FACTORS AFFECTING HOUSEHOLD DEMAND FOR SWEET POTATO IN TWO REGIONS OF THE PHILIPPINES

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ABSTRACT

Factors affecting the demand for sweet potato were determined through a consumer survey of 1200 households from 2 regions of the Philippines. Using the regression technique, the demand functions were generated and the demand coefficients estimated. Separate regression analysis was made using the double log form for low income and high income households. The four relevant variables found to affect household demand for sweet potato included income of the head of the household, household size, retail price of sweet potato and age of the principal shopper. Sweet potato was found to be a superior good for lower income groups and inferior good at higher income levels.

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KEY WORDS: Sweet potato. Demand factors. Elasticity.

INTRODUCTION

Modern technology in agriculture has brought about large increases in food production in recent years in the Philippines. But the faster rate of population growth over food production has resulted in increased pressure on increasing food supply. Hence, more and more lands have been devoted to food crops particularly rice. Despite this expansion, the price of rice and other food crops has continued to rise sharply. This situation apparently favors the root crop industry. Statistics indicate, however, that the production rate of sweet potato registered an annual average of only 0.35% over the 25-year period from

1957 to 1981 (NEDA, 1975). For the same period, the annual per capita consumption of sweet potato showed a considerable decline from 31 kg in 1957 to 19 kg in 1981 (Table 1). This might indicate that sweet potato is a weak substitute for rice or corn. In his study on the demand for rice, Nasol (1971) suggested that the rice-consuming population might have substituted lower quality rice for first-class rice instead of switching to root crops, such as sweet potato.

An understanding of the structure will help policy makers develop workable production and marketing strategies and to understand their ramifications. For instance, if the government encourages production of sweet potato to increase farmers' income, countervailing

Table 1. Per capita consumption and retail price of sweet potato from 1957 to 1981 in the Philippines.

Year	Annual Per Capita Consumption (kg)	Average Retail Price (per 100 kg)
1957	30.9	₱ 4.51
1958	30.4	6.13
1959	29.0	6.27
1960	26.3	7.26
1961	23.3	6.06
1962	21.9	6.41
1963	24.1	7.91
1964	23.0	9.01
1965	21.5	11.54
1966	19.7	11.92
1967	18.7	12.46
1968	18.3	14.15
1969	19.1	14.31
1970	17.7	16.62
1971	16.3	21.31
1972	15.6	25.15
1973	15.3	27.62
1974	21.1	36.54
1975	22.0	27.85
1976	16.4	36.23
1977	18.9	38.62
1978	21.3	41.69
1979	22.4	51.77
1980	20.2	61.54
1981	18.9	70.00

Source: Philippine Food Balance Sheet series, NEDA and Bureau of Agricultural Economics records.

programs must be formulated to mitigate the effects of increased supply. Knowledge of demand elasticities and the characteristics of consumer demand will play a major role in this regard. Moreover, an understanding of the nature of demand for sweet potato will be helpful in the reallocation of resources among farmers.

This study proposed to determine (1) whether sweet potatoes are consumed to a greater extent in the predominantly corn consuming regions of the Visayas or in regions where rice is predominantly consumed, and (2) the factors that affect consumer demand which might suggest the reasons for the decline in the per capita consumption of sweet potato.

METHODS

To find out the determinants of household demand for sweet potato, a multi-stage random sampling of 1,200 households from 6 provinces (Cebu, Bohol, Negros Occidental, Negros Oriental, Iloilo, Aklan) in Regions VI and VII was done. These 2 regions were chosen to detect any variations in consumption patterns between Region VI, a predominantly rice-eating population, and Region VII with predominantly corn consumers.

Method of Analysis. — Multiple regression of the dependence method in multivariate analysis was considered to be the most appropriate and was used because the variables analyzed were intervally scaled with only one designated dependent variable. Nominally scaled variables were transformed using dummies to suit regression techniques.

Basic Assumptions. — In this study, a predetermined supply was assumed. This implies that the supply curve is nearly vertical or highly inelastic. This assumption is necessary because studies on sweet potato and data on supply of the commodity are not available. If this assumption holds, estimation of the demand using a single equation regression is possible.

It was also assumed that a linear relationship exists between a variable Y and k-1 explanatory variables $X_2, X_3, \ldots X_k$ and a disturbance term u. If we have *n* sample observations on Y and X's, the relationship can be written as:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \ldots + \beta_k X_{ki}$$

$$i = 1, 2, \ldots, n.$$

where:

Y = the dependent variable.
X = the independent variables that are thought to influence Y,
u = the stochastic disturbance term, and,
β's = the regression parameters.

In addition, the following basic OLS (ordinary least squares) assumptions were also assumed to hold (Klein, 1962; Kmenta, 1971; Johnston, 1977; Maddala, 1977):

$E(u) = 0_i$
$E(uu) = \sigma^2 I_n$,
X is a set of fixed numbers and,
X has a rank of K less than n.

The Demand Models. — Recent studies have included variables such as family size, education, occupation, ethnic background and regional residency as explanatory variables in demand analysis using survey data. In this study, as many variables as deemed appropriate that fit the theory were used in the regression represented in general form.

QP = f (PP, YI, SH, AGE, ED, LCN, STPL, u)

where:

PP = the retail price of sweet potato
YI = the annual income of the household head
SH = the size of household regardless of age
AGE = the age of principal shopper
ED = the number of years of schooling of the principal shopper
LCN = binary dummy variable for the location of the household: 1 if urban, 0 if otherwise.
STPL = the staple food normally consumed by the household.

Eight functional forms of the general model were tried in the regression analysis. These include the following:

Model I. Simple linear
Model II. Double log
Model III. Double log (with squared income term)
Model IV. Semi-log (with logged dependent variable)
Model V. Semi-log (with logged independent variable)
Model VI. Semi-exponential
Model VII. Modified hyperbolic
Model VIII. Inverse transformation

The Variables. — It is often argued that elasticities using survey data are impossible to obtain based on the assumption that households operate in the same market and that data lacked price variability. The inclusion of the retail price as an explanatory variable in this study was based on the preliminary observation that the variability of price responses was sufficient to meaningfully estimate the price elasticity. Inclusion of price greatly increased the R^2 of the estimating equation.

An attempt was made to do a per capita demand analysis. However total household income was not available; hence, no such analysis was made. Size of household refers to the total number of persons living in the household including children and relatives. In the analysis, household size was used without regard to age. Age was an interval variable. The location variable was represented as a dummy with the value of 1 if the household was located in an urban center and 0 if located in the rural area.

The main staple food of the household was also dummied. When the main staple was rice, the dummy was one (1); otherwise it was zero (0).

Scaling Down the Model. — All the abovementioned variables were used in the preliminary analysis. To minimize committing a Type I error in rejecting a null hypothesis, the cut-off point was set at the 80% confidence level.

Regression was first made individually to avoid the problem of multicollinearity. Those variables which were found to have significant coefficients were used in the regression analysis. Education, location and occupation exhibited a very low level of significance and were deleted in the subsequent estimation. Price of sweet potato, income, age and size of household showed a high level of significance, thus, they were included in the subsequent regression analysis following the general format:

$$Qp = f(PP, YI, AGE, SH, \mu)$$

Testing for Income Homogeneity. — The next question resolved was whether there was sufficient ground to combine the data for the low and high income households drawn from both Regions VI and VII. This required testing the equality of the two income groups for homogeneity of the complete relationship (intercepts and slopes). The testing was done by contrasting the reduction of the residual sum of squares by going from the restricted to unrestricted regression model using complete analysis of covariance test (Johnston, 1972). Having computed all the sum of squares required for these tests, the slope coefficients were compared in the form of null hypothesis;

$$H_O : b_{12} = b_{21}$$; and the

alternative hypothesis was

$$H_a : b_{12} \neq b_{21}$$

The null hypothesis in both Regions VI and VII was rejected suggesting that the sample households were significantly different across income groups. Separate regression analyses were, therefore, recommended.

RESULTS AND DISCUSSION

Of the eight regression models tried in the analysis, only the double log form performed best. First, the model showed lower standard errors of the coefficients. Second, using the *ex post* criteria, the model had greater explanatory power than the other models. Third, it was preferred because the model automatically estimated the elasticity as shown by its coefficients. The algebraic formulation of the model was of the form:

$$LQP = b_0 + b_1 LPP + b_2 LYI + b_3 LAGE + b_4 LSH + \mu$$

where:

LQP = log of the amount of sweet potato consumed by the household;
LLP = log of the retail price of sweet potato;
LYI = log of income of the household head ;

LAGE = log of the age of the principal shopper;
LSH = log of the size of the household;
bj = regression parameter; and
μ = stochastic disturbance term

The most significant variable affecting household consumption of sweet potato in both regions and for both income categories was the income of the household head, followed by the retail price of sweet potato (Table 2). Size of the household was significant for Region VI but not for Region VII. Age of the principal shopper was only significant for higher income levels in Region VI while it had very low significance in other subgroups.

The signs of the income coefficients confirm the hypothesis that sweet potato is a superior good of households at lower income levels and an inferior good at higher levels. The coefficient thus has a negative sign for higher income categories and a positive sign for lower income categories.

To improve the estimates of the significant variables, a subsequent regression analysis for Region VII was done to determine whether household size and age were superfluous variables. This was done by regressing LQP first, without LAGE, then without LSH. The results were statistically tested to determine whether the addition of one variable significantly decreased the standard error of the residual. LAGE was later deleted because it was determined to be a superfluous variable. LSH was significant at the 90% confidence level of the lower income group but not for the higher income group. The final demand functions for Region VII are as follows (figures in parenthesis are t-values):

Lower income households:

$$LGQP = -7.933 - 0.8279\,(LGPP) \quad (-3.884)^{**}$$
$$+ 1.3010\,(LGYI) \quad (17.217)^{**}$$
$$+ 0.1779\,(LGSH) \quad (1.965)^{**}$$
$$R^2 = .5916$$
$$F = 144.905^{**}$$

Higher income households:

$$LGQP = 21.0858 - 0.7350\,(LGPP) \quad (-5.421)^{**}$$
$$- 1.8186\,(LGYI) \quad (-20.860)^{**}$$
$$- 0.0271\,(LGSH) \quad (0.361)^{ns}$$
$$R^2 = .6744$$
$$F = 204.405^{**}$$

**highly significant
ns not significant

Elasticities of Demand.

Sweet potato has a slightly inelastic demand price except for the higher income category in Region VI (Table 3). Price elasticity of demand for households with income below the median was -0.67. For households with income above the median, the price elasticity of demand was -1.10. The negative sign of the coefficients suggests that household consumption of sweet potato tends to decrease as the price of sweet potato increases. The income elas-

Table 2. Estimated demand coefficients foer sweet potato by income categories in Region VI and VII, Philippines.[1]

Income Group	Dependent Variable	Constant	Independent Variables[2]				
			LPP	LYI	LSH	LAGE	
			Region VI				
Lower Income	Log QP	-7.3230	-0.663 (-3.370)**	1.2389 (12.679)**	0.3139 (2.538)**	0.0389 (0.258)ns	.4607
Higher Income	Log QP	21.0623	-1.1013 (-5.109)**	-1.7693 (-14.7360)**	0.4949 (4.300)**	-0.3909 (-2.774)**	.5741
			Region VII				
Lower Income	Log QP	-6.8452	-0.8075 (-3.772)**	1.2944 (17.069)**	0.1679 (1.843)ns	-0.1271 (-1.022)ns	.5930
Higher Income	Log QP	-20.9870	-0.7350 (-5.411)**	- 1.8216 (-20.792)**	-0.0278 (-0.370)ns	0.0344 (0.408)ns	.6746

[1] Figures in parenthesis are t values.
**Significant at 95% level.
ns Not significant.

[2] where:
LPP = log of the retail price of sweet potato
LYI = log of income of the household head
LAGE = log of the age of the principal shopper
LSH = log of the size of the household
R^2 = Coefficient of multiple determination

Table 3. Estimated demand elasticities and related descriptive statistics by income categories for Region VI and Region VII, Philippines.

Income Group	Epp	Eyi	N	$\overline{QP}$	$\overline{PP}$	$\overline{YI}$	$\overline{SH}$
			Region VI (Median YI = 7305)				
Lower Income	**-0.666**	**1.239**	**300**	**58.04**	**1.05**	**4387.89**	**5.67**
Higher Income	**-1.101**	**-1.769**	**299**	**75.39**	**0.99**	**13594.85**	**5.73**
			Region VII (Median YI = 7197)				
Lower Income	**-0.828**	**1.301**	**300**	**53.15**	**1.07**	**4075.40**	**5.34**
Higher Income	**-0.735**	**-1.819**	**300**	**77.90**	**1.09**	**11451.67**	**6.10**

where:

Epp = own price elasticity of demand
Eyi = income elasticity of demand
N = sample size
$\overline{QP}$ = mean household consumption
$\overline{PP}$ = mean retail price of sweet potato
$\overline{YI}$ = mean annual income of head of household
$\overline{SH}$ = mean size of household

ticity for both low income households and high income households were elastic or greater than 1 in absolute terms. Positive sign of the elasticity coefficient for the low income households implies that consumption tends to increase as income of the household head increases. However, the negative income elasticity for high income group suggests that household consumption of sweet potato decreases as income increases.

In Region VII, the demand price was still slightly inelastic with a value of -0.83 for the lower income group and -0.74 for the higher income levels (Table 3). Income

elasticities also had opposite signs; positive (+1.30) for the lower income levels and negative (-1.82) for higher income households.

The size of household had a positive effect on consumption; i.e., as size of household increases, its consumption of sweet potato also increases. The effect, however, was very little with an elasticity coefficient ranging from 0.18 to 0.49. The effect of household size for the high income group in Region VII was not significant.

IMPLICATION AND RECOMMENDATION

In economic theory, it is advantageous for the farmers to increase the price of the product if its demand is inelastic, as in the case of sweet potato. This is because consumption is not very responsive to price change, thus total revenue obtained by the farmers will increase. However, increase of farmers' income cannot be realized through the program of increased production. Such program is contrary to the basic economic theory of supply and demand. Since the program of increased production is already in existence, countervailing programs to mitigate the effect of increased supply is a must. It is suggested, therefore, that a program to stimulate an increased demand for sweet potato be established.

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