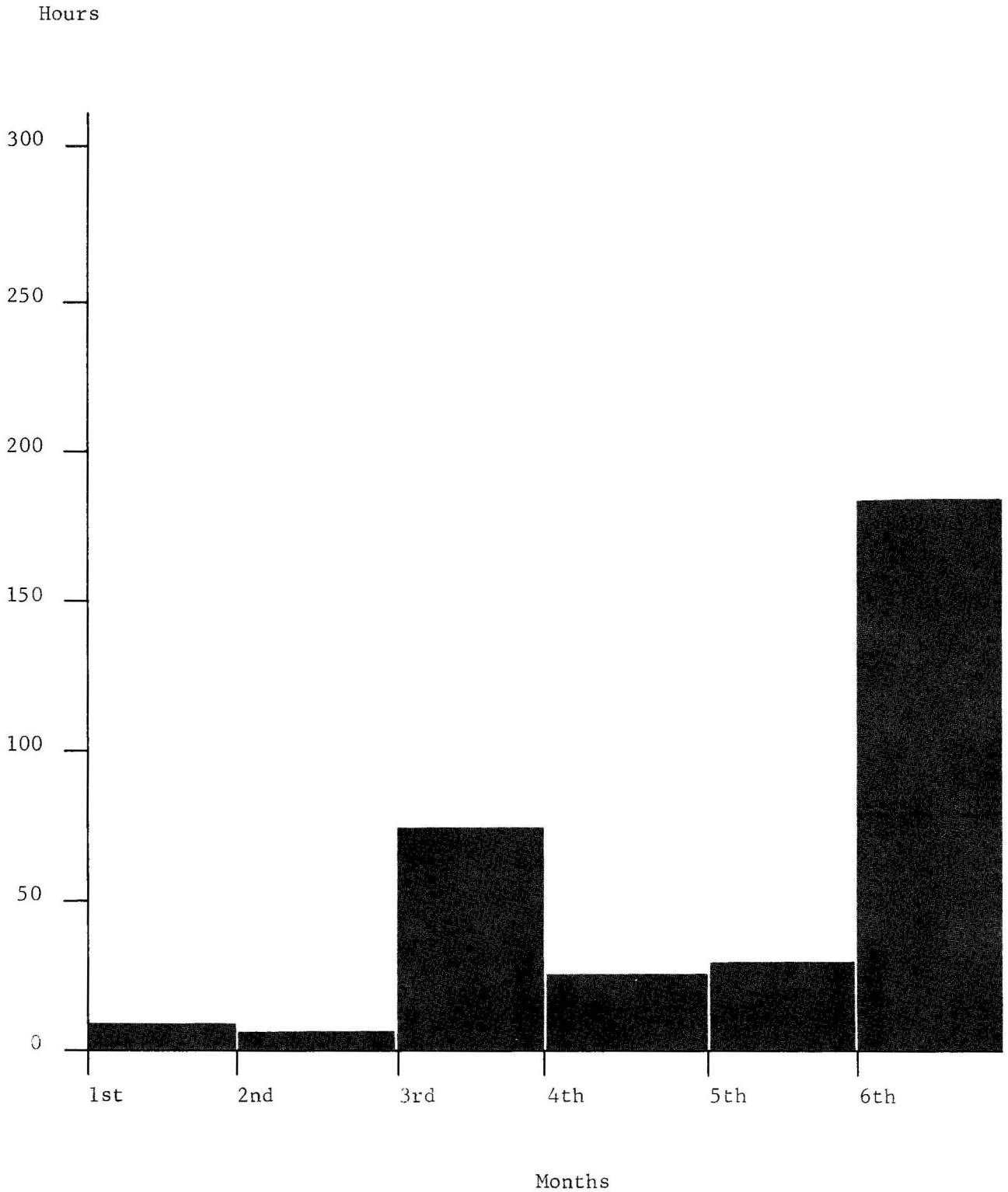


Figure 8. Typical schedule of labor use per acre per crop by month for a representative dry onion grower in Kula and Omaopio, Maui, Hawaii vegetable crop survey, 1966



COSTS OF PRODUCING HEAD CABBAGE

In this study the cost of producing head cabbage for each location is based on practices and materials use reported by the interviewed farmers in Kula, Waimea (Kamuela), and the other areas on Hawaii. This report does not reveal the costs and practices of any of the individual farmers interviewed. When the farmers were interviewed, they were asked about their practices under normal conditions. Under conditions of severe storms or unusual insect and disease problems, the estimates of the amounts of materials used, the techniques practiced, and the yields achieved must be adjusted to the changed conditions.

Head cabbage costs of production by location have been separated into direct and indirect costs. In this way the costs are identified that vary with production and those that remain fixed for the season, no matter what happens to the crop. Direct costs of production are related to the actual growing and harvesting of the crop and include such things as labor and materials. Indirect costs are related to the entire farm operation and consist of depreciation cost of machinery, rent, and minor overhead costs.

Indirect Costs

The value of investment and depreciation per year for representative farms of each area together with cost of machinery per acre of head cabbage is given in Table 8. Ranking the indirect costs by location shows the lowest cost of $34.30 per acre in Kula, followed by $51.00 per acre for the others on Hawaii and $58.90 per acre in Waimea. The representative Waimea (Kamuela) farmer's high indirect costs were attributable to a greater investment in irrigation equipment, tractors, trucks, and pickups. Even though the investment is greater, the representative grower in Kula used his machinery for head cabbage production much more than the growers on Hawaii. The average usage was 86 percent in Kula, 19 percent in Waimea (Kamuela), and 21 percent in the group, others on Hawaii, for growing this crop. A breakdown of the kinds of equipment usually owned by the growers in each area is presented in Table 9. This table suggests that additional investment beyond basis requirements is primarily in wheel and crawler tractors.

Another indirect cost to the farmers is a charge for their land. Since some of the farmers own their land while others rent, it was necessary to set up an equivalent charge. Based on survey information, a rent of $15.00 per acre per crop was charged to each of the growers at all of the locations. The rent was about the same on the two islands.

Direct Costs

The direct costs of producing an acre of head cabbage are the major expense of the growers and are made up of labor cost, materials expenditure, and a gross income tax.

For this study, the cost of labor is assumed to be $1.25 per hour. This was the prevailing wage in the three areas at the time of the survey. Both hired and family labor are charged at this rate, although it is assumed that only the hired

Table 8. Indirect cost of machinery and buildings, representative head cabbage growers, Kula, Waimea (Kamuela), and others on Hawaii, Hawaii vegetable crop survey, 1965 and 1966

Item	Value of investment[a]			Depreciation per year[b]			Cost per acre to the head cabbage enterprise[c]		
	Kula ($)	Waimea ($)	Others ($)	Kula ($)	Waimea ($)	Others ($)	Kula ($)	Waimea ($)	Others ($)
Irrigation equipment	1501.90	3101.50	0.00	118.88	291.56	0.00	4.40	6.30	0.00
Implements	706.90	1297.90	354.30	73.51	193.62	68.95	3.30	8.60	3.60
Sprayers	238.30	513.10	284.70	37.07	135.36	63.35	2.00	6.30	5.40
Garden tillers	92.50	0.00	95.70	14.71	0.00	17.87	1.10	0.00	1.60
Tractors	2030.70	3786.40	4327.70	192.95	395.33	411.62	6.40	13.00	20.80
Trucks and pickups	2216.40	3736.50	2213.60	283.95	513.56	411.75	15.10	24.10	19.60
Buildings and others	540.20	376.50	0.00	50.45	101.50	2.61	2.00	.60	0.00
Total	7326.90	12,811.90	7276.00				34.30	58.90	51.00

[a] Value of investment was calculated by first depreciating the original price of each piece of equipment in order to determine the value. Next, these values for each category were added and divided by the number of interviewed farmers.

[b] Depreciation per year was determined by dividing the purchase price of each piece of equipment by the number of years it could be used. These amounts were then added for each category and divided by the number of interviewed farmers. This depreciation also covers the cost of repairs and maintenance, which is a relatively minor cost since the farmers do not extensively use their equipment.

[c] Per-acre cost to the head cabbage enterprise was calculated by adding the depreciation per year for each item and reducing this to a per-acre basis. This was multiplied by the percentage of use of each item of the representative head cabbage crop.

Table 9. Machinery and equipment of representative growers in Kula, Maui; Waimea (Kamuela), Hawaii; and others on Hawaii; Hawaii vegetable crop survey, 1965 and 1966

Kula	Waimea (Kamuela)	Others on Hawaii
Irrigation equipment	Irrigation equipment	
1-Disk harrow	2-Disk harrows	1-Disk harrow
1-Moldboard plow	1-Cultivator	1-Disk plow
1-Cultivator	2-Seeders	1-Garden tiller
1-Garden tiller	2-Fertilizer applicators	1-Power sprayer (hose)
2-Knapsack sprayers	1-Power sprayer (hose)	1-Knapsack sprayer
1-Boom sprayer or Mist blower	1-Knapsack sprayer	1-Tractor, 1960, wheel
1-Tractor, 1964, wheel	1-Tractor, 1946, crawler	1-Pickup truck, ½ ton, 1962
1-Pickup truck, ½ ton, 1955 (½ of the growers)	1-Tractor, 1961, wheel	
1-Truck, 1½ ton, 1954	1-Tractor, 1954, wheel	
	1-Pickup truck, ½ ton, 1963	
	1-Truck, 2 ton, 1952	

labor is actually paid on a regular basis. In a later section of this study, an analysis will be made of the effect of family labor on family earnings.

Based on the labor hours required for cabbage operations in Tables 3 and 4, the cost of labor per acre per crop is $237.50 (summer) and $207.50 (winter) in Kula, $240.00 (summer) and $233.80 (winter) in Waimea (Kamuela), and $277.50 (summer) and $320.00 (winter) for the grower representing the group, others on Hawaii.

Within the Kula area there is an indication that as the size of the operation, acres per year (ac/yr), increases, there is a corresponding decrease in the total man hours of labor per acre for growing this crop.[7] However, judging from the survey data these economies are not very great. A breakdown of the representative direct costs of materials as shown in Table 10. Factors that account for the variations in costs among the interviewed farmers are discussed below under the various input categories.

[7]Using the Spearman Rank Correlation Test, the relationship is significant at the 2.5% level [t = 2.33 summer and t = 2.44 winter for d.f. = 16 (a one-tailed test)]. Therefore, we reject the null hypothesis that there is no relationship between size and efficiency.

Seed. All of the interviewed growers used an average of approximately one pound of seed per acre. However, four growers in Kula used a much more expensive hybrid seed. One farmer in the group, others on Hawaii, also used hybrid seed.

Fertilizer. Farmers in the survey applied a variety of fertilizer formulations. The most usual application and formulation serve as representative. On this basis, the representative grower in Kula would apply 1,600 pounds per acre of 8-20-5 fertilizer (called X-4 in Kula) to his head cabbage crop. On Hawaii the representative farmer in Waimea (Kamuela) would use 1,100 pounds per acre of primarily 10-10-5+20. The +20 stands for minor elements. The grower representing the others on Hawaii would use 2,000 pounds per acre, which explains the higher cost of this item for this area (see Table 10).

Spray Materials. A wide variety of types and amounts of fumigants, herbicides, insecticides, and fungicides were used by the surveyed farmers. The estimated costs of these materials in Table 10 are representative of the growers in each area.

Bags. Cabbages are bagged for shipment. Each bag holds 50 pounds of head cabbage. The cost of bags per acre depends on the grower's yield and whether the uses new or used bags. A used bag costs from 10 to 15 cents, while new ones cost from 25 to 28 cents each. For the interviewed growers an average of 68 percent of the bags used were new. The cost of bags was a major expense for the head cabbage growers. For the growers in Kula, this was their highest single materials cost item and amounted to 30 percent of the total cost of materials.

Table 10. Direct cost of materials, representative head cabbage grower, Kula, Maui; Waimea (Kamuela), Hawaii; and others on Hawaii; Hawaii vegetable crop survey, 1965 and 1966

Item	Average cost per acre (dollars/acre)					
	Kula		Waimea (Kamuela)		Others Hawaii	
	Summer	Winter	Summer	Winter	Summer	Winter
Seed	$ 3.90	$ 3.90	$ 5.20	$ 5.20	$ 5.40	$ 4.80
Fertilizer	75.20	74.50	57.30	57.30	110.30	116.00
Spray materials	59.70	57.20	46.20	46.20	40.90	35.70
Bags	91.50	80.90	65.10	42.50	55.00	50.70
Gas and oil	26.50	27.50	26.90	26.90	34.00	37.90
Irrigation water	56.70	16.60	17.00	4.70	0.00	0.00
Total	$313.50	$260.60	$217.70	$182.80	$245.60	$245.10

Gas and Oil. The growers were asked to estimate how much gas and oil they used per month. This was then converted to the cost per acre of head cabbage.

Irrigation Water. Each farmer was questioned about the cost of water per month in the summer and in the winter. Based on the estimates of their water bills, the cost was allocated to each crop depending on the amount of water used.

Table 10 shows the total direct costs per acre of materials as $313.50 (summer) and $260.60 (winter) in Kula; $217.70 (summer) and $182.80 (winter) in Waimea; and $245.60 (summer) and $245.10 (winter) in the group, others on Hawaii. Two factors accounting for higher cost of materials in Kula are higher costs per acre for irrigation water and use of more bags per acre because of the higher yields.

The final direct cost item included is the gross income tax. This was computed by taking one-half of one percent of the gross income of the farmer from an acre of head cabbage.

Total Costs and Net Returns

To compare the growers representing the three areas, two things are of primary importance: production costs and yields. The representative total costs of production for the Kula grower were $604.30 in the summer and $523.60 in the winter (Table 11). On the island of Hawaii the representative grower's total costs of production per acre per crop in Waimea (Kamuela) were $534.80 (summer) and $495.10 (winter), and in the group, others in Hawaii, they were $592.30 (summer) and $636.40 (winter), as shown in Tables 12 and 13.

Making up for his higher costs, the Kula grower had representative yields of 21,300 (summer) and 19,100 pounds per acre (winter); while on the island of Hawaii the Waimea (Kamuela) grower had yields of only 17,000 (summer) and 14,250 pounds per acre (winter); and the grower for the others on Hawaii had 17,000 (summer) and 16,250 pounds per acre (winter).

Because of the Kula grower's higher yields, his costs per pound of head cabbage were lower than in the other areas. These costs were 2.8 cents per pound in the summer and 2.7 cents per pound in the winter. In contrast to this the Waimea (Kamuela) grower had a higher cost of 3.1 cents per pound (summer) and 3.5 cents per pound (winter). The highest of all was the grower for the others on Hawaii, whose costs per pound were 3.5 cents (summer) and 3.9 cents (winter). Consequently, the Kula area emerges as the most efficient in producing head cabbage (see Tables 11, 12 and 13).

In order to determine net returns to the growers, prices of 3.8 cents per pound in the summer and 6.5 cents per pound in the winter were assumed for all three areas.[8] The average price per pound to the growers did not differ by very much between the islands as was reported by the Hawaii Crop and Livestock Reporting Service.[9]

[8]These prices were based on the interviews with the farmers and the data in Statistics of Hawaiian Agriculture, 1965, Hawaii Crop and Livestock Reporting Service, pp. 42 and 47.

[9]Statistics of Hawaiian Agriculture, 1965, Hawaii Crop and Livestock Reporting Service, June, 1966, p. 42.

Based on these prices and the representative yields reported by the growers, the gross returns from growing head cabbage per acre are shown in Tables 11, 12 and 13. Deducting the cost of production from the gross return gives the net farm earnings per acre per crop. In Kula the representative grower's net farm earnings per acre were $205.10 (summer) and $717.90 (winter); in Waimea $111.20 (summer) and $431.20 (winter); and others on Hawaii $53.70 (summer) and $419.90 (winter), as shown in Tables 11, 12 and 13. Of course these net returns are dependent on the assumed prices and yields. If either should vary, then there could be a great difference in the return.

A further breakdown was made in the tables in order to show the manager's share of the net farm earnings. To determine this return to management, a 6 percent interest on the investment has been deducted from the net farm earnings.

Judged by the representative grower's net farm earnings at each location, the head cabbage production in Kula is more profitable than in either location on the island of Hawaii. Production in Waimea (Kamuela) is slightly more profitable than in the others on Hawaii. However, in each area there are individual growers who have a higher net return than growers in the other areas. Consequently, more efficient growers on the island of Hawaii are able to compete effectively with the Kula growers.

Among the Kula growers there appeared to be no relationship between the size of operation and the net return per acre. Statistical tests indicate there were constant returns to scale from 4 to 45 years per year in the production of head cabbage on Maui.[10] In other words, the net return per acre neither increased nor decreased as the number of acres of head cabbage per year for a grower was expanded.

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[10]Using the Spearman Rank Correlation Test, the relationship of size of operation to net returns is not significant ($t = .32$ summer and $t = -1.12$ winter; d.f. = 16; a one tailed test; $t_{.01} = 2.58$ and $t_{.05} = 1.75$).

Table 11. Representative cost of and net return from producing head cabbage in Kula, Maui, Hawaii vegetable crop survey, 1966

Item	Cost per acre		Cost per pound	
	Summer ($/ac)	Winter ($/ac)	Summer (¢/lb)	Winter (¢/lb)
DIRECT COSTS:				
Labor	237.50	207.50	1.1	1.1
Materials	313.50	260.60	1.5	1.4
Gross income tax	4.00	6.20	n.a.	n.a.
Total direct costs	555.00	474.30	2.6	2.5
INDIRECT COSTS:				
Machinery and buildings	34.30	34.30	.1	.1
Rent	15.00	15.00	.1	.1
Total indirect costs	49.30	49.30	.2	.2
Total cost of production	604.30	523.60	2.8	2.7
Total gross return per acre (Summer 21,300 lbs/ac @ 3.8¢/lb) (Winter 19,100 lbs/ac @ 6.5¢/lb)	809.40	1,241.50	3.8	6.5
FARM EARNINGS:				
Interest on investment[a]	19.10	19.10	.1	.1
Net return to management	186.00	698.80	.9	3.7
Net farm earnings	205.10	717.90	1.0	3.8

[a] Interest was set at 6 % per year on the representative total investment.

Table 12. Representative cost of and net return from producing head cabbage in Waimea (Kamuela), Hawaii, Hawaii vegetable crop survey, 1965

Item	Cost per acre		Cost per pound	
	Summer ($/ac)	Winter ($/ac)	Summer (¢/lb)	Winter (¢/lb)
DIRECT COSTS:				
Labor	240.00	233.80	1.4	1.7
Materials	217.70	182.80	1.3	1.3
Gross income tax	3.20	4.60	n.a.	n.a.
Total direct costs	460.90	421.20	2.7	3.0
INDIRECT COSTS:				
Machinery and buildings	58.90	58.90	.3	.4
Rent	15.00	15.00	.1	.1
Total indirect costs	73.90	73.90	.4	.5
Total cost of production	534.80	495.10	3.1	3.5
Total gross return (Summer 17,000 lb/ac @ 3.8¢/lb) (Winter 14,250 lb/ac @ 6.5¢/lb)	646.00	926.30	3.8	6.5
FARM EARNINGS:				
Interest on investment[a]	29.40	29.40	.2	.2
Net return to management	81.80	401.80	.5	2.8
Net farm earnings	111.20	431.20	.7	3.0

[a] Interest was set at 6 % per year on the representative total investment.

Table 13. Representative costs and returns for producing one acre of head cabbage for the other areas on Hawaii, Hawaii vegetable crop survey, 1965

Item	Cost per acre		Cost per pound	
	Summer ($/ac)	Winter ($/ac)	Summer (¢/lb)	Winter (¢/lb)
DIRECT COSTS:				
Labor	277.50	320.00	1.6	2.0
Materials	245.60	245.10	1.5	1.5
Gross income tax	3.20	5.30	n.a.	n.a.
Total direct costs	526.30	570.40	3.1	3.5
INDIRECT COSTS:				
Machinery and buildings	51.00	51.00	.3	.3
Rent	15.00	15.00	.1	.1
Total indirect costs	66.00	66.00	.4	.4
Total cost of production	592.30	636.40	3.5	3.9
Total gross return (Summer 17,000 lb/ac @ 3.8¢/lb) (Winter 16,250 lb/ac @ 6.5¢/lb)	646.00	1,056.30	3.8	6.5
FARM EARNINGS:				
Interest on investment[a]	23.60	23.60	.1	.2
Net return to management	30.10	396.30	.2	2.4
Net farm earnings	53.70	419.90	.3	2.6

[a] Interest was set at 6 % per year on the representative total investment.

LABOR AND MANAGEMENT EARNINGS FROM HEAD CABBAGE PRODUCTION

The contribution of family labor to farm earnings can now be analyzed. In the previous analysis the enterprises were charged for family labor at a rate of $1.25 per hour. Whether or not this amount is actually paid to the family members it adds to the family income and must be included in the net farm return figure to give the actual family income from an acre of head cabbage.

In comparing the three areas this concept is especially important because the Kula and others on Hawaii growers used almost entirely family labor (Table 14). Only three of the 18 growers in Kula and one of the six growers in others on Hawaii hired workers. On the other hand, Waimea growers depended heavily on hired labor. All five of the interviewed growers in Waimea hired workers.

Table 14 shows the lowest, average, and highest percentages of the interviewed farmers' family labor for the three locations, plus the effect each of the percentages has on the income to the families in each situation. In Kula and the other areas on Hawaii the growers' farm operations allow this heavy dependence on family labor, but the Waimea (Kamuela) growers have larger farm operations and a wider variety of crops, some of which require intensive labor applications and they must therefore use hired laborers.

Because the Kula growers used less hired labor, the difference in family incomes between Kula and Waimea from an acre of head cabbage was greater than the difference in their net farm incomes per acre. One must remember that this return shown in Table 14 is per acre and not for an entire farm operation. It is possible for the Waimea (Kamuela) farmers to have a greater net return per year from all of their crops than the Kula and others on Hawaii farmers.

Table 14. Effect of family labor on family income in producing head cabbage, Kula, Waimea (Kamuela), and the other areas on Hawaii

	Range and average percentage of family labor			Income to family per acre of head cabbage		
	Kula	Waimea	Others	Kula	Waimea	Others
Lowest	80 %	39 %	53%	$ 395.10 (summer) $ 883.90 (winter)	$ 204.80 (summer) $ 522.40 (winter)	$ 200.80 (summer) $ 589.50 (winter)
Average	97 %	53 %	92 %	$ 435.50 (summer) $ 919.20 (winter)	$ 238.40 (summer) $ 555.10 (winter)	$ 309.00 (summer) $ 714.30 (winter)
Highest	100 %	75 %	100 %	$ 442.60 (summer) $ 925.40 (winter)	$ 291.20 (summer) $ 606.60 (winter)	$ 331.20 (summer) $ 739.90 (winter)

COSTS OF PRODUCING DRY ONIONS

As in the case of head cabbage, the cost of producing dry onions is based on practices and materials use reported by the interviewed farmers, though only in the Kula-Omaopio area on Maui. When the farmers were interviewed, they were asked about their usual practices under normal conditions.

Since there was a very definite difference in labor hours for producing dry onions, the growers were separated into two relatively homogeneous groups: low-labor producers and high-labor producers.

Indirect Costs

The cost per acre of the machinery and buildings allocated to the low-labor grower was $64.60 and to the high-labor grower, $57.80 (Table 15). The investment in various types of equipment is also given in Table 15.

A difference of $4,250 exists between the investments of the two types of growers (Table 15). The larger investment is due primarily to the head cabbage growers who have a larger total farm operation. The breakdown of equipment in Table 9 for the Kula head cabbage grower is very similar to that of the onion grower's equipment.

Direct Costs

Dry onion direct costs consist of the labor cost, the materials cost, and a gross income tax.

As was done before, the cost of labor was set at $1.25 per hour, which was the prevailing wage paid to hired workers. Both hired and family labor have been charged at this rate. The cost of labor, based on total labor hours per acre estimated in Table 7, for the representative low-labor producer was $420.00 and for the high-labor producer, $841.30 (Table 17).

There was no separation into summer and winter seasons since dry onions are usually planted one or two times in the winter or spring and harvested in the summer months.

Materials expenses are given in Table 16 for the two types of representative growers. These are the costs of seed, fertilizer, spray material, bags, gas and oil, and irrigation water.

Seed. All of the growers used 1½ pounds of dry onion seed for their seedbeds which produced enough seedlings for one acre.

Fertilizer. The cost of fertilizer for the low-labor producer was twice that of the high-labor producer. Based on survey observations, 1,130 pounds per acre of 8-20-5 was assumed to be applied by the low-labor grower. A much smaller amount of 630 pounds per acre of 8-20-5 was used by the high-labor grower. Four surveyed farmers in the first group also applied lime at a rate of 880 pounds per acre per crop of dry onions. This was not considered representative.

Table 15. Indirect cost of machinery and buildings, representative dry onion grower, Maui, Hawaii vegetable crop survey 1966

	Representative value of investment 1966[a]		Representative depreciation per year[b]		Representative per acre cost to the dry onion enterprise[c]	
	Low-labor producer	High labor producer	Low-labor producer	High-labor producer	Low-labor producer	High-labor producer
Irrigation equipment	$ 2132.00	$ 902.00	$ 186.00	$ 99.38	$ 9.10	$ 10.40
Implements	788.00	267.00	94.00	28.99	7.50	3.80
Sprayers	287.00	111.00	69.00	21.56	2.50	2.00
Garden tillers	114.00	105.00	26.00	17.16	2.20	2.90
Tractors	3279.00	2175.00	392.00	189.97	18.80	12.30
Trucks and pickups	1948.00	1591.00	310.00	243.56	21.30	17.20
Buildings and others	1062.00	210.00	78.76	33.73	3.20	9.20
Total	9610.00	5361.00			64.60	57.80

[a] Value of investment was calculated by first depreciating the original cost of each piece of equipment in order to determine the value. Next these values for each category were added and divided by the number of interviewed farmers.

[b] Depreciation per year was determined by dividing the purchase price of each piece of equipment by the number of years it could be used. These amounts were then added for each category and divided by the number of interviewed farmers. This depreciation also covers the cost of repairs and maintenance which is a relatively minor cost since the farmers do not extensively use their equipment.

[c] Per-acre cost to the dry onion enterprise was calculated by adding the depreciation per year for each item and reducing this to a per-acre basis. This was multiplied by the percentage of use of each item of the representative dry onion crop.

Table 16. Direct cost of materials for representative low labor and high labor dry onion producers, Kula-Omaopio, Maui, Hawaii vegetable crop survey, 1966

	Cost per acre (dollars/acre)	
	Low-labor producer	High-labor producer
Seed	$ 11.90	$ 6.90
Fertilizer	60.60	31.30
Spray materials	45.90	71.00
Bags	81.20	41.70
Gas and oil	29.90	37.70
Irrigation water	46.60	12.50
Total	$ 276.10	$ 201.10

Spray Materials. Reversing the previous difference, the high-labor producer used twice as many chemical sprays as did the low-labor producer. Many factors affect the amount of the various sprays used for each crop over the years, thus causing variation in the cost in each year and among the growers.

Bags. The growers used bags that hold 50 pounds each of dry onions. Both used and new bags were bought by the growers. The cost per bag was about the same as for the head cabbage bags: used bags cost 10 to 15 cents and new, 25 to 28 cents.

Because the low-labor producer had a slightly higher representative yield per acre and used more new bags, his bag cost was almost twice as much as the high-labor producer's. This cost was $81.20 per acre, which is 29 percent of the total materials cost. It was the highest materials cost for the low-labor grower.

Gas and Oil. There appeared to be very little difference in the cost of gas and oil per acre for the two groups.

Irrigation Water. The estimates were based on the growers' water bills per month for their entire farm and an estimate of the percentage of this bill used for dry onion production.

Total costs for materials were estimated at $276.10 for the representative low-labor producer and $201.10 for the representative high-labor producer.

Total Costs and Net Returns

Because of the much lower labor cost, the low-labor producer's representative total cost per acre was $784.00 as compared with $1,123.50 for the high-labor producer (Tables 17 and 18).

Table 17. Average cost of and net return from producing dry onions by a representative low-labor producer in Kula-Omaopio, Maui, Hawaii vegetable crop survey, 1966

Item	Cost per acre ($/ac)		Cost per pound (¢/lb)	
DIRECT COSTS:				
Labor	$ 420.00		2.2 ¢	
Materials	276.10		1.5	
Gross income tax	8.30		n.a.	
Total direct costs		704.40		3.7
INDIRECT COSTS:				
Machinery and buildings	64.60		.3	
Rent	15.00		.1	
Total indirect costs		79.60		.4
Total cost of production	784.00		4.1	
Total gross return (19,000 lb/ac @ 8.7¢/lb)	1,653.00		8.7	
FARM EARNINGS:				
Interest on investment	28.70		.2	
Net return to management	840.30		4.4	
Net farm earnings		869.00		4.6

Table 18. Average cost of and net return from producing dry onions by a representative high-labor producer in Kula-Omaopio, Maui, Hawaii vegetable crop survey, 1966

Item	Cost per acre ($/ac)		Cost per pound (¢/ac)	
DIRECT COSTS:				
Labor	$ 841.30		4.4 ¢	
Materials	201.10		1.1	
Gross income tax	8.30		n.a.	
Total direct costs		1,050.70		5.5
INDIRECT COSTS:				
Machinery and buildings	57.80		.3	
Rent	15.00		.1	
Total indirect costs		72.80		.4
Total cost of production	1,123.50		5.9	
Total gross return (19,000 lb/ac @ 8.7¢/lb)	1,653.00		8.7	
FARM EARNINGS:				
Interest on investment	38.10		.2	
Net return to management	491.40		2.6	
Net farm earnings		529.50		2.8

An analysis of the survey results shows similar yields per acre for the two groups. For this study both low-labor and high-labor producers were assumed to produce 19,000 pounds per acre. Consequently, the low-labor producer's total cost of production was 4.1 cents per pound. The high-labor producer had a higher cost of 5.9 cents per pound.

Assuming the price received by the dry onion growers on Maui was 8.7 cents per pound, then the net farm earnings were $869.00 per acre for the low-labor producer and $529.50 per acre for the high-labor producer.[11] In terms of return per pound, they were, respectively, 4.6 cents per pound and 2.8 cents per pound (Tables 17 and 18).

On the basis of this analysis it appears that the low-labor producer is more efficient and realizes a much higher net return per acre. He is also more typical because of the much larger number of growers that are represented by this group.

One must remember that these net returns are based on the stated yields and prices received by the farmers. If either should change, the net returns given in Tables 17 and 18 will be different.

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[11] Statistics of Hawaiian Agriculture 1965, Hawaii Crop and Livestock Reporting Service, p. 42.

LABOR AND MANAGEMENT EARNINGS FROM DRY ONION PRODUCTION

About one-third of the surveyed growers in each group depended to some degree on hired workers; the rest used only family labor. In order to determine the contribution of family labor to family income, the net farm income was added to the return to family labor in Table 19.

With this addition, the family income per acre of dry onions was higher for the high-labor producer than for the low-labor producer. However, since these families used twice as much labor to produce one acre of dry onions, they were not able to grow as many acres of dry onions or other crops per year as the low-labor producers.

Table 19. Effect of family labor on family income in producing dry onions in Kula-Omaopio, Maui, Hawaii vegetable crop survey, 1966

	Range and average percentage of family labor		Income to family per acre of dry onions	
	Low-labor producers	High-labor producers	Low-labor producers	High-labor producers
Lowest	45 %	86 %	$ 1058.00	$ 1214.80
Average	88 %	95 %	$ 1238.60	$ 1290.60
Highest	100 %	100 %	$ 1289.00	$ 1332.70

RESPONSE TO PRICE FLUCTUATIONS

An important aspect of the production of head cabbage and dry onions is the response of the farmers to price changes. Each interviewed grower was asked how he would respond to a price increase or decrease that would then remain fairly stable. Also, they were asked at what price level they would stop producing a certain crop.

In Kula, one-half of the head cabbage growers would not respond to an increasing or decreasing price; rather, they would maintain their present planting schedule and acreages. The remaining growers would double production of head cabbage if the price increased and stabilized at 6.8 cents per pound to the farmers. One-third of the growers would not stop growing head cabbage no matter what the price. One of the largest producers claimed he would not stop even at 1.0 cent per pound. Eleven of the 18 interviewed growers felt they would stop producing this crop if the price dropped to and stabilized at an average of 2.4 cents per pound.

A different situation exists on the island of Hawaii. The Waimea and others on Hawaii head cabbage growers were all responsive to price changes, in contrast to the Kula growers. Four of the five interviewed growers in Waimea would double their acreage if the price increased and stabilized at 8.0 cents per pound. Four would cut production in half if the price went down to a stable 4.0 cents per pound to the growers. The Waimea and others on Hawaii growers would stop growing head cabbage at 2.5 cents per pound.

Apparently the growers on Hawaii are willing and able to allocate their resources to other crops when the price of head cabbage declines. In contrast, the Kula growers are not as willing and may not be able to shift to other crops.

As for the dry onion growers, 7 of the 13 interviewed felt they would stop producing dry onions if the price dropped to an average of 5.5 cents per pound. The Kula onion growers who also grew head cabbage were not very responsive to price changes mainly because dry onion made up such a small portion of their overall operation.

SUMMARY AND IMPLICATIONS

Head cabbage production appears to be more profitable in Kula than in any of the other producing areas of the state. Kula does not have the lowest total cost per acre but it does have the highest yield and largest acreage, ensuring its predominance in head cabbage production. Reflecting this situation is the fact that Kula now produces 86 percent of the state's output of this crop. Furthermore, the farmers have allocated almost all of their resources to head cabbage production. Dry onions and a few other crops are also grown on a very small scale in this area. Specialization and relatively large acreages characterize the area.

In contrast, the Waimea growers and those in the other areas on Hawaii consider head cabbage as one of a number of alternative crop enterprises. The growers on this island feel they can only supply whatever demand for this vegetable that is not satisfied by Kula or the mainland. They are a potential source whenever the Kula crop is damaged by storms or insect infestations. These growers on the island of Hawaii can easily shift to other crops when the price declines, but the Kula growers cannot or do not shift as easily, which was clearly illustrated by their differing responses to price fluctuations.

The Kula growers depend heavily on family labor whereas the Waimea growers depend on hired workers for almost one-half of their labor supply. This suggests Kula could more easily survive a period of low prices than could Waimea. On the other hand, Waimea could more readily shift to other crops when faced with this situation.

Although there appear to be some labor economies in Kula as the size of operation is expanded, there seems to be no significant monetary economies. The net farm earnings per acre do not appear to be significantly different within a range from 4 acre to 45 acres per year of head cabbage.

Dry onions are produced by about 40 percent of the head cabbage growers. The acreage per farmer is limited to one or two acres per year because mainland competition limits the local market. Even though net farm earnings per acre are much higher than head cabbage, dry onions remain a minor enterprise. Furthermore, as compared with the head cabbage, the low-labor onion grower uses twice as much labor per acre, which means a Kula grower can handle two acres of head cabbage simultaneously or one acre of dry onions. The Kula growers is thus efficiently allocating his resources to his highest return.

Dry onion acreages tend to be larger and are more important as a crop alternative in Omaopio (Lower Kula), Maui. The growing of head cabbage is not as well suited to the climatic conditions in Omaopio. Even in this area dry onion production is a minor rather than a major enterprise. Lettuce, tomatoes, cucumbers, Chinese cabbage, and snap beans are also grown. Only about one-half of the farmers in Omaopio grow dry onions.

Since 94 percent of the state's head cabbage is locally produced, there is not much possibility for expansion by replacing mainland imports.[12] What will probably happen is that the location of production will shift even more to Kula, espe-

[12] Ibid. pp. 19 and 20.

cially if the price should decrease. In the near future, it appears feasible for the Kula area to expand head cabbage production. At present the area supplies approximately 81 percent of the Hawaiian market. Expansion of the area's production by about 30 acres more per year would be needed to replace present mainland imports. A 28-percent increase in total acreage, or 100 acres, would enable Kula to supply the entire market at present. If transportation rates from the mainland decrease, the area will face increased competition. If this occurs, it is likely that the less efficient Kula growers will drop out of farming, thereby allowing the more efficient growers to obtain more land for expanding their farm operations. Most of the Waimea and others on Hawaii growers would likely shift to other crops.

The dry onion situation is entirely different. Only 11 percent of the State's demand for dry onions is satisfied by local production, 10 percent being from the Kula-Omaopio area on Maui. One reason is that dry onions can be stored for long periods. Consequently, mainland dry onions can be shipped to Hawaii in good condition. Dry onions are not a major crop, even on Maui. If freight rates decline, the mainland sources may take over the entire market. This is not too serious since most producers plant this crop on a speculative basis and do not rely on it as a principal source of livelihood.

Since the completion of the Maui survey, one farmer in the Kihei area has shifted to a large scale, capital intensive, labor saving dry onion operation. If this development is successful, there will be major changes in dry onion production in this state.

APPENDIX A

Table A-1. Size distribution of head cabbage growers by acreage per year in Kula, Maui[a]

	0.0-3.9 ac/yr	4.0-9.9 ac/yr	10-14.9 ac/yr	15-24.9 ac/yr	25-34.9 ac/yr	35-45 ac/yr
Number of farmers growing head cabbage[b]	1	6	5	5	4	3
Average head cabbage acreage	3.0	7.0	12.0	16.0	26.0	41.0
Number of these farmers growing dry onions	1	1	1	3	0	2
Average acreage of dry onions[c]	3.0	.1	.2	.7	-	1.0
No. of head cab. farmers growing other veg. crops (includes dry onions)	1	4	3	4	1	2
Average acreage of other vegetable crops (includes h. cab.)	6.0	2.0	1.50	1.0	1.50	1.0
Average acreage per yr. of all veg. crops	9.0	9.0	13.5	17.0	27.5	42.0

[a] Source: Hawaii vegetable crop survey, 1965 and 1966; and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Six of these 24 farmers were not interviewed; one in the 0.0 to 3.9 group, three in the 4.0 to 9.9 group, one in the 10.0 to 14.9 group, and one in the 25.0 to 34.9 group.

[c] This is an average of all head cabbage growers in each group, even though some farmers do not grow this particular crop.

Table A-2. Size distribution of head cabbage growers by acreage per year in Waimea (Kamuela), Hawaii[a]

	0.0-3.9 ac/yr	4.0-9.9 ac/yr	10.0-14.9 ac/yr	15.0-24.9 ac/yr	25.0-above ac/yr
Number of farmers growing head cabbage[b]	2	5	1	0	0
Average head cabbage acreage	2.0	7.5	13.0	-	-
No. of these farmers growing lettuce	2	4	1	-	-
Ave. Ac. of lettuce[c]	20.0	14.0	4.0	-	-
No. of these farmers growing celery	1	3	1	-	-
Ave. Ac. of celery[c]	6.5	3.0	4.5		
No. of these farmers growing chin. cabbage	2	1	1	-	-
Ave. Ac. of chin. cab.[c]	13.0	4.0	9.5	-	-
No. of these farmers growing daikon	0	2	0	-	-
Ave. Ac. of daikon[c]	0	11.0	0		
Ave. Ac. of other veg. (excludes only head cab.)	50.0	34.0	18.25	-	-
Ave. Ac. of all veg.	52.0	41.5	31.25		

[a] Source: Hawaii vegetable crop survey, 1965 and 1966 and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Three of these eight farmers were not available for interviews, two were in the 4.0 to 9.9 size classification, and one in the 10.0 to 14.9 classification.

[c] This is an average of all the head cabbage growers in each group even though some of the farmers do not grow this crop.

Table A-3. Size distribution of head cabbage growers by acreage per year in Volcano, Hawaii[a]

	0.0-3.9 ac/yr	4.0-9.9 ac/yr	10.0-14.9 ac/yr	15.0-24.9 ac/yr	25.0-above ac/yr
Number of farmers growing head cabbage[b]	2	1	1	0	0
Ave. Ac. of head cabbage	.75	8.0	12.0	-	-
No. of these farmers growing lettuce	2	1	1	-	-
Ave. Ac. of lettuce[c]	20.4	19.5	13.5	-	-
No. of these farmers growing chin. cabbage[c]	0	1	1	-	-
Ave. acreage of chin. cabbage[c]	-	16.5	5.5	-	-
Ave. acreage per year of other veg. (no. h. cab.)	20.9	35.5	19.0	-	-
Ave. acreage per year of all vegetable crops	21.65	43.5	31.0	-	-

[a] Source: Hawaii vegetable crop survey, 1965 and 1966; and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Only one of these five growers was interviewed about head cabbage. He was in the 4.0 to 9.9 size classification.

[c] This is an average of all the head cabbage growers in each group even though some of the farmers do not grow this crop.

Table A-4. Size distribution of head cabbage growers by acreage per year for others on Hawaii (Honokaa, Keeau, Mt. View, and Pepeekeo)[a]

	0.0-3.9 ac/yr	4.0-9.9 ac/yr	10.0-14.9 ac/yr	15.0-24.9 ac/yr	25.0-above ac/yr
Number of farmers growing head cabbage[b]	6	1	0	0	0
Average head cabbage acreage	2.04	6.5	-	-	-
No. of these farmers growing cucumbers	5	1	-	-	-
Ave. Ac. of cucumbers[c]	3.70	1.0	-	-	-
Ave. acreage of other veg. (not head cab.)	7.72	4.5	-	-	-
Ave. acreage of all vegetable crops	9.76	11.0	-	-	-

[a] Source: Hawaii vegetable crop survey, 1965 and 1966; and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Two of these seven farmers were not interviewed; both in the 0.0 to 3.9 group.

[c] This is an average of all head cabbage growers in each group, even though some farmers do not grow this particular crop.

APPENDIX B

Table B-1. Size distribution of dry onion growers by acreage per year in Kula, Maui[a/b]

	Ac/yr	Ac/yr	Ac/yr	Ac/yr
No. of farmers growing dry onions	7	8	6	2
Average acreage of dry onions	1.0	2.44	4.58	8.5
No. of these farmers growing head cabbage	4	3	1	0
Average acreage of h. cab.[c]	10.21	8.23	.50	-
No. of these farmers growing lettuce	1	4	2	1
Average acreage of lettuce[c]	.11	1.05	1.17	9.75
No. of these farmers growing tomatoes	2	3	4	1
Average acreage of tomatoes[c]	.46	1.13	4.0.	8.0
No. of these farmers growing cucumbers	1	1	2	0
Average acreage of cucumbers[c]	.14	.25	1.13	-
No. of these farmers growing chinese cabbage[c]	0	3	3	0
Ave. acreage of chinese cab.[c]	-	.92	1.27	-
Ave. acreage of veg. other than dry onions	11.36	12.76	8.43	17.75
Ave. Ac of all veg. crops	12.36	15.20	13.02	26.25

[a] Source: Hawaii vegetable crop survey, 1965 and 1966; and the Agricultural Crop Analysts of the Hawaii Crop and Livestock Reporting Service.

[b] Of the 23 onion growers, only 12 were interviewed; 5 in the 0.0 to 1.9 group, 4 in the 2.0 to 3.9, 2 in the 4.0 to 5.9, and 1 in the 6.0+ group.

[c] This is an average of all the dry onion growers in each group, even though some of the farmers do not grow this particular crop.

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