14 The Effect of a Short-Lived Plantation on Income, Consumption, and Nutrition: An Example from Papua New Guinea

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Agricultural Commercialization and Nutrition Problems in the Study Setting

This case study captures the story of a short-lived, temporarily successful, yet unsustainable commercialization project. Many such commercialization projects have surfaced and disappeared soon after in low-income countries (see chapter 9), and little is known about their effects on people's welfare, including children's nutrition.

Papua New Guinea is well endowed with natural resources relative to its population. In 1980, the population was 3.0 million and was projected to reach 4.0 million by 1991. Agriculture is the most important sector of the economy, supporting, directly or indirectly, about 85 percent of the population and, according to the 1993 World Bank *World Development Report*, accounting for about 26 percent of the GDP and 35 percent of exports. At the time of the 1980 census, over 90 percent of rural households and over 80 percent of all households were dependent on small-scale farming systems, which combine subsistence food production with variable amounts of cash cropping (DPI 1984).

The main food staples are root crops (sweet potato, taro, and yams) and sago, with bananas being an important co-staple in some areas and a secondary staple in others. The value of subsistence production is not well documented, but recent estimates indicate that subsistence food cultivation accounts for approximately half the total value of agricultural production (World Bank 1988b).

The extent and type of involvement of the rural population in cash

Based on work done by the authors for a joint project by the Papua New Guinea Institute of Medical Research, Madang, and the Department of Agricultural Economics and Business Management, University of New England, Armidale, Australia. The project was originally funded by the Australian Centre for International Agricultural Research (ACIAR). ACIAR also contributed funds for the preparation of this chapter.

cropping varies with the region of the country, itself a determinant of the nature and length of contact with Europeans, the cash crops produced, and the mode of production. The most important cash crops are coffee, cocoa, coconuts, oil palm, tea, and rubber. Cardamom is also produced now. These cash crops are produced mainly for export; together, they earned 80 percent of Papua New Guinea's nonmining export income and 33 percent of all export income in 1986 (World Bank 1988b). In the early 1970s, plantations provided three-quarters of total production, but by the mid-1980s smallholders accounted for 70 percent of total production. The majority of the smallholders are based in villages, but there are increasing numbers located on land settlement schemes, group-owned blocks, and subdivided plantations.

Malnutrition is a significant health problem in Papua New Guinea. Estimates from the 1982–83 National Nutrition Survey indicate that approximately 38 percent of children under five years of age were below 80 percent of the Harvard standard for weight-for-age (Heywood, Singleton, and Ross 1988). The general growth pattern is of a rapid decline in weight-for-age during the first year of life and a continuing but much slower decline over the next four years, at the end of which approximately half the children are below 80 percent of the standard (Heywood 1983).

Debate has been vigorous, but inconclusive, about the nutrition effects of increased participation by rural households in Papua New Guinea in the cash economy through shifts from subsistence crops to cash crops (Lambert 1979; Hide 1980; Harvey and Heywood 1983). Cash cropping has been associated with increased food imports, leading to concerns about food dependency and national and local food security. Increases in cash incomes have led to increased supplementation of traditional diets with imported foods, chiefly canned fish and rice.

The Cardamom Plantation at Karimui

The Karimui census division is in the southern part of the mountainous Simbu Province. The area is remote, accessible only by small aircraft or on foot. About 5,000 people live in dispersed hamlets on the plateau of an extinct volcano, about 1,100 meters above sea level. Almost all households grow subsistence crops, chiefly sweet potatoes, in a slash-and-burn farming system. Most households also own small plots of cash crops. The main smallholder export cash crops are coffee, cardamom, and chillies. Peanuts and other crops grown in excess of family needs may also be sold locally.

Smallholder cardamom production in Karimui commenced in the early 1970s. Production remained at a low and fluctuating level through

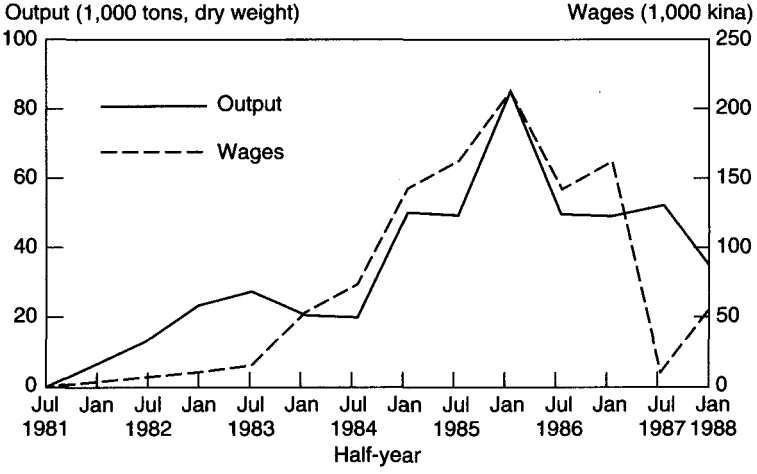
the 1970s, due to management and marketing difficulties. In 1978, local smallholders formed the Karimui Cardamom Growers Association (KCGA), with the immediate aim of improving marketing and a long-term aim of establishing a nucleus plantation to dry and market smallholder production. In 1981, a new company, Karimui Spice Company (KSC), 70 percent of whose equity was owned by the KCGA and 30 percent by the provincial government, was granted lease over 230 hectares (later increased to 388 hectares) to establish a plantation. By 1985, 300 hectares had been planted. The even distribution of rainfall, combined with high expenditure on agricultural inputs, resulted in very high yields (over 300 kilograms of dry cardamom per hectare per year), compared to the major producer, India, where average yields are approximately 120 kilograms per hectare per year.[1]

The plantation provided an important source of paid employment to men for clearing forest, planting, and maintenance; and to men, women, and children for harvesting. By mid-1987, the KSC employed about 260 male laborers for maintenance and grading and about 300 female pickers. Picking was on a casual employment basis, with a high turnover of pickers from one picking fortnight to the next. Since labor was abundant and people (especially women) were eager to work, the KSC was usually assured of sufficient pickers to harvest the crop. The flexible picking program allowed women to work on the days convenient to them.

Despite increasing cardamom production (figure 14.1), high costs resulted in capital shortages for the KSC. The capital constraint that had prevailed throughout the development stage of the project was exacerbated by a drought that reduced production in 1987. The situation reached a crisis point in the latter part of that year with banks and agricultural produce suppliers demanding to be paid. In November and December 1987, laborers' wages were reduced (figure 14.2), most laborers were laid off, and maintenance was reduced to a minimum for several months while graders processed the existing stock. Low prices and poor quality of the cardamom, combined with destruction of the new cardamom-curing facility by fire, prevented the company from solving its financial problems. A second consecutive dry year (1988) resulted in low production, making financial management of the plantation difficult. By October 1989, the plantation and facilities were closed.

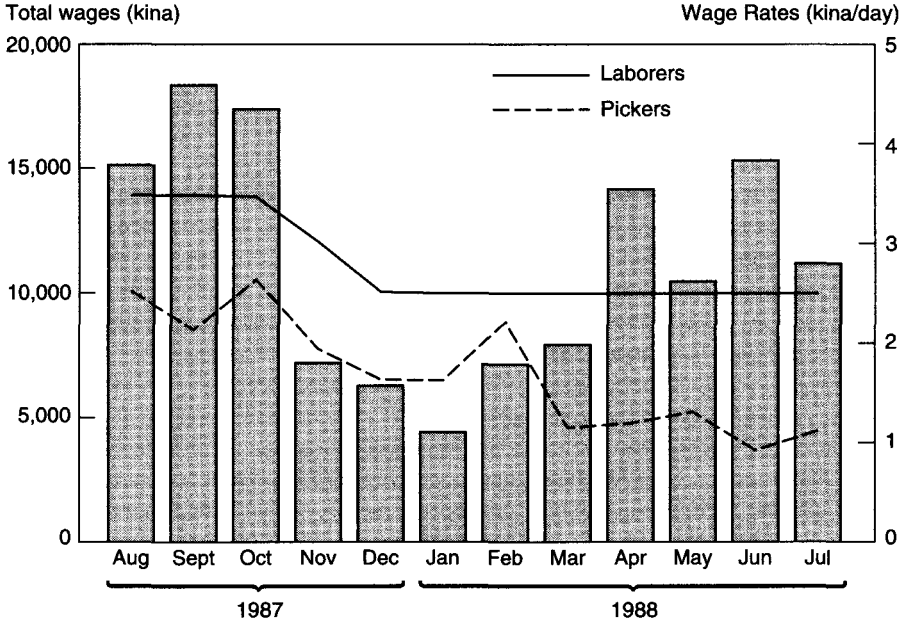
1. The major producers of cardamom are India and Guatemala, each contributing about one-third of the annual world production of 10,000 tons. Cardamom is largely consumed in the Middle East, South Asia, and, to a lesser extent, Europe. Cardamom price is variable and determined by production levels and quality of cardamom in the two main producer countries, which, in turn, are affected by seasonal growing conditions. Lower grades of cardamom are severely penalized on the world market.

FIGURE 14.1 Cardamom production and wages at the Karimui Spice Company, July 1981 to June 1988



Source: Finlayson et al. (1991).

FIGURE 14.2 Total wages paid and daily wage rates at Karimui Spice Company, August 1987 to July 1988



Source: Finlayson et al. (1991).

This chapter evaluates the effects of wage incomes at Karimui on the nutritional status of young children on the basis of a detailed one-year study conducted between July 1987 and August 1988, when the KSC was already generally in decline. Thus, this case study captures commercialization-nutrition linkages under adverse circumstances.

Research Design and Analytical Framework

The settlement patterns in the area, the distances between villages, the lack of vehicular access, and the necessarily high intensity of data collection dictated selection of households in clusters. Three clusters were chosen to represent a range of distances from the cardamom plantation and, hence, varying degrees of involvement in the cash economy.[2]

Initial selection and stratification of households were based partly on household wage employment status. The most significant factor affecting cash incomes during the course of the study was KSC's changing economic situation. By January 1988, almost all KSC laborers had been laid off, and picking had ceased. Alternative opportunities for wage employment were limited. When the company recommenced operations, wage rates for "permanent" (male) laborers were reduced from K3.50 per day, which had been paid during the early part of the study, to K2.50 per day. Rates for pickers (mainly women) were maintained at K0.25 per kilogram, but lower cardamom yields, which resulted from lower rainfall and also, perhaps, from changes in management practices, meant generally lower rates of pay per day by the end of the study period.

In much of the analysis below, the results are presented separately for two consecutive periods:

- The first period, from July 1987 to January 1988, which corresponded to the time when employment and wage income was falling;
- The second period, from February 1988 to August 1988, which corresponded to the time when employment increased temporarily and then fell once more.

Sample Household Characteristics

For the purpose of this analysis, households were grouped into wage-earning and non-wage-earning categories in each survey period. Households earning more than K6.00 per fortnight in wages, or spending more than 10 percent of surveyed days in wage employment, were

2. Details of survey and study design are in Finlayson et al. (1991).

classified as wage households; all others were classified as nonwage households. There were 34 nonwage and 53 wage households in the first survey period and 38 nonwage and 49 wage households in the second survey period. Fourteen wage households from the first period became nonwage households in the second period, and 10 nonwage households from the first period became wage households in the second period.

The size of surveyed households varied from 3 to 21 persons. To control for variation in household size and composition, the analysis was carried out on an adult-equivalent basis (Finlayson et al. 1991). There were small differences between nonwage and wage groups in the age of household head, size of household (adult-equivalents), and educational standard of the household head (grade), but they were not found to be significant.

Ownership of land is traditionally by clans. The right of a household to use of land is established by clearing virgin forest, and subsequent rights to use that land are usually passed on patrilineally. Land was not a scarce resource in the sample villages, although utilization of available land appeared to be more difficult as distance from villages to new land increased.

Households obtained food from both cultivated and uncultivated land. The size of cultivated food gardens varied considerably between households, as did the type of crops grown. Food trees were grown in abandoned food gardens or forest. Wage households had lower average total garden areas than nonwage households in both periods, but the only differences between wage and nonwage households that were statistically significant were those for coffee garden areas ($p < 0.05$) and total garden areas ($p < 0.01$), in the second period (table 14.1).

Coffee, cardamom, and chillies are perennial crops grown for sale. Eighty-six percent of households had coffee gardens, and 31 percent had cardamom gardens. The average areas were small—for both these cash crops, the average area across all surveyed households was 0.27 hectares.

The division of labor in domestic agricultural activities remains pronounced at Karimui. Men perform tasks such as cutting forest and making fences and houses, while women (including teenagers and young girls) are responsible for burning and clearing the undergrowth and planting, maintaining, and harvesting food gardens. Females cook, take care of children, and perform other domestic activities more often than males. Females are involved in wage employment as frequently as males and, overall, perform production and income-generating activities more frequently than males (Finlayson et al. 1991).

The sample households lacked material possessions, with few capital assets other than houses, land, and crops, indicating the limited extent to which the economy has changed from subsistence to an emergent cash

TABLE 14.1 Selected demographic features and crop areas of nonwage and wage households, Papua New Guinea, 1987–88

Feature	Nonwage Households		Wage Households	
	Period 1[a]	Period 2[b]	Period 1[a]	Period 2[b]
Number of households	34	38	53	49
Household wage (kina/fortnight)[c]	1.71	1.53	15.50	16.48
Age of household head (years)	39.3	37.9	38.0	38.9
Education of household head (years)	1.4	1.5	1.9	1.8
Household size (adult-equivalent)	4.8	4.6	5.2	5.0
Number of food trees	13.1	12.7	12.2	12.5
Food garden area (square meters/adult-equivalent)	803	769	671	646
Coffee area (square meters/adult-equivalent)	650	674*	317	271*
Cardamom area (square meters/adult-equivalent)	239	318	124	53
Total area (square meters/adult-equivalent)	1,692	1.761**	1,112	969**

SOURCE: Surveys undertaken by the authors.
[a]July 1987–January 1988.
[b]February 1988–August 1988.
[c]K1.00 = US$1.1256, averaged over the duration of the study.
*Significant difference at the 0.05 level.
**Significant difference at the 0.01 level.

economy. Almost all households owned their own house (built from local materials) and, on average, had two axes, two to three bush knives, and a spade—tools important for food production. Only a few households owned tools for maintenance of cash crops such as pruning saws, coffee pulpers, or secateurs.

Household Income Sources and Role of Wages

Average net income levels[3] per adult-equivalent per fortnight for wage and nonwage households were similar (table 14.2). Subsistence income for nonwage households was significantly higher than for wage households in the second survey period, with an increase in subsistence food production being the main contributor to the difference. Food gifts received by households significantly increased in the second period for

3. Net income is defined as follows: (subsistence food production + food gifts received + animal sales + cash crop sales + market sales + wages + trade store receipts + cash gifts/traditional exchange received) − (food gifts given + farm inputs + animal costs + trade store inventory purchases + cash gifts/traditional exchange given).

TABLE 14.2 Household income and expenditure of nonwage and wage households, Papua New Guinea, 1987–88

Income and Expenditure	Nonwage Households		Wage Households	
	Period 1[a]	Period 2[b]	Period 1[a]	Period 2[b]
	(kina per adult-equivalent per fortnight)			
Income				
Subsistance income	6.69[c]	9.81	6.12	7.20[c]
Subsistence production	5.91	6.92	5.53	4.86[d]
Food gifts received	0.78[c]	2.89	0.59	2.34
Farm production	1.04	0.81	1.32	0.88
Farm (animals/cash crops)	0.55	0.33	0.73	0.50
Market (subsistence surplus)	0.49	0.47	0.59	0.38
Off-farm income	4.22[c]	2.07	7.33[c]	5.73[c]
Wages	0.49	0.39	3.80[e]	3.67[e]
Karimui Spice Company wages	0.31	0.31	2.46	2.36
Other wages	0.18	0.08	1.32	1.31
Cash gifts received	3.02[d]	1.17	2.93	2.02
Store receipts	0.71	0.51	0.60	0.04
Total income	10.91	11.88	13.45	12.93
Expenses				
Inputs	0.05	0.17	0.27	0.39
Animals	0.10	0.03	0.12	0.03
Store inventory purchases	0.90	0.48	0.85	0.14
Cash given away	1.78	0.67	3.01[c]	2.14[d]
Food gifts given	0.24	0.50	1.01[c]	0.29
Total expenses	3.07	1.85	5.26	2.99
Net income	7.84	10.03	8.19	9.94

SOURCE: Surveys undertaken by the authors.

[a]July 1987–January 1988.

[b]February 1988–August 1988.

[c]Significant difference at the 0.05 level, same group.

[d]Significant difference at the 0.01 level, between groups.

[e]Significant difference at the 0.001 level, between groups.

both wage and nonwage households. The value of farm production for both wage and nonwage households fell during the latter part of the study, but the difference between the two survey periods and between the two groups of households was not significant. Farm inputs for wage households were larger, on average, than for nonwage households, while expenditures for the purchase of animals and store inventory were simi-

lar for both. In the second period, there was a reduction in the average amount spent on animals and store inventory.

As expected, wage households received significantly more off-farm income than nonwage households in both periods. Nonwage households earned significantly less off-farm income in the second period than in the first, mainly due to a reduction in receipts of cash gifts, reflecting the contraction of the cash economy. Although fortnightly wage earnings from KSC fell sharply during the first period, then recovered somewhat and fell again late in the second period, average wages received were not significantly different between the two periods for either the wage or nonwage groups. Thus, the averages hide to a large extent the considerable fluctuation in wage incomes that many households suffered over the full period of the study, and they particularly hide the fall in wage incomes during the first six months.

The fall in wage rates from KSC coincided with low household sales of coffee and cardamom. Coffee sales were reduced, in part, because of the discovery of coffee rust in the region. Yields were reduced by the rust itself, but also by coffee renovation practices that included stumping of existing plants to combat rust and permit new growth to occur.

The relatively high values of food and monetary transfers shown in table 14.2 indicate that gifts and exchanges are important components of the Karimui socioeconomic network. The differences between food gifts received and food gifts given may be due, in part, to some underreporting of food given away before returning to the house, where most of the recording was done. Consequently, subsistence production may be undervalued, but the estimates of subsistence consumption should not be affected.

Differences in the ability or willingness to be employed contributed to considerable inequality of cash incomes between sample households. Comparing the distributions of wage and nonwage households by income tercile and survey period shows that there was a higher percentage of wage households than nonwage households in the upper income tercile, but the difference was not significant for either period, or overall, using a chi-square test at $p < 0.10$ level of significance.

Females contributed 86 percent of the total value of subsistence food and accounted for 53 percent of total income (cash and subsistence) (table 14.3). These percentages exclude the contribution males make in establishing food gardens by felling trees and fencing the area.

Household Expenditure and Energy Availability Effects

Household expenditure is defined net of the costs and transfers already deducted in the calculation of net income (see table 14.2). On

TABLE 14.3 Mean cash and subsistence income received by males and females over ten years of age, by source of income, Papua New Guinea, 1987–88

Income Source	Males[a]	Females[b]
	(kina/capita/fortnight)	
Wages	3.82	1.60
Farm sales	1.55	0.95
Cash gifts	5.32	0.73
Store receipts	1.20	0.01
Total cash receipts	11.89	3.29
Value of subsistence food	2.07	12.49
Total	13.96	15.78

SOURCE: Adapted from Finlayson et al. 1991.

NOTE: Average across all sample households for the full recording period (26 fortnights)

[a]1.64 males over ten years of age per household.

[b]2.37 females over ten years of age per household.

average, about 70 percent or more of household expenditure was allocated to food by both wage and nonwage households (table 14.4). Wage households spent significantly more on store and market foods than did nonwage households in both periods. Store foods were more expensive in terms of energy or protein than local foods when the latter were valued at prevailing average market prices. For example, sweet potatoes provided approximately 83 kilocalories per toea, while rice supplied approximately 37 kilocalories per toea (1 toea = 0.01 kina).

Subsistence sources, including forests and gifts, supplied most of the average energy consumed in both nonwage and wage households. Subsistence gardens and other "tree" food plants (such as sago, breadfruit, and pandanus) contributed, on average, about 80 percent and 70 percent of available energy for nonwage and wage households, respectively. Overall, while nonwage households apparently had more available food energy (2,800–3,100 kilocalories per adult-equivalent per day), on average, than wage households (2,400–2,600 kilocalories), the difference was significant only in the second survey period. Nonwage households obtained significantly more energy from subsistence food gardens in both periods than did wage households. Conversely, as expected, wage households obtained significantly more energy from purchased food than nonwage households for both periods.[4]

4. It should be noted, however, that the methods of data collection for food from purchased and nonpurchased sources were different, and the possibility of overestimation of subsistence consumption for nonwage households cannot be discounted. If it were present, it would explain at least part of the apparent difference in energy availability between the wage and nonwage households.

TABLE 14.4 Expenditure shares of foods and nonfoods of nonwage and wage households, Papua New Guinea, 1987–88

Expenditure Category	Nonwage Households		Wage Households	
	Period 1[a]	Period 2[b]	Period 1[a]	Period 2[b]
	(percent)			
Food	69.8	83.5	61.4	72.0
Subsistence food	56.7[c]	73.1	38.0[c]	54.4[d]
Store food	9.5[e]	5.3	13.0[e]	11.8[e]
Food gifts given	2.1	3.9	7.5[d,e]	2.3
Market food	1.5	1.2	2.8[e]	3.5[f]
Cash gifts given	15.6	7.6	22.5[d]	16.4[d]
Store inventory expense	7.9	3.7	6.3	1.1
Animals	1.0	0.2	0.9	0.2
Farm inputs	0.4	1.3	2.0	3.1
Other expenditure	5.4	3.6	6.9	6.8[d]
	(kina/adult-equivalent/fortnight)			
Total expenditure	11.38	12.74	13.41	12.69

SOURCE: Surveys undertaken by the authors.

[a]July 1987–January 1988.

[b]February 1988–August 1988.

[c]Significant difference at the 0.05 level, between periods, same group.

[d]Significant difference at the 0.05 level, between groups, same period.

[e]Significant difference at the 0.01 level, between periods, same group.

[f]Significant difference at the 0.001 level, between groups, same period.

What are the effects of changed sources and levels of income on household food energy availability? In general, calorie availability may be expected to increase with increases in net income. In addition, subsistence foods will be replaced by purchased foods as the proportion of income earned as cash rises. Unless there is perfect substitution, the proportion of income earned as cash will affect the amount of food energy available. Hypotheses about these possible impacts on energy availability are tested using the combined cross section and two-period time series of observations from the sample households. In interpreting the results, the reservations already noted about the reliability of the subsistence data should be kept in mind.

Females at Karimui were involved in income-producing activities on more surveyed occasions than were males (Finlayson et al. 1991). Males earned more cash per capita than females, but females contributed a greater value of subsistence food. It is hypothesized that the proportion of cash income received by females had a significant and positive effect on the amount of food energy available for consumption at the household level.

Certain household characteristics may also have affected the availability of energy. In particular, the effect of household size on available food energy is explored in the model. Finally, the market prices of the main food staples—sweet potatoes, taro, and cooking bananas—are expected to have affected the availability of energy.

Regression analysis suggests that energy availability increased with net income. The elasticity of energy availability with respect to income, evaluated at the mean of the observations, is 0.34 (table 14.5). The proportion of total income earned as wages was found to have a negative, but insignificant, effect on energy availability. The share of cash income to females in the household had a significant and positive effect on the level of food energy available. Household size appeared to have a significant and negative effect on energy availability, suggesting that, in larger households, there was less food per adult-equivalent. The price of staples was found to have a negative, but insignificant, effect on food energy available for consumption.

Morbidity and Nutritional Status Effects

Nutritional status in the Karimui census division is poor in comparison with many other parts of the country. Cross-sectional anthropometric surveys in 1981 (Harvey and Heywood 1983) and 1985 (Groos 1988), respectively, showed 47 and 41 percent of children under five years of age to be less than the 80 percent weight-for-age standard, using the

TABLE 14.5 Regression analysis of energy availability

Explanatory Variable[a]	Parameter	*t*-Value	Mean	Standard Deviation
TOTINC	100.7005	3.459	9.9757	6.0974
TINCSQ	−.0163	−.014	136.4787	155.4409
PROPWAGE	−251.7340	−1.321	.2348	.3773
PROPFEM	5.9633	2.040	36.5527	24.9242
STAPRICE	−42.4235	−.891	10.1696	1.4597
AVADEQ	−82.1084	−2.772	4.9189	2.4227
Constant	2,355.8876	4.496	—	—
R^2	0.3852			

NOTE: The dependent variable is kilocalories per adult-equivalent per day.
[a]Definitions of variables:
TOTINC = total net disposable income in kina per adult-equivalent per fortnight.
TINCSQ = $(\text{TOTINC})^2$.
PROPWAGE = proportion of total income from wages.
PROPFEM = percentage of cash income obtained by females.
STAPRICE = staple price index.
AVADEQ = household size in adult-equivalent.

Harvard growth standards. While there appeared to be a general improvement in nutritional status, Groos (1988) found that children of mothers who had been working at the KSC did not show the same level of improvement on all indices of nutritional status as did other children in South Simbu. By 1987, the generally favorable trend appeared to have been reversed, since 43 percent of children surveyed were less than 80 percent of the standard weight-for-age (Groos and Hide 1989).

Since morbidity and nutritional status appear to be interrelated in many situations (Lehmann, Howard, and Heywood 1988), fortnightly recall surveys of morbidity were carried out by selected symptoms for mothers, and children under five years of age. Six broad categories of symptoms were considered in the analysis of factors affecting growth: diarrhea, breathlessness/pneumonia, fever, coughs, nasal/upper respiratory tract infections, and all others. In general, the frequency of sickness increased with age for young children, reaching a peak at about 12 months of age and decreasing thereafter. Children aged between 51 and 56 months in the first period, and between 57 and 62 months in the second period, were sick almost as often as those in the 15- to 20-month age group.

Diarrhea was found to be important in explaining growth and nutritional status of children. Diarrhea generally occurred more frequently in the first period than in the second, with children between 9 and 20 months having the highest incidence for both periods. Comparison of the frequency of episodes of diarrhea by net income tercile and household wage status indicates that in nonwage households the frequency of diarrhea declined with increasing levels of income, while, conversely, in wage households, the frequency of diarrhea increased with increasing levels of income (table 14.6). The causes of these relationships are not clear at this stage.

TABLE 14.6 Frequency of diarrhea in children of nonwage and wage households, by income tercile, Papua New Guinea, 1987–88

	Percentage Frequency of Diarrhea[a]	
Income Tercile	Nonwage Households	Wage Households
1	7.5 (49)	7.4 (56)
2	6.9 (51)	9.7 (54)
3	5.6 (28)	10.5 (64)
Total	6.8 (128)	9.2 (175)

SOURCE: Surveys undertaken by the authors.

NOTE: Number of observations are in parentheses.

[a]Every two weeks, mothers were asked if their under-five-year-old children had diarrhea in the previous two weeks.

Anthropometric measurements of sample children were made three times during the study, at approximately six-month intervals. Nutritional indices were calculated using U.S. National Center for Health Statistics standards. Averages for each index and the percentage of individuals below commonly accepted cut-off points for children from wage and nonwage households are presented in table 14.7. Children who were less than three months of age at the end of either the first or the second interval were left out of the analysis for that interval. On average, the nutritional status of children from nonwage households and wage households was not significantly different. However, in some cases, a greater percentage of children from wage households were below cut-off points for the indices of nutritional status.

Overall, rates of change between survey rounds for each nutritional index were similar for children from wage and nonwage households. However, children from nonwage households in the lowest income tercile appear to be worse off than children from wage households, while, in

TABLE 14.7 Means of three nutritional indices and percentages of children below cut-off points for each index for Karimui children, by nonwage and wage households, Papua New Guinea, August 1987, February 1988, and August 1988

	Nonwage Households			Wage Households		
Nutritional Index	Mean of Standard (percent)	*N*	Below Cut-off Point[a] (percent)	Mean of Standard (percent)	*N*	Below Cut-off Point[a] (percent)
Weight-for-age						
August 1987	83.7	117	39*	81.6	171	47*
February 1988	83.6	128	38*	80.4	174	44*
August 1988	81.8	127	48*	79.3	172	52*
Height-for-age						
August 1987	92.5	113	30	92.5	168	30
February 1988	92.0	128	32	91.2	174	36
August 1988	91.2	127	48	90.9	172	36
Weight-for-height						
August 1987	96.0	112	26	93.6	164	37
February 1988	97.0	128	22	94.6	174	31
August 1988	96.6	127	14	94.0	172	30
Average age (months)						
August 1987	23.3	117		24.0	171	
February 1988	28.9	128		27.5	174	
August 1988	34.0	127		32.1	172	

SOURCE: Surveys undertaken by the authors.

[a]Unless otherwise indicated, the cutoff point is 90 percent. An asterisk indicates a cut-off point of 80 percent.

the upper-income tercile, children from nonwage households appear to have made greater improvements in their nutritional status than children from wage households.

Children's nutritional status is influenced by age, sex, genetics, and factors such as morbidity and food intake. Chronically low levels of available food energy can be expected to result in low levels of attained nutritional status. Two sets of models are specified to examine the effects of household energy availability and other factors on nutritional status. In one set of models, the dependent variables are changes in the percentage points of the three nutritional indices per month in the two intervals between anthropometric measurements. The corresponding independent variables relate to measurements within the corresponding periods. The growth of young children is very sensitive to changes in their health, and these models are designed to reveal any short-term impacts of health on growth.

Results indicate that measures of initial nutritional status and age were generally the most powerful explanators of change in the nutritional status of young children (table 14.8). Models for all three indicators show that children who started the growth interval with poor nutritional status had greater rates of improvement in nutritional status than those who were better off initially. The effects of age were more complex, as reflected in the coefficients on the variances of MIDAGE and AGESQ.

Availability of food energy at the household level had an insignificant effect on change in the nutritional status of children. The share of available energy from purchased sources was also found to have an insignificant effect on weight and height rates of growth. The frequency of diarrhea was found to be significant and negative in its effect on change in percentage of standard height-for-age. The effect of being weaned was negative on the rate of change in percentage standard for all nutritional indices, and, to a significant degree, in the case of weight-for-height growth. The sex of child and size of household were not found to be significant predictors of rate of change of nutritional status.

In the set of models in table 14.9, on the other hand, factors affecting the attained level of nutritional status are examined, using, as dependent variables, percentages of standard of three nutritional indices at both the midpoint and the end of the study. For the midpoint observations, the independent variables were measured over the first period only, whereas those for the observations at the end of the study are averages over both periods. In interpreting the results in table 14.9, therefore, the data limitations should be recognized. That is, although attained nutritional status reflects the longer-term impacts of nutrition and other factors on growth of children, energy consumption, frequency

of diarrhea, and weaning status are based on one year of observations at most, and, in about half the cases, on only six months of observations. Effects on the attained level of nutritional status of events that occurred before the time of data collection obviously could not be included in the models.

Age had significant negative impacts on nutritional status in all three models (table 14.9). Boys generally had lower scores than girls, and children being weaned did less well than others in terms of weight-for-height. As expected, diarrhea had a negative effect overall on the nutritional status of children and significantly so for weight-for-age and height-for-age. Frequency of diarrhea over the survey period appears to have had a significant negative effect on height-for-age, while a child's recent history of diarrhea (in the previous fortnight) was shown to have a significant and negative effect on weight-for-age, but an insignificant impact on weight-for-height. Energy availability had a significant and positive effect on height-for-age. Negative coefficients on KCALSQ indicate diminishing returns to increased availability of energy. The coefficient for the share of available food coming from purchased sources was not significant.

Conclusions

The experience of the KSC underscores that long-term viability of small- and medium-scale export-oriented agricultural projects depends upon adequate capital and sound financial management. Management and administrative skills are often lacking, particularly in marketing and in cash flow and risk management. Technical assistance is therefore an essential ingredient in these areas as well as in the more generally recognized areas of agronomy and postharvest processing.

The failure of the KSC demonstrates the riskiness of export crop production. Planners in Papua New Guinea need to give more thought to ways of reducing these risks. Some spreading of risk will usually be possible by diversification. For example, cardamom production could have been combined at KSC with production of other cash crops, such as coffee. Or, smallholder production of cash crops could have been encouraged in parallel with the development of the plantation. In many areas of the country there is scope for smallholder growers to expand food production for local sale, often with lower production risks than production of cash crops for export. To exploit this scope more fully, major improvements may be required in the food marketing system, including transportation services, handling, market facilities, and market information.

The experience at Karimui demonstrates that there are important

TABLE 14.8 Regression models for change in percentage of standard for weight-for-age, height-for-age, and weight-for-height per month of children in sample households

Explanatory Variable[a]	Mean	Model 1: Change in Percentage Weight-for-Age/Month (mean = −.2489) Parameter	Model 1 *t*-Value	Model 2: Change in Percentage Height-for-Age/Month (mean = −.1608) Parameter	Model 2 *t*-Value	Model 3: Change in Percentage Weight-for-Height/Month (mean = .0835) Parameter	Model 3 *t*-Value
MIDAGE	28.12	.0312	1.971	.0153	2.731	−.0535	−2.939
AGESQ	1,074.76	−5.4E-04	−2.017	−2.5E-04	−2.420	1.1E-04	1.975
SEX	.51	−.1531	−1.184	.0127	.277	−.2665	−1.767
AVADEQ	5.50	.0038	.134	−.0049	.488	.0096	.289
WEAN	.63	−.6232	−3.774	−.0866	−1.490	−.96318	−4.945
WAMED	82.34	−.0530	−8.841	—	—	—	—
HAMED	92.12	—	—	−.0316	−5.722	—	—
WHMED	95.15	—	—	—	—	−.1011	−11.503
DIAR	8.21	.0056	.799	−.0061	−2.474	.0138	1.662
KCAL	2,652.26	2.0E-04	.676	6.7E-05	.663	1.1E-04	.315
KCALSQ	8.2E+06	−2.6E-08	−.550	−1.1E-08	−.669	−1.2E-09	−.022

EXPCAL	12.34	.0047	.608	.0029	1.053	−.0032	−.352
Constant		3.8424	4.900	2.5152	4.586	10.8810	9.839
R^2		.29393		.22031		.39000	
$\hat{R}^2$		.26966		.19352		.36904	
F-value		12.11377		8.22249		18.60513	
Degrees of freedom		291		291		291	

[a]Definitions of variables:

MIDAGE	= mid-interval age in months.
AGESQ	= (age)^2
SEX	= male = 1, female = 0.
AVADEQ	= household size in adult equivalent.
WEAN	= pre/post = 0 weaning = 1.
WAMED	= initial percent standard weight-for-age.
HAMED	= initial percent standard height-for-age.
WHMED	= initial percent standard weight-for-height.
DIAR	= percent of occasions of diarrhea in the fortnight preceding anthropometric measurement.
KCAL	= available energy in kilocalories per adult-equivalent per day.
KCALSQ	= (available energy)^2.
EXPCAL	= percent of available energy that was purchased.

TABLE 14.9 Regression model for attained levels of anthropometric standards of children

Explanatory Variable[a]	Mean	Model 1: Weight-for-Age (mean = 80.92) Parameter	Model 1 *t*-Value	Model 2: Height-for-Age (mean = 91.26) Parameter	Model 2 *t*-Value	Model 3: Weight-for-Height (mean = 95.40) Parameter	Model 3 *t*-Value
AGE	30.87	−.3761	−2.809	−.2045	−3.788	−.4183	−4.068
AGESQ	1,238.42	.0050	2.373	.0023	2.745	.0056	3.483
SEX	.51	−2.4920	−2.346	−1.1149	−2.604	−1.2632	−1.549
BIRTHNUM	4.04	.0643	.260	.1716	1.718	−.3078	−1.617
HEIGHT	150.10	.6328	5.313	.2953	6.151	.1066	1.166
WEAN	.63	−.6453	−.472	.4760	.864	−3.0483	−2.905
DIAR	8.21	−.1173	−2.019	−.0630	−2.691	−.0319	−.714
KCAL	2,652.26	.0030	1.156	.0021	2.067	−2.9E-04	−.147
KCALSQ	8.2E+06	−3.1E-07	−.779	−2.8E-07	−1.731	1.3E-07	.411
EXPCAL	12.34	.0045	−.068	.0324	1.217	−.0683	−1.346
Constant		−11.4508	−.616	46.7110	6.238	89.9921	6.307
R^2		.19593		.25248		.17106	
$\hat{R}^2$		.16830		.22679		.14258	
F-value		7.09098		9.82883		6.00518	
Degrees of freedom		291		291		291	

[a]Definitions of variables:

AGE	= age in months.
AGESQ	= (age)^2
SEX	= male = 1, female = 0.
BIRTHNUM	= birth order (first = 1, etc.).
HEIGHT	= mother's height in centimeters.
WEAN	= pre/post = 0, weaning = 1.
DIAR	= percent of occasions of diarrhea.
KCAL	= available energy in kilocalories per adult-equivalent per day.
KCALSQ	= (available energy)^2.
EXPCAL	= percent of available energy that was purchased.

advantages where commercial plantation crop production can be introduced in a manner that is compatible with the preservation, to a large degree, of the integrated smallholder subsistence/cash cropping system. Not only does the low-investment smallholder system provide a platform from which efforts to attain economic growth in the rural sector can be launched, but it can also serve as a fallback should commercial cropping fail. Planners need to be alert to the dangers of those types of rural development that prematurely cut people off from their subsistence base and, therefore, place at risk the sustainability of more intensive, commercially oriented production systems.

An evaluation of the relationship between agricultural commercialization and nutritional status of children at Karimui indicates that long-term household food security is affected by the level of involvement in the wage labor economy, which can affect the nutritional status of young children. In general, however, these food intake effects are small compared with the nutritional impacts of morbidity and weaning practices. There is an urgent need to improve the long-term health of the community through improvements in hygiene and sanitation, maintenance of health services, and improvements in education about nutrition and weaning practices.

Analyses show that, at the time of this study, households that engaged in wage labor employment had approximately the same income level as households that remained, more or less, out of the wage labor market. However, wage households apparently had less available energy, on average, and significantly less in the second half of the study. Wage households that were more reliant on purchased foods appeared to be at a disadvantage in terms of access to food energy when employment opportunities declined. Nonwage households generally had larger garden areas than wage households, which seemed to provide greater food security. The fact that there were not more severe food shortages may be attributed, in part, to the flexible employment system at KSC—which permitted villagers to largely maintain their food gardens while intermittently engaging in employment—but also to the traditional social support system that involved considerable giving of gifts of food and money.

Energy availability was higher in households with greater proportions of cash income received by females. The opportunities offered by the KSC facilitated women's access to cash—a rather unusual situation compared to other rural areas of Papua New Guinea. The results emphasize the important role of women in the commercialization of the rural economy. Not only are women involved in earning cash to buy food and other necessities through wage labor or through marketing of surplus subsistence agriculture produce, but they also have the main

responsibility for maintaining food supplies for the household for subsistence food gardens.

Neither the level of available food energy nor the share from purchased food appears to have had a significant overall effect on changes in the nutritional status of young children. However, when cumulative effects of availability and source of food energy on attained nutritional status were examined, some response to household calorie availability was found for the height-for-age of children.

The prevalence of diarrhea had a very negative effect on children's weight-for-age and height-for-age. Results presented here thus suggest the need for complementary inputs from the health sector. Children who had diarrhea more often had slower growth rates in height-for-age than other children. Curiously, rates of growth in weight-for-age and weight-for-height were not affected significantly by the prevalence of diarrhea. Furthermore, children from wage households with higher income levels showed a trend toward higher prevalence of diarrhea. Although it is not clear at this stage what factors are most important in determining diarrheal morbidity at Karimui, experience in other areas suggest that weaning patterns, water supply, sanitation, access to health services, and quality of child care are likely to contribute to the prevalence of diarrhea.

Risk from fluctuating export cash crop prices, unreliable marketing systems, and crop disease have encouraged Karimui farmers to seek alternatives to smallholder cash cropping as a means of earning money. The cardamom spice plantation provided alternative opportunities in the form of wage labor. However, poor management and unseasonable conditions undermined the viability of the plantation. Karimui people are now forced back on to their traditional resources in their efforts to support themselves and also to find opportunities to participate in the cash economy. In view of their recent experiences, the people may now view other commercial agricultural ventures with healthy skepticism. Benefits may flow if the lessons of the KSC collapse are learned and if people exercise more caution before cutting back too sharply on their subsistence production activities.