Inter-household variations in subsistence strategies within a rural society of Roviana, Solomon Islands: An analysis of agricultural production and cash income in relation to socio-demographic factors

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Abstract   Since several decades ago, rural societies in Solomon Islands have experienced rapid socioeconomic changes due to the direct and indirect influences of commercial logging operations by foreign companies on their customary lands. This study aims to explore household level subsistence patterns and their variations within a rural society that was subjected to the logging operation in the recent past, in Roviana, Western Province. Crop yield (MJ) and cash income (SBD: Solomon Islands Dollar) were compared among households and adjusted for the consumer unit (CU) and producer unit (PU), respectively. The results indicated large inter-household variations for both of these variables. Multiple regression analyses showed that the variation in crop yield was primarily explained by the available labor force (PU), while that in cash income was determined by the householders' participation in SDC, a local enterprise founded using a portion of royalty money, as well as the labor force. It is suggested that an individual's experience in generating and increasing cash income in local environments increases his/her household's economic level.

Keywords: Inter-household variation, rural development, socioeconomic factor, multiple regression analysis, Roviana, Solomon Islands

INTRODUCTION

In the Solomon Islands in Melanesia rapid population growth and the introduction of market economy took place later than many other developing countries. This country has been in the early stage of economic development and its rate of annual population growth was 2.8% between 1986 and 1999-higher than that of most countries in the Asia-Pacific region (Solomon Islands Government, 2000). On the other hand, its PPP (purchasing power parity) GNI per capita of 1,520 international dollars in 2002 was lower than the average for the low-income countries in the region (World Bank, 2002).

In the Solomon Islands, 84% of the total population lives in the rural sector (Solomon Islands Government, 2000). Villagers have depended on shifting cultivation of tubers, and supplemental fishing, gathering and hunting of natural resources. Since several decades ago, however, commercial logging by foreign companies, and less frequently by the Solomon Islands government, has been conducted in many places. These lands have been traditionally owned and managed by kinship groups and are called "customary land". Timber has become the country's main economic activity as timber sales accounted for more than 50% of total exports in the late 1990s (Department of National Development, 1999). This commercial logging provides the local inhabitants with employment opportunities and forest use royalties. Although the logging seriously deteriorates forest environments (Bennett, 2000; Furusawa *et al.*, 2004), it contributes to improvement of the villagers' living environments through construction of infrastructure, such as schools and health facilities, increases in the villagers' cash income, and emergence of local entrepreneurs (Hviding & Bayliss-Smith, 2000).

In such process of development, inter-household variation in subsistence strategies increased in rural as well as urban societies. Some households remained dependent on agriculture, while others began cash-earning activities, such as selling marine resources and retailing, in addition to agriculture, and some became totally dependent on regularly salaried professional or entrepreneurial work (Hviding & Bayliss-Smith, 2000). To understand the effects of recent socioeconomic changes from a human-ecological viewpoint (Little & Haas, 1989; Ohtsuka & Suzuki, 1990; Moran, 1990), it

is necessary to elucidate subsistence patterns at the household level.

This study aims to explore household-level subsistence patterns in a changing socioeconomic environment. To this end research was conducted in Olive, a rural village subjected to logging operations in the recent past, in Roviana Lagoon, Western Province. Special attention was paid to detect the socio-demographic determinants for inter-household variations in survival and possible contributions to better living standards for the people in Asia-Pacific tropics.

THE REGIONAL CONTEXT

Ecological Settings

A Roviana-speaking population, approximately 12,000 in number (Solomon Islands Government, 2000), inhabits Roviana Lagoon, which extends from Koqu Kalena Bay to the Munda area in the southern part of New Georgia Island, Western Province, Solomon Islands. The average maximum and minimum temperatures were 30.3°C and 24.2°C (in 1993), respectively, and the mean annual rainfall was 3458 mm, with little seasonal variation from 225 mm in October to 390 mm in February (averages from 1987 to 1993), according to the records at Munda, the meteorological station for Roviana (Statistics Office, 1995).

In Roviana Lagoon, there are four customary lands owned and controlled by clans or lineages (hereafter called "tribes"): Saikile Land in the east, Kalikoqu Land in the center, and Kazukuru Right-hand Land and Left-hand Land in the west. This study was conducted in Olive Village in Saikile Land (250 km² in area), which includes Ha'apai, Nusa Hope, Baraulu Villages and several small hamlets.

Historically, the most important subsistence activity of Roviana people has been shifting cultivation. According to the traditional pattern, this cultivation system was based on rotational use of lands, requiring large land areas for cultivation and fallowing; several times more land than the land under cultivation was needed for regeneration of trees for fertilization of soil (Clarke, 1966; Maenu'u, 1977; Whitmore, 1998). In addition, the agriculture of Roviana was the mixed cultivation of tuberous crops (e.g. sweet potato, cassava, taro, and yam), vegetables (e.g. slippery cabbage (*Hibiscus manihot* L.), egg plant, and pumpkin), and nuts and fruits (e.g. papaya and *Canarium* nuts). Since the land used for such a small-scale agriculture in Melanesian societies is generally called a garden, cultivation land is termed garden in this paper.

Socioeconomic Backgrounds

According to oral history, all Roviana people living in any part of Roviana Lagoon are descendants of the Kazukuru tribe, who inhabited the inland part of Kazukuru Right-hand Land until the 16–17th century (Aswani, 1999; Sheppard *et al.*, 2000). The members of Saikile tribe (1,711 in number in 1997 according to government records; Statistics Office, 1997) were descendants of children of intermarriages between migrants from Kazukuru Right-hand and indigenous inhabitants (original landowners) of Saikile in the 18th century. As such, land owning rights have seldom been transferred to other tribes. Communal land use, which was the prevailing land use system in traditional Melanesia (Ward & Kingdon, 1995; Ward, 1997), is still common.

Economic development has come slowly to this region because there are no roads from the villages in Roviana Lagoon to commercial centers (only waterway transportation is available); consequently Saikile people have had few opportunities to earn a cash income. However, in 1984 commercial logging started in Saikile Land, triggering change by providing the people with employment and royalty money. The royalty money was initially paid to the paramount chief of Saikile tribe every year, and then distributed equally to the leader of each of the 10 sub-tribes that have descended from a chief and nine key elders two to three generations before. Within each sub-tribe, the money was paid to elders by the leader and further distributed to their children and grand children. In addition, a local enterprise, Saikile Development Company (SDC), was founded just after logging commenced with the initiative of the chief and the elders of the tribe using a portion of the royalty money. The activities of SDC included transport of cargo, wholesales, fishery, coconut and cocoa plantations and saw milling. SDC activities provided employment opportunities and a cash income source for the people, within their customary lands. Unfortunately, almost all such activities discontinued by the mid-1990s because they did not provide adequate amounts of money. The profits from the logging company, employment and royalty payments, had also been decreasing since 2001 because of the removal of a campsite and intra-tribe disputes about the operation. In 2003, only a small number of villagers were employed at a small-scale saw-milling and fishery organizations that were managed by the chief and elders.

PARTICIPANTS AND METHODS

Study Village

Data were collected in Olive village from July 2003 to February 2004. All inhabitants of Olive, numbering 357 in 65 households in 2003, were engaged in shifting cultivation of tuberous crops, such as sweet potato and cassava, for their own consumption and participated, to various extents, in cash-earning activities, such as collection of marine resources. To collect detailed data, 15 households (60 male and 52 female members in total) from Olive were randomly selected.

Data Collection

One of the authors (TF) stayed for 19 months in Roviana to gain a better understanding of various aspects of human-environment relationships, speaking the local Roviana language and participating in various villagers' activities. Permission for the research was given by the chiefs and elders of the local communities, as well as the Solomon Islands Government (Minister for Education and Training and Director of Immigration Office). All of the data presented in this study were collected after oral informed consents were obtained from the head and all other members of each household.

Areas of all gardens (lands under cultivation) of the participant households were measured. To calculate land productivity, all crops harvested from gardens, including tubers, vegetables, and nuts and fruits, were weighed everyday for 14 consecutive days; TF routinely (five to seven times per day) visited the households for weighing from morning (08:00) until night (20:00). The amount of harvest (hereafter called 'crop yield') is expressed as the energy contained (MJ); energy contained in the harvested crops was calculated, referring to food composition tables for the Pacific region (Dignan *et al*., 1994; Puwastien *et al*., 2000); edible portions of plant foods were estimated according to Umezaki (1999) and Kagawa (2001).

All adults in the participant households were also visited by TF every evening for the 28 consecutive days and asked about the amount and source of cash income as well as the amount of cash expended by purpose. The latter half of the 28-day period, i.e. 14 days, overlapped with the above-mentioned study period for measuring harvests from gardens. Net income from retailing was calculated based on the amounts earned and expended for necessities.

To compare the amounts of produced foods and money among the households, the consumer unit (CU) and producer unit (PU) were applied. In this study, the CU of a household was defined as the sum of each members' energy requirements (FAO/WHO/UNU, 1985), since it was generally assumed that foods or commodities were distributed proportionately according to each individual's energy requirements (Ohtsuka *et al*., 1985; Umezaki *et al*., 1999). The CU of an adult male with average body weight (62.8 kg) was defined as 1.0, and each individual was calculated on the basis of relative energy requirement taking sex, age, body weight, and reproductive status into account. Food energy requirements of lactating or pregnant women were assumed to be 2100kJ (500 kcal) or 850 kJ (200 kcal) higher than those of non-lactating and non-pregnant women, respectively, of the same age and body weight.

The PU was defined as 1 for all 18–70-year-old males or females, but 0 for the others. This was because, according to the authors' observation, the elders over 70 years old seldom conducted agricultural and cash-earning activities, while other adults and adolescents (18 years and older) of both sexes played major roles in both agricultural and cash-earning activities. Children, who usually engaged in house-keeping and firewood collection, were not counted as laborers since their contributions for either agricultural production or cash income were minimal in this society, as well as other Melanesian societies (Umezaki *et al*., 1999; 2000). The ratio of CU to PU (CU/PU) was regarded as an index for how many persons' consumptions (adjusted as the number of adult males in this study) one adult supported in production.

In the research conducted in 2001 and 2003, male and female householders (e.g., a male household head and his spouse, or a widowed female and her first son in a female-headed household) of each household were asked about the duration (in years) after marriage, migrations to town/stays in town, educational experience (higher than primary school education or not), and the amount of royalty paid by the logging company during the past one year. The total CU values of each participant household in 2001 and in 2003 were used to calculate per-CU royalty received in 2000 and 2002, respectively.

Interviews also included questions about whether any household members were employed at the logging company SDC, or other workplaces outside their customary land and whether any members had been employed elsewhere before 1984, when the logging operation began in the Saikile land. To assure accuracy, both householders confirmed data and information. In addition, the years of marriage were verified by referring

to the written record if available, and when not by well-known dates, such as the Independence Day and the date logging operations in this area commenced.

Statistical Analyses

Coefficient of variance (CV) was calculated as the SD (standard deviation) divided by the mean. The Wilcoxon rank test was used for inter-household comparisons. Spearman's rank correlation analysis was used to explore correlations between the subsistence variables and the household socioeconomic variables.

Multiple regression analysis was performed to elucidate the household variables that determined the amount of cash income and crop yield. The variables inputted in the models were selected by the stepwise method from the following variables: the per-CU amount of royalty received in 2000 and in 2002, age, birthplace (others = 0, Saikile = 1), educational experience (no = 0, yes = 1), experience living in town (no = 0, yes = 1) of male and female householders, any members' experience of paid labor (no = 0, yes = 1) and professional occupation before logging (no = 0, yes = 1), job at the logging company (no = 0, yes = 1), SDC (no = 0, yes = 1), and another job outside their customary land (no = 0, yes = 1), duration of marriage and ratio of consumer unit to producer unit (CU/PU). Significance levels for both entry (SLE) and staying (SLS) were set at 0.15.

All statistical analyses were made using SAS version 8.2. A P value of <0.05 was considered to be statistically significant.

RESULTS

Variations in Ecological and Economic Variables

Table 1 shows ecological variables of the participant households. Coefficient of variation (CV) for CU/PU showed moderate inter-household variation (CV = 0.27), while those for the number of members (0.41), CU (0.39), and PU (0.47) were high. Variation was much larger for cash income (CV = 0.92 for unadjusted net cash income (SBD) per day) than for agricultural variables (CV = 0.60 and 0.63 for unadjusted garden area (m^2) and unadjusted crop yield (MJ) per day, respectively). In addition, when adjusted either by CU or PU, CVs decreased for agricultural variables (i.e. CV = 0.47 and 0.51 when adjusted by CU, and CV = 0.44 and 0.38 when adjusted by PU, respectively for garden area and crop yield), but changed little for cash income (CV = 1.05 when adjusted by CU and 0.94 by PU).

In the table, households are shown in increasing order of CU/PU, which indicates how many consumers (adjusted as the number of adult males) one laborer (adjusted as one adult) supported. Relations of household demographic compositions (i.e. CU/PUs) with agricultural variables (i.e., garden area (m^2) per CU and crop yield (MJ) per day per CU) and those with cash-economical variable (net cash income (SBD) per day per CU) were different, indicating that the strategy in each household was also influenced by other factors. For instance, although households M, N, O with higher CU/PUs (M: 2.5; N: 2.5; and O: 3.1) had lower crop yield

Table 1. Ecological and economic variables of 15 households in Olive. The households were sorted by the order of CU/PU

Household	No. of members	CU[a]	PU[b]	CU/PU	No. of gardens	Cultivation area (m^2)			Crop yield (MJ) per day			Net cash income[d] (SBD[e]) per day		
						Unadjusted[c]	Per CU	Per PU	Unadjusted[c]	Per CU	Per PU	Unadjusted[c]	Per CU	Per PU
A	3	2.4	2	1.2	2	515.3	215.9	257.6	16.8	7.1	8.4	12.4	5.2	6.2
B	5	3.9	3	1.3	2	660.5	169.3	220.2	24.5	6.3	8.2	18.8	4.8	6.3
C	13	9.9	7	1.4	3	1572.4	159.4	224.6	48.9	5.0	7.0	7.6	0.8	1.1
D	10	7.6	5	1.5	1	1023.1	135.5	204.6	17.6	2.3	3.5	12.1	1.6	2.4
E	6	4.6	3	1.5	1	796.2	172.2	265.4	16.8	3.6	5.6	46.9	10.1	15.6
F	6	5.0	3	1.7	3	548.2	108.9	182.7	17.2	3.4	5.7	4.6	0.9	1.5
G	4	3.4	2	1.7	1	679.4	199.7	339.7	13.3	3.9	6.6	2.5	0.7	1.2
H	12	8.6	5	1.7	5	2305.9	268.6	461.2	45.2	5.3	9.0	21.1	2.5	4.2
I	12	9.0	5	1.8	2	656.2	73.3	131.2	24.7	2.8	4.9	11.1	1.2	2.2
J	7	5.4	3	1.8	2	849.7	156.9	283.2	14.3	2.6	4.8	3.0	0.6	1.0
K	5	3.8	2	1.9	3	1168.7	310.4	584.3	17.2	4.6	8.6	5.6	1.5	2.8
L	6	4.4	2	2.2	1	530.6	119.9	265.3	2.8	0.6	1.4	11.2	2.5	5.6
M	8	7.4	3	2.5	2	412.1	55.8	137.4	17.8	2.4	5.9	2.7	0.4	0.9
N	7	4.9	2	2.5	2	596.6	121.1	298.3	13.4	2.7	6.7	6.6	1.3	3.3
O	8	6.1	2	3.1	2	387.7	63.2	193.9	5.3	0.9	2.7	16.4	2.7	8.2
Mean	7.5	5.8	3.3	1.8	2.1	846.8	155.3	270.0	19.7	3.6	5.9	12.2	2.5	4.2
SD	3.0	2.2	1.5	0.5	1.1	510.8	72.3	119.7	12.5	1.8	2.2	11.2	2.6	3.9
CV	0.41	0.39	0.47	0.27	0.50	0.60	0.47	0.44	0.63	0.51	0.38	0.92	1.05	0.94

[a] An adult male with average body weight (62.8 kg) was defined as 1.0 CU (consumer unit), and each individual was labeled by a relative ratio on the basis of his/her energy requirement (FAO/WHO/UNU, 1985).
[b] PU (producer unit) was defined as: adults with 18–70 years of age = 1 and other individuals = 0.
[c] Per-household value without adjusted by CU or PU.
[d] Net income from retailing was calculated based on the amounts earned and expended for necessity.
[e] 1 SBD (Solomon Islands Dollar) ≒ 0.14 USD in the study time.

per CU (M: 2.4 MJ; N: 2.7 MJ; and O: 0.9 MJ) than the average (19.7 MJ), cash income per CU was low in M (0.4 SBD), moderate in N (1.3 SBD), and high in O (2.7 SBD).

Figure 1 shows each household's net cash income, broken down by the source type, per CU per day. The main economic activity was selling marine resources, such as *Nassarius* shells, (used as traditional currency in Papua New Guinea) and sea cucumbers. All households but one (household O) earned income by selling marine resources; this activity contributed to 55.9% of the total income on average, ranging from 9.2% to 100% among the households, except for O. Three households (D, H, and B) had income from wage labor within the customary land. In addition, two households (O and A) depended greatly on remittance from relatives. Crop yield (MJ) per day per CU was also shown in the figure; the majority of crop yields was from tuberous crops, such as sweet potato and cassava. Crop yield per CU and cash income per CU were not correlated ($r = 0.29$, $p = 0.29$).

Although households L and O were characterized by a low crop yield and high cash income, their strategies for income were different. Household O, which consisted of an 80-year-old male head and his two daughters and five grandchildren, depended totally on the remittance from a daughter's husband. In contrast, in household L the male

head, who had stayed and worked in town until one year before the study period, earned money by selling marine resources, the common method in the village. The two households (B and A), which had highest crop yields and higher cash income than the other households except for E, also earned money from different sources, though both of them depended on modernized commercial activities for cash income (i.e., remittance and wage labor), supplemented by selling local marine resources. Household E, which ran a small-scale retail business, achieved the highest income, most of which came from selling marine resources. This household engaged in buying *Nassarius* shells from other villagers and selling them to traders outside the village, resulting in it earning a larger amount of money than other households.

Factors Relating to Cash Income and Crop Yield
Table 2 shows the associations between the household characteristics and crop yield per day per CU and net cash income per day per CU for the participant households. Cash income differed significantly between the households with and without members engaged in logging jobs as manual laborers and between the households with and without female householders born in Saikile. As shown in Table 3, crop yield per day per
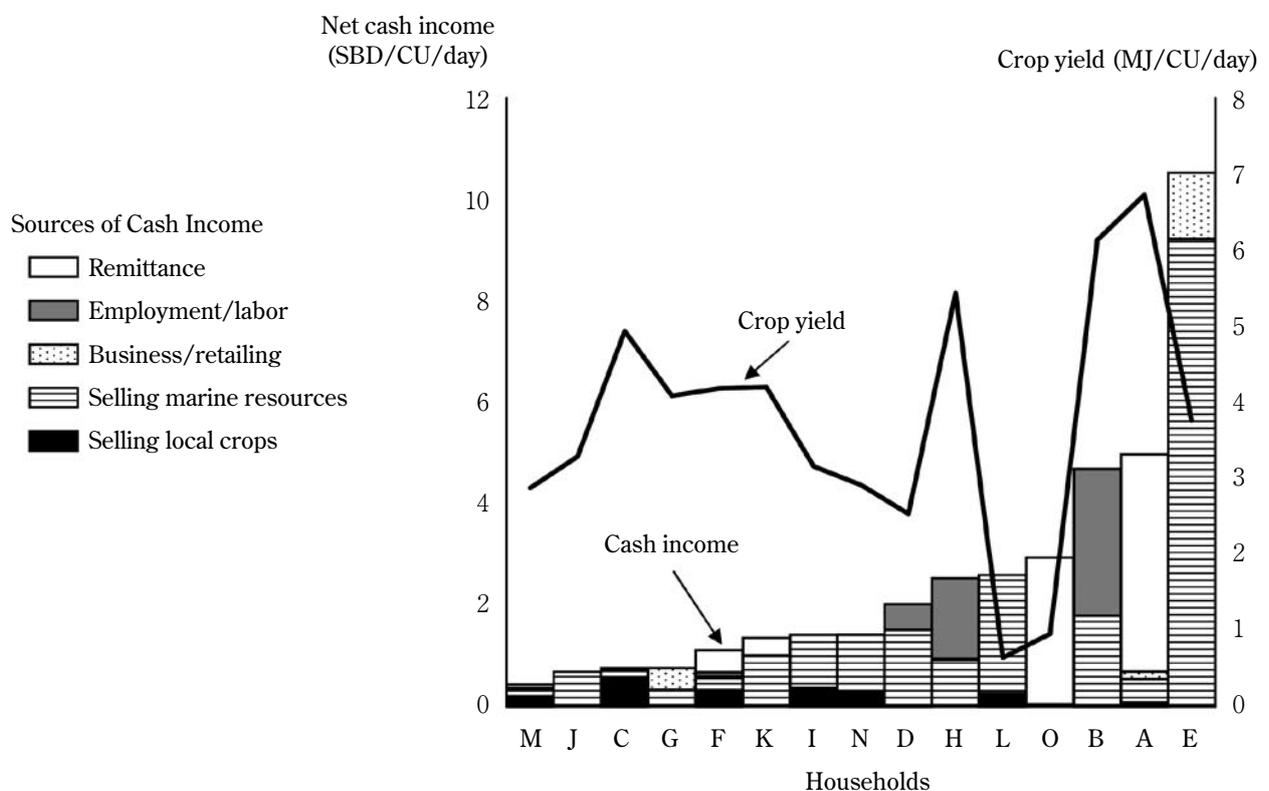

Fig. 1. **Cash income by source and crop yield of each household per day per CU. The households were arranged by the order of total amount of cash income per CU.**

CU was negatively correlated with CU/PU. The amount of royalty, which was much higher before removal of the camp from the area near to Olive in 2000 than after removal of the camp in 2002, was correlated with neither cash income nor crop yield in both years. Table 4 shows the regression models for clarifying the significant predictors of per-CU cash income per day and crop yield per day; seven and four independent variables were selected for the former and the latter, respectively, by stepwise method. Both variables were determined by demographic pattern (i.e., CU/PU) when other variables were adjusted. Employment at SDC was a positive determinant for cash income, but negative for crop yield, though other socioeconomic variables, such as secondary education and members' jobs outside the customary land, had negative effects on the former and no effects on the latter.

DISCUSSION

It has generally been assumed that a small-scale society is homogeneous in terms of subsistence activities, while the economic levels of households in an economically developed society are diversified. This study, however, showed that the inter-household variation was large in both agricultural production and cash income in a rural society in Solomon Islands. It was reported that the variation for crop yield increased as modernization gradually progressed in rural societies in Papua New Guinea, though the variation in such societies were much smaller than that shown in the present study (Umezaki *et al.*, 2000). In addition, the variation in the cash income per CU in the study village was higher than that of the urban settlers (CV = 0.62, N = 8) of Port Moresby, Papua New Guinea (Umezaki & Ohtsuka, 2003). It is thought that the rapid socioeconomic changes in the Solomon

Table 2. Comparisons of cash income/CU and crop yield/CU of Olive households according to household characteristics (N = 15)

	N	Net cash income (SBD)/CU/day		Crop yield (MJ)/CU/day
Member's job in pre-logging period (manual labor)				
yes	2	108.4 ± 53.2		3.69 ± 4.30
no	13	62.6 ± 74.3		3.73 ± 1.35
Member's job in pre-logging period (professional occupation)				
yes	2	30.2 ± 20.5		2.91 ± 0.53
no	13	74.6 ± 75.8		3.85 ± 1.79
Member's job at the logging company				
yes	5	128.8 ± 92.5	*	3.51 ± 2.69
no	10	38.6 ± 35.6		3.83 ± 1.11
Member's job at SDC				
yes	3	118.0 ± 143.9		3.50 ± 0.86
no	12	56.4 ± 11.8		3.78 ± 1.87
Member's job outside the customary lands				
yes	2	31.0 ± 14.8		4.15 ± 0.08
no	13	74.5 ± 76.0		3.66 ± 1.82
Male's birthplace				
Saikile	14	63.2 ± 71.4		3.51 ± 1.53
Others	1	146.0		6.73
Female's birthplace				
Saikile	11	86.0 ± 77.4	*	3.88 ± 1.96
Others	4	20.9 ± 11.7		3.29 ± 0.56
Male's secondary education				
yes	4	56.4 ± 53.3		4.24 ± 1.47
no	11	73.2 ± 79.6		3.54 ± 1.80
Female's secondary education				
yes	1	20.5		4.09
no	14	72.1 ± 73.5		3.70 ± 1.76
Male's stay in town				
yes	8	50.4 ± 42.8		3.65 ± 1.65
no	7	89.6 ± 95.1		3.82 ± 1.87
Female's stay in town				
yes	4	49.1 ± 33.3		2.25 ± 1.70
no	11	78.9 ± 82.9		4.26 ± 1.40

* *P* <0.05; Wilcoxon rank test.

Table 3. The mean (± SD) of numerical variables of Olive households and their correlations with cash income/CU and crop yield/CU (N = 15)

		Correlation coefficients	
	Mean ± SD	Net cash income (SBD)/CU/day	Crop yield (MJ)/CU/day
Royalty (SBD) in 2000/CU	1024.4 ± 506.1	− 0.20	0.05
Royalty (SBD) in 2002/CU	108.6 ± 116.9	0.32	− 0.07
Duration of marriage (years)	23.1 ± 12.9	− 0.16	− 0.13
Male's age (years)	49.7 ± 15.7	0.04	− 0.25
Female's age (years)	44.2 ± 13.3	− 0.24	0.20
CU/PU	1.73 ± 0.45	− 0.29	− 0.68 [*]

[*] $P < 0.05$; Spearman's rank correlation.

Table 4. Regression models (stepwise selection method) for per-CU net cash income and crop yield of Olive households (N = 15)

Dependent variables	Variables[a]	Coefficients (SE)	P
Net cash income (SBD)/CU/day	CU/PU	− 174.36 (15.50)	<0.0001
	Female's age	− 7.46 (0.69)	<0.0001
	Member's job at SDC	111.63 (14.94)	0.0001
	Male's age	2.95 (0.48)	0.0005
	Male's secondary education	− 57.87 (13.21)	0.0032
	Member's job outside the customary land	− 67.48 (18.44)	0.0081
	Member's job in pre-logging period (professional occupation)	− 30.83 (16.5)	0.1045
	Intercept	580.26 (47.44)	<0.0001
	Model adjusted R-squre	0.94	0.0001
Crop yield (MJ)/CU/day	CU/PU	− 2.77 (0.52)	0.0005
	Member's job at SDC	− 1.64 (0.62)	0.0276
	Member's job in pre-loggin period (professional occupation)	− 1.28 (0.75)	0.1204
	Female's stay in town	− 1.02 (0.60)	0.1258
	Intercept	9.01 (1.06)	<0.0001
	Model adjusted R-square	0.64	0.0009

[a]Independent variables shown were selected by stepwise method from all variables shown in Tables 2 and 3.

Islands, represented by the sudden rise in opportunities for cash income at the logging company or local enterprises (Bennett, 2000; Hviding & Bayliss-Smith, 2000), caused the large inter-household variations.

Since data was only collected for less than one month, the data on crop yield and cash income may have not represented the villagers' behavior for an entire year. However, the effects of seasonality were minimal in this study because, firstly, due to the tropical climate, the study sites did not have large enough seasonal variations to effect the villagers' agricultural practices (Statistics Office, 1995; Hviding and Bayliss-Smith, 2000), and secondly all of the cash-earning activities observed were practiced by the villagers throughout the year. It is also noted that the amount of royalty paid in 2003 was very small (less than 100 SBD per household per year).

From the analysis using the multiple regression models, this study reveals that the cash income of the households was positively affected by the job experience at SDC and the available labor force (i.e., PU), but negatively by other socioeconomic statuses (e.g., secondary education and job outside the customary land). It is thought that such employment at SDC aides the villagers in finding other jobs or sources of income within the community or the customary land. For instances, household E male head who had experienced work at SDC, developed a business based on local activities and the rich marine environment in Saikile (Aswani, 2002). In this regard, negative effects of job experience in town and high education experience are thought to have come from less applicability of such experience to cash earning activities in the local community. The royalty money which Olive households received was primarily spent for expensive modern items, such as permanent house construction materials and outboard motors, resulting in lowering the cash income contribution later on (Ohtsuka, 2003). In other words, the acquisition of skills that are appropriate in the rural settings plays a significant role in increasing cash income.

For the crop yield, the same analysis revealed

that the CU/PU ratio in households played the most significant role in the amount of crop yield, followed by members' jobs at SDC, with negative effects on all variables. Since agriculture is managed at the household level, it is natural to assume that the available labor force, the most important determining factor of CU/PU, had the most significant role in Olive. Although job experience at SDC reduced the agricultural production, the fact that other socioeconomic variables (e.g., high education and stay in town) had no effect on the production indicated that a modernized lifestyle was seldom related to nor affected inversely agricultural productivity. Working at SDC is thought to have reduced the labor inputs on agriculture in the past.

In summary, the amount of cash income in the rural households in Olive depended mostly on the members' job experiences at local enterprises and agricultural productivity depended primarily on the available work force. It is reasonable to conclude that households with a greater work force produce more crops and cash, since the population density of Saikile was low (approximately eight people per square kilometer), limiting neither the villagers' subsistence nor cash earning activities on terrestrial or marine environments (Aswani 2002; Furusawa, 2005). The finding that an individual's job experience at (participation in) local enterprises increases his/her household's cash income suggests that the creation of such enterprises might have positive effects on rural communities in terms of economic development. Previous studies have indicated that local enterprises, at which villagers operated portable saw milling or tourism, should be able to increase economic levels of rural societies, but they have usually encountered financial difficulties in the Solomon Islands (Hviding and Bayliss-Smith, 2000; Ohtsuka, 2004). The results of this study, however, show that local enterprises have given the local people experience in earning cash incomes. So in spite of the enterprise's eventual financial failure, the enterprise was partially successful. Further studies should be undertaken to assess sustainability of household-level economic activities and that of local environments.

As it has been proposed in the debates on increasing population pressure and sustainability of food production in Melanesian societies (cf. Ohtsuka, 1996), villagers should increase their cash incomes, while maintaining subsistence agriculture (Furusawa, 2005). In this regard, it is suggested that the villagers' efforts should be directed to develop their own projects for earning cash incomes, based on their own skills obtained on the job and natural and socioeconomic environments. In fact,

some Olive villagers have already begun reforestation practices (cf. Furusawa *et al.*, 2004), and such projects are expected to expand to the whole village, minimizing the inter-household economic disparities.

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