ISN 79737
PN-ABM-633

ASPAP/DAI Report No. 212

FOOD CONSUMPTION PARAMETERS FOR AGRICULTURAL HOUSEHOLDS IN RWANDA AND THEIR APPLICATION IN ANALYSING THE IMPACT OF THE STRUCTURAL ADJUSTMENT PROGRAM

Rwandan Agricultural Surveys and Policy Analysis Project

Contrat USAID no. 696-0126

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Kigali, Rwanda
September, 1992

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1. INTRODUCTION[1]

The economic restructuring program being followed in Rwanda, has consequences for individual welfare due to modifications in relative product and factor prices. Changes in food prices will result in modification in food consumption patterns, nutrient intake and consequently the nutritional status of the population, particularly among agricultural households which form a large proportion of the total population. The magnitude of these effects can be investigated from income and price elasticities of demand for food among the agricultural households.

Data from a 1990 survey on Expenditure and Revenue among agricultural households in Rwanda conducted by the Division des Statistiques Agricole (DSA), was used to estimate expenditure (income) and own and cross price elasticities of demand for eight staple food crops viz:- beans, sorghum, cassava, peas, maize, cooking bananas, Irish potatoes and sweet potatoes. These elasticities were then used to analyze the effect of price changes, resulting from the structural adjustment program, on food consumption and nutrient (calorie) intake of different population groups of the rural sector. The population groups are identified by geographical zones being; North-West, South-West, North-Central, South-Central and East. The population groups were identified by the five geographical zones rather than by the twelve agricultural zones because the data were collected by geographical zones and not agricultural zones. The evaluation of the impact of changing price levels on food consumption and nutrient intake was done using a model developed by Edgan J. Ariza-Nino, of the Nutrition Economics Group, Technical Assistance Division, Office of International Cooperation and Development, U.S. Department of Agriculture. This model with the acronym PICNIC which stands for "Price and Income Changes and Nutritional Impact on Consumers," uses own and cross price and income demand elasticities for individual commodities and commodity groups for identified segments of the population, to compute and display the food consumption and nutritional effects of price and income changes on each population segment.

2. Income and Price elasticities of Demand among agricultural Households in Rwanda.

Tables 1, 2, 3, 4, 5, 6 and 7 below present the own and cross price and expenditure elasticities of demand of the eight staple food crops (beans, sorghum, cassava, peas, maize, cooking bananas, potatoes and sweet potatoes), among the agricultural households by geographical zones and at the national level. The elasticities were calculated from demand relationships presented

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[1]. The author acknowledges contribution by Dr. Scott Loveridge in the estimation of the elasticities as well as comments from Dr. David Tardif-Douglin, Samuel MUNYANEZA, Serge RWAMASIRABO, Hyacinthe FABIOLA and other staff of the Division des Statistiques Agricole (DSA) on the draft document.

in Appendix 1.

Table 1. Own and cross price elasticity of demand - North-West

	BEANS	SORGHUM	CASSAVA	PEAS	MAIZE	BANANA	POTATO	SW.POTATO
BEANS	-1.88	0.38	0.03	-0.91	-0.45	-1.97	-1.53	-2.21
SORGHUM	-0.52	-3.63	5.17	-0.95	-1.70	-4.30	-0.91	3.96
CASSAVA	-0.89	-0.91	1.11	-0.93	-0.97	-1.12	-0.95	-0.80
PEAS	1.20	-4.39	-3.92	-1.96	-1.17	-7.82	-3.05	5.37
MAIZE	-3.41	1.35	-8.17	-0.14	2.25	1.42	-6.17	6.52
BANANA	-1.21	-1.23	-1.52	-1.05	-1.00	-1.51	-1.08	-1.02
POTATO	-0.28	-0.93	-3.01	-1.31	-1.30	3.49	-0.09	-2.99
SW.POTATO	-0.87	-1.18	-0.37	-1.01	-1.01	-0.39	-1.16	0.12

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

Table 2. Own and cross price elasticity of demand - South-West

	BEANS	SORGHUM	CASSAVA	PEAS	MAIZE	BANANA	POTATO	SW.POTATO
BEANS	-1.25	-1.54	0.94	-0.75	-1.30	1.33	-0.39	-1.41
SORGHUM	-0.85	-0.16	0.18	-0.69	-1.36	-3.45	-1.17	-6.93
CASSAVA	-2.07	-0.64	0.82	-1.07	-0.67	-0.55	-1.92	1.08
PEAS	0.27	-8.37	14.95	0.29	3.75	-11.06	-8.03	-7.45
MAIZE	0.95	0.95	-9.20	-2.09	0.23	-5.61	-1.21	3.40
BANANA	-1.10	-1.24	-1.11	-1.10	-1.05	1.24	-1.06	-1.16
POTATO	-1.15	-0.77	-0.25	-1.06	-1.12	-0.51	-0.23	-0.96
SW.POTATO	-1.09	-1.21	-0.56	-0.98	-0.84	-3.09	-0.79	-0.12

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

Table 3. Own and cross price elasticity of demand - North-Central

	BEANS	SORGHUM	CASSAVA	PEAS	MAIZE	BANANA	POTATO	SW.POTATO
BEANS	-0.60	-0.50	-0.39	-1.14	-1.35	-1.41	-0.71	-2.35
SORGHUM	-0.94	-1.11	-0.90	-1.13	-1.17	-0.44	-2.77	-0.43
CASSAVA	-0.87	-5.52	1.31	-0.95	-0.86	-0.73	-0.50	-0.31
PEAS	-1.59	-0.55	-3.71	-1.50	-1.25	-7.43	1.39	-5.25
MAIZE	1.98	0.30	-21.21	-1.38	-0.77	0.78	-0.59	-0.18
BANANA	-1.60	-1.63	-0.93	-0.98	-0.87	1.24	-0.86	-0.95
POTATO	-1.02	-1.38	-0.02	-0.81	-1.16	-1.22	-0.43	-0.38
SW.POTATO	-1.16	-0.90	-1.24	-1.00	-0.75	-1.60	-1.00	-0.33

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

Table 4. Own and cross price elasticity of demand - South-Central

	BEANS	SORGHUM	CASSAVA	PEAS	MAIZE	BANANA	POTATO	SW.POTATO
BEANS	-0.69	-0.50	-0.79	-0.93	-1.32	-1.09	-1.05	-2.99
SORGHUM	-1.32	-0.67	-2.45	-1.25	-1.07	0.55	-1.61	-0.89
CASSAVA	-1.01	-1.37	1.40	-0.81	-1.05	-1.20	-0.18	-0.49
PEAS	-7.31	9.26	7.59	-0.67	-1.87	-18.93	-1.29	-9.60
MAIZE	-0.79	-0.64	-1.38	-0.98	-0.84	-0.69	-0.91	-0.43
BANANA	-1.12	-1.23	-1.13	-1.02	-1.01	-1.54	-1.94	-0.48
POTATO	-0.75	-5.02	-1.74	-0.98	-0.95	-2.24	-0.94	-0.23
SW.POTATO	-1.01	-1.20	-1.90	-1.05	-0.93	-0.31	-0.33	-0.32

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

Table 5. Own and cross price elasticity of demand - East

	BEANS	SORGHUM	CASSAVA	PEAS	MAIZE	BANANA	POTATO	SW.POTATO
BEANS	-0.56	-1.25	-0.87	-1.27	-0.99	0.82	-1.10	-1.88
SORGHUM	-1.16	-0.44	-1.88	-1.27	-1.26	-1.05	-0.93	-1.83
CASSAVA	-0.88	-0.88	1.34	-0.94	-0.88	-1.29	-1.04	-0.75
PEAS	-1.84	-2.47	-4.48	-1.46	-0.32	1.29	-2.33	-2.11
MAIZE	-0.79	-0.90	-0.80	-0.84	-0.93	-1.31	-1.23	-0.07
BANANA	-1.24	0.05	-0.58	-0.68	-1.25	-3.29	-2.98	-1.57
POTATO	-1.15	-0.95	0.03	-0.99	-1.18	-0.56	-0.33	1.25
SW.POTATO	-1.18	-0.79	-0.98	-1.04	-0.97	-0.92	-0.89	-0.75

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

Table 6. Own and cross price elasticity of demand - Rwanda

	BEANS	SORGHUM	CASSAVA	PEAS	MAIZE	BANANA	POTATO	SW.POTATO
BEANS	-0.64	-0.47	-0.32	-1.03	-1.33	0.44	-1.06	-2.25
SORGHUM	-0.86	-0.45	0.11	-1.17	-1.40	-1.54	-1.59	-0.77
CASSAVA	-0.82	-1.00	-0.95	-0.89	-0.88	-1.13	-0.74	-0.26
PEAS	-0.35	1.82	1.44	-1.16	-0.96	-6.62	-3.48	-0.50
MAIZE	-0.18	0.44	-11.85	-1.28	-0.83	-0.19	-5.16	2.77
BANANA	-1.58	-1.58	-0.91	-0.96	-0.88	-2.45	-1.37	-1.21
POTATO	-1.15	-1.01	-1.11	-1.04	-1.11	-0.07	-1.12	-0.16
SW.POTATO	-1.04	-0.87	-1.00	-0.99	-0.95	-1.04	-1.01	-0.46

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

Table 7. Expenditure Elasticity of Demand

	North-West	South-West	North-Central	South-Central	East	Rwanda
BEANS	0.86	0.81	0.90	0.82	0.92	0.87
SORGHUM	1.31	0.97	1.27	1.30	1.24	1.22
CASSAVA	1.09	1.10	1.01	1.04	1.04	1.01
PEAS	1.26	0.78	1.17	1.40	1.17	1.19
MAIZE	0.63	1.35	0.53	0.97	1.02	1.18
BANANA	1.08	0.97	0.99	1.18	0.60	1.01
POTATO	0.89	0.99	0.94	1.23	0.77	1.02
SW.POTATO	0.41	1.02	0.72	0.60	0.86	1.25

Source: Estimated from DSA "Enquête Revenu-Dépense, 1990."

2.1 Food Consumption and contribution to calorie intake by Geographical region

From the results of the "Enquête Nationale sur le budget et la Consommation (ENBC)" of MINIPLAN (1988, vol.4), and reported in Table 8 below, beans are consumed in all the five geographical zones of the country and are the principal source of calories among the rural population. For the other staple food crops, consumption varies from one geographical zone to another. For example cereals (or cereal based products), are more important in the diets and second to beans in terms of contribution to the calorie intake of residents in the North-Western region of the country (Gisenyi, Kibuye, Ruhengeri).

In the other regions, tubers and bananas come after beans in terms of their contribution to the calorie intake of the residents. In the South-West (Cyangugu, Gikongoro) beans, sweet potatoes, cassava, and sorghum beer are more important in the diet. These four food items contribute about 67% of the total calorie needs of the residents in the South-West region. The South-Central zone (Butare, Gitarama, part of Gikongoro) is also characterized by its high dependence on beans, sweet potatoes, cassava and sorghum beer. These four food items alone contribute around 85% of the total calorie needs of the residents in this region. For the North-Central region (Byumba, Ruhengeri, Gitarama, Kigali, Gisenyi), these four food items contribute around 76% of the total calorie intake. The principal source of calories in this region is beans and sweet potatoes which together contribute 61% of the total calorie intake. Residents of the Eastern Region (Kibungo, Byumba, Kigali) depend on beans, bananas, cassava and sweet potatoes for 80% of their calorie intake, and half of this is contributed by beans. Compared with the North-Central zone, the Eastern zone has a greater variety of food items in the diet of the residents.

Table 8. Order of importance of the different food items in the percentage calorie contribution by geographical region

	Total Pop.	Ord.	North-West	Ord.	South-West	Ord.	North-Cent.	Ord.	South-Cent.	Ord.	East
Beans	32.3	1	27.0	1	21.0	1	36.0	1	32.0	1	39.0
Sw.Potato	17.4	5	11.0	2	21.0	2	25.0	2	21.0	4	10.0
Cassava	12.3	7	4.0	3	14.0	3	9.0	3	18.0	3	15.0
Sorghum beer	8.7	2	14.0	4	11.0	5	6.0	4	14.0	6	4.0
Cook. banana	7.9		-	7	4.0	4	9.0	6	3.0	2	16.0
Banana beer	4.7	6	5.0	6	5.0	6	4.0	5	4.0	5	6.0
Maize	4.0	3	13.0	5	9.0	-		-			
Potato	3.5	4	12.0	8	3.0	7	3.0	7	2.0		
Other	9.2		15.0		13.0		12.0		6.0		10.0

Source: Consommation Alimentaire en Milieu Rural, MINIPLAN 1988, Vol.4

2.2 Food Expenditure Pattern

Budget shares on food, by product and by geographical region were calculated from the data of the DSA "Revenus et dépenses" survey and presented in Table 9 below.

Table 9. Food Budget Shares, by Product and by Geographical Region

	North-West	South-West	North-Central	South-Central	East	Total Pop.
Beans	33.47	38.07	47.62	40.63	26.35	36.85
Sorghum	18.86	17.17	10.51	7.60	8.16	11.66
Cassava	1.58	7.84	3.68	8.48	3.75	5.02
Peas	1.72	2.46	0.74	0.94	0.30	1.09
Maize	5.90	2.35	2.30	0.20	0.17	1.91
Cooking Banana	0.16	0.08	1.17	0.41	4.57	1.58
Potato	15.72	3.14	10.72	6.43	7.64	8.64
Sw.Potato	7.58	5.30	5.77	8.42	4.32	6.08
TOTAL (%)	84.99	76.41	82.51	73.16	55.26	72.83

Source: Calculated from DSA "Enquête Revenu-Dépense, 1990."

From Table 9, one can observe that beans are much more important in the food budget of all agricultural households, representing respectively, 33%, 38%, 47.6%, 40.6% and 26% of the total food budget in the North-West, South-West, North-Central, South-Central and Eastern regions of the country. Sorghum, potatoes, sweet potatoes and maize come after beans in importance in the food budget of residents of the North-West region, representing 18.9%, 15.7%, 7.6% and 5.9% respectively of the total food budget. In the South-West region, sorghum, cassava, sweet potatoes and potatoes come after beans in importance in the food budget, representing 17%, 7,8%, 5% and 3% respectively in the total food budget. For the North-Central region, after beans, comes sorghum, potatoes, sweet potatoes and cassava in the food budget, representing 10.5%, 10.7%, 5.8% and 3.7% respectively of the total food budget.

In the South-Central region, Cassava, sweet potatoes, sorghum and potatoes are next to beans in the food budget of the residents, representing 8.5%, 8.4%, 7.6% and 6.5% respectively of the total food budget. Whereas in the Eastern region, after beans comes sorghum, potatoes, cooking bananas, sweet potatoes and cassava, representing 8%, 7.6%, 4.6%, 4.3% and 3.8% respectively of the total food budget. Cooking bananas are the least represented in the total food budget of residents in the North-West and South-West regions. Whereas peas are the least represented in the North-Central region and maize in the South-Central and Eastern regions. The price and expenditure elasticities of demand of the eight staple food crops would reflect the regional consumption patterns as presented above.

2.3 Own-price Elasticities of Demand

The own-price elasticities of demand are those values along the main diagonal of each of Tables 1, 2, 3, 4, 5 and 6. They represent the percentage change in the share of the food budget devoted to the different food items for one percent change in the market price. The own-price elasticities give the magnitude of the sensitivity of the consumption of the various food items to changes in the market prices. For example in the North-Western region, the own-price elasticity of demand for beans is -1.88. Which means that if the market price of beans increases by 1 percent, the consumption of beans will decrease by 1.88 percent. The own-price elasticities of demand for sorghum, cassava, peas, maize, cooking bananas, potatoes and sweet potatoes in the North-Western region of the country are -3.63, 1.11, -1.96, 2.25, -1.51, -0.09 and 0.12 respectively. The demand for sorghum is very sensitive to price.

Except cassava, maize and sweet potatoes, the elasticities of demand are within the range of those estimated for other countries and those estimated using the 1984 MINIPLAN ENBC data. The own-price elasticities of demand for cassava, maize and sweet potatoes are positive instead of negative. This implies that as the prices of these food items increase more are consumed. This could be explained by the fact that these are food items of necessity among the rural residents. Normally a price rise leads to reduced real income and thus consumers with limited income are forced to cut back on "luxury" food consumption and consume more of those of necessity. Since these food items are of necessity and take up a large portion of the poor households' food expenditure budget, a price rise will still see a rise in their consumption.

In the South-West region, the own-price elasticities of demand are less than 1, except for beans and cooking bananas, with own-price elasticities of -1.25 and 1.24 respectively. For the North-Central region, the demand of sorghum, cassava, peas and cooking bananas are more sensitive to price fluctuations than the other food items. In the case of the South-Central region, it is cassava and cooking bananas, whose demand is more sensitive to fluctuations in market prices than the other food items. For the Eastern region, the food items that are more responsive to market price fluctuations are cassava, peas, cooking bananas, particularly cooking bananas with an own-price elasticity of demand of -3.29. It can be observed that cassava has a positive own-price elasticity of demand in all the geographical regions. This is a food item of necessity for almost all rural consumers and thus as the price of cassava increases, a greater proportion of household food budget is spent on cassava, for example in the Eastern region, a 1% increase in the price of cassava results in an increase in cassava's budget share of 1.34%.

Contrary to the common notion that demand for agricultural products is highly inelastic, the values obtained for Rwanda indicate very elastic markets for beans (-1.88), sorghum (-3.88), peas (-1.96), cooking bananas (-1.51) in the Norh-West region;

beans (-1.25) in the South-West; sorghum (-1.11), peas (-1.50), in the North-central region; cooking bananas (-1.54) in the South-Central region; peas (-1.46), cooking bananas (-3.29) in the Eastern region. The low own-price elasticities for potatoes, sweet potatoes and cassava could be attributed to the fact that the market for these is thin or a small proportion of these are commercialized or go through the marketing system. A greater proportion being retained and consumed by the producer.

2.4 Cross-price Elasticities

The off-diagonal elements in the matrices in Tables 1, 2, 3, 4 and 5, represent the cross-price elasticities of demand of the food items named in the rows, with respect to the price of the food items heading the columns. The cross-price terms are indicative of the trade-offs in consumption among the various foods. A positive cross-price elasticity means that the two food items are substitutes or when the price of one food item goes up its consumption will be cut back and the consumption of its substitute will be increased. On the other hand, a negative cross-price elasticity means that the two food items are complements or they are consumed together so that when the price of one goes up the consumption of the two food items will be cut back. For example the cross-price elasticity between cassava and sweet potato in the South-Western region is 1.08 which means that when sorghum price increases by one percent, its consumption is cut back and the consumption of beans increases by 1.08 percent. The cross-price elasticity between beans and potatoes is -1.53, which implies that when potato price increases by one percent, the consumption of beans its complement, will be reduced by one and half times the increase in the price of potatoes.

Most cross-price elasticities are negative, indicating that foods are in general complements in the diets of agricultural households in Rwanda. However, the results show that there is a very strong substitution between cassava and sorghum (5.17), cooking bananas and potatoes (3.49), sweet potatoes and maize (6.52) in the North-West region; beans and maize (6.95), cassava and peas (14.95), maize and peas (3.75) in the South-West region; sorghum and peas (9.26), cassava and peas (7.59) in the South-Central region. On the whole, the cross-price terms provide a plausible structure of consumption trade-offs among foods, compatible with the diet habits in Rwanda. However, in a few cases the prices of some food items have a dramatic effect on the consumption of the other food items. This is the case for cooking bananas and peas with cross-price elasticity of demand of (-11.06) in the South-West region; cassava and maize with cross-price elasticity of demand of (-21.21) in the North-Central region and cooking bananas and peas with cross-price elasticity of demand between them of (-18.93) in the South-Central region.

Table 7 also shows the expenditure (income) elasticities of demand for the eight staple food crops by geographical region and at the national level. These give the percentage change in the demand (consumption) of these food items resulting from a 1% change in expenditure (income). For most food items, the

expenditure elasticities of demand are less than 1.0 and positive in all the regions. This implies that, the part of the total food expenditures allocated to these food items decreases as the well-being or level of income of the households increases. On the other hand some of the food items have expenditure elasticity of demand slightly greater than 1.0. This implies that the part of the total food expenditures allocated these food items would increase at the same rate as the increase in the income of the agricultural households.

In the North-West region, beans, maize, potatoes and sweet potatoes have expenditure elasticities of less than 1.0 and thus their share of the total food budget will decline as income increases in this region. On the other hand sorghum and peas have expenditure elasticities slightly greater than 1.0 and thus their consumption will increase at the same rate as the growth of the economy in this region. For the South-West region, beans, sorghum, peas, cooking bananas and potatoes are consumed less as income increases, whereas maize consumption will increase at the same rate as the increase in income in this region. In the case of the North-Central region, beans, cassava, maize, cooking bananas, potatoes and sweet potatoes consumption will decrease as income increases, whereas sorghum and peas consumption will increase at the same rate as the increase in income in this region. For the South-Central region, beans, cassava, maize and sweet potatoes consumption will decrease with increase in income, whereas sorghum, peas, cooking bananas and potatoes consumption will increase at the same rate as the increase in income in this region. In the Eastern region, beans, cassava, maize, cooking bananas, potatoes and sweet potatoes are foods items whose consumption will decrease as income increases, whereas sorghum and peas are food items whose consumption will increase at the same rate as the growth of the economy in this region.

3. APPLICATION TO ASSESSMENT OF IMPACT OF STRUCTURAL ADJUSTMENT PROGRAM, THE WAR, AND DELAYED RAINS.

The price and expenditure (income) elasticities of demand of the staple food crops presented above are useful for analysing the effects of price and income modifications resulting from the economic restructuring program, on the consumption and nutrient intake of Rwandan rural households. For people in the low income strata, the level of income is the principal determinant of nutritional status. Low-income households who are integrated into the market and not heavily subsistence oriented, more readily adjust their food consumption patterns than the well-off in response to food price changes. They consume more food with a rise in their incomes and adjust the composition of their diets in response to changes in relative prices. A reduction in the price of a given food induces not only higher consumption of that food, but will cause a round of adjustments in other foods. For example a price drop in beans will increase the consumption of beans, and that of potatoes which is consumed with beans, and might reduce the intake of sorghum and cassava. The net effect of all these changes on the household nutrient intake can only

be evaluated through knowledge of the magnitude of these substitutions in the diet. This can be accomplished with the PICNIC model.

The PICNIC model is a program designed to enable analysts to evaluate the impact of changing prices and income levels on the nutrient intake of different population groups. The basic structure of the model is in Lotus 1-2-3 and the analyst simply introduces the necessary information such as percentage change in price, percentage change in income, budget shares, own and cross price and income elasticities of demand and the nutrient contribution of the different food items under study. The changes in food consumption and nutrient (calorie, protein etc) are automatically calculated.

3.1 The Program and Method

There are two ways that a change in the price of a food item, say a drop in price, can affect the pattern of food consumption of a hypothetical consumer. First, there is the direct response in the form of an increase in the consumption of the food item and a decline in the consumption or consumption at the same level of other foods. Second, there is an indirect effect through the impact of a change in price on the overall level of the consuming household income. A drop in price translates into an increase in real income, which in turn stimulates the consumption of most other goods, including the food whose price changed. The first type of impact is referred to as price-effect and the second as income-effect.

Certain parameters are needed to analyse the impacts of a price change on food consumption. These parameters are:- own price elasticity for each food; cross-price elasticities of all foods on the consumption of each food; share of each food in total food expenditure; income elasticity for each food; and nutrient (calorie, protein, lipids etc) contribution by each food. The elasticities and the budget shares have been estimated from the DSA data on Agricultural household Revenue and Expenditure survey and reported in Tables 1,2,3,4,5,6,7 and 9. The percentage contribution to calorie intake by each food item, by geographical region were obtained from MINIPLAN (1988, vol.4) and presented in Table 8. Table 9 shows that a high proportion of the food budget is spent on beans and sorghum in all the geographical regions. A substantial proportion of the food budget is also spent on cassava, potatoes and sweet potatoes. A very small proportion is spent on cooking bananas. The eight food items, beans, sorghum, cassava, peas, maize, cooking bananas, potatoes and sweet potatoes take up 85 percent of the food budget of agricultural households in the North-Western region, 76 percent in the South-West, 82 percent in the North-Central, 73 percent in the South-Central and 55 percent in the East.

Table 10. Percentage Contribution to Calorie Intake by Each Food, by Geographical Region

	North-West	South-West	North-Central	South-Central	East
Beans	23.3	19.13	31.25	28.40	35.37
Sorghum	1.95	0.74	13.88	2.90	9.04
Cassava	4.56	13.88	9.04	18.14	15.07
Peas	3.79	2.90	3.39	0.95	0.78
Maize	12.78	9.04	0.94	0.24	1.52
Cooking Banana	2.75	3.55	9.04	2.60	15.55
Potato	11.90	3.46	3.04	1.60	0.52
Sw.Potato	11.02	20.52	25.14	21.20	10.36
TOTAL (%)	72.05	73.22	95.72	76.03	88.21

Source: Consommation Alimentaire en Milieu Rural, MINIPLAN (1988, Vol.4)

Table 11. Percentage Change in Prices (Dec 89-Aug 90 vs Dec 91-Aug 92), by Product, by Geographical Region, used in PICNIC Program

	North-West	South-West	North-Central	South-Central	East
Beans	17	14	27	20	29
Sorghum	30	39	31	45	37
Cassava	-5	2	-16	-30	-21
Cooking Banana	21	30	5	14	17
Potato	-5	-2	-1	4	5
Sw.Potato	-31	-40	-24	-48	-9

Source: Calculated from MINIPLAN price data

Table 11 presents the percentage changes in prices between the pre-structural adjustment program period (December 1989-August 1990) and the post-structural adjustment program period (December 1991-August 1992), by product and by geographical region, used in the PICNIC Program to simulate the effect of the Structural Adjustment Program on food consumption and calorie intake among agricultural households. Prices from December 1991 to August 1992 will reflect the effect on prices of the measures taken thus far under the structural adjustment program as well as the war and the delayed rains at the beginning of 1992. The percent change in prices of the various food items between the pre-structural adjustment period and the post-structural period were calculated from monthly market price data collected by the Ministry of Planning.

3.2 The effect of the Structural Adjustment Program, war and delayed rains on food consumption and calorie intake among agricultural households

The food consumption and calorie intake impact of price changes, by geographical region, possibly due to the structural adjustment program, the war and the delayed rains was simulated with the PICNIC model. The PICNIC computes instantaneously the changes in

food consumption whenever the price of one or several foods are modified. Tables 12 through 16 present the output generated by PICNIC when the percentage change in prices by food item, by geographical region is introduced into the model. The first column of Tables 12 through 16 indicates the percentage change in the price of each food item introduced into the model. The columns labelled Group 1 (North-West), Group 2 (South-West), Group 3 (North-Central), Group 4 (South-Central) and Group 5 (East) give the percentage change in the consumption of each food item in each region due to the price changes in the first column. The last row of each table presents the net impact on calorie intake of the price changes. Table 12 presents the simulation results of the price changes in the North-West region, while Tables 13, 14, 15 and 16 present results of price changes in the South-West, North-Central, South-Central and Eastern regions of the country. Changes in the price of food items in one region will affect food consumption in other regions because of interregional trade in the different food items which permits the movement of food items among regions.

In Table 12 the price modifications in the North-West, have resulted in an increase in the consumption of beans and potatoes, but also a compensating reduction in the consumption of sorghum, cassava, cooking bananas and sweet potatoes. The price modifications in the North-West region have also resulted in an increased consumption of sorghum and cooking bananas, but a compensating reduction in the consumption of beans, cassava, potatoes and sweet potatoes in the South-West region. In the North-Central region, beans consumption has gone up, but a compensating reduction in the consumption of sorghum, cassava, cooking bananas, potatoes and sweet potatoes. Whereas in the South-Central and Eastern regions, there is an increase in the consumption of beans and sorghum, but a compensating reduction in the consumption of cassava, cooking bananas, potatoes and sweet potatoes. The net impact on calorie intake is a 1.5 percent increase in the intake of calories in the North-West region, 39.5 percent reduction in the intake of calories in the South-West region, 33.5 percent reduction in the intake of calories in the North-Central region, 14.6 percent reduction in the South-Central region and 4 percent reduction in the Eastern region. The adjustment in the composition of the diet of the agricultural households by region, reflects the own and cross price effects for these populations.

Table 13 presents the adjustments in the diet of agricultural households by geographical region as a result of an increase in the price of beans by 14%, increase in the price of sorghum by 39%, increase in the price of cassava by 2%, increase in the price of cooking bananas by 30%, a reduction in the price of potatoes by 2% and a reduction in the price of sweet potatoes by 40% between the pre-adjustment and post-adjustment period, in the South-Western region of the country. The net impact on calorie intake is a 2% increase in the intake of calories in the North-West region, 46 percent reduction in the South-West region, 44.6 percent reduction in the North-Central region, 20.6 percent reduction in the South-Central region and 8.8 percent reduction

in the East region.

In Table 14, one observes the effect of a 27% increase in the price of beans, 31% increase in the price of sorghum, 16% reduction in the price of Cassava, 5% increase in the price of cooking bananas, 1% reduction in the price of potatoes and 24% reduction in the price of sweet potatoes in the North-Central region between the pre-adjustment and post-adjustment period. This has resulted in a 7.9 percent reduction in calorie intake in the North-West region, 48.6 percent reduction in the South-West region, 36 percent reduction in the North-Central region, 17.5 percent reduction in the South-Central region and 13.3 percent reduction in the East region.

Table 15 presents the results of a 20% increase in the price of beans, 45% increase in the price of sorghum, 30% reduction in the price of cassava, 14% increase in the price of cooking bananas, 4% increase in the price of potatoes and 48% reduction in the price of sweet potatoes between the pre-adjustment and post-adjustment period in the South-Central region of the country. The net impact on calorie intake of these price modifications is, an 11.8 percent increase in the intake of calories in the North-West region, 53.6 percent reduction in the South-West region, 26.7 percent reduction in the North-Central region, 1.6 percent increase in the South-Central region and a 3.6 percent increase in calorie intake in the East region.

Finally, Table 16 presents the results of a 29% increase in the price of beans, 37% increase in the price of sorghum, 21% reduction in the price of cassava, 17% increase in the price of cooking bananas, 5% increase in the price of potatoes and a 9% reduction in the price of sweet potatoes between the pre-adjustment and post-adjustment period in the Eastern region of the country. The consequence of this on calorie intake is, 30 percent reduction in calorie intake in the North-West region, 69 percent reduction in calorie intake in the South-West region, 71.6 percent reduction in the North-Central region, 48.7 percent reduction in the South-Central region and a 47.9 percent reduction in the Eastern region.

Table 12. Food Consumption and Calorie Intake Impact of Price Changes in the North-West Region of Rwanda due to the Structural Adjustment Program, war and delayed rains

FOOD CONSUMPTION EFFECTS, PER PRODUCT AND GEOGRAPHICAL REGION (%)

CHANGE (%)	Income	North-West 0	South-West 0	North-Central 0	South-Central 0	East 0
17	Beans	7.59	-5.55	16.12	47.69	33.14
30	Sorghum	-361.99	119.71	-37.31	9.64	8.81
-5	Cassava	-50.18	-103.42	-198.09	-80.19	-52.57
21	Bananas	-52.71	8.58	-19.82	-64.64	-25.58
-5	Potato	142.10	-29.75	-78.08	-196.73	-101.40
-31	Sw.Potato	-57.55	-118.05	-64.83	-41.96	-35.33
	CALORIES	1.54	-39.48	-33.54	-14.61	-4.31

Source: PICNIC output

Table 13. Food Consumption and Calorie Intake Impact of Price Changes in the South-West Region of Rwanda due to the Structural Adjustment Program, war and delayed rains

FOOD CONSUMPTION EFFECTS, PER PRODUCT AND GEOGRAPHICAL REGION (%)

CHANGE (%)	Income	North-West 0	South-West 0	North-Central 0	South-Central 0	East 0
14	Beans	13.98	14.02	17.26	54.02	38.11
39	Sorghum	-434.66	149.42	-58.84	-0.91	-1.10
2	Cassava	-54.22	-118.18	-241.24	-86.18	-56.87
30	Bananas	-79.00	10.90	-18.81	-95.13	-50.14
-2	Potato	171.09	-32.09	-96.18	-272.23	-123.89
-40	Sw.Potato	-76.43	-159.18	-92.36	-63.68	-50.31
	CALORIES	2.07	-46.00	-44.58	-20.63	-8.75

Source: PICNIC output

Table 14. Food Consumption and Calorie Intake Impact of Price Changes in the North-Central Region of Rwanda due to the Structural Adjustment Program, war and delayed rains

FOOD CONSUMPTION EFFECTS, PER PRODUCT AND GEOGRAPHICAL REGION (%)

CHANGE (%)	Income	North-West 0	South-West 0	North-Central 0	South-Central 0	East 0
27	Beans	-4.41	-65.00	13.48	38.48	3.43
31	Sorghum	-339.64	108.25	-50.19	-3.21	15.37
-16	Cassava	-67.70	-128.30	-223.68	-95.57	-67.74
5	Bananas	-40.61	-26.48	-61.22	-55.16	-2.97
-1	Potato	91.07	-41.63	-78.16	-163.85	-99.26
-24	Sw.Potato	-62.43	-81.53	-47.35	-33.02	-32.87
	CALORIES	-7.90	-48.55	-36.10	-17.50	-13.28

Source: PICNIC output

Table 15. Food Consumption and Calorie Intake Impact of Price Changes in the South-Central Region of Rwanda due to the Structural Adjustment Program, war and delayed rains

FOOD CONSUMPTION EFFECTS, PER PRODUCT AND GEOGRAPHICAL REGION (%)

CHANGE (%)	Income	North-West 0	South-West 0	North-Central 0	South-Central 0	East 0
20	Beans	41.96	-45.51	58.52	107.35	50.20
45	Sorghum	-596.51	240.78	-50.91	54.41	75.05
-30	Cassava	84.56	-172.55	-312.75	-123.06	-90.14
14	Bananas	-21.78	15.02	-27.72	-56.04	8.47
4	Potato	225.53	-21.60	-91.75	-218.95	-140.64
-48	Sw.Potato	-79.56	-109.87	-44.18	-10.51	-15.58
	CALORIES	11.76	-53.63	-26.67	1.65	3.62

Source: PICNIC output

Table 16. Food Consumption and Calorie Intake Impact of Price Changes in the East Region of Rwanda due to the Structural Adjustment Program, war and delayed rains

FOOD CONSUMPTION EFFECTS, PER PRODUCT AND GEOGRAPHICAL REGION (%)

CHANGE (%)	Income	North-West 0	South-West 0	North-Central 0	South-Central 0	East 0
29	Beans	-74.51	-90.45	-47.25	-27.87	-27.71
37	Sorghum	-389.79	-49.45	-85.47	-16.70	-28.40
-21	Cassava	-114.80	-144.31	-284.28	-137.78	-116.60
17	Bananas	-85.85	-41.22	-76.34	-98.88	-84.40
5	Potato	93.88	-71.01	-113.45	-225.28	-98.96
-9	Sw.Potato	-80.43	-133.66	-80.67	-44.47	-64.48
	CALORIES	-30.25	-69.05	-71.56	-48.72	-47.87

Source: PICNIC output

4. CONCLUSION

Own and cross-price elasticities and expenditure elasticities of demand were estimated from data generated through a Revenue and Expenditure Survey conducted by the Division des Statistiques Agricole (DSA) in 1990, among agricultural households in Rwanda. On the whole most of the elasticity estimates were within the range of estimates obtained in earlier studies for other countries. With the exception of cooking bananas and peas in the South-West region, cassava and maize in the North-Central region, and cooking bananas and peas in the South-Central region, the prices of most food items do not have dramatic effects on the consumption of the other food items. The elasticities were then used to analyse the impact of the Structural Adjustment Program and possibly the effect of the war and the delayed rains in early 1992, on nutrient (calorie) intake by geographical region among agricultural households in Rwanda. The overall average impact of the price modifications is a 4.6% reduction in calorie intake in the North-West, 51% reduction in the South-West, 42% reduction in the North-Central, 20% reduction in the South-Central region and 14% reduction in the Eastern region. The South-West region is worse of, in terms of calorie intake, as a result of the price modifications, followed by the North-Central region. The North-West region is the least affected. Thus in general, calorie intake among agricultural households has declined as a result of food price modifications due to the Structural Adjustment Program, the war and the delayed rains. These findings are the effect of price changes alone and do not include income changes. Structural Adjustment Programs are designed to lead to a more efficient use of resources and thus improvement in income and standard of living. Thus to have a better understanding of the impact of the Structural Adjustment Program on the rural sector, we also need information on the modification of incomes. The ongoing, annual Revenue and Expenditure surveys conducted by DSA can provide such information. The elasticities could also be used to analyse the effect of price changes on the distribution of income over households, government revenues and expenditures as well as to analyse the effect of agricultural procurement policy, taxation and food subsidy schemes.

APPENDIX 1

The demand relationships that were used to estimate the demand elasticities are as follows:-

(1) $$w_i = \alpha_i + \beta_i \ln X + \Sigma\gamma_{ij}\ln\Gamma_j + \theta' z + u_i$$

(2) $$Ep_{ii} = -1 + \frac{P_i}{w_i} * \frac{(\gamma_{ii} + \gamma_{ii} D)}{P_i}$$

(3) $$Ep_{ij} = -1 + \frac{P_i}{w_i} * \frac{(\gamma_{ij} + \gamma_{ij} D)}{P_j}$$

(4) $$E_i = 1 + \frac{\beta_i}{w_i}$$

where w_i is the share of the budget devoted to good i, X is total expenditure on food, pj are the prices, z is a vector of other relevant exogenous variables (geographic or demographic), α_i, γ_{ii}, γ_{ij}, and β_i are the estimated parameters, D is a dummy variable representing geographic region and u_i is random error term. The own and cross-price and expenditure elasticities of demand were calculated from equation 2 (own price elasticity of demand), equation 3 (cross-price elasticity of demand) and equation 4 (expenditure elasticity of demand):

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