AGRICULTURAL LABOR ABSORPTION AND ITS POSSIBLE QUANTIFICATION IN LOW-INCOME COUNTRIES: THE FIJI CASE

By

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In many low-income countries there comes a stage when the rate of growth in labor force outruns non-agricultural employment opportunities. It would appear that Fiji has now reached this stage. In the period 1970-75 it is estimated that a successful implementation of the present development plan would generate an additional 19,000 new jobs (1, p. 39). The estimated rate of increase in the labor force for the same period is 31,900 (1, pp. 38-41). The surplus will have to be either absorbed into agriculture or join the ranks of the urban unemployed. The welfare effects on rural households from absorbing more labor will be a major determinant of the rate of growth of urban unemployment.

The "dualistic" nature of Fiji agriculture would seem to suggest that welfare effects of increased labor absorption will differ significantly between Fiji's two major racial groups: Fijian and Indian.[1/] The relative availability of land between these two groups means a bimodal distribution of the rural population along the man land ratio continuum. Chart 1

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* The essay was first submitted as a term paper for Ag. Econ. 560: Food, Population, and Employment, Spring term 1971-72.

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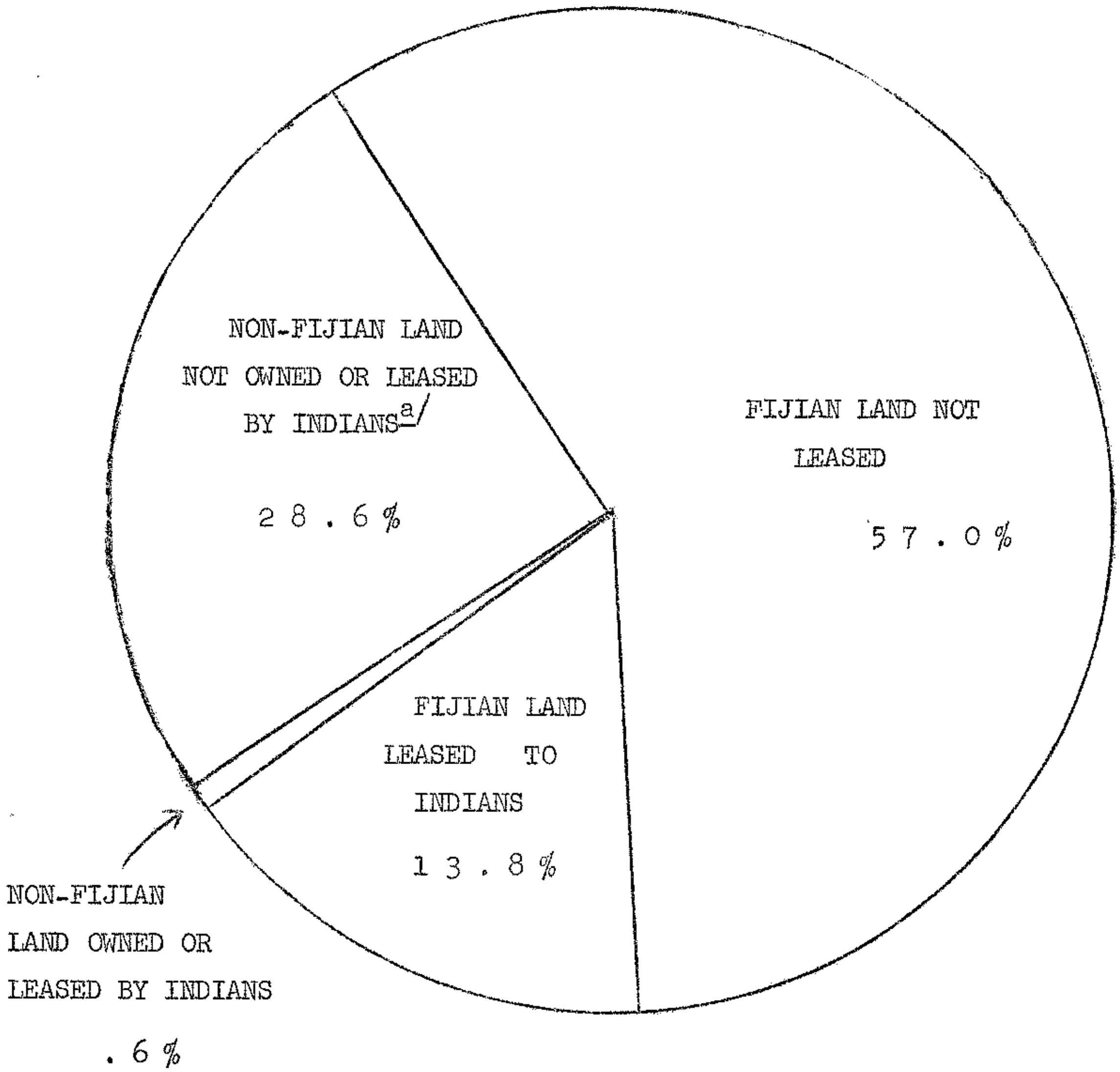
1/ Fiji Indians are mainly the descendents of indentured laborers from the subcontinent of India, Fijians are the indigenous Melanesian inhabitants of the Fiji Islands. There are 15,000 rural Indian households and 17,000 Fijian (2, p. 18).

CHART 1. DISTRIBUTION OF ARABLE LAND IN FIJI: 1956*



*Derived from data presented by Ward (5, pp. 61, 118, 121). The total area of arable lands is approximately 2,100 square miles.

a/ Includes crown land and land owned or leased by other ethnic groups.

shows the total distribution of available arable land among the two groups. Chart 2 depicts their relative distribution along the man land ratio cintinuum. Fiji has a "dualistic" agriculture based solely on man land ratios. The low incomes of Fijian farmers[2/] make it different than the peasant capitalist dualism described by Sen for India (4, p. 43).

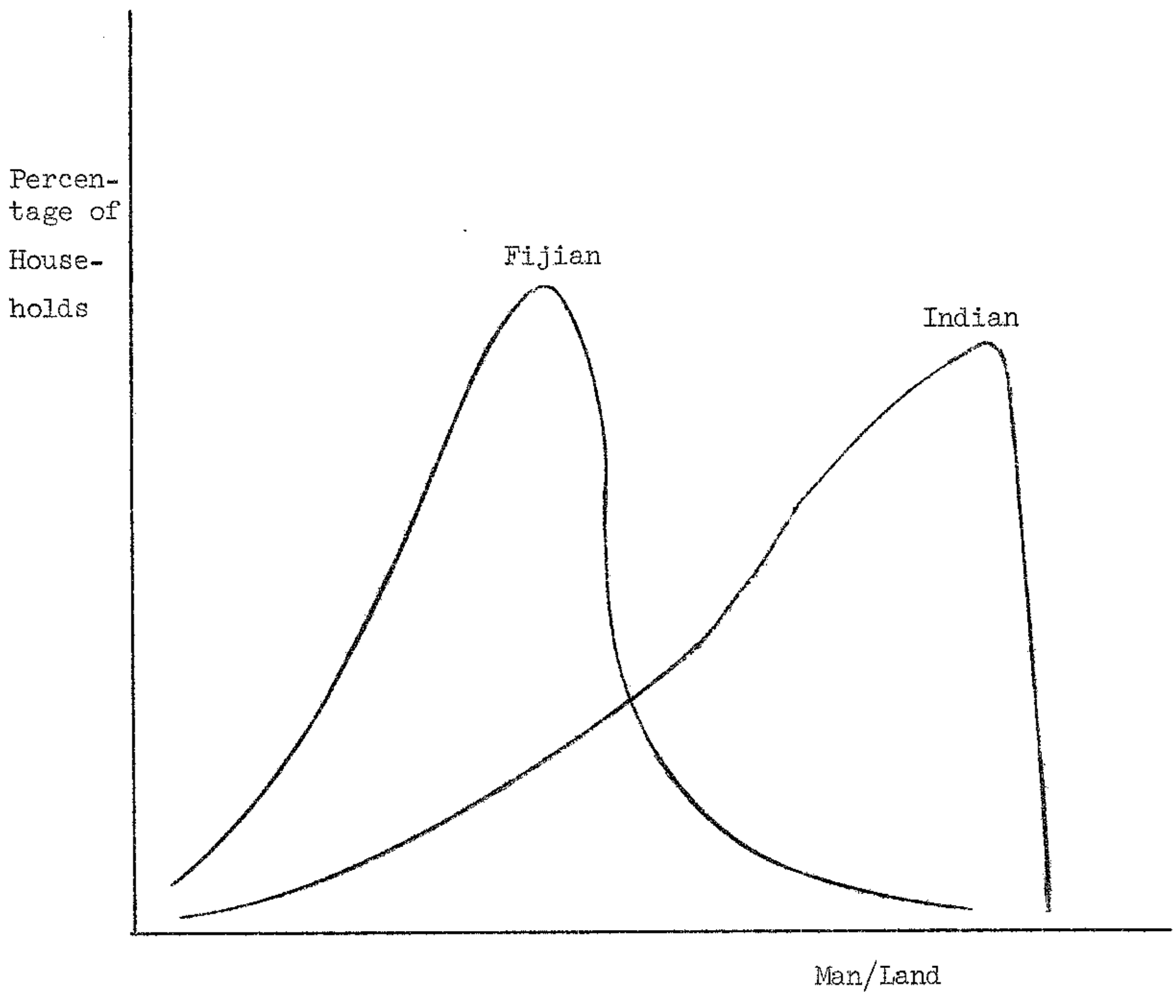
It would appear intuitively obvious that Fijian households with low man land ratios would be better able to absorb more labor than Indian households with high man land ratios. Thus, Indians would be more inclined to seek urban employment; the racial composition of the major urban areas seem to support this hypothesis (see Table 1). But unless some quantification of the welfare effects of increased labor absorption can be made, realistic predictions on the size and racial composition of urban unemployment is not possible.

To be able to meaningfully discuss the possibility of quantification it is first necessary to develop a conceptual model of comparative welfare maximization for Fijian and Indian households.[3/] Let us consider a representative Fijian household f and a representative Indian household i ; f's man land ratio is low while i's is high. Except for differences in man land ratios the households are identical. Each household has the same production potential per acre. Their members have the same psychological response to work as well as to consumption. Within each household all members have the same level of consumption and do the same amount of work.

2/ Belshaw found in a sample of 20 Fijian villages, that 76 percent of the households had incomes of less than $200/annum (3, p. 207).

3/ The following theoretical discussion to a certain extent draws on the ideas of Fisk, Mellor and Sen (6, 7, and 4).

CHART 2. THE COMPARATIVE MAN-LAND DISTRIBUTION OF FIJIAN AND INDIAN RURAL HOUSEHOLDS*



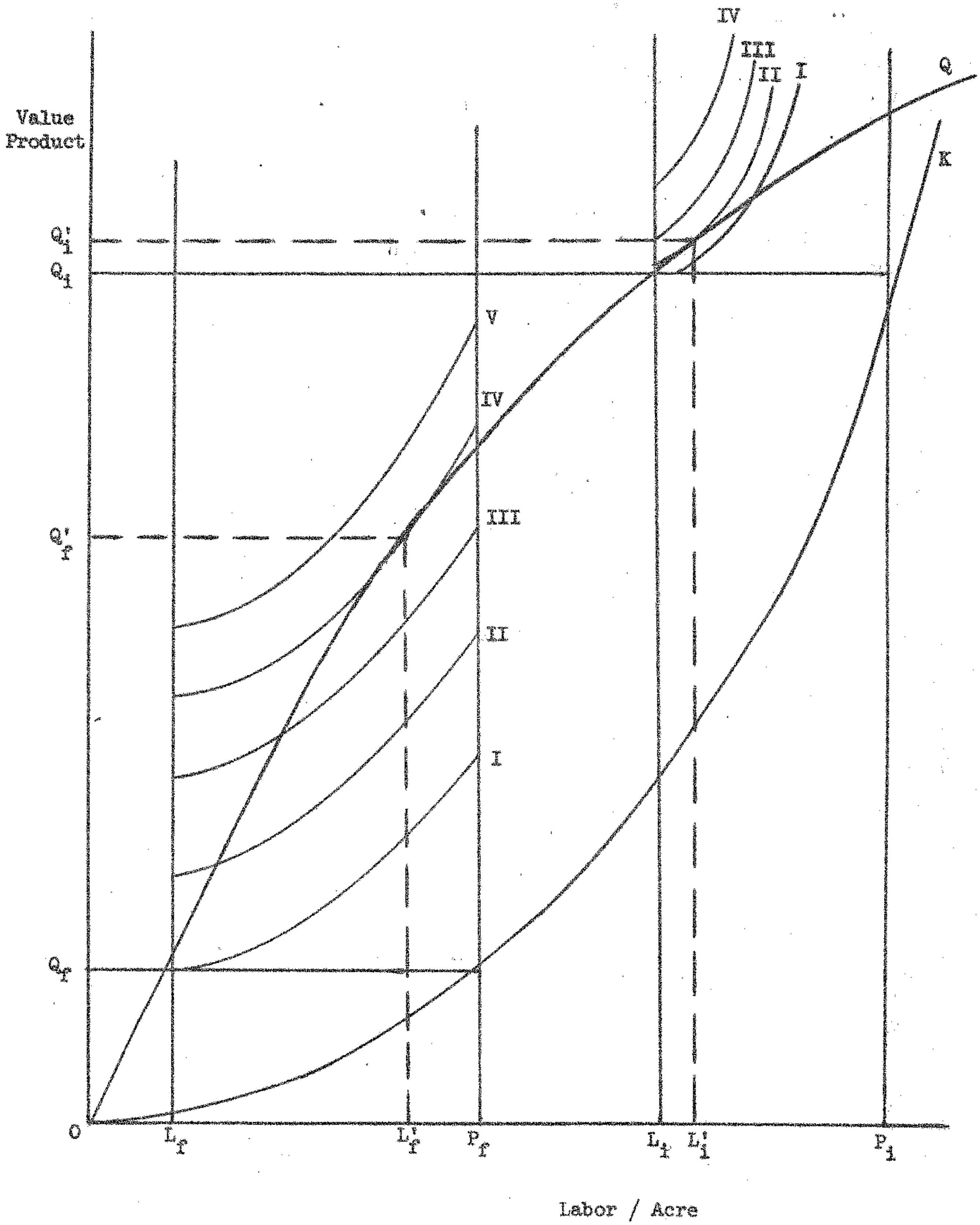
* The shapes of these curves are derived largely from personal observations supported with some evidence from 2, p. 19.

TABLE 1. THE DISTRIBUTION OF FIJIANS AND INDIANS IN THE MAJOR URBAN CENTERS OF FIJI: 1956*

Center	Population	Fijian (percent)	Indian (percent)
Suva	37,371	26.1	51.7
Lautoka	7,420	25.6	52.7
Ba	3,258	12.0	70.8
Labasa	2,202	14.6	67.3

*Source: 5, p. 108.

CHART 3. HOUSEHOLDS f AND i: LABOR INPUT REQUIRED TO MAXIMIZE SATISFACTION



The two households are shown in Chart 3. OQ is their potential value product response per acre for actual labor inputs L.

$$Q = Q\ (L) \text{ with } Q''\ (L) < 0 \qquad \text{Equation 1}$$

P_f and P_i represent the potential labor supply at a point of time within the two households respectively. For all possible levels of P along the horizontal axis a minimum consumption level can be identified, shown as curve OK.

$$K = K\ (P) \text{ with } K'\ (P) > 0 \text{ and } K''\ (P) > 0 \qquad \text{Equation 2}$$

The declining marginal product (MP) of labor explains the shape of OK; individual members of the household must increase their individual labor input if consumption is to be maintained. Increased individual labor inputs means greater total energy expenditure of the household and thus greater minimum caloric needs. The satisfaction of equation 5 for each level of potential labor, justifies the existence of one unique OK curve.

L_f and L_i are minimum actual level of labor input required for the survival of the two households respectively. Bare survival would only exist if the MP of additional labor inputs was zero or if the marginal utility (MU) of additional output was zero, neither would appear to apply in Fiji today.[4]

Members of both households have identical disutility functions for physical work that shows increasing marginal disutility for work.

$$V = V\ (L) \text{ with } V'(L) > 0 \text{ and } V''\ (L) > 0 \qquad \text{Equation 3}$$

4/ The latter may have applied to the Fijian agriculture before the existence of a market economy.

Similarly they have identical utility functions for consumption that show diminishing marginal utility for consumption.

$$U = U(Q) \text{ with } U'(Q) > 0 \text{ and } U''(Q) < 0 \qquad \text{Equation 4}$$

To maximize the satisfaction of its members each household will apply increments of labor until the marginal disutility of the last increment just equals the marginal utility of the output from that last increment.

$$V'(L) = Q'(L) \cdot U'(Q) \qquad \text{Equation 5}$$

In Chart 3, the satisfaction of equation 5 can be seen where a consumption leisure indifference curve is tangential to the production response curve.5/ To maximize the satisfaction of its members household f applies L'_f labor for Q'_f output while household i applies L' labor for Q' output.

The combined effects of declining MP of labor input and increasing marginal disutility of work, decreases the average satisfaction of the members of both households as their potential labor supply increases. Clearly a given increase in potential labor supply would decrease the level of satisfaction more in household i than f; the marginal product of additional labor input of i is less while the marginal disutility of that input is more.

Our simplistic abstraction indicates the relevant interrelated variables that need quantification if the welfare effects of increases labor absorption are to be predicted. In summary these variables are:

5/ Logically the location of the indifference curve map for each household is determined by the potential labor supply and the labor input required for survival. We would expect the indifference curves to be steeper in household i; the utility of leisure being greater at higher level of labor input. Value product includes both subsistence production and goods purchased through the sale of farm produce.

1) The production response curve for actual labor input (Equation 1)
2) The marginal disutility of additional labor inputs (Equation 3)
3) The marginal utility of additional output (Equation 4)
4) The increase in subsistence requirements as the potential labor supply increases (Equation 2)

Let us discuss the possibilities of quantifying each of these in turn.

The Response Curve

Most estimates of production response relationships have labor input as an independent variable. This variable is generally measured by farmer recall. Such a method has two major weaknesses that preclude accurate measurement and thus result in biased estimates. First, farming does not tend to be a "clock watching" occupation and thus accurate recall cannot be expected. Second, time units of measurement don't give any indication of the intensity of physical effort. Our model suggests that the measurement of labor input is not necessary. Labor input for given levels of technology, capital use and a given leisure consumption indifference map is a direct function of the man land ratio. Thus the easily measured variable, man land ratio, can be used as an instrument for the difficult-to-measure labor input.

A production function was estimated using the man land ratio instrument for a cross section of 32 farmers from Fiji. The estimating procedure and results obtained will be discussed briefly for illustration.

The following model based on our earlier discussion was used;

$$Q = f\ (L, C, N, P, E)$$

Where Q = value product

L = man land ratio

C = capital land ratio

N = non farm income man ratio

P = the production quota land ratio

E = ethnic group

The logic of including L has already been discussed. K would affect Q by changing the shape of the labor value product response curve, OQ in Chart 2. Increases in N reduce Q by decreasing the marginal utility of consumption at any given level of output. A production quota in some cases could be less than the satisfaction maximizing output, in such cases an increase in P would increase Q. Cultural differences between Fijians and Indians could cause different shaped consumption leisure indifference schedules and thus, cet. par., different levels of Q.

All farmers in the sample were mixed sugar tobacco producers, producing on land of similar production potential. Nineteen of the households were Indian and 13 were Fijian. The farmers were chosen in a region where comparable Indian and Fijian man land ratios existed. For our sample the mean ratio for Fijians was .65 and for Indians .64, the respective standard deviations were .64 and .39.

A log log function was chosen as the functional form. The choice was based first on our previous theoretical discussion that indicated a curvilinear relationship between variables. Secondly with only 32 observations it was desirable to use a functional form that was economical with degrees of freedom.

Two equations were estimated, one with an intercept dummy used to measure the significance of culture. The results are presented in Table 2.

TABLE 2. VALUE RRODUCT RESPONSE RELATIONSHIPS

Equation	L	C	N	Q_1 a/	Q_2 b/	E c/	R^2
1	.978 (.313) d/	.231 (.180)	.026 (.076)	.437 (.264)	.086 (.105)		.36
2	1.003 (.188)	.018 (.112)	.002 (.046)	.112 (.165)	.219 (.066)	1.554 (.225)	.78

a/ Q_1 is the sugar quota.

b/ Q_2 is the tobacco quota.

c/ E is interpreted as the deviation of the Indian intercept from the Fijian intercept.

d/ The standard error of the coefficient.

Clearly the ethnic dummy is significant and thus equation 2 is the appropriate equation.[6/] Apart from the ethnic classification, only L and Q_2 proved significant (see Table 3).

Although we are using a small and probably non-representative sample, the elasticity coefficient of 1.00 between the man land ratio and value product is notable. It suggests that, assuming diminishing marginal productivity, individual labor input increases as the man land ratio increases.

An explanation of C not being significant could be that farmers substituted labor for capital along the same production isoquant. See Chart 4.

The non-significant N could be explained by farmers substituting hired labor or capital for household labor retaining the same level of production.

6/ The hypothesis being the intercept between the two classes are the same. Using an F test to compare equation 1 and 2,

$$F_{1,25} = \frac{S_1 - S_2}{S_2} \cdot \frac{V_2}{V_1}$$

Where S_1 = sum of squared residuals of equation 1

S_2 = sum of squared residuals of equation 2

V_1 = the degrees of freedom of equation 1 minus the degrees of equation 2

V_2 = the degrees of freedom of equation 2

$$F_{1,25} = \frac{24.385 - 7.501}{7.501} \cdot \frac{25}{1}$$

$$= 56.30$$

$$F_{1,25}\ (.05) = 4.24$$

$$56.30 > 4.24$$

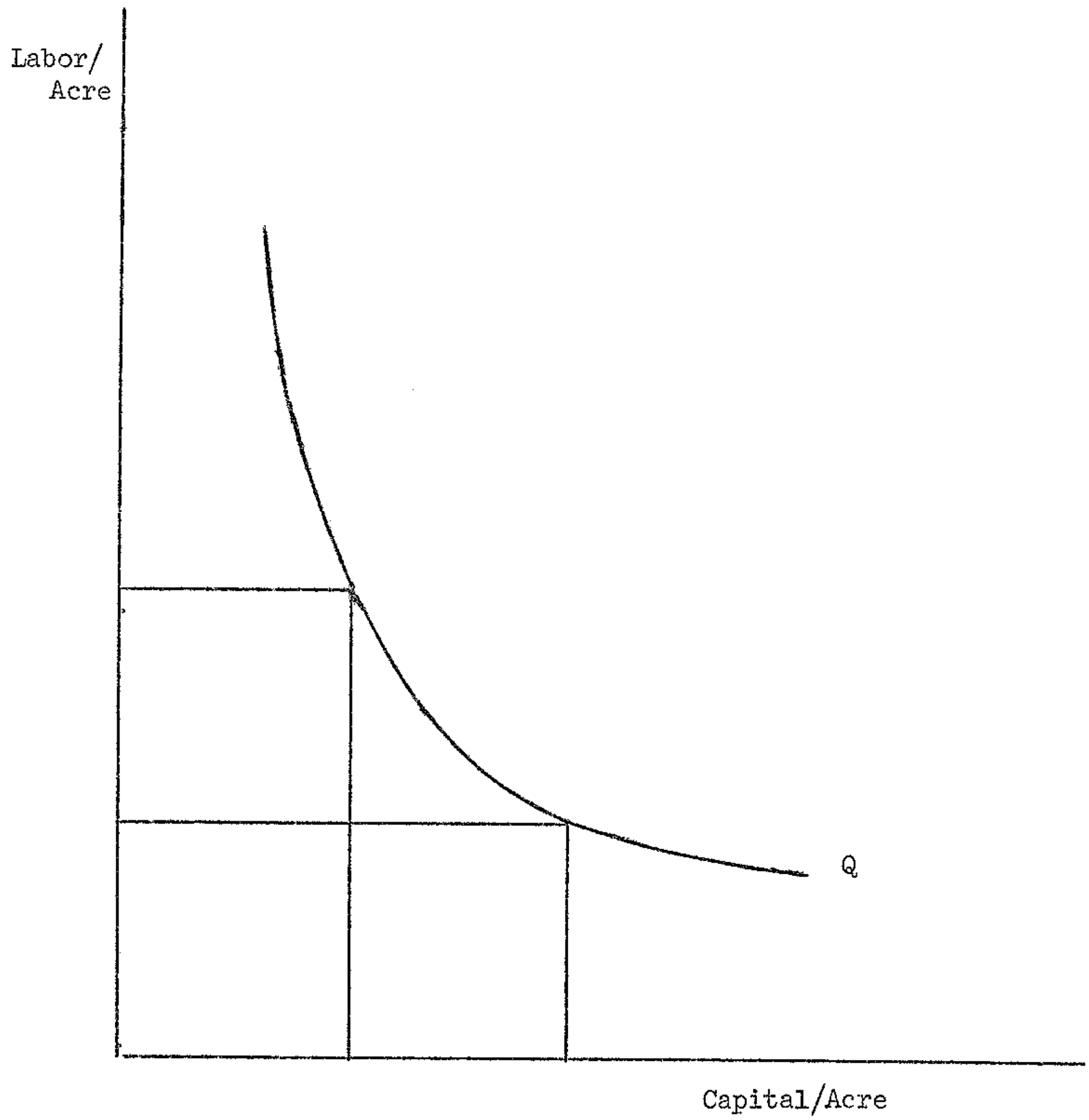
$\therefore$ We reject the hypothesis that the intercepts of the two classes are the same.

TABLE 3. TESTS OF SIGNIFICANCE AND ELASTICITY OF VARIABLES IN VALUE PRODUCT RESPONSE RELATIONSHIPS

Variable	Coefficient T Value	Table T Value at 5% Level	Elasticity
L	5.34	1.71	1.00
C	.17	2.06[a]	
N	- .07	-1.71	
Q_1	.68	1.71	
Q_2	3.32	1.71	.22

a/ Due to the counteracting effects of labor saving and land saving a two tail test was appropriate.

CHART 4. THE SUBSTITUTION OF CAPITAL FOR LABOR
MAINTAINING THE SAME PRODUCTION



The non-significant sugar quota may result from equilibrium production being less than the quota. The lack of importance of the pre-season cane quota, which was used in estimation in production decisions could result from upward adjustments during the production season. Table 4 shows these adjustments during the period 1966-70.

In situations where the researchers interest requires the use of labor input as an independent variable, problems of recall and work intensity measurement may be overcome by the use of calorie common denominators.

Let us consider calorie measurement and its application. The energy expenditure (calorie expenditure) of an individual is a function of a constant, basic metabolic rate, and a variable level of physical activity. The energy expended by individual above basal can be inferred by indirect calorimetry. An inconspicuous lightweight instrument (SAMI) can be carried by the free ranging farmer to measure his heart rate. The linear realtionship that exists between heart rate and oxygen consumption permit an accurate measurement of the farmer's energy expenditure.[7/] The SAMI technology now provides a means to simultaneously measure along with heart beat, the posture of the wearer; i.e. how long he spends sitting, standing, walking, etc., (9, p. 120). Thus, the SAMI combined with activity recall from the farmer, not time recall, enables work and non-work to be separated. The periods of work can then be expressed in units of work intensity, the calorie common denominator.

The SAMI is offered as a possible means of reducing errors in variables and thus bias in response curve estimation where labor input is used

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7/ Beeghly and Poleman discuss in detail the use of the heart rate SAMI with tropical farmers (8).

TABLE 4. PERCENTAGE INCREASES IN THE PRE-HARVEST CANE QUOTAS DURING PRODUCTION PERIOD: 1966-70

Year	Percent of Increase
1970	30
1969	40
1968	65
1967	64
1966	50

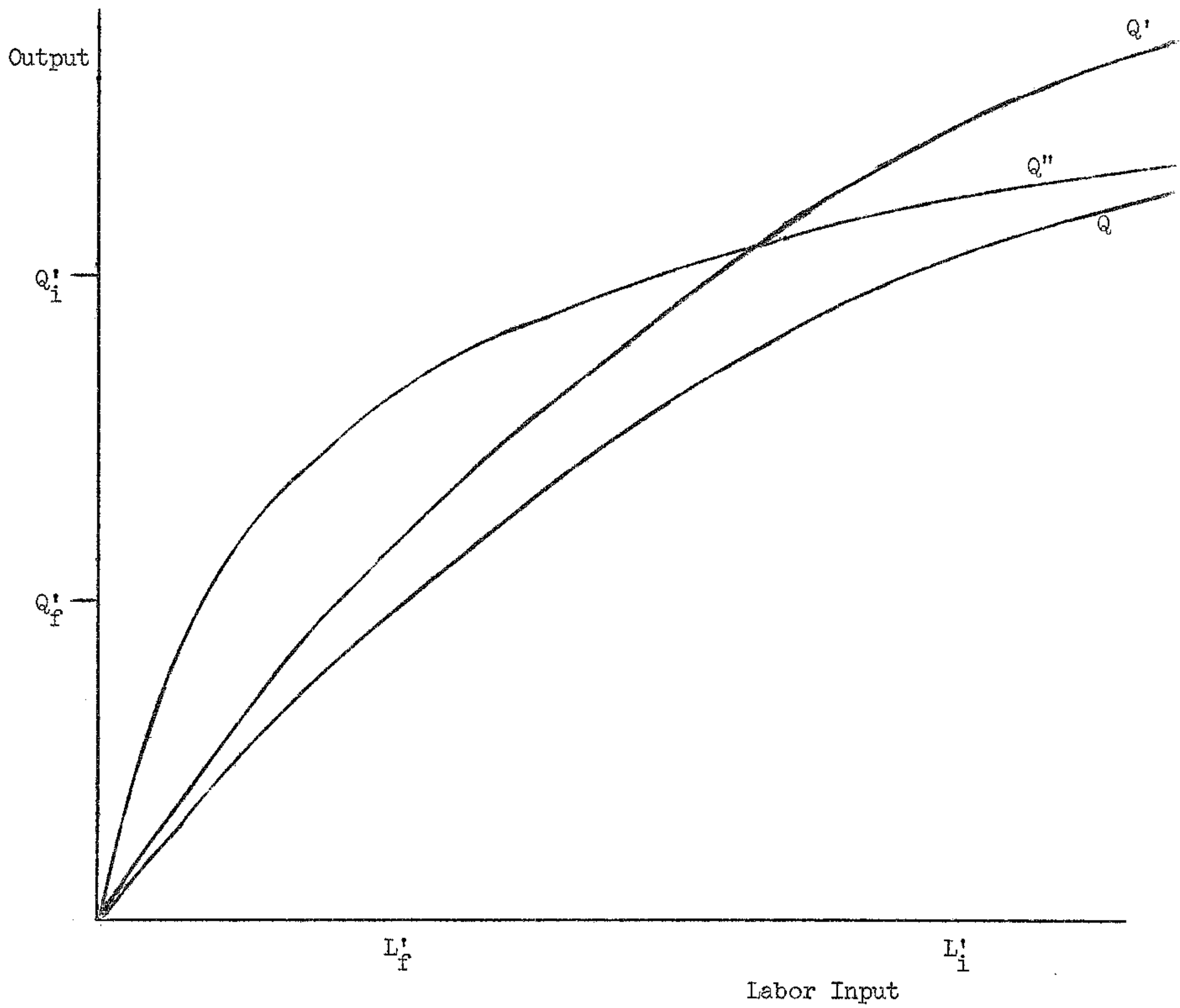
as an independent variable. It should be remembered, however, that even if the variables are measured without error the procrustean nature of functional forms commonly used in estimation result in inaccurate estimates of marginal productivity.

To make useful predictions of the effect of a labor absorption, some account of the influence of technological change on the response curve need be taken. Although accurate ex-ante predictions of the shift in the response curve are difficult, particularly where adequate time series data is not available, a knowledge of broad research and extension priorities would give important clues. Broadly, innovations can be classed into two categories; labor saving and land saving. An example of the former is the replacement of wooden digging sticks with metal spads; an example of the latter is a new breed of sugar cane. In Chart 5, OQ' is a land saving innovation and OQ" is a labor saving innovation. Clearly then government preference would have significantly different welfare effects on our "typical" Indian and Fijian household. Fijians with higher MP of applied labor benefiting most if the innovations are labor saving and Indians with higher MP of land benefiting most if innovations are land saving.

The Disutility Function

The marginal disutility of additional labor input has until now been considered by economists to be unquantifiable. The usual assumption of increasing marginal disttility has been based on subjective evaluation by writers on the "distastefulness" of physical work.

CHART 5. THE EFFECT ON THE LABOR RESPONSE CURVE OF LABOR SAVING AND LAND SAVING TECHNOLOGICAL INNOVATIONS[a]



a/ The general shape of these curves has been derived from Fisk (6, p. 372).

It would seem that heat stress was a major component of the disutility of physical work in tropical countries. The SAMI technology provides a means of simultaneously measuring heart stress together with heart beat and posture and thus gives an indication of the marginal dissatisfaction of increasing increments of physical work (9, p. 119). No meaningful common denominator seems available for quantifying the psychic cost of work (or possibly non-work).

The Utility Function

The marginal utility of consumption appears at present impossible to quantify directly. Accurate indications of the relative satisfaction from increments of subsistence production can be given by estimates of the income elasticities for those goods. Estimates of the satisfaction from increments in cash crop production are more difficult, substitution between purchased goods by consumers make income elasticities less reliable indicators of the general level of satisfaction. Thus intuitive judgment will be more crucial with Indian households because of their much smaller subsistence component. Appendix I shows the breakdown between subsistence and purchased consumption for a "typical" Indian household.

Conceptually it seems feasible to provide varying increments of the goods households consume and then to measure the effects of these "gifts" on labor input; labor input being expressed in calorie common denominators.[8/] This would give some indications of the indifference surface between leisure and consumption. This may even be practically feasible in a Fijian village context where the giving of goods is culturally acceptable.

8/ I am indebted to Mr. Peter Matlon for this suggestion.

The "Caloric" Function

Estimates of increases in individual caloric needs as the potential labor supply increases, i.e., the shape of the curve OK, can be estimated by the regression of household caloric expenditure K on household size P.

From our model an appropriate functional form may be

$$\log K = \beta \log P \qquad \text{where} \qquad \beta > 1$$

β would again have to be estimated from a cross section of Fijian and Indian households. Measurement of P presents no real difficulties, an appropriate code could be developed to distinguish sex/age combinations within households. The particular level of K for each household could be measured by the conventional household consumption survey. The assumption being that caloric needs are equated with intake: Appendix I shows the estimation of K for a "typical" Indian household by this method. The use of the household budgets is based on the assumption that caloric intake equals caloric needs. Although this assumption seems justifiable, the accuracy of the household budget as a measuring tool is limited. Twenty-four hour recall, the most common method of estimating consumption invariably is biased below the true level of consumption (10, p. 85). Even the more precise, but time consuming method of weighing overlooks calorie ingested between meals.9/ The SAMI methodology provides an alternative method, free from the bias of human recall, that estimates caloric needs by measuring caloric expenditure.10/

9/ The low level of fruit consumption in Appendix I, I would suggest, results from this problem.

10/ This method requires members of the household to wear the SAMI for sample 24-hour periods. This obviously requires the SAMI to be worn while asleep. Limited experimentation by Professor Poleman with students at Cornell University indicated that this presented no social acceptability problems.

Policy Possibilities

Quantification of economic variables is done to improve policy decision making; measurement of the welfare effects of labor absorption in Fiji is, of course, no exception. Appropriate policies in this case would be aimed at offsetting undesirable trends in the level and racial composition of urban unemployment. The obvious differences in our abstract model are probably not quite as apparent in the real world, thus making the need for quantification even greater.

Promotion of technological innovation in agriculture would seem a politically expedient policy measure.[11/] It would seem that, a priori, emphasis on land saving innovations would have relatively more beneficial welfare effects on Indian rural households than Fijian; see Chart 5. This judgment is based on speculation regarding the effect of relative differences in man land ratios on the MP of land. The quantification discussed, allows not only estimates of the MP's but also provide indications of the MU of consumption and the disutility of labor, both important determinants of farmers willingness to adopt innovations.

If the policy objective is to reduce the urban migration of a particular rural group, the most appropriate innovation to promote, subject to budget constraints, is the one that potentially will increase the welfare of that group the most. In terms of our discussion this would be the innovation that maximizes the positive difference between the expected change in utility of consumption and the expected change in disutility of labor input. In

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11/ Policy proposals such as the redistribution of substantial quantities of Fijian land to Indian farmers would be considered at present politically infeasible. It has been illegal since 1908 to sell Fijian land.

Chart 6, V'_{t-1} is the marginal disutility of labor input before an innovation was adopted, and V'_t is the marginal disutility after it was adopted.[12] While U'_{t-1} is the marginal utility of consumption from the last unit of labor before an innovation was adopted and U_t is the marginal utility after it was adopted. The change in satisfaction after the adoption if this innovation is the area a b c d. Thus the policy maker would wish to choose innovations to promote that maximized a b c d for households in the relevant rural group.

Price support is another policy alternative. Discussion here accepts price policy as already a reality in Fiji and is thus not concerned with the general desirability of price policy in low-income countries.[13] The quantification of the variables discussed would help decisions on the type, the level and commodity orientation of price policies.

A number of commodities in Fiji are predominantly produced by one racial group: sugar, rice and dairying by Indians, root crops, coconuts and bananas by Fijians. Thus, *a priori*, it would seem price policy is specially suited to reducing disparitions between racial groups in the adverse effects of labor absorption.

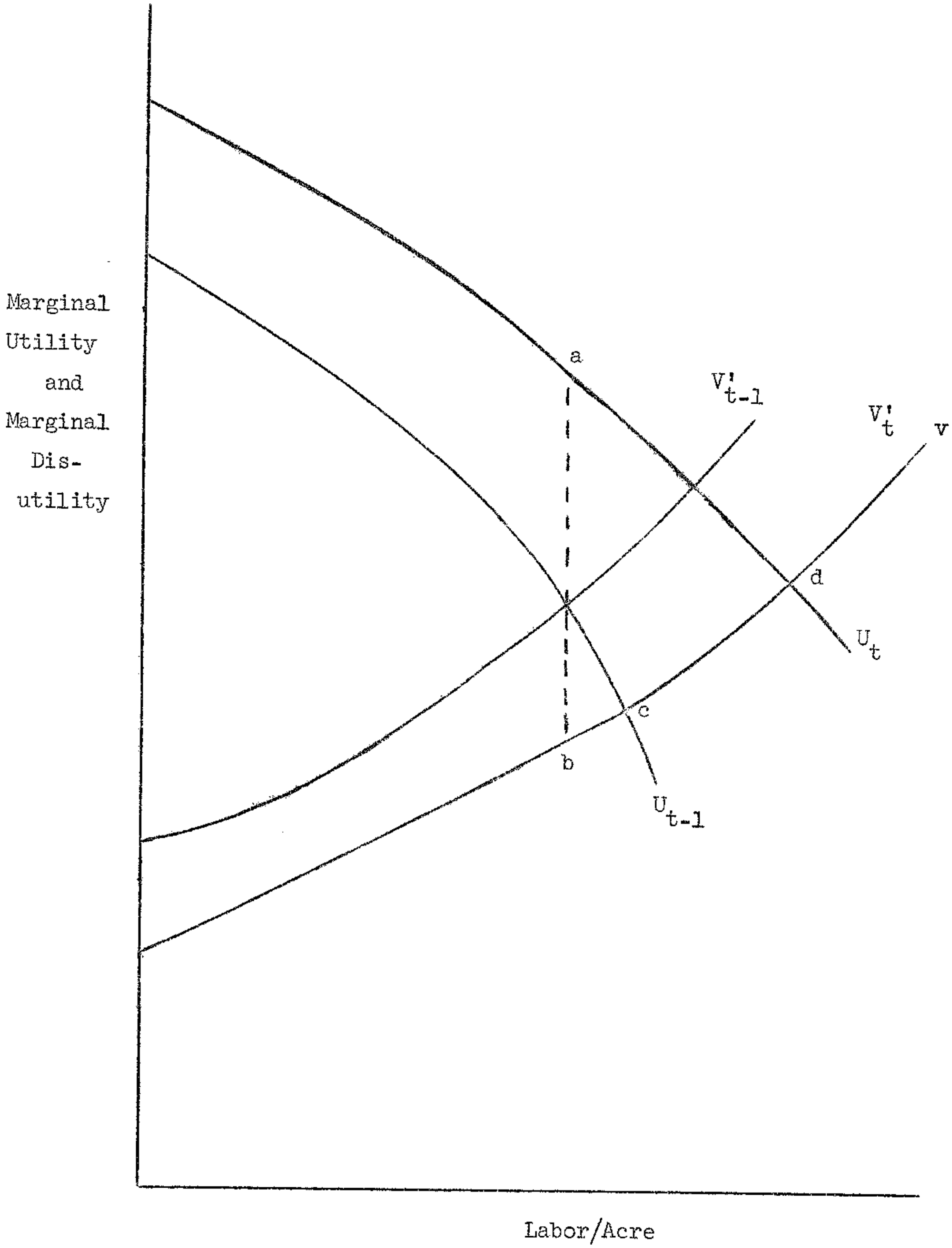
A Recapitulation

The paper has discussed the potential importance to rural household welfare of increased labor absorption, this has been done with particular reference to the Fiji case. An abstract model incorporating two extreme cases has been constructed to identify the interrelated variables that required quantification if meaningful predictions on the welfare effects of labor absorption are to be made. In the light of the inadequacy of conventional methods

12/ V'_t assumes that for a given time period the innovation has made the task easier.

13/ Input subsidies exist in the coconut, rice, beef, dairy, and root crop industry. Output studies exist for rice and a price stabilization scheme is in operation for sugar.

CHART 6. THE CHANGE IN SATISFACTION FROM THE ADOPTION OF AN INNOVATION[a]



a/ The downward shift in the disutility function implies a labor-saving innovation.

of measuring the relevant variables, the SAMI technology was proposed as a possible means of getting over some of the problems. It was suggested that measurement of heart rate, posture and heat stress may help to give meaningful indications of the effects of labor absorption. In production function estimation our theoretical discussion indicated in some cases it was not necessary to measure labor input. A production function was estimated using the man land ratio as an instrument for labor input. The importance of quantification for policy decision making was stressed. Two politically expedient policy alternatives in the Fiji context were proposed as candidate for implementation, once the effects of labor absorption had been quantified.

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APPENDIX I

"DAILY" CONSUMPTION OF A REPRESENTATIVE FIJI INDIAN HOUSEHOLD*

Product	Subsistence Consumption			Purchased Consumption			Total Calories per Capita
	Quantity	Calories[a/]	Calories per capita[b/]	Quantity	Calories[a/]	Calories per capita[b/]	
	(lbs.)			(lbs.)			
Cereals							
Rice	.28	452	50.3	2.30	3,807	423.3	
Bread				.05	62	6.9	
Wheat Flour				7.00	11,205	1,245.7	
Sub-total			50.3			1,675.9	1,726.2
Roots and Tubers							
Bread Fruit	.23	117	13.5				
Cassava	1.38	765	85.1	.17	351	39.4	
Potatoes (Irish)				.92	266	29.6	
Taro				.51	245	27.3	
Yams				.09	36	4.0	
Sub-total			98.6			100.3	198.9
Legumes							
Beans	.81	115	13.0				
Dhal	.78	1,179	131.8	.05	67	75.9	
Cow Peas	.06	81	9.5				
Ground Nuts	.10	90	10.6				
Sub-total			164.9			75.9	240.8
Vegetables							
Egg Plant	.43	36	4.0	.16	11	1.2	
Leaves (high carotene)	.41	75	8.4				

(continued . . .)

"DAILY" CONSUMPTION OF A REPRESENTATIVE FIJI INDIAN HOUSEHOLD* (continued)

Vegetables (cont.)							
Leaves (med. carotene)	.13	12	1.4				
Chillies	.02	11	1.2				
Cucumbers	.23	8	.9				
Okra	.23	29	3.3				
Tomatoes	.05	5	.6				
Ground Onion	.51	49	5.5	.14	37	4.1	
Sub-total			25.3			5.3	30.6
Fruit							
Citrus	.06	8	.9				
Pawpaw	.06	11	1.2			2.1	
Sub-total			2.1			2.1	4.2
Meat and Eggs							
Eggs	.03	20	2.2				
Goat				.62	297	33.9	
Mutton (canned)				.03	34	3.8	
Mutton (fresh)				.10	90	10.3	
Poultry	.19	81	8.9				
SubSub-total			11.1			48.0	59.1
Canned Fish	3.5	1,008		.25	189	21.2	
Sub-total						21.2	21.2
Milk Products	3.5	1,008	112.7				
Sub-total			112.7				112.7
Fats and Oils							
Ghee	.04	117	13.1	.08	315	35.4	
Veg. Oils				.17	684	76.3	
Sub-total			13.1			111.7	124.8

(continued . . .)

"DAILY" CONSUMPTION OF A REPRESENTATIVE FIJI INDIAN HOUSEHOLD* (continued)

Sugar		3,528	392.6	
Sub-total			392.6	392.6
ALL CATEGORIES TOTAL	478.0		2,433.1	2,911.1

* 24-hours recall data was collected for 14 sample households on six occasions during 1971. From the 84 sample days the daily diet of the "average" household was derived. Averaging results in a more diversified diet than would exist on any one day.

a/ Source of calorie conversion: Food Composition Tables for the South Pacific (11).

b/ Weights to household members derived from FAO (12, p. 43).