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DOMESTIC DEMAND FOR AGRICULTURAL PRODUCTS IN COSTA RICA

A case study for eight products

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THE ATLANTIC ZONE PROGRAMME

CATIE

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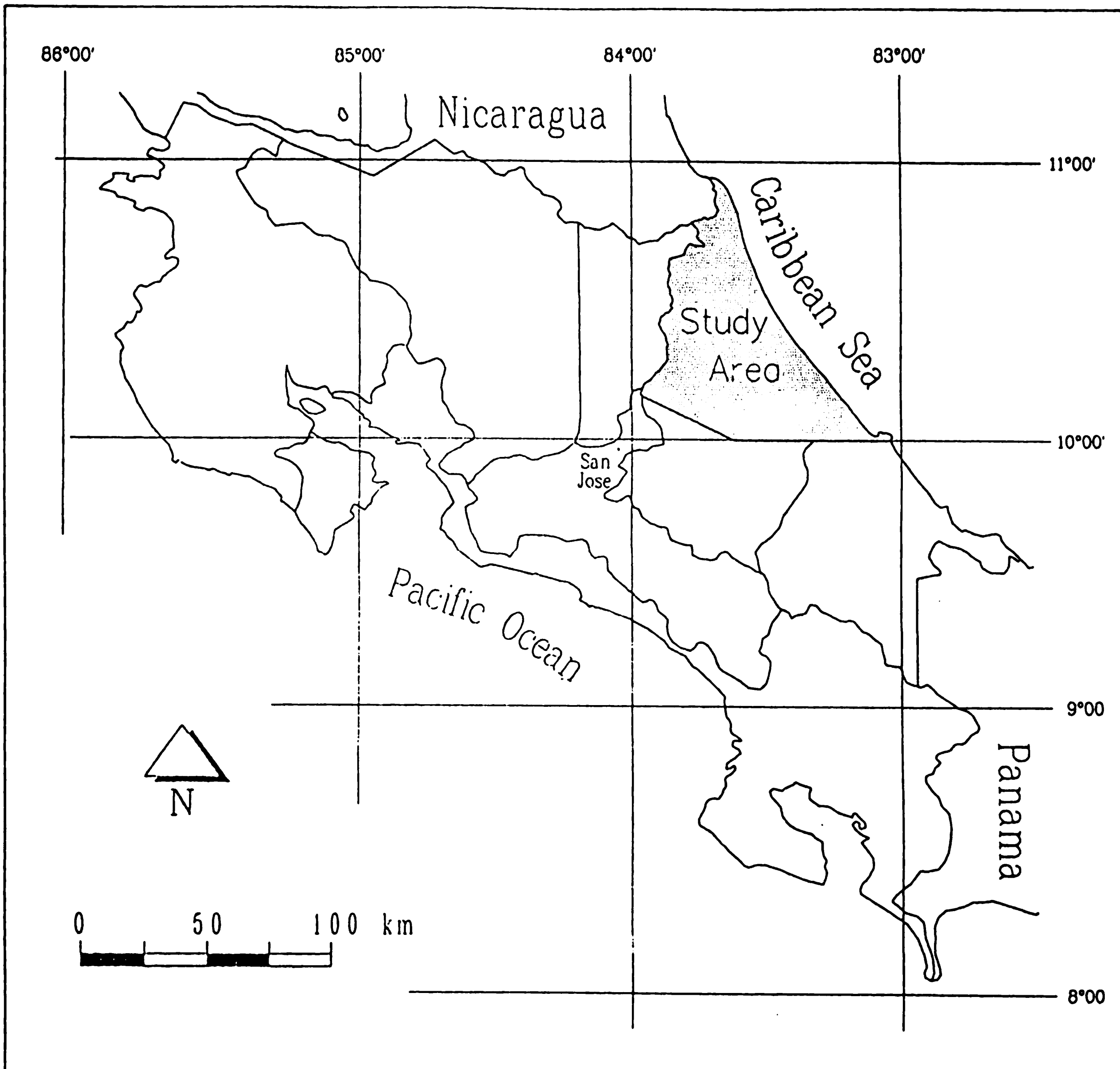
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1. INTRODUCTION

The Atlantic Zone Programme (AZP) aims to develop a methodology to analyze sustainable and economically feasible land use. Three hierarchical levels of analysis can be distinguished. (AZP, 1991)

1. The land use system (LUS)
2. The farming system (FS)
3. The regional system (RS)

The third level (RS) analyses the agro-ecological and socio-economic boundary conditions for the farm level and the incentives presented by development oriented organisations. The Department of Development Economics of the Wageningen Agricultural University is involved in the research since the beginning of the AZP in 1986. This department is working on a LP-model for land use planning. For this model it is important to analyze the position of the farmers, the traders and the markets for the most important products of the Atlantic Zone. To gain a clear understanding of the latter, analysis of consumer data are necessary.

In addition the analysis of a number of important policy questions, within the agricultural sector, requires an understanding in relation to consumer demand. For example, the policy maker might require information on the following:

In the course of economic development with average incomes rising, which producers will enjoy an increasing demand for their products and which producers will face a stagnant or declining market? Will an increased rate of urbanization have any effect on consumption?

If the price of a particular food product is changed, say by imposing a sales tax or a subsidy, how will consumers respond?

A basis for theoretical and empirical work on these types of questions is provided by the traditional or neo classical model of consumer behaviour. (Colman & Young, 1989). Traditional economic theory suggests that, given the consumer's tastes and preferences, the demand for a product will be determined by: the price of the product, the prices of other products and the consumer's income.

In 1987-88 the Costa Rican Ministry of Economic Affairs conducted a consumer survey focusing on income and expenditures of Costa Rican households. The relevant data sets of this survey were provided by the Ministry. In this study these data sets were analyzed with the SPSS-PC package. Eight products, with important production in the Atlantic Zone are selected and admitted into the data sets. These products are: ayote sazón (small pumpkin), plátano maduro (plantain), banana (banana), papaya (papaya), piña (pineapple), nampí (eddoe), tiquisque (cocoyam) and yuca (cassava).

Analyses were carried out with the newly created data set. The first part of the analysis was focused on the average consumption of the selected products and the average income and expenditure for the total country as well as for the specified zones and regions. The next step was to look at price differences for the products and to a correlation between demand and prices, and between demand and incomes. The last part of the analysis was focused on the estimation of a demand function, the relationship between the quantities of a product and the factors which influence the consumer's choice.

2. THEORETICAL FRAMEWORK.

A basis for theoretical and empirical work on consumer data analysis is provided by the traditional or neoclassical model of consumer behaviour. In this model it is hypothesised that the consumer has preferences among different products. In addition the consumer will attempt to get the highest satisfaction out of consumption allowed by a limited budget. The decision-making unit is supposed to be the individual consumer, although the analysis could apply equally to the household.

A consumer's demand for a product is the amount in which the consumer is willing and being able to buy, under given conditions, per unit of time, in a specified market and at specified prices. The economic analysis of demand considers the actual market behaviour.

Traditional economic theory suggest that, given the consumer's tastes and preferences, the demand for a product will be determined by:

- the price of the product;
- the prices of other products;
- the consumer's income.

It is hypothesised that the consumer gains satisfaction, welfare or utility from the consumption of goods. The consumer will try to get the greatest possible satisfaction. He must decide how much of each good he is going to purchase. The choice is constrained by the consumer's income and will be influenced by the prices of the available goods. The theory recognises that consumer behaviour will depend to some degree on individual preferences, which may be linked to the age, sex, education, religion, social class, location or other characteristic of the consumer. However, the theory does not attempt to explain the formation of tastes but rather it asserts that at a given point in time, a consumer's tastes and preferences can be taken as given.
Based on these assumptions about the consumer the theory is used to derive the following three basic relationships

The demand function. The relation ship between the quantities of a good (say Q_1) and the economic factors which influence the consumer's choice can be summarised in the demand function (equation 2.1)

$$Q_1 = f(P_1, P_2, \ldots, P_n, M) \qquad \text{Equation 2.1}$$

where Q_1 is the quantity of the good purchased in a given period, $P_1, \ldots P_n$ are the prices of the n consumer goods in the market and M denotes the consumer's income. This relationship is specified given the consumer's tastes.
In the analysis of applied economic problems it is useful to present graphically elements in this demand relationship. Two devices are often employed: the *demand curve* and the *Engel curve*. (see appendix 2)

The demand curve, or demand schedule, is the representation of the quantities of the commodity which the consumer is willing and able to purchase at every possible price over the relevant range with all the other factors kept constant. A typical demand curve is presented in appendix 2.1. It is downward sloping indicating an inverse relationship between price and quantity, i.e.

the lower the price, the more Q_1 the consumer will buy. A change in price would induce a movement *along* the demand curve. As all other factors are held constant, the demand curve can be represented mathematically as:

$$Q_1 = f(P_1 \mid P_2, \ldots, P_n, M) \qquad \text{Equation 2.2}$$

If there is a change in income or in the price other than P_1, the whole demand curve will *shift*.

The Engel curve describes the relationship between the quantity of a good purchased and the consumer income with all other factors kept constant. If, as income rises, the consumer chooses to buy more of a particular commodity, the commodity is termed a *normal good* (see appendix 2.2(a)). On the other hand, if less of a good is purchased as income rises, the commodity is termed an *inferior good* (see appendix 2.2(b)). Some foods (perhaps cassava) that may be normal goods at low income level may become inferior goods at high incomes levels. The Engel curve is the graphical representation of the following form of the demand function:

$$Q_1 = f(M \mid P_1, P_2, \ldots, P_n) \qquad \text{Equation 2.3}$$

In the traditional theory, prices and consumer income are the main determinants of consumer demand. In the analysis of many development issues, the income elasticity, by which consumer responsiveness to an income change is measured, is a particularly important parameter. Engel's law, which seems to have universal validity, predicts that as per caput incomes grow in the course of economic development, the demand for food will increase but less than in proportion to the income change. Hence, the focus of economic activity will shift away from agriculture; agriculture's share of national income will decline in relative terms.

A study of income elasticities at the individual commodity level can also be instructive. Some agricultural products, typically grains and starchy roots, have low, perhaps negative income elasticities. Other food products such as fruits can be more income elastic. A given increase in income will thus change the pattern of consumption; the demand for these food products with high income elasticities will rise relative to the other products in the food budget. These changes will signal shifts in resource usage within the agricultural sector.

In addition low income households tend to have larger income elasticities for food products than high income families. The income distribution will be a significant determinant of food consumption patterns. In the course of economic growth, the income distribution will change and this will have implications for food consumption levels in the various income strata and thus for the agricultural sector itself. In the LDC's high rates of population growth are found. A growing population must also be supported with increased food supplies. The annual rate of increase in demand for food is given by $D = p + \delta g$, where p and g are the rate of population growth and per capita income, and δ is the income elasticity of demand for agricultural products (Meier, 1989). As indicated by Johnston and Mellor (1961), not only high rates of population growth are found in the LDC's, but the income elasticity is considerably higher than in high-income countries. A given rate of increase in per capita income therefore has a considerably stronger impact on the demand for agricultural products in the low-income countries than in the economically advanced countries.

Knowledge of price elasticities is essential for many policy analyses. The theory suggest that the demand for food as group of products and for some individual food products will be price inelastic. But the demand for special products may be price elastic and empirical analyses suggest that the demand for food products is more price elastic in low than in high income households (Colman & Young, 1989)

The foregoing suggests that there is a need for quantitative information on the sign and magnitude of these consumption parameters for the different products. The traditional approach to demand analysis offers some useful insights.

3. METHODOLOGY OF DATA COLLECTION AND DATA ORGANIZATION

With the financial help of the Banco Interamericano de Desarrollo (BID) and the technical assistance of the Comisión Económica para América Latina y el Caribe (CEPAL), the government of Costa Rica, through the dirección General de Estadística y Censos (DGEC), carried out la Enquesta Nacional de Ingresos y Gastos de los Hogares 1987-1988. This was a part in the activities provisional to the covenant MEIC-BID-CEPAL ATN /Sf-2419-CR.

The questionnaire gives information about the general composition of the families. It gives knowledge of the sum of the incomes and the destination of the income to different commodities. Also a mix of variables related to the social and economic characteristics of the household members is admitted.

In 1984 were 10,500 segments determined in a census. For this study the 10,500 segments were stratified by region (1-6) and zone (urban and rural). Then 514 segments were sampled with probability proportional to the number of households in each segment. Within the sampled segments 12 households were sampled, 6 in each period of six months during 1987/1988. Although the total sample size thus can be calculated to be 514 * 12 = 6168 households. Because of some problems during the data collection, in reality only 3910 households were interviewed. The collection of the information was done by direct interviews and by auto registration about the daily expenditures. The medium number of visits were four per family in a course of time of eight days. The information was collected in seven questionnaires, namely:

1. Questionnaire 1. General characteristics of the way of life and the persons in the household.
2. Questionnaire 2.1. Inventory of the purchased food products.
3. Questionnaire 2.2. Daily expenditures of the household.
4. Questionnaire 3. Daily personal expenditures.
5. Questionnaire 4. Budget of the household.
6. Questionnaire 5. Agriculture production.
7. Questionnaire 6. Equipment of the centre of the village.

The results of the questionnaires were translated to two groups of data: *'Hogar'* and *'Bienes y servicios'* and were transferred into two blocks of cases within the SPSS-PC+ program. The file *Hogar.dit* contains eleven variables with data for the general information about the family and data for the income and expenditures per family (see first eleven variables of appendix 1). In this file is also the *'Factor de Expancion'* admitted. This factor expresses the representativeness of each household for the total population of 617,000 households in Costa Rica. The 'Factor Expancion' is used as a weight variable in SPSS-PC+. The other data file, 'Bysshort.dat', contains five variables about the purchased products (see appendix 3).

To analyse the consumption data it was necessary to relate the two data sets of variables. The combining of the two data files was possible because both files contain the key variable 'familia'. With the newly created file (hogbys.sys) the analyses were carried out. The statistical methods used in the data-analyses are explained in the relevant chapters.

4. SOCIO-ECONOMIC CHARACTERISTICS OF INTERVIEWED FAMILIES

This chapter describes some socio-economic characteristics of the households in the survey. Aspects such as: where do they live?, how many family members are there?, and what income level do they have?, are treated here.
The households are situated in different parts of Costa Rica. In the survey distinctions were made between zones and regions. The zones were distinguished in rural and urban whereas the regions were distinguished in Central, Chorotega, Pacífico, Brunca, Atlántica and Huertar Norte. More or less half of the households live in urban zones and the other half in rural zones. About 33 percent of the households in the survey live in the Central region which includes the capital San José (see first part table 4.1). However, because of the composition of the sample (see chapter 3) these households represent more than 60 percent of the population (see second part of table 4.1). The other families are located in Chorotega, Pacífico, Brunca, Atlántica and Huertar Norte (see table 4.1).

Table 4.1: Location of the households (count).

ZONA	REGION Centr. 1	 Choro. 2	 Pacif. 3	 Brunc. 4	 Atlan. 5	 H.Nort. 6	 Row Total
1 Urban	784	182	265	106	165	74	1576 40.3%
2 Rural	491	389	242	461	347	404	2334 59.7%
Column Total (%)	1275 32.6.	571 14.6	507 13.0	567 14.5	512 13.1	478 12.2	3910 100.0

Table 4.1 (cont.): Location of the households (count), weight by factor expancion.

ZONA	REGION Centr. 1	 Choro. 2	 Pacif. 3	 Brunc. 4	 Atlan. 5	 H.Nort. 6	 Row Total
1 Urban	1566	127	106	68	104	27	1998 51.1%
2 Rural	922	218	101	284	231	155	1912 48.9%
Column Total (%)	2489 63.6	346 8.8	207 5.3	352 9.0	336 8.6	181 4.6	3910 100.0

The area where the households are situated is important in consumption analyses. Therefor it is interesting to test if all regions have an equal percentage of urban population. The *one-sample chi-square test* can be used here. To calculate the one-sample chi-square statistic, the data have to be classified into mutually exclusive categories of interest (regions and zones in this case), whereafter expected frequencies for these categories are computed. Expected frequencies are the frequencies that would be expected if the null hypothesis is true. For this data the hypothesis to be tested is that the degree of urbanization is the same for each region. When the expected frequencies are obtained, the chi-square statistic is computed as in Equation 4.1.

$$\chi^2=\sum_{i=1}^{k}\frac{(O_i-E_i)^2}{E_i} \qquad \text{Equation 4.1}$$

In Equation 4.1 O_i is the observed frequency for the ith category, E_i is the expected frequency for the ith category, and k is the number of categories. If the null hypothesis is true, the chi-square statistic has approximately a chi-square distribution with k-1 degrees of freedom. This statistic will be large if the observed and the expected frequencies are substantially different. In this case the observed chi-square value is 531.22 with a significance level of 0.000. Because the observed significance is small, the hypothesis that urban zones are evenly distributed over regions is rejected. Studying the cross-table (see table 4.1), it appeared that relative more households in Chorotega, Brunca, Huetar Atlántica and Huetar Norte live in rural than in urban areas. Reversely, in Central and less profound in Pacifico, more households live in urban areas.

Family Size varied from one to twenty members. About 30 percent of the families consist of 3 mémbers or less, 20 percent of 4 members, 30 percent had 5 or 6 members and about 15 percent had more than 6 members (see table 4.2).

Table 4.2: Family size.

Number of family members	Frequency	Percent
1	195	5.0
2	424	10.8
3	628	16.1
4	821	21.0
5	724	18.5
6	499	12.8
>6	619	15.8
Total	3910	100.0

Gross monthly income per family (INGRBRUT) varied from 125 to 308,100 Colones. Mean gross monthly income was 28081 with standard deviation of 26712. To test the hypothesis that the Costa Rican people were equally distributed over the continue variable income, a *F*-test was done. For rural and urban zone as well as for the six regions, a *F*-statistic is calculated with Equation 4.2.

$$F = \frac{\text{BETWEEN GROUP MEAN SQUARE}}{\text{WITHIN GROUP MEAN SQUARE}} \qquad \text{Equation 4.2}$$

The ***within-groups sum of squares*** is a measure of the variability within groups. It is calculated as Equation 4.3.

$$SSW=\sum_{i=1}^{k} (N_i-1)\, S_i^2 \qquad \text{Equation 4.3}$$

where S_i^2 is the variance of group *i* about its mean, and N_i is the number of cases in group *i*. Variability of the group means is measured by the ***between-groups sum of squares***, which is

$$SSB=\sum_{i=1}^{k} N_i(\overline{X_i}-\overline{X})^2 \qquad \text{Equation 4.4}$$

The mean of the i-th group is denoted $\bar{x}_i$, and the mean of the entire sample is $\bar{x}$.

The F-value for relating income to the zones and regions were respectively 254.338 and 116.15. The observed significance level is obtained by comparing the calculated *F* to values of a *F* distribution with *k*-1 and *N*-*k* degrees of freedom. The observed significance level is the probability of obtaining a *F* statistic at least as large as the one calculated when all income strata have the same amount of households from the different zones and regions. If this probability is small enough, the hypothesis that all income strata have an equal part of urban as well as rural households is rejected. In this case, the observed significance level for both zones as regions is 0.000. Thus, it appears unlikely that households in the different zones and regions have the same income.

The relation between Gross Monthly Income and Region is presented in table 4.4

Table 4.4: Gross Monthly Family Income related to region.

REGION Region of planification
by INGRBRUT Gross Monthly Income per family

REGION	Count / Row Pct / Col Pct / Tot Pct	INGRBRUT 0-9002 (1)	9003-14635 (2)	14636-21544 (3)	21545-34101 (4)	34105-803100 (5)	Total
1 Central	Count	135	190	233	312	405	1275
	Row Pct	10.6	14.9	18.3	24.5	31.8	32.6
	Col Pct	17.3	24.3	29.8	39.9	51.8	
	Tot Pct	3.5	4.9	6.0	8.0	10.4	
2 Chorotega	Count	173	139	93	87	79	571
	Row Pct	30.3	24.3	16.3	15.2	13.8	14.6
	Col Pct	22.1	17.8	11.9	11.1	10.1	
	Tot Pct	4.4	3.6	2.4	2.2	2.0	
3 Pacifico	Count	132	104	113	95	63	507
	Row Pct	26.0	20.5	22.3	18.7	12.4	13.0
	Col Pct	16.9	13.3	14.5	12.1	8.1	
	Tot Pct	3.4	2.7	2.9	2.4	1.6	
4 Brunca	Count	150	151	118	92	56	567
	Row Pct	26.5	26.6	20.8	16.2	9.9	14.5
	Col Pct	19.2	19.3	15.1	11.8	7.2	
	Tot Pct	3.8	3.9	3.0	2.4	1.4	
5 Atlantica	Count	93	91	122	109	97	512
	Row Pct	18.2	17.8	23.8	21.3	18.9	13.1
	Col Pct	11.9	11.6	15.6	13.9	12.4	
	Tot Pct	2.4	2.3	3.1	2.8	2.5	
6 H.Norte	Count	99	107	103	87	82	478
	Row Pct	20.7	22.4	21.5	18.2	17.2	12.2
	Col Pct	12.7	13.7	13.2	11.1	10.5	
	Tot Pct	2.5	2.7	2.6	2.2	2.1	
Column Total		782	782	782	782	782	3910
		20.0	20.0	20.0	20.0	20.0	100.0

For an easier analysis of the results all the data were converted on a yearly basis. The mean gross income per year (INGRBRAN) was 336,980 colones with a standard deviation of 320,555 colones. The mean gross income per year per capita (INGCAPAN) was 88,662 colones with a standard deviation of 110,745 colones. Besides information about the incomes of the households, information about the expenditures of households to different consumption categories is available (Annex 1). GASTCANO is the total expenditure per year for all consumption goods. The mean total consumption was 271,256 colones with a standard deviation of 307,290. The variable GASALIAN gives the expenditure on food stuffs per year. The mean food expenditure was 90,246 colones with standard deviation of 71,677 colones. It is interesting to see if there are differences in these incomes and expenditures per zone and per region. In order to analyze these differences Table 4.5 was constructed where the 6 regions and the two zones were related to the means of the four variables.

The problem by estimating means is that $\bar{x}$ is an estimate of the mean (μ) and S^2 is an estimate of the standard deviation (σ^2). The most accurate estimator for μ can be calculated by equation 4.5:

$$\bar{x}=\frac{1}{n}\sum_{i=1}^{n}x_i \qquad \text{Equation 4.5}$$

The outcome of equation 4.5 is a point estimation (one number). It is clear that the real (unknown) value of μ will deviate from this. It is possible to give an interval in which μ with specific certainty will fall. The probability that a given sample mean falls within certain limits around the population mean can be derived from *z*-tables. For the variables mentioned above (INGRBRAN, INGCAPAN, GASTCANO and GASALIAN) the critical z-values were derived for the selected standard errors. These z-values help to define the so-called 'confidence limits'. The confidence limits are generalized in equation 4.6, in which $\bar{x}$ is the sample mean of variable X, z_c is the critical z value for the selected level and $\sigma_{\bar{x}}$ is the standard error of the sample mean.

$$\bar{X}\pm z_c\sigma_{\bar{X}} \qquad \text{Equation 4.6}$$

For the 95 per cent (0.95) level the critical z value is 1.96. In the case for the variables INGRBRAN, INGCAPAN, GASTCANO, and GASALIAN the 95 per cent confidence limits are given by:

INGRBRAN: 336,980 ± 1.96 * 5126 = ¢ 326,932 < μ < ¢ 347,028

INGCAPAN: 88,662 ± 1.96 * 1771 = ¢ 85,191 < μ < ¢ 92,134

GASTCANO: 271,256 ± 1.96 * 4913 = ¢ 261,626 < μ < ¢ 280,886

GASALIAN: 90,246 ± 1.96 * 1146 = ¢ 87,999 < μ < ¢ 92,492

For small samples, where the sampling distributions can be distorted by the nature of the population's distribution, a student's *t*-distribution should be used. However, in this study, with a large sample size (3910), the sample may be considered to have a normal distribution.

Table 4.5: Mean-gross yearly income and expenditures, total and per zone, region

	REGIONS					
Variables	Central	Chorotega	Pacifico	Brunca	H.Atlant.	H.Norte
Ingrbran	389484.57	255787.42	229080.68	214671.42	278731.70	277556.78
Ingcapan	104452.80	60145.65	60243.06	50648.67	70500.30	66130.90
Gastcano	316275.65	178245.48	190225.98	166960.76	212503.88	234286.86
Gasalian	99361.72	73361.70	70261.63	69059.08	88485.67	78213.23

	ZONE		
Variables	Urban	Rural	Total
Ingrbran	414486.65	255990.40	336980.34
Ingcapan	114329.27	61842.71	88662.80
Gastcano	336145.47	203450.15	271256.08
Gasalian	101091.18	78913.10	90245.87

To test the hypothesis that the incomes and expenditures are significantly different for the six regions and in the urban and rural zone the *F*-statistic is calculated (table 4.6). The observed significance level for the four variables is 0.000. Thus, it appears unlikely that households in the different zones and regions have the same expenditures and incomes.

As can be concluded from table 4.5 the mean-gross income were higher in the urban than in the rural zones. For the different regions it appears that the higher income and expenditures levels were more often found in the Central region. The lowest mean-income and expenditures were more often represented in the Chorotega, Pacifico and Brunca regions. In the Atlantic region the households belong relatively more to the middle income-and expenditures groups.

Table 4.6: Results of the F-test for income and expenditure differences.

	REGIONS	ZONES
Variables	F-Value (sign. v. F)	F-Value (sign.v.F)
Ingrbran	40.5937 (0.000)	254.3381 (0.000)
Ingcapan	30.1081 (0.000)	232.4523 (0.000)
Gastcano	2.2159 (0.000)	191.0468 (0.000)
Gasalian	21.1764 (0.000)	95.8089 (0.000)

It is interesting to see what percentage of the household incomes was spent on food products, and if differences between the regions and zones exist. The first part of table 4.7 presents the average percentage of food-expenditures in relation to total expenditures (GASTPERC) and in relation to gross-income per household. The results of the *F*-test are set in the second part of the table. For regions as well as for zones the null-hypothesis that there is no difference in percentage of income spent on food products is rejected.

Table 4.7: Average percentage of incomes and expenditures to foodstuffs

	REGIONS						ZONES		
Variables	Cent.	Chor.	Pac.	Brun.	H.At.	H.No.	Urban	Rural	Total
Gastperc	38.6	46.6	43.3	45.9	43.2	42.9	36.8	45.0	40.8
Ingrperc	33.9	44.5	38.6	42.8	39.9	39.3	31.9	41.6	36.6

table 4.7 (cont.): Results of the F-test

	REGIONS	ZONES
Variables	F-value (sign. of F)	F-value (sign.of F)
Gastperc	10.7762 (0.000)	83.6654 (0.000)
Ingrperc	18.8093 (0.000)	172.3798 (0.000)

From table 4.7 can be concluded that in the urban zones relatively less of the total expenditure (37% versus 45%) and also less of the incomes (32% versus 42%) was spend on food products than in the rural zones. For the different regions it appears that in the Central zone the lowest percentage was spend on food. In the other five regions this percentage was more or less the same, between 43% and 47% of total expenditures and between 39% and 45% of gross-income.

In addition, the relation between income-strata and percentage spent on foodstuffs can be calculated. Thereby, questions will be handled such as, did richer households spend relatively less of their income to food compared to poorer households?; does the Engel Law holds true for this case? (see chapter 3). It gives also an idea if food-expenditures increases when average income raise. To test if the percentage of food-expenditures is equal for all income-groups a F-Statistic is calculated. In order to interpret the results of the F-test table 4.8 is presented. Five income strata, which all enclose 782 households, were distinguished. Strata 1, the lowest income strata encloses households with a family gross yearly income from ¢ 0 to ¢ 129,936. The second strata runs up to ¢ 203,616, strata 3 runs up to 298,232, strata 4 runs up to ¢ 475,891 and the highest strata enclosed the remainder. Per strata the percentage of expenditure to food products are calculated. In the second part of table 4.8 the results of the F-test are printed. The null-hypothesis that there is no difference is rejected for both the percentage of food-expenditures per total expenditures as well as per gross-family-income.

Table 4.8: Expenditures to foodstuffs per income-strata (in percentage)

	INCOME-STRATA					
Variables	Strata 1	Strata 2	Strata 3	strata 4	Strata 5	Total
Gastperc	51.5	44.4	42.9	36.4	28.9	40.8
Ingrperc	56.7	41.8	37.5	27.7	19.4	36.6

Table 4.8 (cont.): Results of the F-test

	INCOME-STRATA
Variables	F-value (sign. of F)
Gastperc	168.1540 (0.0000)
Ingrperc	165.9122 (0.0000)

From table 4.8 can be concluded that the higher the incomes the lower the percentages spending on food products. In the lowest income-strata the households spent 56.7% of their income and in the highest income-strata households spent only 19.4% of their income on this goods.

5. PRODUCT CHARACTERISTICS

At first, this chapter describes the average-consumption of the selected products, for the total country and for the specified zones and regions. Subsequently these data are linked to income and to the prices of the products. The eight selected products are: Ayote sazón, Plátano, Banana, Papaya, Piña, Nampí, Tiquisque and Yuca. The product codes of all the products existing in the data-set are presented in appendix 3.

The quantity of purchased product was calculated in kilograms accept for platano, banana and piña, which was calculated per unit. In table 5.1 the mean-consumption and the mean value of the consumed quantity are presented for the different zones and regions. The extension of the variable names are *can*, *val*, and *cap*, which stands for quantity, value and quantity per capita respectively. For example, aysancan stands for the quantity of ayote sazón consumed per year, *aysanval* represent the value of quantity consumed ayote sazón and aysazcap is the quantity consumed per capita per year. For the declaration of the other variables see appendix 1.

In the subsequent analysis mostly the consumption per capita per year was used. Average consumption per capita of ayote sazón was 0.67 kilogram per year with standard deviation (σ) of 4.67 kilogram. The average consumption was rather low and the standard deviation relatively large because many of the households did not consume ayote sazón at all but nevertheless were admitted in the sample as a zero and thereby lowering the average consumption per capita. For platano the mean consumption per capita per year was 27 plátanos with σ of 70, for banana it was 51 bananas per capita per year with σ of 141 bananas. For papaya 3.43 kilogram (σ =12.27), for piña 2.60 piñas (σ =10.29), for ñampi 0.29 kilogram (σ =2.58), for tiquisque 0.44 kilogram (σ =3.67), and for yuca the mean consumption per capita was 4.30 kilogram per year (σ=13.68).

With help of Eq. 5.1 the 95 per cent confidence limits are defined.

$$P[\bar{X}-1.96\frac{\sigma}{\sqrt{n}}<\mu<\bar{X}+1.96\frac{\sigma}{\sqrt{n}}]=0.95 \qquad \text{Equation 5.1}$$

Aysazcap: 0.67 ± 1.96 * 0.08 = 0.52 < μ < 0.82 kg

Platacap: 27.0 ± 1.96 * 1.12 = 24.8 < μ < 29.2 pieces

Banancap: 51.0 ± 1.96 * 2.25 = 46.6 < μ < 55.4 pieces

Papaycap: 3.43 ± 1.96 * 0.20 = 3.05 < μ < 3.82 kg

Piñacap : 2.60 ± 1.96 * 0.17 = 2.28 < μ < 2.92 pieces

Nampicap: 0.29 ± 1.96 * 0.04 = 0.21 < μ < 0.37 kg

Tiquicap: 0.44 ± 1.96 * 0.06 = 0.33 < μ < 0.55 kg

Yucacap : 4.30 ± 1.96 * 0.22 = 3.88 < μ < 4.72 kg

Table 5.1: Mean-consumption, mean-value and mean-consumption per capita (total and per zone, region).

	REGIONS						ZONES		
Variables	Cent.	Chor.	Pac.	Brun.	H.At.	H.No.	Urban	Rural	Total
Aysancan	3.47	2.23	0.49	0.85	1.84	3.04	2.76	2.86	2.81
Aysanval	74.86	64.51	18.02	7.83	76.01	57.36	30.49	23.89	27.27
Aysazcap	0.85	0.43	0.07	0.16	0.53	0.65	0.68	0.66	0.67
Plaancan	114.8	94.48	92.70	129.8	94.73	144.8	117.7	107.8	112.8
Plaanval	703.8	567.7	572.9	626.8	631.4	618.5	744.9	587.2	667.8
Platacap	28.12	23.09	21.28	28.76	22.69	35.95	30.49	23.89	27.27
Banancan	265.1	180.9	132.9	92.59	59.05	168.9	272.1	151.2	212.9
Bananval	386.8	287.7	209.8	146.6	111.9	205.9	384.7	242.3	315.0
Banancap	63.51	41.71	32.77	19.66	13.81	46.87	66.58	34.66	50.97
Papancan	16.97	5.68	6.85	4.03	6.85	5.76	18.37	7.15	12.88
Papanval	493.9	136.8	121.6	138.0	170.3	155.1	550.6	175.4	367.1
Papaycap	4.57	1.38	1.66	0.91	1.84	1.38	5.11	1.66	3.43
Pinancan	11.61	5.88	5.81	5.37	4.66	6.80	12.87	5.80	9.41
Pinanval	309.4	179.9	183.4	176.7	136.3	149.4	361.1	148.4	257.1
Pinacap	3.30	1.36	1.62	1.14	1.28	1.58	3.82	1.31	2.60
Namancan	1.16	0.40	0.32	0.52	2.09	5.14	1.21	1.31	1.26
Namanval	28.57	11.64	12.50	12.05	57.43	115.5	30.91	31.60	31.25
Nampicap	0.27	0.09	0.06	0.15	0.46	1.08	0.28	0.30	0.29
Tiqancan	1.64	2.00	1.22	0.74	0.91	3.65	1.83	1.36	1.60
Tiqanval	47.00	59.00	45.97	25.47	27.92	79.25	57.48	33.86	45.93
Tiquicap	0.50	0.45	0.28	0.16	0.19	0.83	0.54	0.34	0.44
Yucancan	20.02	9.23	11.05	15.58	14.47	28.72	18.20	18.04	18.12
Yucanval	365.6	185.9	275.7	252.5	290.1	381.2	351.6	305.5	329.02
Yucacap	4.83	2.28	2.45	3.42	3.19	6.87	4.60	3.99	4.30

The results of table 5.1 are compared with results of a study of the Ministry of Agriculture, MAG (1991). In that study an estimation was given of the yearly consumption per capita of the most important products for several years. Data belonging to ñampi and ayote sazón were not available in that study. The data for plátano, banana and piña had to be converted into kilograms because the comparing MAG-data were all in kilograms and not by piece. For platano the MAG-study gives a mean consumption per cap. of 6.1 kg and with a mean of 4 plátanos per kg, this study gives 27.27/4 = 6.8 kg. With a mean of 6.5 bananas per kg the comparison for bananas was 8.7 kg versus 50.97/6.5 = 7.8 kg. A piña has a average weight of 1.5 kg and so the comparison was 9.5 kg to 2.6 * 1.5 = 3.9 kg. For papaya it was 5.34 kg versus 3.43, for tiquisque it was 1.0 versus 0.44 and for yuca the comparison was 5.80 kg in the MAG-study versus 4.30 in this study. There are no extreme differences, only for piña and tiquisque the differences are large.

To test whether the consumption per capita differs per zone and per region a *F-test* was done. The test indicates whether the population consumption per capita are probably unequal. The results of the test for the eight products are presented in table 5.2. The hypothesis that the average consumed amount was equal in the six regions is rejected for all the products accept for platano (significance 0.1972) and tiquisque (significance 0.2467). The consumption per capita was for the most products significant higher in the central region and significant lower in the pacifico- and brunca region (see table 5.1). In the case of the zones the null hypothesis is rejected for platano (0.0036), banana (0.0000), papaya (0.0000) and piña (0.0000). The consumption per capita was in these cases significant higher in the urban- than in the rural-zones

Table 5.2 Results of the F-test for differences in consumption per capita

	REGIONS	ZONES
Variables	F-value (significance of F)	F-value (significance of F)
Aysazcap	2.5096 (0.0283)	0.0126 (0.9107)
Platacap	1.4676 (0.1972)	8.5029 (0.0036)
Banancap	13.3217 (0.0000)	50.9869 (0.0000)
Papaycap	12.4513 (0.0000)	78.7786 (0.0000)
Pinacap	6.6654 (0.0000)	58.9869 (0.0000)
Nampicap	4.6675 (0.0003)	0.0859 (0.7695)
Tiquicap	1.3345 (0.2467)	2.5514 (0.1103)
Yucacap	5.0316 (0.0001)	1.9580 (0.1618)

To gain a insight into the consumer's demand it can be useful to look at the consumption per capita for households which consume a certain product (see table 5.3). For some parts of the country there were little cases and we can question the correctness of these data. But it gives a good indication how much the households consume of a product when they actually buy the products.

Table 5.3: Mean -consumption of households which actually buy the product (number of case)

	REGIONS						ZONES		
Variables	Cent. (2489)	Chor. (346)	Pac. (207)	Brun. (352)	H.At (336)	H.No (181)	Urban (1998)	Rural (1912)	Total (3910)
Aysazcap [in kg]	51.66 (167)	71.78 (11)	70.77 (1)	66.66 (4)	56.22 (11)	54.76 (10)	42.89 (128)	71.46 (77)	53.57 (205)
Platacap [in pcs]	293.9 (972)	306.2 (107)	269.7 (71)	470.4 (97)	410.6 (77)	677.9 (39)	271.5 (866)	414.8 (497)	323.8 (1363)
Banancap [in pcs]	740.2 (891)	607.7 (103)	486.1 (57)	613.8 (53)	473.4 (42)	961.6 (32)	702.6 (774)	716.1 (404)	707.22 (1177)
Papaycap [in kg]	79.14 (534)	90.06 (22)	113.4 (12)	65.24 (22)	76.30 (30)	78.54 (13)	77.63 (473)	85.28 (160)	79.56 (633)
Pinacap [in pcs]	71.16 (406)	56.63 (36)	57.51 (21)	101.3 (19)	48.81 (32)	90.93 (14)	67.19 (383)	76.91 (144)	69.84 (527)
Nampicap [in kg]	47.70 (61)	46.23 (3)	26.59 (2)	46.60 (4)	60.04 (12)	70.47 (13)	43.65 (55)	63.08 (40)	51.76 (95)
Tiquicap [in kg]	45.85 (89)	37.78 (18)	26.74 (9)	35.39 (7)	32.95 (9)	64.11 (10)	40.59 (90)	48.41 (54)	43.52 (144)
Yucacap [in kg]	63.68 (782)	59.19 (54)	64.88 (35)	91.10 (60)	83.37 (58)	139.2 (37)	59.23 (614)	83.40 (414)	68.96 (1027)

To test whether the consumption per capita differs per zone and per regions the *F*-test was also carried out for these data (see table 5.4). The test indicates for the regions that the consumption per capita were unequal for platano (0.000), banana (0.0019), piña (0.0290) and yuca (0.000).

For the zones we can see something interesting. In the rural areas few households consume the products, but those which actually consume the products have a higher consumption per capita than the households in the urban areas. Comparing table 5.3 to table 5.1 (mean consumption for all the cases) we see that the mean consumption in the latter is higher for the urban areas than for the rural areas but in table 5.3 we see that this is caused by the number of households which purchases the products. So in the urban areas more households consume yet in lower quantities while in the rural areas the households consume relative more quantity of the few products they purchases.

Table 5.4: Results of the F-test for significant differences in table 5.3

	REGIONS		ZONES	
Variables	F-value	(significance of F)	F-value	(significance of F)
Aysazcap	0.3507	(0.8814)	13.5941	(0.0003)
Platacap	11.0435	(0.0000)	41.1275	(0.0000)
Banancap	3.8409	(0.0019)	0.0967	(0.7559)
Papaycap	0.6975	(0.6255)	1.1347	(0.2872)
Pinacap	2.5148	(0.0290)	2.5240	(0.1127)
Nampicap	0.4792	(0.7909)	2.6656	(0.1059)
Tiquicap	0.8218	(0.5362)	0.8809	(0.3496)
Yucacap	6.2267	(0.0000)	17.5355	(0.0000)

Another aspect considers the relation between income level and consumption. Only if there is a relation it makes sense to look further to correlations between the two and possibly to the income-elasticity.

In order to analyze the relation between consumption per capita and gross income per year table 5.5 was constructed. It appears that the consumption differs per income-strata. To test if the differences in the relation consumption-income are significant a *F*-test was done (2 continuous variables). For platano (0.000), banana (0.000), papaya (0.000), ñampi (0.000) and yuca (0.0057) the null-hypothesis that there is no difference in consumption per income group is rejected. In general the consumption rises when income rises for these cases (see table 5.5)

Table 5.5 : Consumption per cap. per income group, incomes in colones per year

INGRBRAN						
Variable	0- 129936	129937- 203616	203617- 298232	298233- 475891	475892- 3697200	Total
Aysazcap	0.4975	0.7590	0.3814	0.7578	0.9608	0.6713
Platacap	23.135	22.075	19.846	31.800	39.050	27.270
Banancap	27.824	40.864	57.490	57.658	71.053	50.971
Papaycap	0.969	1.473	2.151	5.145	7.397	3.426
Pinacap	0.761	1.262	1.870	3.175	5.919	2.597
Nampicap	0.099	0.207	0.287	0.527	0.326	0.290
Tiquicap	0.576	0.318	0.221	0.509	0.592	0.443
Yucacap	3.256	4.236	3.694	4.655	5.680	4.304

Table 5.6: Results of the F-test for consumption differences per income-group

INGRBRAN	
Variables	F-value (significance of F)
Aysazcap	1.9150 (0.1053)
Platacap	10.5980 (0.0000)
Banancap	11.2346 (0.0000)
Papaycap	40.7932 (0.0000)
Pinacap	32.4595 (0.0000)
Nampicap	2.9582 (0.0189)
Tiquicap	1.5824 (0.1763)
Yucacap	3.6545 (0.0057)

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In the original questionnaire the prices of the products were not asked. But data about the value of the purchased quantity products are known. The prices are now easily to calculate by dividing value by quantity. For example the price of ayote sazón (AYSAZPR) is the value of the purchased quantity ayote sazón (AYSANVAL) divided by the purchased quantity (AYSANCAN). For the other variables see appendix 4. In table 5.7 the means of the prices in the different zones and regions are presented. It appears that the prices do not differ much in the different zones and regions. To test if this indeed turns out the F-test is applied. The results of these tests are presented in table 5.8. Only in some cases the null-hypothesis is rejected. The hypothesis that there is no significant difference in the prices between the regions is rejected for piña (0.0007) and yuca (0.0000). For the price differences within the regions we see directly that the prices for all the products (except banana) are higher in the urban than in the rural zones. But the results of the F-test show that the price is only significant higher for ayote sazon (0.0014). In general the prices in the rural zones are lower than in the urban zones. For banana something strange appears. The prices for bananas are significant higher in the rural than in the urban areas. (¢1.47 in the urban and ¢1.66 in the rural areas per banana).

Table 5.7: Mean-prices of the products, total and per zone, region

	REGIONS						ZONES		
Variables	Cent.	Chor.	Pac.	Brun.	H.At.	H.No	Urban	Rural	Total
Aysazpr	28.44	33.92	31.20	25.19	37.15	20.86	33.08	21.57	28.78
Platapr	6.56	6.89	7.21	5.49	6.56	5.61	6.66	6.27	6.52
Bananpr	1.48	1.70	1.80	1.75	1.56	1.60	1.47	1.66	1.53
Papaypr	31.22	31.72	30.69	34.97	29.94	28.42	31.53	30.38	31.24
Pinapr	27.23	31.83	32.59	32.26	32.77	22.85	28.22	27.98	28.16
Nampipr	28.05	36.12	36.43	21.27	29.49	23.31	29.67	25.09	27.76
Tiquipr	29.35	33.62	40.80	31.48	38.04	23.02	32.57	28.01	30.86
Yucapr	19.90	22.37	27.48	19.49	19.93	17.08	20.40	19.83	20.17

Table 5.8: Results of the F-test for the differences in prices per zone and region

	REGIONS		ZONES	
Variables	F-value	(significance of F)	F-value	(significance of F)
Aysazpr	0.5548	(0.7345)	10.5613	(0.0014)
Platapr	1.7461	(0.1211)	2.3508	(0.1254)
Bananpr	1.4136	(0.2165)	5.9076	(0.0152)
Papaypr	0.2208	(0.9536)	0.3733	(0.5415)
Pinapr	4.3412	(0.0007)	0.0481	(0.8265)
Nampipr	0.9082	(0.4795)	2.6017	(0.1101)
Tiquipr	2.0179	(0.0798)	2.8771	(0.0920)
Yucapr	6.0798	(0.0000)	0.9006	(0.3428)

6. CORRELATION STATISTICS

A scatterplot is the first step in studying the association between two continuous variables. After that it is useful to quantify the strength of the association by calculating a summary index. In these analyses one commonly used measure is the Pearson correlation coefficient, denoted by *r*. It is defined as Equation 6.1.

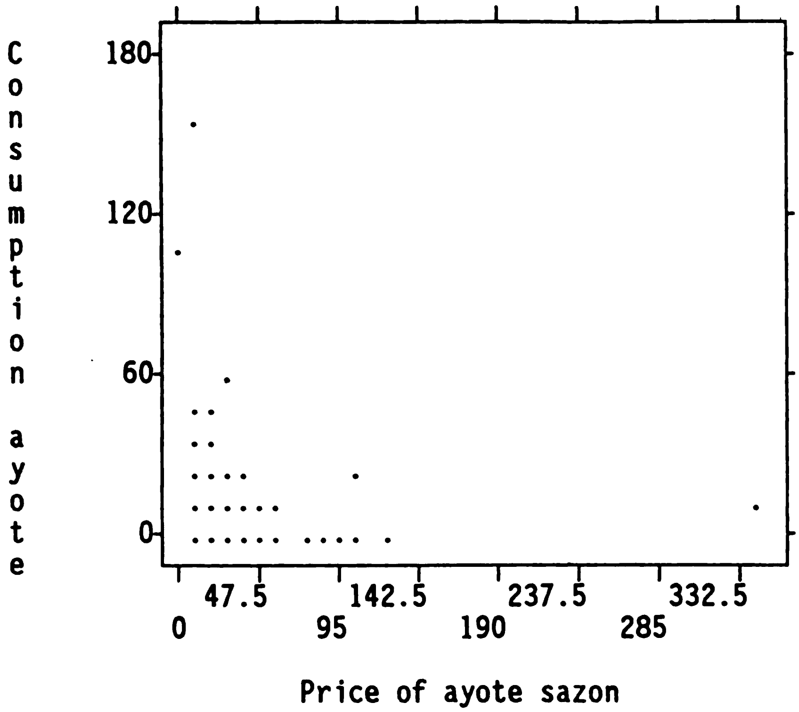
$$r = \frac{\sum_{i=1}^{N} (X_i - \bar{X})(Y_i - \bar{Y})}{(N-1) S_x S_y}$$

Equation 6.1

N is the number of cases and S_x and S_y are the standard deviation of the two variables. The absolute value of *r* indicates the strength of the linear relationship between the two variables. The largest possible absolute value is 1, which occurs when both variables are equally correlated and the points fall exactly on a line. When the line has a positive slope, the value of r is positive. That is, $\bar{Y}$ increases for increasing values of $\bar{X}$. And when the slope of the line is negative, the value of r is negative. That is, $\bar{Y}$ decreases for increasing values of $\bar{X}$. A value of 0 indicates no linear relationship. Two variables can have a strong association but a small correlation coefficient if the relation is not linear. So it is important to examine correlation coefficients together with scatterplots. It is also important to understand that correlation not automatically implies causation while interpreting the correlation coefficients. For example, while consumptions of the products are correlated with prices of the products, they are also correlated with other variables, such as income of the family. Price decreases alone does not necessarily result in increased consumptions.

For example in figure 6.1 the variables AYSAZPR, price of ayote sazon, and AYSAZCAP, consumed quantity ayote sazon per capita per year, are plotted. Some points mark more than one observation. The variables have a correlation coefficient of -0.248.

Figure 6.1: Plot of aysazcap with aysazpr



In this case the linear association is not really strong. For all the eight products the price of the product were plotted with the consumed quantity. The linear association was not too strong in the scatterplots and the correlation coefficients confirmed this. Table 6.1 presents the correlation coefficients between the prices of a product and the consumption level of that specified product. The correlation coefficient is only used to describe the observed strength of the association. Next the correlation coefficients (the significance of the relation) has to be tested. The test that the coefficient is zero can be based on the statistic

$$t=r\sqrt{\frac{N-2}{1-r^2}}$$ Equation 6.2

which has a Student's t distribution with N-2 degrees of freedom. In this case a one-tailed test is used. That is, the hypothesis that the coefficient is zero is rejected for extreme negative values of t. Table 6.1 also presents the one-tailed observed significance levels. For example for ayote sazon, the probability that a correlation coefficient of at least -0.2475 is obtained when there is no linear association in the population between consumption level and prices is less than 0.001.

Table 6.1: Correlation coefficients between consumption level per capita and prices and significance level

Product	Corr. coef.	Significance level
Ayote sazon	-0.2475	0.001
Platano	-0.1511	0.001
Banana	-0.1260	0.001
Papaya	-0.1842	0.001
Piña	-0.2360	0.001
Nampi	-0.2897	0.01
Tiquisque	-0.2149	0.01
Yuca	-0.1950	0.001

The correlation coefficients have a negative sign this means, consumption of the products decreases for increasing values of prices of the products, as it should be in conventional consumption theory. The correlation that is found is highly significant. The values of the correlation coefficients are in accordance with results of earlier studies to price elasticities for food (Pinstrup-Andersen, 1985).

Another important relation in demand theory is the relation between consumption per capita and the yearly gross-income per capita. To get an idea if there is a linear relation the income-consumption correlation coefficient was calculated. The correlation-coefficients for the demand for the eight products are presented in table 6.2. Also the one-tailed student's *t*-test was done. The observed significant levels are presented in table 6.2.

Table 6.2: Correlation coefficients between consumption level per capita and yearly gross-income per capita and significance level

Product	Corr. coef.	Significance level
Ayote sazon	0.0212	0.093
Platano	0.1210	0.001
Banana	0.1163	0.001
Papaya	0.3070	0.001
Piña	0.2644	0.001
Nampi	0.0092	0.282
Tiquisque	0.0529	0.001
Yuca	0.0647	0.001

The correlation coefficients are positive so these can be defined as 'normal goods', by definition this means that in these cases demand rises when income is increased. The correlation is not strong but for the most products it is highly significant (except ayote and ñampi). The explanation for the low correlation can be that the relation consumption to income not is a completely linear relation. As Engel argued an increase in income is associated with a less than proportionate increase in food expenditures, that is to say, the demand for food is income inelastic. This proposition, known as Engel's Law, has been empirically verified in many occasions. Although individual low-income consumers might have an income elasticity for food of greater than unity, for the average consumer in society food is income inelastic. This observation has important implications for the study to regression relations as presented in Chapter 7.

7. REGRESSION ANALYSES

Income appeared to be one of the factors influencing food consumption per capita as showed up in the correlation analyses. For the preparation of demand projections in the framework of economic planning, it is therefore essential to know what is likely to be the influence of rising incomes on food consumption. To measure this influence in this study a systematic analysis of the relationship between income and food consumption is undertaken, based on consumption functions described in Goreux (1977). Price seems to be one of the other important factors that influence food demand. The first part of this chapter describes the different types of functions generally used for measuring the relationship between income and food consumption and price and food consumption and also deals with the analysis of the household data. In the second part a more recent approach in consumption analysis is addressed, the so called 'Linear Expenditure System'.

7.1 Consumption functions

In order to measure the influence of income on consumption, consumption functions describing the relationship between per capita consumption and income were computed. In order to illustrate the effect of the different consumption functions, the first four demand functions are shown in appendix 5. This relationship gives the income elasticity coefficients which measure the percentage change in consumption corresponding to a one percent rise in income. This coefficient is the logarithmic derivative of the consumption function.

Experiments were made with several consumption functions, particularly those shown in table 7.1. The linear function (1) is obviously the simplest, but generally unsuited for the analysis of food consumption because it assumes that the coefficient of elasticity tends toward unity as income increases unlimited. The logarithmic function (2) is often satisfactory when the income range is sufficiently narrow and when food consumption is expressed in terms of expenditure rather than in terms of quantities. The logarithmic function has the practical advantage that the regression coefficient is equal to the elasticity coefficient. When food consumption is expressed in quantities, it is often preferable to use the semilogarithmic function (3). In this function the elasticity coefficient is inversely proportional to the quantity consumed. However, none of these three functions allows for a saturation level as income grows to infinity. Therefore, when food consumption is expressed in terms of quantities and when the data cover a broad income range, the log-inverse function (4), which has a saturation level, seems better suited than any of the functions (1), (2) and (3). Function (5) comes very close to function (4), the curve corresponding to this function has a sigmoid shape rather similar to that of function (4). Because function (5) has three parameters instead of two it is considerably more flexible; but its fitting has to be made by successive approximations, a rather laborious process on the computers available. Functions (1), (2), (3), (4) and (5) have been used in this study.

Table 7.1: Consumption Functions (based on demand-income relation)

	Function	Coefficient of elasticity
(1) linear	$y = a + bx$	$b\ x/y$
(2) logarithmic	$\ln y = a + b \ln x$	b
(3) semilogarithmic	$y = a + b \ln x$	b/y
(4) log-inverse	$\ln y = a - b/x$	b/x
(5) log-log-inverse	$\ln y = a - b/x - c\ln x$	$\frac{b - cx}{x}$

* y = quantity purchased per capita, x = income per capita

Appendix 6 presents the definition files for these analysis with the SPSS-PC program. The results of the estimation of the demand functions are presented in Table 7.3 to Table 7.10. Each table presents for one product the estimations of the parameters for the five functions. In the same tables are also presented the estimations of the parameters for a other group of demand functions. These functions give a specification of the functional relationship between demand and price of a good. Three different functions are specified and presented in table 7.2

Table 7.2: Consumption Functions (based on demand-price relations)

	Function	Coefficient of elasticity
(1) linear	$y = a + b\ P_t$	$b \cdot p/y$
(2) logarithmic	$\ln y = a + b \ln P_t$	b
(3) semilogarithmic	$y = a + b \ln P_t$	b/y

* y = consumed quantity per household, ln y = ln(consumed quantity per capita), P = price

In this type of consumption functions only cases with a consumption level larger than zero can be used because those are the only cases where the price can be calculated. Function (1) shows a linear consumption function. Dixit(1979), among others, has developed a theoretical basis for this function. The slope of the demand function is negative, indicating that consumers will buy less if of the product as its price increases. Another popular shape for the demand function is based on the notion of constant price elasticity. This is function (2), the exponent *b* (< 0) is the price elasticity, which is constant for all prices. This form of demand function has been very popular among analists because it represents elasticity parametrically, making it easy to translate it mathematically. It also has empirical support (see Simon, 1989, for example). Sometimes it can be useful to use the semilogarithmic function (3), the elasticity is in this function inversely proportional to the quantity consumed. These are the three functions that are normally used in price-demand analyses and therefor have been used in this study.

Table 7.3: Consumption functions for ayote sazon (significance)
(3910 cases, 205 actual consumption)

		a	b	c	R^2
	(1)	0.59 (0.0000)	$8.9 * 10^{-7}$ (0.1860)	-	0.00045
	(2)	2.34 (0.7970)	-0.026 (0.0418)	-	0.00033
INCOME	(3)	-2.19 (0.0210)	0.26 (0.0025)	-	0.00234
	(4)	2.00 (0.0000)	-2127.49 (0.7224)	-	0.00062
	(5)	1.76 (0.4760)	-3171.97 (0.7617)	-0.020 (0.4760)	0.00067
	(1)	70.87 (0.0000)	-0.60 (0.0000)		0.27272
PRICE	(2)	5.24 (0.0000)	-1.01 (0.0000)		0.54207
	(3)	197.8 (0.0000)	-45.6 (0.0000)		0.48293

Table 7.4: Consumption functions for platano (significance)
(3910 cases, 1363 actual consumption)

		a	b	c	R^2
INCOME	(1)	20.41 (0.000)	7.7 $*10^{-5}$ (0.0000)	-	0.01465
	(2)	0.94 (0.0119)	0.26 (0.0000)	-	0.04349
	(3)	-92.91 (0.0000)	10.93 (0.0000)	-	0.01783
	(4)	3.89 (0.0000)	2250.30 (0.0390)	-	0.00611
	(5)	0.51 (0.2672)	-1497.89 (0.1010)	-0.29 (0.000)	0.04538
PRICE	(1)	420.2 (0.0000)	-14.8 (0.0000)		0.16914
	(2)	5.45 (0.0000)	-0.89 (0.0000)		0.32876
	(3)	953.3 (0.0000)	-352.4 (0.0000)		0.33912

Table 7.5: Consumption functions for banana (significance)
(3910 cases, 1177 actual consumption)

		a	b	c	R^2
INCOME	(1)	37.85 (0.0000)	$1.5 * 10^{-4}$ (0.0000)	-	0.01353
	(2)	1.59 (0.0001)	0.28 (0.0000)	-	0.04907
	(3)	-195.58 (0.0000)	22.43 (0.0000)	-	0.01896
	(4)	4.85 (0.0000)	7945.38 (0.0000)	-	0.02330
	(5)	0.91 (0.1825)	-2936.77 (0.2205)	-0.33 (0.0000)	0.05028
PRICE	(1)	831.2 (0.0000)	-81.2 (0.0000)		0.14924
	(2)	4.91 (0.0000)	-0.68 (0.0000)		0.28130
	(3)	827.7 (0.0000)	-388.6 (0.0000)		0.22148

Table 7.6: Consumption functions for papaya (significance)
(3910 cases, 633 actual consumption)

		a	b	c	R^2
	(1)	0.41 (0.0863)	3.4 $*10^{-5}$ (0.0000)	-	0.09423
	(2)	-2.67 (0.0000)	0458 (0.0000)	-	0.09226
INCOME	(3)	-38.20 (0.0000)	3.78 (0.0000)	-	0.07123
	(4)	2.76 (0.0000)	16440.88 (0.0000)	-	0.02897
	(5)	-6.40 (0.0000)	-23471.25 (0.0002)	-0.75 (0.0000)	0.11150
	(1)	107.5 (0.0000)	-0.89 (0.0000)		0.23339
PRICE	(2)	5.04 (0.0000)	-0.75 (0.0000)		0.29763
	(3)	262.0 (0.0000)	-54.9 (0.0000)		0.32113

Table 7.7: Consumption functions for piña (significance)
(3910 cases, 527 actual consumption)

		a	b	c	R^2
INCOME	(1)	0.49 (0.03699)	$2.5 * 10^{-5}$ (0.0000)	-	0.06988
	(2)	-1.78 (0.0189)	0.37 (0.0000)	-	0.05616
	(3)	-28.86 (0.0000)	2.86 (0.0000)	-	0.05780
	(4)	2.59 (0.0000)	11757.78 (0.0116)	-	0.01207
	(5)	-6.66 (0.0000)	-32061.63 (0.0001)	-0.75 (0.0000)	0.08279
PRICE	(1)	102.9 (0.0000)	-1.18 (0.0000)		0.20922
	(2)	5.01 (0.0000)	-0.79 (0.0000)		0.28416
	(3)	177.9 (0.0000)	-33.2 (0.0000)		0.22729

Table 7.8: Consumption functions for ñampi (significance)
(3910 cases, 95 actual consumption)

		a	b	c	R^2
	(1)	0.27 (0.03699)	2.1 $*10^{-7}$ (0.5641)	-	0.00009
	(2)	-0.70 (0.6820)	0.24 (0.1080)	-	0.02758
INCOME	(3)	-0.77 (0.1439)	0.10 (0.0436)	-	0.00104
	(4)	2.25 (0.0000)	9719.25 (0.2520)	-	0.01410
	(5)	-3.80 (0.3951)	-15218.03 (0.4523)	-0.50 (0.1771)	0.03357
	(1)	82.6 (0.0000)	-1.1 (0.0094)		0.26532
PRICE	(2)	5.12 (0.0000)	-0.95 (0.0000)		0.41291
	(3)	175.9 (0.0000)	-38.6 (0.0023)		0.30916

Table 7.9: Consumption functions for tiquisque (significance)
(3910 cases, 144 actual consumption)

		a	b	c	R^2
	(1)	0.29 (0.0001)	$1.7 * 10^{-6}$ (0.0009)	-	0.00280
	(2)	0.35 (0.7929)	0.14 (0.2479)	-	0.00941
INCOME	(3)	-2.06 (0.0008)	0.23 (0.0060)	-	0.00287
	(4)	1.91 (0.0000)	-716.29 (0.9085)	-	0.00009
	(5)	-4.50 (0.0956)	-24041.49 (0.0385)	-0.53 (0.0180)	0.03922
	(1)	70.8 (0.0000)	-0.89 (0.0005)		0.28719
PRICE	(2)	5.08 (0.0000)	-0.95 (0.0000)		0.41993
	(3)	142.4 (0.0000)	-29.9 (0.0001)		0.31551

Table 7.10: Consumption functions for yuca (significance)
(3910 cases, 1027 actual consumption)

		a	b	c	R^2
	(1)	3.60 (0.0000)	$7.9 * 10^{-6}$ (0.0001)	-	0.00419
	(2)	0.66 (0.1165)	0.15 (0.0000)	-	0.01629
INCOME	(3)	-11.76 (0.0000)	1.46 (0.0000)	-	0.00853
	(4)	2.41 (0.0000)	1298.24 (0.2614)	-	0.00123
	(5)	0.07 (0.8932)	-2447.38 (0.0889)	-0.20 (0.0000)	0.01907
	(1)	108.9 (0.0000)	-1.98 (0.0000)		0.20249
PRICE	(2)	4.81 (0.0000)	-0.83 (0.0000)		0.35579
	(3)	233.8 (0.0000)	-56.5 (0.0000)		0.25169

In these tables it appeared that income hardly plays a prominent part in the demand for food. A great part of the variance in demand is declared by the prices of the products (15% to 53%). The logarithmic consumption-price function gives the best approach to reality. In the following analysis this logarithmic consumption function is used.

As showed above, price is the main determinant of the demand for food. Pinstrup-Andersen (1985) says that particularly for low-income consumers the level of the food prices is an important determinant of their purchasing power. Poor consumers spend a large budget share on food. Even relatively small price changes for food staples may seriously influence the ability of poor consumers to meet their basic needs. So the estimation of the price elasticities should also be done by income stratum. The utility of income-specific parameters for policy analysis has been demonstrated in a number of studies, e.g. Pinstrup-Andersen (1977), Timmer and Alderman (1979), and Trairatvorakul (1985). Estimates of price elasticities for the selected commodities by income stratum for the logarithmic demand function are presented in Table 7.11.

Table 7.11: Price elasticities of demand for selected products, by income group. (R^2)

Commodity	30% of population with lowest incomes	Middle 50%	20% of the population with highest incomes
Ayote sazon	-1.44 (0.695)	-0.86 (0.484)	-1.02 (0.561)
Platano	-0.95 (0.367)	-0.81 (0.309)	-1.10 (0.354)
Banana	-0.86 (0.353)	-0.58 (0.217)	-0.69 (0.359)
Papaya	-1.21 (0.490)	-0.78 (0.268)	-0.67 (0.323)
Piña	-0.59 (0.320)	-1.03 (0.344)	-0.57 (0.209)
Nampi	-0.55 (0.299)	-1.14 (0.467)	-0.44 (0.224)
Tiquisque	-0.17 (0.108)	-1.14 (0.272)	-0.54 (0.198)
Yuca	-0.64 (0.304)	-0.90 (0.374)	-0.77 (0.324)

* based on logarithmic demand functions

As expected, the income strata are different responsive to food price changes. But not always are the poor more responsive than the better-off population groups. The whole population in Costa Rica responds strong to food price changes. Absolute values above one are not uncommon and it is clear that food price changes cause larger relative quantity adjustment among the different income groups than indicated by the parameters for society as a whole.

7.2. Linear Expenditure System

The economic theory of consumer behavior assumes that a consumer attributes certain values of utility to products. Further it supposes that the consumer has a complete understanding of the market (Lluch, Powell & Williams, 1977). The quantities purchased by a consumer are supposed to be optimal quantities, i.e, quantities determined by maximizing his utility function under a budget constraint. Formally, a consumer is supposed to maximize $u = f(x_1,\ldots,x_n)$ subject to the linear constraint

$$\sum_{i=1}^{n} p_i q_i = y \qquad \text{Equation 7.1}$$

where p_i and q_i represent the price and the quantity of the ith commodity and y designates his total expenditures, called 'income'. The solution of the optimalization gives a system of equations.

$$q_i = f(p_1, p_2, \ldots, p_n, y) \quad \text{for } i = 1,2,\ldots,n$$

The Linear Expenditure System (LES) (Philips, 1974) is a set of demand functions that is derived in such a way. This model was first used for development countries in a study of the Development Research Center of the World Bank (Lluch et al.,1977).

With help of the utility function (equation 7.2) and the budget constraint, the LES can be defined for n = 1, 2, ...n (equation 7.3 and equation 7.4).

$$u = \sum_{i=1}^{n} \beta_n \ln(q_i - \tau_i) \qquad \text{Equation 7.2}$$

$$q_i = \tau_i + \frac{\beta_i}{p_i}\left(y - \sum_{j=1}^{n} \tau_j p_j\right) \qquad \text{Equation 7.3}$$

$$p_i q_i = p_i \tau_i + \beta_i \left[y - \sum_j p_j \tau_j\right] \qquad \text{Equation 7.4}$$

Using Equation 7.4, the original equation (7.2) has been transformed into a theoretically acceptable form without losing its linearity. This is known as the real 'linear expenditure system'. The equation may be interpreted as follows: the expenditure on good i, $p_i q_i$, is decomposed into two parts: the first part, $p_i \tau_i$, is the 'minimum' expenditure to which the consumer commits himself in order to attain a minimal subsistence level. Accordingly, τ_i, can be interpreted as the 'minimum required quantity' which is purchased by the consumer first. At given prices, $\Sigma p_j \tau_j$ measures 'subsistence income', so that $(y - \Sigma p_j \tau_j)$ is the 'supernumerary income' which the consumer allocates among the n commodities in the proportions $\beta_1, \ldots, \beta_n$ (which are thus marginal budget shares).

In the linear demand system each quantity is a function of income (y) and all prices. The parameters β_n and τ_n should be estimated from a time series of expenditure and prices for the *n* goods.
In the case of the demand data for Costa Rica the linear demand system was also determined. This was not possible for a complete demand system but with some assumptions a sub-system for the food stuffs was developed. The linear expenditure system, $q_i = \tau_i + \beta_i/p_i(y-\Sigma p_j \tau_j)$, as explained above is translated for the Costa Rican data. For the final part, $\Sigma p_j \tau_j$, are no data because there are no data about the other products in the consumption package of the consumers. It was assumed that the final part can be estimated by the variable 'GASALIAN', expenditures to food stuffs per year. The expenditure to one special product is a very small part in the total expenditures and this part is neglected here. The equation for the demand system is now as eq. 6.5

$$x_i=\tau_i+\beta_i(Y-gasalian)*\frac{1}{p_i} \qquad \text{Equation 6.5}$$

The parameters τ_i and β_i are estimated with the regression statistics within SPSS-PC+ for the consumption per capita for the eight products. Table 7.11 presents the results of these estimations. The significance of the estimated values and the R^2 of the total regression equation are also presented.

Table 7.12: The Linear Expenditure System, estimation of the parameters (τ_i, β_i), R^2 and the significance of the parameters.

	Constant (= τ_i)	β_i	R^2
Ayote Sazon	10.85 (0.0000)	$1.36 * 10^{-4}$ (0.0414)	0.02033
Platano	65.33 (0.0000)	$2.6 * 10^{-4}$ (0.0000)	0.02384
Banana	155.84 (0.0000)	$6.1 * 10^{-5}$ (0.0128)	0.00526
Papaya	16.50 (0.0000)	$3.2 * 10^{-4}$ (0.0000)	0.05706
Piña	17.69 (0.0000)	$9.8 * 10^{-5}$ (0.0570)	0.00688
Nampi	11.13 (0.0000)	$8.5 * 10^{-4}$ (0.5333)	0.00419
Tiquisque	12.52 (0.0000)	$-4.0 * 10^{-5}$ (0.7058)	0.00101
Yuca	16.52 (0.0000)	$-8.1 * 10^{-6}$ (0.8102)	0.00006

Table 7.12 shows that the estimation of the complete Linear Expenditure System cannot be carried out in this case. Although the theory suggests that the LES gives a good explication of the expenditures of households, the significance of the coefficients and the standard deviation are extremely bad. Where is the snake in this Eden? Unfortunately, complete demand systems can only be estimated for groups of commodities, these commodities must therefor be large aggregates. But in this case it was tried to set up demand equations for individual commodities ('Banana' rather than 'foods'). Even after transforming the original LES into the demand system for individual products (see Eq. 6.5) there are no usable results.

8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study gives information about the domestic demand of eight selected products coming out the Atlantic Zone. Also because of the relatively short time the extensive data set has been used only for a small part. Hopefully this study will give the first impuls to further research with this valuable data set.

First, much information is given about the eight products. The final part of this study contains for each product estimations of several demand function. The demand-price relations appear to give the best approach to reality. The demand-income relations are of inferior quality.

Within the demand-price relations the logarithmic demand function gives the best approach to reality. The results of these logarithmic demand functions indicate where the possibilities of growth can be obtained. Given a situation of decreasing prices the demand will grow considerable. Especially for the production of non-traditional products (ayote sazón, ñampi, tiquisque and yuca) it is possible to achieve growth. It can be profitable to invest in these products and government intervention should be focused on the further development of the non-tranditionals in the Atlantic Zone. Possible policies options like research, advisory services and subsidies can direct farmers to production with more possibilities in the future.

This study also gives valuable information about consumers' behavior which can and should be used in policy analyses. In the regression analysis the prices of the products appear to be the main determinants in the short-term demand functions. There seems to be a difference in responds to price changes among the consumers in the different income-strata. Income-specific price parameters are of great importance for policy analyses.

The government tries with intervention in food prices to achieve a multitude of goals through food-price manipulations. In that case it is extremely important how the various options available to the government are likely to influence the different income-strata. Supply incentives which are price policies to expand food production through higher food prices, may seriously influence the ability of poor consumers to meet their basic needs. Higher food prices result in reduced real incomes. Because of the large part of the budget spent on food among the poor, the negative impact on an increase in food-prices is much higher among the poor than among the better-off population groups. In the short-run increasing food-prices are likely to influence income distribution. Consequently, attempts to increase domestic food prices to provide stronger incentives to farmers while ignoring the implications for the poor would be short-sighted. Understanding the implications of the different policy options is extremely important. With the help of consumer analyses like this, the choice of policy instruments could become more appropriate and the goals - economic, social, or political - could be achieved more efficiently.

The statistical analysis as used in this study is necessary in the demand analysis. However, the fact that this instrument is rather elaborated gives no illusions to the accuracy of the final results; some problems are:

(1) Statistical data refers to markets in which several individuals operate. However, demand theory describes the behavior of the individual consumer. This results in a problem in this study of aggregation of individuals to come to an estimation for society as a whole.

(2) The final results of the statistical data analysis remain, to a large extent, conditions determined by a number of subjected choices. It is impossible to eliminate these subjectivity in a research like this.

While interpretating the results of this study one has to take into account that the statistical data have been rearranged and transformated in a way adapted to a theoretical hypothesis. So, theoretical insight is a necessary condition for a right interpretation of the data.

REFERENCES

Barten, A.P., 1968. Estimating demand equations. Econometrica 36: 213-235.

Colman, D. and T. Young, 1989. Principles of agricultural economics; markets and prices in less developed countries.

Corsten, L.C.A. and P. van der Laan, 1984. College voortzetting statistiek.

Dixit, A., 1979. A Model of Duopoly Suggesting a Theory of Entry Barriers. The Bell Journal of Economics, Vol.10, no.1, 107-125.

Goreux, L.M.,1977. Income and food consumption. Agricultural economics and statistics 1952-1977, FAO-Studies: 390-402.

Hair, F., R. Anderson and R. Tatham, 1992. Multi variate data analysis.

Laan, P. van der and F. Kuipers, 1986. Handleiding bij het college regressie and steekproeftechnieken.

Lilien, G., P. Kotler and K. Sridhar Moorthy, 1992. Marketing Models

Lluch, C., A.A. Powell and R.A. Williams, 1977. Patterns in Household Demand and Saving.

MAG, 1991. Estimacion del consumo domestico anual de alimentos consumos per capita y global en kilogramos y tonelades metrica respectivamente 1986,1991.

Meier, G.M., 1989. Leading Issues in Economic Development, section VII.A. "Importance of agriculture": 327-341.

Norusis, K.S., 1990. SPSS/PC+ 4.0 Base manual

Norusis, K.S., 1990. SPSS/PC+ Statistics 4.0

Norusis, K.S., 1990. SPSS/PC+ Advanced Statistics 4.0

Phlips L., 1974. Applied consumption analysis.

Pinstrup-Andersen, P., 1977. Decision-making on food and agricultural research policy: The distribution of benefits from new agricultural technology among consumer income strata. Journal of Agricultural Administration 4: 13-28.

Pinstrup-Andersen, P., 1985. Food prices and the poor in development countries. Economic Review of Agricultural Economics 12, 1/2: 69-81.

Simon, H., 1989. Price Management.

Steel R.G.D. and J.H. Torrie, 1981. Principles and procedures of statistics.

Thio, K.S., 1986. Planning van de landbouw sector.

Timmer, C.P. and H. Alderman., 1979. Estimating consumption parameters for food policy analysis. American Journal of Agricultural Economics 61: 982-987.

Trairatvorakul, P., 1985. Effects on Income Distribution and Nutrition of Alternative Rice Price Policies in Thailand. Research report 32. Washington, D.C.: International Food Policy Research Institute.

Wieringa, B. and W.F. van Raaij, 1987. Consumentengedrag, theory, analyse en toepassing.

Appendix 1:List of variables.

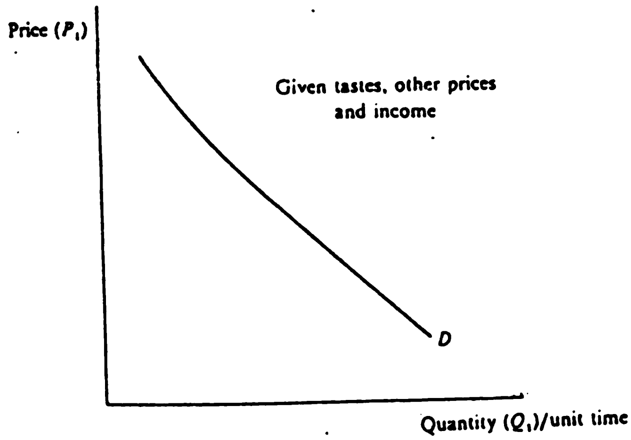
```
PERIODO  'Fecha del periodo de la entrevista'.
FAMILIA  'Numero identificacion de la familia'.
ZONA     'Zona de referencia: urbano o rural'.
REGION   'Region de planificacion'.
MIEMBROS 'Numero de miembros de la familia'.
INGRBRUT 'Ingreso bruto por mes de la familia'.
INGRCAPI 'Ingreso por capita por mes'.
GASTOALI 'Gastos alimentos total por mes de la familia'.
ALIFUERA 'Gastos para alimentos fuera vivienda por mes'.
GASTCON  'Gastos consumo total por mes de la familia'.
FACEXP   'Factor de expancion'.
TIPOREG  'Tipo de cuestionario'.
CODIGO   'Codigo de producto'.
CANTIDAD 'Cantidad consumida'.
VALOR    'Valor del producto'.
AYSAZCAN 'Cantidad ayote sazon'.
AYSAZVAL 'Valor ayote sazon'.
PLATACAN 'Cantidad platano maduro'.
PLATAVAL 'Valor platano maduro'.
BANANCAN 'Cantidad banana'.
BANANVAL 'Valor banana'.
PAPAYCAN 'Cantidad papaya'.
PAPAYVAL 'Valor papaya'.
PINACAN  'Cantidad piña'.
PINAVAL  'Valor piña'.
NAMPICAN 'Cantidad ñampi'.
NAMPIVAL 'Valor ñampi'.
TIQUICAN 'Cantidad tiquisque'.
TIQUIVAL 'Valor tiquisyue'.
YUCACAN  'Cantidad yuca'.
YUCAVAL  'Valor yuca'.
AYSANCAN 'Cantidad ayote sazon por ano'.
PLAANCAN 'Cantidad platano por ano'.
BANANCAN 'Cantidad banana por ano'.
PAPAYCAN 'Cantidad papaya por ano'.
PINANCAN 'Cantidad piña por ano'.
NAMANCAN 'Cantidad ñampi por ano'.
TIQANCAN 'Cantidad tiquisque por ano'.
YUCANCAN 'Cantidad yuca por ano'.
AYSANVAL 'Valor ayote sazon por ano'.
PLAANVAL 'Valor platano por ano'.
BANANVAL 'Valor banana por ano'.
PAPAYVAL 'Valor papaya por ano'.
PINANVAL 'Valor piña por ano'.
NAMANVAL 'Valor ñampi por ano'.
TIQANVAL 'Valor tiquisque por ano'.
YUCANVAL 'Valor yuca por ano'.
AYSAZCAP 'Cantidad ayote sazon por ano per capita'.
PLATACAP 'Cantidad platano por ano per capita'.
```

Appendix 1 (cont).

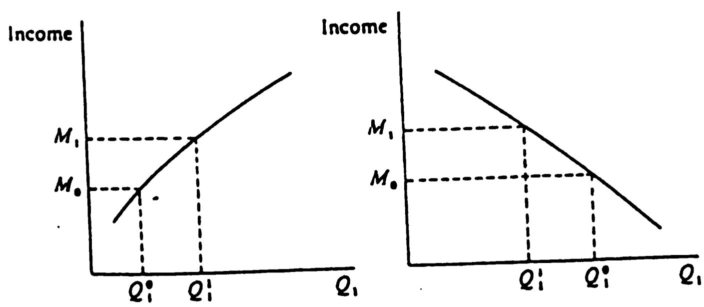
```
BANANCAP 'Cantidad banana por ano per capita'.
PAPAYCAP 'Cantidad papaya por ano per capita'.
PINACAP  'Cantidad piña por ano per capita'.
ÑAMPICAP 'Cantidad ñampi por ano per capita'.
TIQUICAP 'Cantidad tiquisque por ano per capita'.
YUCACAP  'Cantidad yuca por ano per capita'.
INGRBRAN 'Ingreso bruto por ano de la familia'.
INGCAPAN 'Ingreso bruto por ano per capita'.
GASTCANO 'Gastos consumo total por ano de la familia'.
GASALIAN 'Gastos alimentos total por ano de la familia'.
GASTPERC 'Porcentaje gastos alimentos de gastos cosumo total'.
INGRPERC 'Porcentaje gastos alimentos de ingreso bruto'.
AYSAZPR  'Precio de ayote sazon'
PLATAPR  'Precio de platano'
BANANPR  'Precio de banana'
PAPAYPR  'Precio de papaya'
PINAPR   'Precio de piña'
ÑAMPiPR  'Precio de ñampi'
TIQUIPR  'Precio de tisquisque'
YUCAPR   'Precio de yuca'
```

Appendix 2: The demand curve and the Engel curve.

App. 2.1 The demand curve



App. 2.2 The Engel curve



(a) Normal Good (b) Inferior Good

Appendix 3: Data definition for products purchased by households; product codes, quantities and values per product.

```
DATA LIST  FILE='BYSSHORT.DAT'/
           FAMILIA   1-11
           TIPOREG     12
           CODIGO   13-18
           CANTIDAD 19-26 (3)
           VALOR    27-34.
VARIABELE LABELS FAMILIA  'Numero identificacion de familia'/
                 TIPOREG  'Tipo de cuestionario'/
                 CODIGO   'Codigo de producto'/
                 CANTIDAD 'Cantidad consumida'/
                 VALOR    'Valor del producto'.

VALUE LABELS CODIGO
110141 'Harina maiz'
110145 'Maiz cascado'
110146 'Maiz dulce'
110149 'Masa de maiz'
110155 'Tortilla de maiz'
110157 'Maiz corriente'
110201 'Alipego'
110234 'Otras carnes de res'
110401 'Leche agria'
110402 'Leche condensada'
110403 'Leche en polvo'
110404 'Leche envaporado'
110405 'Leche fresca'
110406 'Leche homog. y past.'
110412 'Otras leches'
110419 'Queso amarillo'
110420 'Queso blanco'
110421 'Queso crema'
110422 'Queso procesado'
110507 'Mantequilla'
110508 'Mantequilla de maní'
110509 'Margarina'
110607 'Ayote sazon'
110608 'Ayote tierno'
110613 'Chayote'
110614 'Chile dulce'
110615 'Chile picante'
110618 'Elote'
110626 'Platano maduro'
110658 'Maiz dulce en cons.'
110659 'Palmito en conserva'
110703 'Banana'
110709 'Coco'
110717 'Guayaba'
110736 'Papaya'
110737 'Pejibaye'
110738 'Piña'
110762 'Macadamia'
110784 'Pejibayes en cons.'
110785 'Pina en conserva'
110803 'Frijoles blanco'
110806 'Frijoles negros'
110807 'Frijoles rojos'
110808 'Frijoles no especif.'
110902 'Camote'
110903 'Name'
110904 'Nampi'
110906 'Tisquisque'
110907 'Yuca'
110920 'Harina de yuca'.
```

Appendix 3 (cont.).

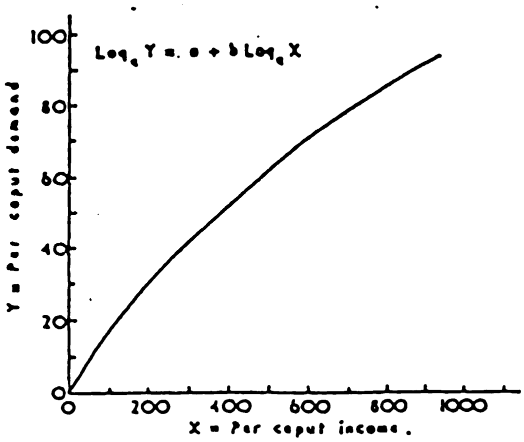
```
IF (codigo=110607) AYSAZCAN=CANTIDAD.
IF (codigo=110607) AYSAZVAL=VALOR.
IF (codigo=110626) PLATACAN=CANTIDAD.
IF (codigo=110626) PLATAVAL=VALOR.
IF (codigo=110703) BANANCAN=CANTIDAD.
IF (codigo=110703) BANANVAL=VALOR.
IF (codigo=110736) PAPAYCAN=CANTIDAD.
IF (codigo=110736) PAPAYVAL=VALOR.
IF (codigo=110738) PINACAN =CANTIDAD.
IF (codigo=110738) PINAVAL =VALOR.
IF (codigo=110904) NAMPICAN=CANTIDAD.
IF (codigo=110904) NAMPIVAL=VALOR.
IF (codigo=110906) TISQUCAN=CANTIDAD.
IF (codigo=110906) TISQUVAL=VALOR.
IF (codigo=110907) YUCACAN =CANTIDAD.
IF (codigo=110907) YUCAVAL =VALOR.

VARIABELE LABELS AYSAZCAN 'Cantidad ayote sazon'/
                 AYSAZVAL 'Valor ayote sazon'/
                 PLATACAN 'Cantidad platano maduro'/
                 PLATAVAL 'Valor platano maduro'/
                 BANANCAN 'Cantidad banana'/
                 BANANVAL 'Valor banana'/
                 PAPAYCAN 'Cantidad papaya'/
                 PAPAYVAL 'Valor papaya'/
                 PINACAN  'Cantidad piña'/
                 PINAVAL  'Valor piña'/
                 NAMPICAN 'Cantidad ñampi'/
                 NAMPIVAL 'Valor ñampi'/
                 TISQUCAN 'Cantidad tiquisque'/
                 TISQUVAL 'Valor tiquisyue'/
                 YUCACAN  'Cantidad yuca'/
                 YUCAVAL  'Valor yuca'.
```

Appendix 4: Variable definition for price variables.

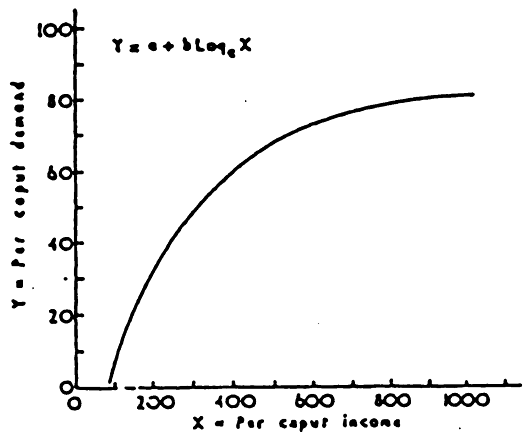
```
GET /FILE 'FACANO.SYS'.

COMPUTE AYSAZPR = AYSANVAL /AYSANCAN.
COMPUTE PLATAPR = PLAANVAL /PLAANCAN.
COMPUTE BANANPR = BANANVAL /BANANCAN.
COMPUTE PAPAYPR = PAPANVAL /PAPANCAN.
COMPUTE PINAPR  = PINANVAL /PINANCAN.
COMPUTE NAMPIPR = NAMANVAL /NAMANCAN.
COMPUTE TIQUIPR = TIQANVAL /TIQANCAN.
COMPUTE YUCAPR  = YUCANVAL /YUCANCAN.

VARIABLE LABELS AYSAZPR 'Precio de ayote sazón'
                PLATAPR 'Precio de plátano'
                BANANPR 'Precio de banana'
                PAPAYPR 'Precio de papaya'
                PINAPR  'Precio de piña'
                NAMPIPR 'Precio de ñampí'
                TIQUIPR 'Precio de tiquisque'
                YUCAPR  'Precio de yuca'
```

Appendix 5: Curves representing different consumption functions

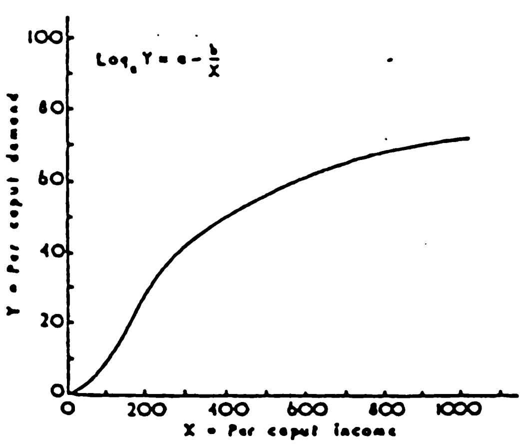
1 The Logarithmic Demand Function



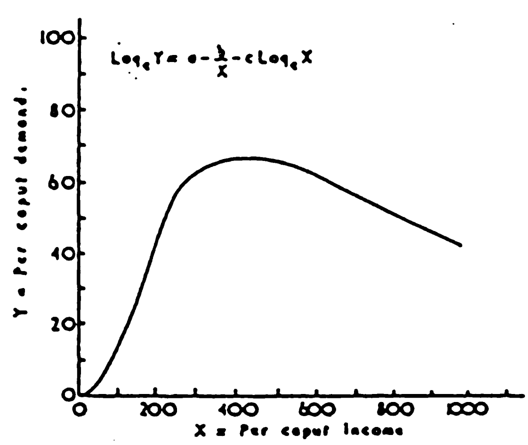
2 The Semi-Logarithmic Demand Function



3 The Log-Inverse Demand Function



4 The Log-Log-Inverse Demand Function



Appendix 6: Defenition files for estimating the demand functions for income

```
GET /FILE 'facano.sys'.

COMPUTE LNINGR  = LN(INGRBRAN).
COMPUTE LNINGC  = LN(INGCAPAN).
COMPUTE LNGAST  = LN(GASTCANO).
COMPUTE LNGASA  = LN(GASALIAN).
COMPUTE LNAYCAP = LN(AYSAZCAP).
COMPUTE LNPLCAP = LN(PLATACAP).
COMPUTE LNBACAP = LN(BANANCAP).
COMPUTE LNPACAP = LN(PAPAYCAP).
COMPUTE LNPICAP = LN(PINACAP).
COMPUTE LNNACAP = LN(NAMPICAP).
COMPUTE LNTICAP = LN(TIQUICAP).
COMPUTE LNYUCAP = LN(YUCACAP).
COMPUTE CLNINGC = 0-(LNINGC).
COMPUTE INVERSE = 0-(1/INGCAPAN).

VARIABLE LABELS LNINGR 'LN(Ingreso bruto por ano de la familia)'
                LNINGC 'LN(Ingreso por capita por ano)'
                LNGAST 'LN(Gastos consumo por ano de la familia)'
                LNGASA 'LN(Gastos alimentos por ano de la familia)'
                INVERSE '0-(1/INGCAPAN)'.

REGRESSION /DEPENDENT AYSAZCAP /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNAYCAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT AYSAZCAP /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNAYCAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNAYCAP  /METHOD ENTER INVERSE CLNINGC .

REGRESSION /DEPENDENT PLATACAP /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNPLCAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT PLATACAP /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNPLCAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNPLCAP  /METHOD ENTER INVERSE CLNINGC .

REGRESSION /DEPENDENT BANANCAP /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNBACAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT BANANCAP /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNBACAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNBACAP  /METHOD ENTER INVERSE CLNINGC .

REGRESSION /DEPENDENT PAPAYCAP /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNPACAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT PAPAYCAP /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNPACAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNPACAP  /METHOD ENTER INVERSE CLNINGC .
```

Appendix 6 (cont.)

```
REGRESSION /DEPENDENT PINACAP  /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNPICAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT PINACAP  /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNPICAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNPICAP  /METHOD ENTER INVERSE CLNINGC .

REGRESSION /DEPENDENT NAMPICAP /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNNACAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT NAMPICAP /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNNACAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNNACAP  /METHOD ENTER INVERSE CLNINGC .

REGRESSION /DEPENDENT TIQUICAP /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNTICAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT TIQUICAP /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNTICAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNTICAP  /METHOD ENTER INVERSE CLNINGC .

REGRESSION /DEPENDENT YUCACAP  /METHOD ENTER INGCAPAN.
REGRESSION /DEPENDENT LNYUCAP  /METHOD ENTER LNINGC .
REGRESSION /DEPENDENT YUCACAP  /METHOD ENTER LNINGC.
REGRESSION /DEPENDENT LNYUCAP  /METHOD ENTER INVERSE .
REGRESSION /DEPENDENT LNYUCAP  /METHOD ENTER INVERSE CLNINGC .
```