# Honduras Technical Manual: Conceptual Framework and Software Documentation

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# CHAPTER 1

# Introduction

## Scope and Purpose

This manual describes the worksheet version of the Food Aid and Food Security Analysis System (FAFSAS) for Honduras and details the step-by-step procedure of using the analytical system for policy analysis. The general purpose of the FAFSAS is to develop a database and analytical system capable of monitoring and evaluating the impacts of changes in the international markets and in domestic policies on food security (e.g., food availability and accessibility) of developing countries, especially the food importing developing countries.

This analytical framework can be used to assess the impacts on domestic food security of changing global agricultural and trade environments as well as trade policies and domestic market policies in the country itself. The analysis provided by FAFSAS can be used to evaluate policy decisions within the country or decisions by donor agencies regarding development assistance or food programs. This information will also enhance interagency coordination of food aid and development resources and programs, including analytical linkages to nutritional outcomes of significant dietary changes in recipient countries.

This manual and the accompanying FAFSAS represent a first step in obtaining results by combining worldwide data from the Food and Agricultural Policy Research Institute (FAPRI) models with country-specific information. The manual provides the basic tools for successfully using and managing the FAFSAS and includes:

- a conceptual framework and model that combine FAPRI data with country-specific information, described in a series of equations;
- worksheet documentation of the FAFSAS model;
- instructions for conducting various policy analyses using this analytical system.

**How to Use the Manual**

This manual is divided into four main sections. Chapter 1 details the scope and purpose of the manual. Chapter 2 contains the conceptual framework describing the key equations of the FAFSAS model and covers production, consumption, net trade, and price transmission. Chapter 3 describes the data sources, estimation procedures, and parameter estimates, along with elasticities and validation statistics. Chapter 4 documents the worksheet version of this model and also provides step-by-step instructions for running a simulation. Finally, Chapter 4 includes steps involved in modifying and updating the worksheet version of the model.

# CHAPTER 2

# CONCEPTUAL FRAMEWORK AND MODEL

The FAFSAS links a number of individual models; each provides results to be fed into the next model in the system. Figure 1 shows a diagram of the system. The CARD/FAPRI international trade model measures the commodity-specific factors related to production, prices, trade, economic issues, and weather data of major players in the international agricultural markets. Key components of the model are agricultural policies in the United States and European Union, including the U.S. Farm Bill, the Common Agricultural Policy (CAP), and the Lome Protocol. Use of the CARD/FAPRI model allows researchers to translate changes in international exogenous variables into world prices and world production, consumption, and trade patterns. The outcomes then become the primary factors affecting a particular developing country.

A unidirectional flow of causal impact from the world to a country is assumed for a small open economy. Hence, the next step in the system, the country commodity model, takes these outcomes (specifically the equilibrium prices) and translates them into the specific production, consumption, and trade patterns that should be anticipated by a developing country. Consumption patterns are then evaluated with a demand system to formulate the food security impact. In particular, using food composition data and the recommended daily allowance for each nutrient category, the consumption pattern is translated into nutritional impact. This impact is further disaggregated into population groups according to socioeconomic and demographic groupings. In this way, we can provide possible outcomes that are based on solid, accurate data from an individual developing country to predict how specific population groups will be affected by changes at the world level or the policy level.

The capacity to combine the worldwide data with country-specific information makes the FAFSAS valuable. It allows us to make accurate and dependable recommendations for developing countries that are based on solid information from the modeling system.

The rest of this chapter explains the key equations that implement the conceptual framework into an operational model.

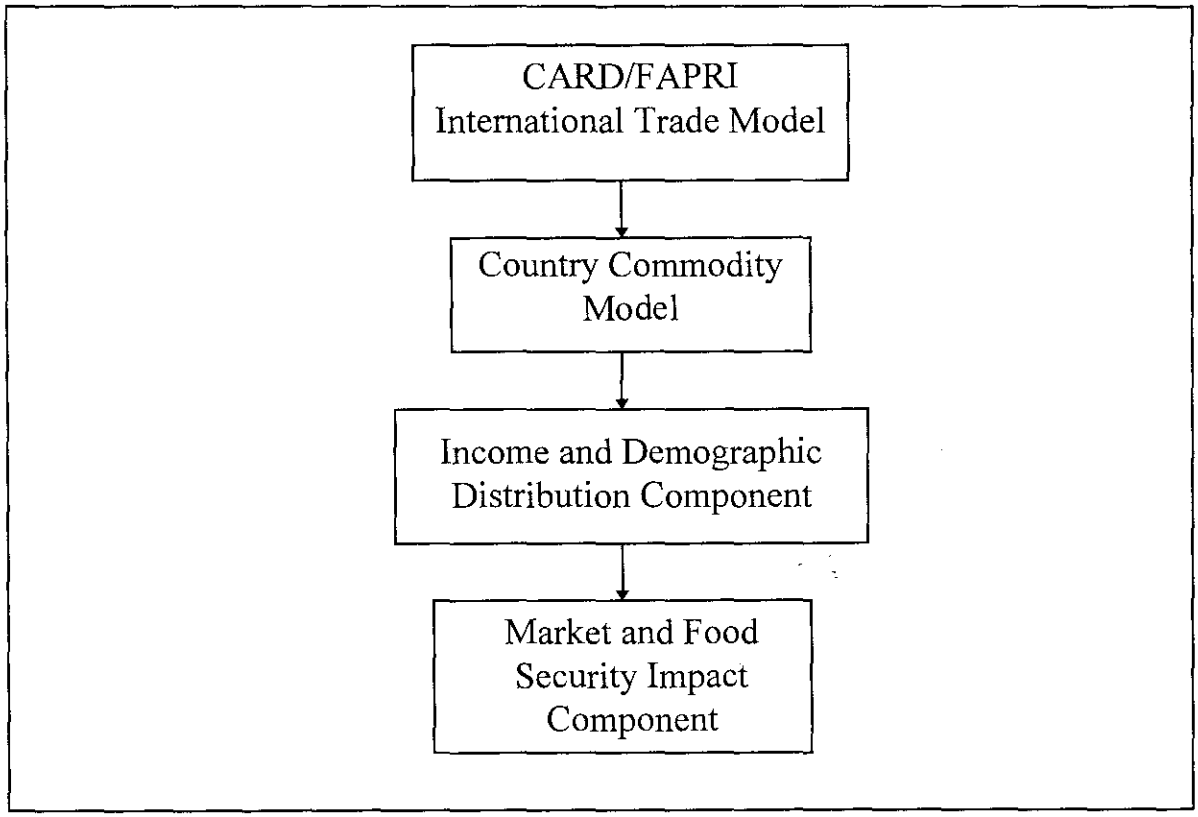


**Figure 1. Conceptual Framework of the FAFSAS**

## Key Equations

### CARD/FAPRI International Trade Models

The CARD/FAPRI International Trade Models use a multicountry, multicommodity, nonspatial, and partial equilibrium structure. The structure is nonspatial because country-specific trade flows are not identified and it is partial equilibrium because most nonagricultural sectors and some agricultural commodities are treated as exogenous. The equilibrium price, demand, and net trade quantities are determined simultaneously in the system so that supply and demand are balanced in each country or region and trade is balanced across all countries and regions. The major difference between the CARD/FAPRI International Trade Models and the Country Commodity Model is highlighted later in this section.

The foundation of the CARD/FAPRI International Trade Model includes supply and demand functions for major trading countries and regions. The unique feature of the demand and supply specifications is the incorporation of country-specific domestic and trade policies. The excess demand,

in the case of importing countries, and excess supply, in the case of exporting countries, are derived from the country supply and demand functions. These equations are presented here in a general manner.

**The Excess Demand of a Net Importing Country**

$$[1] \quad ED_i(p,G) = D_i(p,G) - S_i(p,G)$$

where

- $ED$ is excess demand
- $p$ is a vector of economic variables (e.g., prices)
- $G$ is a vector of government policy variables (e.g., subsidies)
- $S$ is supply function
- $D$ is demand function
- $i$ is country index ($i$= 1, ..., n)

The excess demand functions of all importing countries are summed horizontally across countries for all price levels to derive the aggregate world excess demand for each commodity.

**The Aggregate Excess Demand for N-Country Net Importers**

$$[2] \quad AED_k(p,G) = \sum_{i=1}^{n} ED_i(p,G)$$

- $AED$ is aggregate excess demand
- $k$ is the commodity index.

The same procedure is carried out for the excess supply side in the case of exporting countries to generate the world aggregate supply. Equations [3] and [4] are the supply counterparts of equations [1] and [2].

**The Excess Supply of a Net Exporting Country**

$$[3] \quad ES_i(p,G) = S_i(p,G) - D_i(p,G)$$

- $ES$ is excess supply

**The Aggregate Excess Supply for M-Country Net Exporters**

$$[4] \quad AES_k(p,G) = \sum_{i=1}^{m} ESi(p,G)$$

$AES$ is aggregate excess supply

The equilibrium prices, quantities, and net trade are determined by equating the aggregate world excess demand and the aggregate world excess supply. Except where they are set by governments, domestic prices of individual countries are linked to world prices through price linkage equations reflecting bilateral exchange rates and marketing cost margins.

The equilibrium condition for commodity $k$ is the world clearing price; that is, the world price $P^W$ that satisfies equation [5].

**The Equilibrium Condition**

$$[5] \quad AED_k(p,G) = AES_k(p,G)$$

The CARD/FAPRI trade models have four primary components: (1) U.S. crops (2) U.S. livestock, (3) international crops, and (4) international livestock.

The impact of the GATT is captured in the trade model through country-specific changes in the policy variable G as a result of the GATT disciplines. The four sections of the GATT agreement relating to international agricultural trade include: (1) market access through tarification, with commitments to a phased tariff reduction and elimination of nontariff barriers; (2) reduction of export subsidies in both the quantity of subsidized exports and the amount spent to subsidize; (3) phased reduction of internal support; and 4) setting minimum sanitary and phytosanitary standards and prohibiting use of sanitary and phytosanitary measures to inhibit trade. Specific country commitments in these areas are captured in the specification of the model equations so that they will have an impact on the outcome of the model solution if they are binding.

**Country Commodity Model**

The country-specific model is linked to the CARD/FAPRI international trade model for the world price of imported, as well as exported, agricultural products. For a small country that is a price-taker

country, the world price together with domestic price policies will drive the production, consumption, and trade patterns of the country. The foundation of the country commodity model is the demand and supply structure specific to the country.

**Price Transmission Equations**

Price transmission equations provide the bridge between the world price and a country's internal price. The new set of world prices determined in the CARD/FAPRI trade model is transmitted to the Honduran country commodity model through these price transmission equations. Ideally, the border price in Honduras differs from the world price by the transportation cost. Since the world price and the border price are highly correlated, it is adequate to generate the border price as a function of the world price. In this case, the border price was not available, so the producer price was used. For the $k^{th}$ commodity, this is

$$[6] \quad P_k^P = f`(P_k^w, ER, C_k)$$

where

$P_k^P$ is the producer price for the $k^{th}$ commodity,
$P_k^w$ is the world price for the $k^{th}$ commodity,
$ER$ is exchange rate, and
$C$ is marketing cost.

All domestic prices are expressed in the local currency and the world price is in U.S. dollars. ER is the price of one U.S. dollar in local currency (i.e., the exchange rate). Marketing cost is represented by the variable $C$, which may include markup, transportation, labor, and other marketing costs. Whenever appropriate, the consumer price index is used as a proxy of marketing cost for the price transmission between different levels in the market chain. Also, possible lags and inclusion of other variables in the regression equations will be determined empirically.

**Domestic Demand Functions**

The aggregrate demand includes demand for human consumption, feed use, inventory demand, and demand for industrial use. The dominant component of aggregrate demand includes both human and feed use. The quantity demanded for human consumption is expressed as a function of own-price, prices of related commodities (e.g. substitutes and complements), consumption expenditures, and other shifters (e.g. to account for dynamics and time trend).

$$[7] \quad Q_k^d = f(p_k, P_s, X, Z_d | \Theta_d),$$

where

$Q$ is the quantity demanded,

$p$ is the own price,

$P$ is a vector of prices of related commodities,

$X$ is real expenditure/income,

$Z$ is a vector of other shifters in the demand equation,

$\Theta$ is a vector of demand coefficients, and

$d$ is a superscript and subscript for demand.

Feed demand is a derived demand that is a function of feed price and the price of livestock as the major output.

**Domestic Supply Functions**

The quantity supplied, on the other hand, is expressed as a function of own-price, price of inputs, and other shifters, i.e.,

$$[8] \quad Q_k^s = f(p_k, W, Z_s | \Theta_s),$$

where

$Q$ is quantity supplied

$W$ is a vector of input prices,

Z is a vector of other shifters in the supply equation,

$\Theta$ is a vector of supply coefficients, and

$s$ is a superscript and subscript for supply.

The equilibrium condition is given in equation [9], where the net quantity traded (quantity imported or exported) is equal to the difference between the domestic quantity demanded and supplied at the equilibrium price.

**Net Trade Equation**

$$[9] \quad Q_k^{nt} = Q_k^s - Q_k^d ,$$

where

$Q$ is net trade (export if positive and import if negative), and

$nt$ is a superscript for net trade.

For a small open economy, the equilibrium is determined by its domestic demand and supply structure and by international market conditions. If the domestic equilibrium price under autarchy is below the world price, the country is a net exporter of that commodity. On the other hand, if the domestic equilibrium price under autarchy is above the world price, the country is a net importer. In the absence of trade distorting policies, a country has an excess demand (in case of net importers) or an excess supply (in case of net exporters). The country faces a perfectly elastic import supply (for net importers) or export demand (for net exporters) since it cannot influence the world market. In this case, world market prices are fully transmitted to the domestic market. Any price differential between domestic and world prices is fully attributed to transport cost. Figure 2 illustrates the case of a small open economy in the absence of trade distorting policies.

**Nutrition Component**

The new set of Honduran prices will enter the Honduras commodity model through the estimated supply and demand equations of the respective commodities (i.e., equations [7], [8], and [9]). The outcomes of the country commodity model are per capita consumption patterns of households, production, and trade patterns. The per capita consumption levels of households by commodities will serve as the input in the nutrition component to determine the macro and micro nutrient intake levels. The consumption of products is translated into nutrient intake using equation [10], i.e.,

$$[10] \quad TN_l = \sum_{k=1}^{n} \beta_{lk} \cdot Q_k^d ,$$

where

$TN$ is total nutrient intake,

$\beta$ is proportion of nutrient per unit weight of commodity consumed, and

$l$ is an index for nutrient.

where $TN$ is the total nutrient intake of the $l^{th}$ nutrient, $\beta_{lk}$ is the proportion of the $l^{th}$ nutrient (e.g., energy) per unit (e.g., kg) of the $k^{th}$ commodity consumed (e.g., wheat). The vector of n-products (i.e., $Q$ with index $k$) consumed includes wheat, corn, beans, rice, sugar, soy oil, bananas, plantains, poultry, beef, and pork. The vector of macro and micro nutrients (i.e, the index $l$) includes energy, protein, fat, carbohydrate, fiber, calcium, iron, vitamin A, thiamine, riboflavin, and niacin.

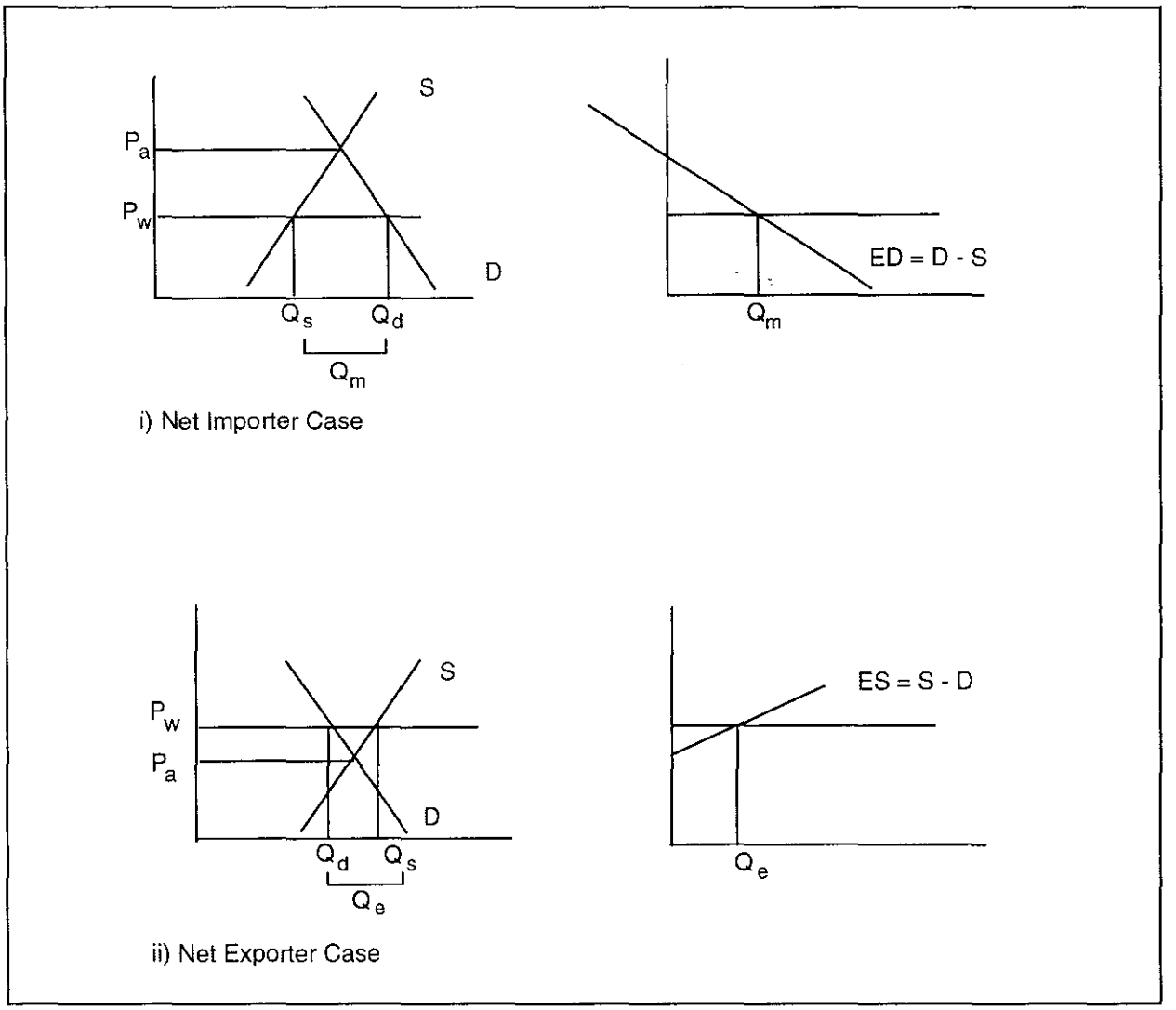


**Figure 2. Demand, Supply, and Trade for a Small Open Economy without Trade Distorting Policies**

Note: Pa = autarchy price, Pw = world price

Furthermore, to evaluate the nutritional outcomes of policy changes, the nutrient intake levels are compared to their respective recommended daily allowances (RDAs) to determine the degree of shortfall (or excess) from the RDAs. To be comparable to the RDA standard, the nutrient intake has to be expressed on a per day basis. A measure of nutrition adequacy is the ratio of the total intake of nutrient $l$ to its corresponding recommended daily allowance.

**The Proportion to RDA Equation**

$$[11] \quad ADQ_l = \frac{TN_l}{RDA_l},$$

where

$ADQ$ is a measure of nutrient adequacy, and

$RDA$ is recommended daily allowance.

If this ratio in [11] approaches unity, it implies that the intake of the $l^{th}$ nutrient is adequate in meeting the recommended daily allowance for that particular nutrient.

**Nutrition Component by Socioeconomic and Demographic Population Groups**

Different population groups (grouped by socioeconomic and demographic characteristics) are affected differently by changes in the economy (i.e., price changes). Of significant interest is the grouping of the population by income. Other than possible differences in taste and preference between low- and high-income groups, their responses to price changes will also differ due to different proportions of expenditure for the commodities in their food basket, and different income elasticities. The nutritional impact is examined on households disaggregated further into socioeconomic and demographic characteristics. The nutrition measures in [10] and [11] are reproduced for each of the population groups by socioeconomic and demographic characteristics. That is, the total nutrient intake is

$$[12] \quad TN_l^h = \sum_{k=1}^{n} \beta_{lk} \cdot Q_k^{d,h}$$

where $h$ is index of household socioeconomic and demographic groupings and the ratio of total nutrient intake to RDAs is:

$$[13] \quad ADQ_i^h = \frac{TN_i^h}{RDA_i}.$$

The added index $h$ represents the $h^{th}$ household group based on socioeconomic and demographic characteristics. The key groupings are based on income. Different price and income elasticities are derived for each income group. Differential price and income elasticities of households in different income groups drive the differences in the consumption and nutritional impacts. Consumption and nutrition impact are also analyzed for household groupings based on location.

## Data, Estimation, and Validation

### Data Requirements

The data requirements of the model are listed in Appendix A. Time series data for a number of variables were needed to estimate the model and generate reasonable demand and supply estimates. The consumption time series was approximated by the disappearance series. The disappearance series is derived as a residual in an accounting identity of the sources and uses of a commodity. Sources of a commodity include current production, imports, and beginning inventory. The uses of a commodity (excluding human consumption) are feed use, industrial use, exports, and ending inventory. Human consumption is calculated by deducting nonfood uses from sources of supply. This approach was used for meat and crops.

Data needed for crop supply were area planted and harvested, total production, yield, and other factors affecting supply such as weather data. Data for meat supply included animal inventory, number slaughtered, and average weight.

Price data for all commodities in the model at all levels in the marketing chain were also needed. These included world price, border price, wholesale price, and retail price. Farm price was also recorded when available. Prices of related commodities (i.e., complements and substitutes) and prices of inputs such as fertilizer and feeds were collected. Basic macroeconomic data such as population, gross domestic product, exchange rate, and consumer price index were also needed. Policy variables included, in particular, the schedule of external and internal tariffs, producer support, and consumer support. Appendix A lists the basic data requirements.

Data from the Household Expenditure Survey were needed to examine differences in the expenditure, consumption, and nutrient intake of households at different income levels and in other sociodemographic groups. These data are also listed in Appendix A.

The Honduran data were collected from a number of sources. Most of the data were collected from *Compendio Estadístico Agropecuario*, published by Council of Agricultural Development (CODA), Unity of Agricultural Sectoral Plannification (UPSA), and *Banco de Datos*, published by Project of Analysis of Agricultural Policies for Honduras (APAH). Data in these publications came from different sources such as the Central Bank of Honduras and the Secretary of Planning and Budget ( SECPLAN). In addition, some of the data on trade and prices were collected from the Department of Industrial Planning (CONSUPLANE) and the Ministry of Economy.

World prices were collected from *International Financial Statistics*, the *USDA Situation and Outlook Reports, FAPRI 1995 U.S. Agricultural Outlook,* and *FAPRI 1995 International Agricultural Outlook* for various commodities. Other unpublished information was collected from the Central Bank of Honduras.

**Parameter Estimation**

The data cover 1970 to 1994. Since Honduras is a small importer of most commodities, it faces a perfectly elastic import supply, making the price exogenous as determined by the world market. Border duties and internal taxes simply put a wedge between world and domestic prices. The demand and supply functions can thus be estimated separately without introducing simultaneity bias in the estimates. The supply equations for commodities with local production were estimated using ordinary least squares (OLS). The demand side of the structural model was treated as a separate block and estimated as a system of equations using Iterative Three-Stage Least Squares. This method gives Maximum Likelihood Estimates at the point of convergence.

Crop and meat demand are specified as an Almost Ideal Demand System (AIDS) specification because of the system's desirable properties. It has a flexible functional form, since it is derived from a second-order approximation of the cost function. When the Stone Price Index is used, the final estimating equation is linear in parameters. Also, it makes it easy to impose demand theoretical properties (i.e., adding-up, homogeneity, and symmetry) through cross-equation parametric restrictions. Furthermore, the system's estimation exploits information on the covariance matrix that improves the efficiency of estimates (i.e., SURE-type advantage). Actual estimation was accomplished through SAS and RATS version 4.0.

The standard specification of an AIDS model expresses the expenditure share of each commodity as a function of its own price, prices of related commodities (compliments and substitutes), and real expenditure. In our specification, lag values of the expenditure share, lag values of some independent

variables, and trend were included to capture dynamic adjustments of consumers. Moreover, the model is reformulated to allow direct estimation of the long-run parameters. The theoretical demand properties were imposed only on the long-run parameters. The estimated parameters for demand systems (staple crops, other crops, and livestock), supply systems, and price transmission equations are presented in Appendix C (Tables 1 to 27). Elasticities estimated from these parameters, including differentiated elasticities in crops and meat products by income and location, are presented in Appendix D (Tables 28 to 39).

Tables 1 to 3 show the estimates of demand for meat, staple food crops, and other food crops. The adequacy of the estimated model is reflected by a number of statistics. The estimated model displays all the theoretical demand properties since these were imposed in the estimation. The long-run parameter estimates have correct signs as shown in the elasticities derived from them. That is, own-price elasticities are negative and expenditure elasticities are all positive. Many of the long-run parameters have coefficient estimates that are significant. Also, lagged regressors and trend are significant, suggesting dynamic adjustment of consumers. Table 4 gives the estimates of the feed demand for corn and Table 5 gives the estimates of the feed demand for soybean meal and sorghum.

Tables 6 to 8 present the estimates of the supply equations of beef, pork, and poultry. Tables 9 to 15 give the estimates of the supplies of food crops (corn, rice, beans, plantains, sugar, and sorghum). The supply functions show very good fit with $R^2$, mostly in the high 80 and 90 percent range. Durbin-Watson statistics suggest the absence of strong serial correlation.[1] A joint test for absence of serial correlation with order higher than one using the Ljung-Box Q(r)-statistic accepts the hypothesis that the first order autocorrelation is random with a true value of zero.[2] Parameter estimates are theoretically consistent, giving the expected positive sign for own-price and negative sign for the input price in a standard supply function. Collinearity may be present, especially when the $R^2$ is high, but individual regressors have low t-values. This can be remedied in a number of ways, such as the principal components method. But since the model is primarily for simulation purposes, this was not pursued. When collinearity is present, estimates are still unbiased but not very efficient.

Tables 16 to 27 give the estimates of the price transmission equations. Linear and logarithmic functions were used according to whatever was statistically appropriate. The price transmission equations show very good fit with $R^2$, mostly in the high 90 percent range. Durbin-Watson statistics

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[1] Some of the D-W statistics are in the inconclusive range. The D-W is not a formal test when lagged values of the dependent variable are in the set of regressors.

[2] Values of the Q(r)-statistics are not reported in the tables.

mostly suggest absence of serial correlation. Parameter estimates are consistent with the expected direction of impact of price change transmission in the market chain. That is, an increase in the world price would increase the price at the producer price and at the retail. Also, changes in the exchange rate (i.e., devaluation) increase the domestic price.

**Elasticity Estimation**

Elasticity estimates provide a scale-free measure of demand or supply responsiveness to changes in its arguments (i.e., own price, income, and input price). The sign of elasticity checks whether the minimum requirement of a downward sloping demand and upward sloping supply are met. Tables 28 to 39 (Appendix D) give the demand elasticities. The own-price elasticities are all negative and all the expenditure elasticities are positive. Also, differentiated elasticities by income groups and location were estimated by merging the time series elasticity with disaggregated information from the Household Expenditure Survey. These estimates are given in Tables 34 to 36.

Price transmission elasticities are presented in Tables 37 to 39. These elasticities show a positive transmission from world to producer and from producer to retail level. Producer prices respond positively to the devaluation of local currency.

**Validation Statistics**

Historical simulation of the model's core equation was employed to validate the estimated model using a selected set of validation statistics. These statistics are presented in Appendix E (Tables 40 to 42). Table 40 shows the mean of actual and predicted values for the core endogenous variables; they are very close to the mean of the actual values, suggesting that the model is adequate. Table 41 shows the prediction error expressed relative to the actual values of the endogenous variables. The first column is the mean of the error. The second column reports the mean of the absolute value of the prediction error. The third column is the root of the mean square error. All three statistics are expressed as a percentage of the actual values of the endogenous variables. Smaller values indicate a good model.

Table 42 decomposes the Mean Square Error (MSE) into three components: bias, variance, and covariance. The second decomposition includes the bias, regression, and disturbance. The latter offers more intuitive appeal than the former. The bias and regression components capture the systematic divergence of the prediction from actual values. Hence, for a good model, the proportion of bias and regression should approach a small number (e.g., zero). On the other hand, the disturbance component,

which accounts for the random divergence of the prediction from the actual values, should explain a large proportion of the MSE. Its value should approach one.[3]

[3] In the first decomposition, a good model will have the covariance component approaching one.

# CHAPTER 3

# Worksheet Documentation

The conceptual framework and estimated parameters, along with elasticities, have been described in previous chapters. This chapter provides detailed information on the installation requirements and use of the worksheet version of the FAFSAS. The discussion assumes that the user is familiar with the basic concepts and operation of DOS and Lotus 123.

## Software and Hardware Requirements

The worksheet version of the FAFSAS is in Lotus Release 4 or 5. The software requirements to run the FAFSAS model include Windows 3.1 or later version, DOS 3.30 or later version, and Lotus 123 Release 4 or 5. The hardware requirements are a 386 or later model PC, mouse, 24 MB RAM (preferably more), 13.7 Mg program file, and VGA or better monitor.

## Hard Disk Installation

It is recommended that the program file "FAFSAS.WK4" be placed in a separate directory . If a suitable directory does not exist, create one using the DOS MD or MKDIR command. Make certain the DOS prompt is in the root directory of the hard disk (C:). Type:

C:>MD \ <directory name> {Enter}

Choose a directory name of not more than eight characters; we recommend FAFSAS for the name of the directory on the installation command line. After creating a suitable directory, copy the program file into the FAFSAS directory by typing: C:\COPY <drive:\FAFSAS.WK4>

## The Program File

The program file (FAFSAS.WK4) accommodates future policy simulation questions. In particular, this program file is designed to examine the impact of changes in international trade agreements such as the GATT or any other policy changes that affect the world commodity prices. The

simulation model is also capable of measuring the impacts of changes in domestic border policies such as the duty and tax structure.

The program file contains six distinct worksheets. The first is the ***DATA*** worksheet. It contains the original data along with its source of collection and unit of measurement. The second is the ***PARAMETER*** worksheet. This is the worksheet where the user specifies the parameters of the policy simulation analysis. It includes parameters for both demand and supply equations. The third is the ***WORK*** worksheet. It includes all the data that are used in the simulation. All transformation and recalculation of original data are done in this sheet. The next worksheet, which contains different commodity groups included in the simulation, is composed of four separate worksheets (***MEAT, STAPLES, OTHER FOOD,*** and ***FEED***). The ***MEAT*** worksheet contains demand and supply equations for meat groups (beef, pork, and chicken). Similarly, the ***STAPLES, OTHER FOOD***, and ***FEED*** sheets contain supply and demand equations for their respective groups. The fifth worksheet contains estimates of the consumption and proportion of RDAs for income and demographic groups such as location using two different worksheets. The worksheet ***INCOME QUINTILE*** contains consumption and nutrient intake for different income groups, whereas ***LOCATION*** covers population groups in different locations. The intake levels are also expressed as proportions of RDAs. The final worksheet contains the output. It combines results from different worksheets such as ***MEAT, STAPLES, OTHER FOOD, INCOME QUINTILE***, etc. For example, it incorporates the production and per capita consumption of beef, pork, and chicken from the ***MEAT*** worksheet. The final section is composed of three different worksheets; ***BASELINE, SCENARIO***, and ***SUMMARY TABLES***. The ***BASELINE*** and ***SCENARIO*** worksheets contain the results of baseline and scenario. The ***SUMMARY TABLE*** sheet combines the results from both the ***BASELINE*** and ***SCENARIO*** sheets. In this sheet, the results are arranged in the form of baseline, scenario, and percentage change from baseline to scenario for each variable.

### How to Go Through the Program File

When the user loads the program file in Lotus 123, the worksheets in the file will appear in the "worksheet Tab" in the following order—***DATA, PARAMETER, WORK, STAPLES, OTHER FOOD, FEED, INCOME QUINTILE, LOCATION, BASELINE, SCENARIO,*** and ***SUMMARY TABLES.*** To go from one worksheet to another, simply put the mouse pointer inside the desired worksheet destination and click the left button of the mouse. Once you reach the desired worksheet, you can move across columns by holding the left button of the mouse at the appropriate horizontal scroll arrow (left arrow to

move left and right arrow to move right), and across rows by holding the left button of the mouse at the appropriate vertical scroll arrow (top arrow to move up and bottom arrow to move down).

### *DATA* Worksheet

As indicated in the previous section, this sheet contains the original data series required for the model along with its source of collection and unit of measurement. This sheet acts as a storehouse for the data, which remains in original format. The data requirements of the model are discussed in the previous chapter. Among other things, these include price, macroeconomic, consumption, production, imports, inventory, feed use, trade, tariffs, export tax.

Also, data from the Household Expenditure Survey were needed to examine differences in the expenditure, consumption, and nutrient intake of households at different income levels and demographic groups such as location. A sample of data section is provided below.

| | A | B | C | D |
|---|---|---|---|---|
| 1 | **DATA** | | | |
| 11 | | | UNITS | SOURCE |
| 17 | | CROP PRODUCTION DATA | | |
| 18 | WHSPRHN_ | Total Wheat Production | MT | Compendium, pp 19-20 |
| 19 | COSPRHN_ | Total Corn Production | MT | Compendium, pp 19-20 |
| 20 | RISPRHN_ | Total Rice Production | MT | Compendium, pp 19-20 |

The first column gives the row address of the data series (e.g., total wheat production is in row 18). Column A gives the mnemonic names corresponding to each of the data series (e.g., RISPRHN_ is the name given to the variable total rice production).[4] Column B provides a descriptive name of the data series. Column C is the unit of measure (e.g., MT). Column D gives the source of the data (e.g., COMPENDIUM). The actual data begin in column F for 1970, the start of the series, and extend up to column AO for 2005.

[4] The first two letters refer to the commodity (e.g., RI for rice), the next three letters refer to the activity (e.g., SPR for production), and the last two letters refer to the country (e.g., HN for Honduras). Mnemonic names are included in the worksheet because they allow easy cross-referencing using the @vlookup function in Lotus 123.

***PARAMETER* Worksheet**

This sheet contains both Hicksian and Marshallian demand elasticities as well as expenditure elasticities obtained from estimating meat, staples, and other food demand systems. These own- and cross-price elasticities and expenditure elasticities are decomposed into demand elasticities by income groups and geographic location and are also reported in this sheet. In addition to demand side parameters, it also contains coefficients of supply equations for each commodity. For the user's convenience, a clip of the ***PARAMETER*** sheet is provided below.

| | A | B | C | D |
|---|---|---|---|---|
| 24 | **MARSHALLIAN ELASTICITIES** | | | |
| 25 | | | | |
| 26 | MEAT | P_BF | P_PK | P_CK |
| 27 | BEEF | -0.988 | -0.089 | -0.088 |
| 28 | PORK | 0.179 | -0.5306 | 0.098 |
| 29 | CHICKEN | -0.279 | 0.041 | -0.544 |

The first column gives the row address of the data series. Demand elasticities are presented in a matrix form, the diagonal elements are the own-price elasticities, and the off-diagonal elements are cross-price elasticities. For example, -0.089 is the cross-price elasticity of beef with respect to pork price. Elasticities estimated from other demand systems and elasticities by income groups and geographic location are also reported in this sheet.

***WORK* Worksheet**

This is similar to the ***DATA*** sheet. In addition to the original data that are present in the ***DATA*** sheet, it also contains all the transformed data (i.e. share, expenditures of all the commodities). The data used in the simulation are taken from this sheet.

**The Commodity Groups**

This section is composed of four worksheets, one for each commodity group. ***MEAT***, the first worksheet in the group, contains demand, supply, and trade equations for the commodities included in the meat group: beef, pork, and chicken.

For each equation, the sheet provides the worksheet address of the equation, the dependent variable, the list of independent variables, estimated coefficients, and the worksheet formula and function that translate the functional form and algebraic relations of the equations in the model into worksheet

equations. The key elements of each equation are the coefficient estimates. The performance of the entire model largely rests on whether the coefficient estimates (given in the previous section) are theoretically consistent and statistically acceptable. In the following section, samples of demand, supply, and trade equations, along with brief descriptions, are provided.

**Demand Equation**

| A | B | C | D |
|---|---|---|---|
| 20 | Pork Demand | | |
| 21 | 1 | Change in Price of Beef | 0.179 |
| 22 | 2 | Change in Price of Pork | -0.531 |
| 23 | 3 | Change in Price of Chicken | 0.098 |
| 24 | 4 | Change in Expenditure | 0.254 |
| 25 | Total | | |
| 26 | Estimated | | |
| 27 | Adjustment | | |
| 28 | Estimated with adjustment | | |
| 29 | Actual | | |

Demand equations are expressed in elasticity form to avoid the complexity of dynamic AIDS specifications through which demand equations are estimated. The first column gives the row address of the equation. Column B identifies the dependent variable in the demand equation (i.e., pork demand) and numbers the independent variables, described in column C. Column D gives the parameter estimates of corresponding independent variables described in column C. Disaggregating the equation into separate rows for each of the explanatory variables has the added advantage of allowing a more detailed examination of which specific variables are significantly impacting the endogenous variable. Column E and the columns following estimate the impact of each independent variable listed in column C by multiplying changes in the independent variable for that particular year with the corresponding parameter estimates in column D. The sum of changes due to all the explanatory variables is presented in row 25 of the corresponding column. Estimated and actual demand are presented in rows 26 and 29, respectively. Actual demand is included for comparison purposes.

***STAPLES* Worksheet**

The ***STAPLES*** worksheet contains information pertaining to the estimation of demand for, supply of, and trade pattern in the commodities included in the staples group: wheat, corn, rice, and beans. We illustrate the methodology by explaining the results for corn. As in the case of the ***MEAT*** worksheet, the top of the sheet contains information on (proportional) change in prices and expenditure on staples. Column B lists the dependent variable (for our example, corn in row 22). The next four rows contain the number of explanatory variables. The names of the explanatory variables are listed in column C, and the elasticities of demand with respect to the corresponding variables (changes in prices and expenditure on staples) are in column D (along the same row). Changes in the demand for corn due to change in each of the variables are given by the product of elasticity of demand (with respect to that price) and the proportional change in price. Columns G through AD contain the results of the products of demand elasticities and change in the corresponding variables over the period 1971 to 1994 (we lose one yearly observation in the estimation process). The sum of the effects of changes in prices and (within group) expenditures is calculated and presented in row 28, designated Total. This row represents the total change in demand for corn in a particular period. Adding this change to the previous period's demand, the next row gives the estimated demand for corn.

| A | B | C | D |
|---|---|---|---|
| 22 | Corn Demand | | |
| 23 | 1 | Change in Price of Wheat | -0.100 |
| 24 | 2 | Change in Price of Corn---- | -1.111 |
| 25 | 3 | Change in Price of Rice | -0.176 |
| 26 | 4 | Change in Price of Beans | -0.127 |
| 27 | 5 | Change in Expenditure | 1.712 |
| 28 | Total | | |
| 29 | Estimated | | |
| 30 | Adjustment | | |
| 31 | Estimated with adjustment | | |
| 32 | Actual | | |

The same procedure is followed for estimating the demand for other staple commodities. Having estimated the demand for each of the commodities, our next job is to estimate the supply of each commodity. We estimate the domestic supply only for those commodities for which there has been a sizable domestic production over the historical period. Again, we use corn as our example. As described in the section on model structure, domestic supply is the product of area allocated to a crop and

the yield of that crop (per unit of land). In the model, we assume that yield is an exogenous variable. Column B lists the dependent variable (area under corn) and the number of explanatory variables (in successive rows, but the same column).

| A | B | C | D |
|---|---|---|---|
| 64 | CORN ACREAGE (000 manzanas) | | |
| 65 | 1 | Constant | 619.2 |
| 66 | 2 | Lag Real Price of Corn | 96.87 |
| 67 | 3 | Lag Real Price of Sugar | -669 |
| 68 | | ESTIMATED | |
| 69 | | ADJUSTMENT | |
| 70 | | ESTIMATED WITH ADJUSTMENT | |
| 71 | | ACTUAL | |

Column C gives the names of the explanatory variables included, and the coefficients of these explanatory variables in the estimated regression equation for corn area are given in column D. Columns G to AO contain the results of the prediction process. The columns along the row representing the constant term remain constant. Columns G through AE along the row representing the price of corn contain the product of the coefficient of price of corn and the producer price of corn. Adding these three rows, we get the estimated area under corn, which is shown in the following row. We estimate the area under other crops in the same fashion. The difference is included in the explanatory variables (estimated with the regression equation).

Having estimated the area under each crop, the domestic supply of each commodity is obtained as the product of yield (assumed exogenous) and the estimated area under that crop. These estimated domestic supply results are shown lower in the sheet. Once domestic supply is estimated (we already have demand side estimated), the trade pattern is obtained by taking the difference between domestic consumption and production. The estimated demand is expressed in terms of per capita consumption. To obtain the aggregate consumption of a product, we multiply the per capita consumption estimate by the population size. However, in the case of corn, there is an additional demand for corn: feed use. The demand for corn for human consumption and the feed demand for corn are used to obtain the total demand for corn. The derivation of corn feed demand is described in the ***FEED*** worksheet.

### *OTHER FOODS* Worksheet

This worksheet contains the estimated results for demand, supply, and trade in bananas, soy oil, sugar, and plantains. It contains the supply estimate for sorghum. The estimation process for demand and supply of any individual commodity is exactly same as for any other commodity described earlier (e.g., pork, corn). Later, aggregate domestic supply and consumption are derived (the former as a product of yield and area, the latter as the product of estimated per capita demand and population). Net trade is then obtained as the excess of domestic supply over demand (net exports). Note, however, there is no domestic production of soybeans. Historically, Honduras has imported soybeans and crushed them internally to obtain both soybean meal and soy oil. There is no import of soybean meal over the historical period. So, given the quantity of soybeans imported (we assumed that they are crushed), we calculated the quantity of domestic soy oil supply and soybean meal supply. If total demand for soy oil exceeds this quantity (from domestic crushing), the remaining demand is met through direct import of soy oil. The domestic supply of soybean meal is equal to the amount obtained through domestic soybean crushing. However, we have not estimated the demand for sorghum and soybean meal. Specifically, sorghum and soybean meal demand stems from their use as feed. In deriving the results of net exports of sorghum and soybean meal, domestic demand is obtained as the aggregate feed demand for sorghum and soybean meal, and the estimation of feed demand is presented in the ***FEED*** worksheet.

### *FEED* Worksheet

The ***FEED*** worksheet contains information on the estimation of demand for sorghum, soybean meal, and corn as feed. As is the case for other commodities, column B contains the dependent variable, and the rows beneath the dependent variable list the number of explanatory variables. Column C gives the names of the explanatory variables included in the estimation of the feed demand for each commodity. The estimated regression coefficients are presented in column D. From columns E through AO, along the rows corresponding to each explanatory variable, we have the product of the explanatory variable and its estimated coefficient in the demand equation. By adding these rows, we get the aggregate demand for each feed commodity. The procedure is same for sorghum, soybean meal, and feed use of corn. These estimated demands for feeds are used in the derivation of net trade of each commodity.

| A | B | C | D |
|---|---|---|---|
| | Synthetic Sorghum Feed Demand | | |
| | | Beef | 0 |
| | | Pork | 1.33 |
| | | Poultry: Production | 1.29 |
| | | TOTAL CHANGES | |
| | | ESTIMATE DEMAND | |
| | | ADJUSTMENT | |
| | | ESTIMATED WITH | |
| | | ACTUAL | |

***INCOME QUINTILE* Worksheet**

The estimation of aggregate demand and domestic production discussed in the previous worksheets deals with national aggregates. They do not provide information on how the different segments of the society are affected by policy changes. This worksheet and the one following look at the consumption and nutritional effects of policies on households in different per capita income quintiles, and on rural and urban households (***LOCATION*** Worksheet). In this worksheet, we use the second tier elasticities of demand that combine the Hicksian elasticities from the first tier estimation, and the income elasticities of different groups obtained from household expenditure survey (HES) data. This merger of the Hicksian elasticities and the income elasticities of different groups (from HES) provides the basis for identifying the differential impacts of policy changes on different socioeconomic groups.

At the top of the worksheet, the average per capita consumption is divided by the corresponding income quintile base on information obtained from the Household Expenditure Survey.

| **A** | **B** | **C** | **D** |
|---|---|---|---|
| | PER CAPITA CONSUMPTION IN QUINTILE 1 | | |
| | Beef | | 0.29 |
| | Pork | | 0.22 |
| | Chicken | | 0.36 |
| | Wheat | | 0.35 |
| | Corn | | 1.11 |
| | Rice | | 1.15 |
| | Beans | | 1.17 |
| | Bananas | | 0.76 |
| | Soy oil | | 0.45 |
| | Sugar | | 0.74 |
| | Plantains | | 0.76 |

Then we estimate the per capita consumption of various commodities for five income quintiles using the same procedure. The only difference is that here we have only price effects (the income effect is merged with the price elasticities). As before, column B contains the dependent variable (for example Beef), followed by the list of the explanatory variables in the row immediately following it. Column C contains the name of the independent variables, while column D contains the elasticities of demand. By multiplying the changes in the prices by corresponding price elasticities and then adding, we get the change in demand for the good in question. Combining this with the per capita demand in the last period, we get the estimated per capita demand for beef for households in income quintile 1. The same procedure is applied to other commodities and households in other income quintiles. Note that the elasticities of demand for any particular good are different for households in different income groups due to differential income elasticities.

| A | B | C | D |
|---|---|---|---|
| | QUINTILE 1 | | |
| | Beef Demand | | |
| | 1 | Change in Price of Beef | -1.56 |
| | 2 | Change in Price of Pork | -0.21 |
| | 3 | Change in Price of Chicken | -0.18 |
| | Total | | |
| | ESTIMATED | | |

Having obtained the per capita demands for different goods for households in different income quintiles, the next step is to calculate nutritional intakes for households in different income brackets.

***Nutrient Intake Equation***

The consumption values are translated into nutrient intake (e.g., energy) using the appropriate food composition data. Column C contains all the nutrients obtained by consuming all the food included in the household food basket. Column G gives the sum of nutrient intake over all commodities.

| A | B<br>Nutritional Intake<br>Quintile 1 | C | D | E | F | G |
|---|---|---|---|---|---|---|
| | | Energy | | | 750103 | |
| | | Protein | | | 15810 | |
| | | Fat | | | 6102 | |
| | | Carbohydrate | | | 129221 | |
| | | Fiber | | | 2900 | |
| | | Calcium | | | 31696 | |
| | | Iron | | | 4417 | |
| | | Vitamin A | | | 25033 | |
| | | Thiamin | | | 282 | |
| | | Riboflavin | | | 163 | |
| | | Niacin | | | 3203 | |

***Proportion of RDA Equation***

The total nutrient intake, which is expressed on a per day nutrient intake basis, will be compared to the RDA values for each nutrient and is compared to the daily recommended allowance to evaluate the nutritional adequacy of the consumption of households.

| A | B<br>Proportion of Intake to RDA<br>Quintile 1 | C | D | E |
|---|---|---|---|---|
| | | Energy | | 2240 |
| | | Protein | | 43 |
| | | Fat | | 43.54 |
| | | Carbohydrate | | 321.90 |
| | | Fiber | | 30 |
| | | Calcium | | 678.5 |
| | | Iron | | 11.84 |
| | | Vitamin A | | 551.30 |
| | | Thiamine | | 0.89 |
| | | Riboflavin | | 1.12 |
| | | Niacin | | 14.99 |

Column C lists the nutrients included in the model and column E states the RDAs corresponding to each of the nutrients.

### *LOCATION* Worksheet

This worksheet contains the same set of information and uses the same methodology as the ***INCOME QUINTILE*** worksheet. Instead of looking at the consumption and nutritional intakes of individuals in different income quintiles, here we look at the consumption and nutritional intakes of individuals living in rural and urban areas. The methodology and information content are exactly the same as in the previous worksheet.

### *BASELINE* and *SCENARIO* Worksheets

The ***BASELINE*** and ***SCENARIO*** worksheets contain the main results of the analysis. The difference between ***BASELINE*** and ***SCENARIO*** is in the assumptions underlying the two situations. The variables contained in each of these sheets are identical. Each sheet contains exogenous world price data from 1995 (column B) to 2005 (column L). These world prices of various products are presented in rows 5 through 17. Then the results on other endogenous variables are presented. Rows 21 through 32 give the retail prices, while rows 37 through 45 report the production of various commodities. Per capita consumption of various commodities is presented in rows 49 to 59. Producer prices appear in rows 63 to 71, and net trade projections are in rows 75 to 86. The projections up to this point are about aggregates. The consumption and nutrition effects on individuals in different income quintiles who live in rural or urban areas are presented in the rest of the worksheet. First, per capita consumption of various commodities is presented for households in different income quintiles. This is followed by projected nutritional impacts (nutritional intake relative to RDA) on individuals in different income quintiles. Finally, the sheet contains the projected per capita consumption of various commodities for rural and urban subpopulations followed by nutritional intakes relative to RDA for these two subpopulations.

### *SUMMARY TABLE* Worksheet

The worksheet ***SUMMARY TABLE*** is a reorganization of results from the baseline and scenario projections. The motivation for presenting the results from baseline and scenario projections is to help compare the effects of the policy change incorporated in the scenario relative to those underlying the baseline projection. To that end, the rows of this worksheet are organized in sets of three. In each set, we first present the baseline projection results; in the next row, we present the projection under the assumptions of the scenario. Then the third row of each set gives the percentage change under scenario relative to the baseline projection. These results are presented for world price, domestic retail and

producer prices, domestic production of various commodities, per capita consumption of different commodities, and net trade in all the commodities. Once these results are presented for national aggregates, the remainder of the worksheet contains baseline, scenario, and percentage change (under scenario relative to baseline) results for per capita consumption and nutritional intakes for individuals in different income quintiles and in rural and urban locations.

**How to Run the Baseline Simulation**

*Step 1.* Once you load the program file (FAFSAS.WK4) into Lotus 123, press Alt-F3, type: /A, and press enter. This command will take you to a highlighted cell. Since you are running a baseline simulation, leave the cell blank.

*Step 2.* Press Alt-F3, type: /B, and press enter. This will take you to a section where you find a blank highlighted space right next to the heading FOOD AID. For the baseline run, leave the space blank.

*Step 3.* After going through steps 1 and 2, simply press F9 to command Lotus to recalculate all the worksheets in the program file. The output generated in all the worksheets is automatically summarized in the ***SCENARIO*** worksheet.

After you run the baseline and before you run the scenario, there are a few intermediate steps. These include range-valuing one sheet and a few variables.

*Step 4.* Press Alt-F3, type: /C, and press enter. This command will range value the scenario sheet to the baseline sheet.

*Step 5.* Press Alt-F3, type: /D, and press enter. This command will range value per capita consumption by quintile in the ***INCOME QUINTILE*** sheet.

*Step 6.* Press Alt-F3, type: /E, and press enter. This command will range value retail price in the ***INCOME QUINTILE*** sheet.

*Step 7.* Press Alt-F3, type: /F, and press enter. This command will range value per capita consumption by location in the ***LOCATION*** sheet.

*Step 8.* Press Alt-F3, type: /G, and press enter. This command will range value retail prices in the ***LOCATION*** sheet.

**How to Run the Scenario Simulation**

After going through these intermediate steps (4-8), you are ready to run the scenario. The first and foremost thing to decide is what scenario you want to run. Some of the important scenarios that can be run using this model include removal of food aid, impact of changes in world policies such as GATT and NAFTA, and impact of domestic policy changes such as changes in tariffs and tax structure. For each scenario, you need to follow a different procedure.

If you are running the scenario that involves removal of food aid, then press Alt-F3, type: /B, and press enter. This will take you to the highlighted food aid section. Type 1 in the highlighted blank space.

If you are running the GATT scenario, it involves changes in world prices, so you need to type new world prices in the ***DATA*** sheet. If you are running the scenario that measures the impact of changes in tariff and tax structures, then you need to go to the ***WORK*** sheet and type the new tariff and tax structure in the appropriate space.

After making appropriate changes, simply press F9 to command Lotus to recalculate all the worksheets in the program file. The output generated for the scenario is automatically summarized in the ***SCENARIO*** worksheet. In addition, the ***SUMMARY TABLE*** sheet summarizes both baseline and scenario results and also provides percentage change from scenario to baseline.

# CHAPTER 4

# Modifying and Updating the Worksheet Program

The worksheet version of the FAFSAS was designed with flexible updating as the primary consideration. Several possible procedures for alterations are discussed in this chapter.

### Availability of New Data

The FAFSAS program lends itself to easy updating when new data are available. The existing system covers the period from 1972 to 1994. If data for 1995 and 1996 are made available, all that is needed to incorporate new data into the model is to go to the ***DATA*** sheet. Once you are in the data sheet, enter the data for 1995 and 1996 in the lower portion of the sheet (after row 239) where the original data are stored. In the next step, link these data in the ***WORK*** sheet from the ***DATA*** sheet for the columns representing the years 1995 and 1996.

### Reestimation of Equations

If new data for a few years (e.g., three years) are made available, there might be a need to reestimate the coefficients of the model. Also, the new estimated coefficients have to be inputted into the corresponding equations. With the updated data and new coefficients, the model will provide new values of all endogenous variables.

### Predicted Values of Exogenous Variables

The solutions of endogenous variables in the CARD/FAPRI International Trade Models are based on many assumed values of exogenous variables such as unilateral policy changes (e.g., CAP Reform), multilateral policy changes (e.g., NAFTA and GATT), and macroeconomic assumptions (e.g., project LINK projections), all of which are updated from year to year. When updated numbers from the CARD/FAPRI models are made available, they can be directly inputted into the appropriate data addresses. (Go to the ***DATA*** sheet and input the new data using the procedure explained previously.)

### New Household Expenditure Survey Data

Household expenditure surveys that have national coverage are conducted infrequently. When new household expenditure survey data are available, elasticities by socioeconomic and demographic groupings can be adjusted to accommodate the new information. The new elasticities will be entered in the ***INCOME QUINTILE*** and ***LOCATION*** sheets.

### Nutrient Fortification

Nutrient fortification can be easily accommodated in the model by changing the nutrient availability per unit of the commodity consumed. A good example is vitamin A fortification in wheat. This will change the value of vitamin A derived from wheat that appears in column C.

### Additional Commodity Coverage

Increasing the commodity coverage of the model is probably the only change that requires major modification of the worksheet. It call for appropriate specification of functional form and choice of explanatory variables. Coefficients will have to be estimated. New rows will have to be added to accommodate new functions. The nutrition component will add a new source of nutrients.

### Calibrating the Model to Analyze Specific Policy Questions

The model can also be calibrated to analyze specific policy questions that cannot be properly captured in the present formulation of the worksheet program. This will require conditioning the values of some of the data in the ***SCENARIO*** worksheet to reflect the policy changes. The relevant equations affected by these data will then have to be instructed to feed from this newly constructed data series. The structure of the ***BASELINE*** and ***PARAMETER*** worksheets will remain as is and will capture the effect of the new policy (ies).

## APPENDIX A.

# Data Requirements

**Data Requirement of Crop Component**

| Crop Coverage | Data Requirement Per Crop |
|---|---|
| 1. Wheat | 1. Area Planted |
| 2. Corn | 2. Yield |
| 3. Rice | 3. Beginning Stock |
| 4. Soybeans | 4. Imports |
| 5. Soy oil | 5. Other Uses |
| 6. Sugar | a. Industrial Use |
| 7. Bananas | b. Feeds |
| 8. Beans | c. Seed |
| 9. Sorghum | d. Losses |
| 10. Plantains | 6. Exports |
| 11. Coffee | 7. Ending Stock |
| | 8. World Price |
| | 9. Domestic Farm Price |
| | 10. Domestic Wholesale Price |
| | 11. Domestic Consumer Price |
| | 12. Price Margins |
| | 13. Marketing Costs (e.g., Labor, Transportation, etc) |
| | 14. Conversion Factors (if needed) |
| | 15. Fertilizer Price |
| | 16. Weather (e.g., rainfall) data |
| | 17. Yield Elasticity |
| | 18. Area Elasticity |
| | 19. Own and Cross Price Elasticity |
| | 20. Income Elasticity |

**Data Requirement of Livestock Meat Component**

| Animal Coverage | Data Requirement per Animal Category |
|---|---|
| | 1. Live Animals<br>1. Breeding Inventory<br>2. Slaughter Number<br>3. Mortality<br>4. Exports<br>5. Imports<br>6. Average Live Weight<br>7. Average Slaughter Weight Farm Price<br>2. Meat<br>1. Beginning Stock<br>2. Imports<br>3. Exports<br>4. Ending Stock<br>5. Live-to-Carcass Conversion Factor<br>6. Farm Price<br>7. Retail Price<br>8. Border Price<br>9. World Price<br>10. Demand Elasticity (price and income)<br>11. Supply Elasticity<br>12. Price of Feed |

**Macro Data Requirement**

VARIABLES AND POLICIES

Variables

1. Population
2. Gross Domestic Product (breakdown)
3. Per Capita Expenditure
4. Exchange Rate
5. Tariff Schedule of Major Traded Commodities
6. Schedule of Internal Taxes
7. Consumer Subsidy of Major Traded Commodities
8. Consumer Price Index
9. Consumer Price Index: All Foods
10. Consumer Price Index: Foods Excluding Meats
11. Consumer Price Index: Foods Excluding Staples
12. Consumer Price Index: Foods Excluding Meat and Staples
13. Consumer Price Index: Meat and Staples
14. Consumer Price Index: Nonfood

Policies

1. Producer Support
2. Consumer Support
3. Research and Development Budget
4. Investment Policies
5. Trade Policies
6. Monetary Policies
7. Fiscal Policies

**Data From Household Expenditure Survey**

A. For Each Household

1. Expenditures on each good/major food groups
2. Total disposable income
3. Family size
4. Location of the household
5. Prices of nonmarketed commodities.

B. Nutrient Intake

1. Recommended daily allowances of major macro and micro nutrients
2. Food composition table

## APPENDIX B.

## Theoretical Framework of the Supply and Demand Functions

Consumers are modeled as maximizing utility subject to some budget constraint. A representative consumer cost function is given in,

$$[\text{B.1}] \quad \ln C(P,U) = a(P) + b(P).U \,,$$

where

$$[\text{B.2}] \quad a(P) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j$$

and

$$[\text{B.3}] \quad b(P) = \beta_0 \prod_{k=1}^{n} p_k^{\beta_k} \,.$$

The demand function is derived using Hotelling's Lemma. That is, taking the first derivative of [B.1] gives the Hicksian demand and substituting out U gives the Marshallian demand, the Almost Ideal Demand System (AIDS). The resulting demand function is of the form,

$$[\text{B.4}] \quad w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{X}{P}\right)$$

where ln(P) is approximated by a Stone Price Index.

From standard microeconomic theory, the supply function is derived from an indirect profit function. That is,

[B.5] $\pi(p,y) = p.y - c(y,w)$

the optimal y* = y(p,w) is substituted in [B.5] to get the indirect profit function:

[B.6] $\pi^*(p,w) = p.y(p,w) - c(y(p,w),w)$

The indirect profit function is now a function of output and input prices and other shifters. It is a common result that the first-order condition of the indirect profit function with respect to output price gives the supply function, and the first-order condition with respect to input price gives the input demand functions. The output supply and input demand functions are given in [B.7] and [B.8].

[B.7] $\frac{\pi^*(p,w)}{p} = y = y^`(p,w)$

and

[B.8] $\frac{\pi^*(p,w)}{w} = x_i = -x_i(p,w)$

## APPENDIX C.

## Parameter Estimates

**Table 1. Parameter Estimates of Meat Demand**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Share of Beef | | |
| INDEPENDENT | | |
| Constant | 0.365 | 0.143 |
| Log of Price of Beef | 0.102 | 0.031 |
| Log of Price of Chicken | -0.052 | 0.020 |
| Log of Real Expenditure | 0.124 | 0.052 |
| First Difference of Beef Share | 0.078 | 0.071 |
| Second Difference of Beef Share | 0.191 | 0.070 |
| Third Difference of Beef Share | 0.198 | 0.069 |
| DEPENDENT | | |
| Share of Chicken | | |
| INDEPENDENT | | |
| Constant | 0.217 | 0.094 |
| Log Price of Chicken | 0.050 | 0.013 |
| Log of Real Expenditure | -0.025 | 0.034 |
| First Difference of Chicken Share | 0.078 | 0.071 |
| Second Difference of Chicken Share | 0.191 | 0.070 |
| Third Difference of Chicken Share | 0.198 | 0.069 |

**Table 2. Parameter Estimates of Staple Food Crops Demand**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Share of Rice | | |
| INDEPENDENT | | |
| Constant | 0.537 | 0.170 |
| Log of Retail Price of Rice | 0.127 | 0.011 |
| Log of Retail Price of Corn | -0.011 | 0.015 |
| Log of Retail Price of Beans | -0.035 | 0.009 |
| Log of Real Expenditure | -0.079 | 0.037 |
| First Difference of Rice Share | 0.143 | 0.047 |
| Second Difference of Rice Share | 0.131 | 0.044 |
| Third Difference of Rice Share | 0.248 | 0.040 |
| DEPENDENT | | |
| Share of Corn | | |
| INDEPENDENT | | |
| Constant | -0.745 | 0.303 |
| Log Retail Price of Corn | 0.013 | 0.032 |
| Log Retail Price of Beans | -0.033 | 0.018 |
| Log of Real Expenditure | 0.247 | 0.065 |
| First Difference of Corn Share | 0.143 | 0.047 |
| Second Difference of Corn Share | 0.131 | 0.044 |
| Third Difference of Corn Share | 0.248 | 0.040 |
| DEPENDENT | | |
| Share of Beans | | |
| INDEPENDENT | | |
| Constant | -0.170 | 0.230 |
| Log Retail Price of Beans | 0.096 | 0.016 |
| Log of Real Expenditure | 0.068 | 0.049 |
| First Difference of Beans Share | 0.143 | 0.047 |
| Second Difference of Beans Share | 0.131 | 0.044 |
| Third Difference of Beans Share | 0.248 | 0.040 |

**Table 3. Parameter Estimates of Other Food Crops Demand**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Share of Soy Oil | | |
| INDEPENDENT | | |
| Constant | 0.743 | 0.080 |
| Log Retail Price of Soy Oil | -0.041 | 0.026 |
| Log of Retail Price of Plantains | 0.043 | 0.018 |
| Log of Retail Price of Bananas | 0.129 | 0.026 |
| Log of Real Expenditure | -0.018 | 0.013 |
| First Difference of Soy Oil Share | 0.262 | 0.047 |
| Second Difference of Soy Oil Share | 0.227 | 0.049 |
| Third Difference of Soy Oil Share | 0.117 | 0.046 |
| DEPENDENT | | |
| Share of Plantains | | |
| INDEPENDENT | | |
| Constant | 0.045 | 0.061 |
| Log of Retail Price of Plantains | 0.015 | 0.017 |
| Log of Retail Price of Bananas | -0.075 | 0.019 |
| Log of Real Expenditure | -0.015 | 0.008 |
| First Difference of Plantains Share | 0.262 | 0.047 |
| Second Difference of Plantains Share | 0.227 | 0.049 |
| Third Difference of Plantains Share | 0.117 | 0.046 |
| DEPENDENT | | |
| Share of Bananas | | |
| INDEPENDENT | | |
| Constant | -0.015 | 0.084 |
| Log of Retail Price of Bananas | -0.004 | 0.038 |
| Log of Real Expenditure | -0.015 | 0.015 |
| First Difference of Plantains Share | 0.262 | 0.047 |
| Second Difference of Plantains Share | 0.227 | 0.049 |
| Third Difference of Plantains Share | 0.117 | 0.046 |

**Table 4. Parameter Estimates of Corn Feed Demand**

| VARIABLES | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Corn | | |
| INDEPENDENT | | |
| Constant | 11949.718 | 1265.944 |
| Beef Production | 0.145 | 0.039 |
| Poultry Production | 0.593 | 0.088 |
| Price of Corn | -0.851 | 0.691 |
| Price of Soymeal | 7.453 | 2.269 |
| Price of Sorghum | -35.117 | 5.682 |
| DIAGNOSTICS | | |
| R-Square | 0.871 | |
| Durbin-Watson | 2.285 | |

**Table 5. Parameter Estimates of Soybean Meal and Sorghum Feed Demand**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Soybean meal | | |
| INDEPENDENT | | |
| Constant | -22881.888 | 6452.198 |
| Price of Beef | 0.501 | 0.192 |
| Price of Poultry | 0.853 | 0.483 |
| Price of Soybeans | 18.712 | 5.567 |
| DIAGNOSTICS | | |
| R-Square | 0.932 | |
| Durbin-Watson | 1.827 | |
| DEPENDENT | | |
| Sorghum | | |
| INDEPENDENT | | |
| Constant | 19123.167 | 5848.147 |
| Beef Production | 0.689 | 0.189 |
| Poultry Production | -2.440 | 0.361 |
| Price of Sorghum | 44.846 | 44.846 |
| DIAGNOSTICS | | |
| R-Square | 0.899 | |
| Durbin Watson | 2.312 | |

**Table 6. Parameter Estimates of Beef Supply**

| VARIABLES | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Beef Production | | |
| INDEPENDENT | | |
| Constant | 5048.33 | 5041.75 |
| Retail Price of Beef | 8.605 | 4.969 |
| Producer Price of Soybean | 16.695 | 8.574 |
| Lag (Beef Supply) | 0.832 | 0.203 |
| DIAGNOSTIC | | |
| R-Square | 0.953 | |
| Durbin-Watson | 1.671 | |

**Table 7. Parameter Estimates of Pork Supply**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Pork Production | | |
| INDEPENDENT | | |
| Constant | 4018.491 | 501.861 |
| Retail Price of Pork | 2.288 | 0.343 |
| Producer Price of Soybeans | -3.162 | 1.142 |
| DIAGNOSTIC | | |
| R-Square | 0.844 | |
| Durbin-Watson | 1.654 | |

**Table 8. Parameter Estimates of Chicken Production**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Chicken Production | | |
| INDEPENDENT | | |
| Constant | -156.809 | 3390.425 |
| Retail Price of Chicken | 7.664 | 3.831 |
| Producer Price of Corn | -16.529 | 3.772 |
| Producer Price of Soybean | -12.567 | 3.781 |
| DIAGNOSTIC | | |
| R-Square | 0.703 | |
| Durbin-Watson | 1.531 | |

**Table 9. Parameter Estimates of the Area Planted to Corn**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted (000 manzanas) | | |
| INDEPENDENT | | |
| Constant | 619.200 | 43.661 |
| Lag (Real Price of Corn) | 96.870 | 25.102 |
| Lag (Real Price of Sugar Cane) | -669.000 | 21.216 |
| DIAGNOSTIC | | |
| R-Square | 0.611 | |
| Durbin-Watson | 2.121 | |

**Table 10. Parameter Estimates of the Area Planted to Rice**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted (000 manzanas) | | |
| INDEPENDENT | | |
| Constant | 8.011 | 2.091 |
| Lag (Real Producer Price of Rice) | 15.817 | 3.904 |
| Lag (Real Producer Price of Beans) | -10.719 | 1.562 |
| Lag (Real Producer Price of Sugar ) | 30.758 | 12.739 |
| Trend | 0.414 | 0.172 |
| DIAGNOSTIC | | |
| R-Square | 0.854 | |
| Durbin-Watson | 1.704 | |

**Table 11. Parameter Estimates of the Area Planted to Beans**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted (000 manzanas) | | |
| INDEPENDENT | | |
| Constant | 91.018 | 12.310 |
| Lag (Real Producer Price of Beans ) | 41.907 | 23.735 |
| Lag (Real Producer Price of Corn) | 119.315 | 88.570 |
| Lag (Real Producer Price of Rice) | -52.923 | 13.222 |
| DIAGNOSTIC | | |
| R-Square | 0.689 | |
| Durbin-Watson | 1.715 | |

**Table 12. Parameter Estimates of the Area Planted to Plantains**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted (000 manzanas) | | |
| INDEPENDENT | | |
| Constant | 9.798 | 1.750 |
| Lag (Real Producer Price of Plantains) | 37.735 | 7.172 |
| Lag (Real Producer Price of Bananas) | -31.970 | 15.151 |
| DIAGNOSTIC | | |
| R-Square | 0.581 | |
| Durbin-Watson | 1.801 | |

**Table 13. Parameter Estimates of the Area Planted to Sugar**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted (000 manzanas) | | |
| INDEPENDENT | | |
| Constant | 11.060 | 2.730 |
| Lag (Real Producer Price of Sugar) | 11.270 | 13.304 |
| Lag (Real Producer Price of Corn) | -20.380 | 16.439 |
| Lag (Area Under Sugar) | 0.001 | 0.000 |
| DIAGNOSTIC | | |
| R-Square | 0.941 | |
| Durbin-Watson | 2.111 | |

**Table 14. Parameter Estimates of the Area Planted to Sorghum**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted | | |
| INDEPENDENT | | |
| Constant | 21.427 | 8.014 |
| Lag (Real Producer Price of Sorghum) | 80.367 | 59.418 |
| Lag (Real Producer Price of Rice) | -29.030 | 15.757 |
| Lag (Area Under Sorghum) | 0.001 | 0.000 |
| DIAGNOSTIC | | |
| R-Square | 0.680 | |
| Durbin-Watson | 2.098 | |

**Table 15. Parameter Estimates of the Area Planted to Bananas**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| DEPENDENT | | |
| Area Planted (000 manzanas) | | |
| INDEPENDENT | | |
| Constant | 14.500 | 6.234 |
| Producer Price of Bananas | 5.400 | 2.121 |
| Lag (Area Under Bananas) | 0.520 | 0.169 |
| DIAGNOSTIC | | |
| R-Square | 0.638 | |
| Durbin-Watson | 1.760 | |

**Table 16. Parameter Estimates of the Price Transmission for Beef**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Beef | | |
| INDEPENDENT | | |
| Constant | -1.509 | 0.159 |
| Log World Price of Beef (in local currency) | 1.317 | 0.080 |
| DIAGNOSTIC | | |
| R-Square | 0.918 | |
| Durbin-Watson | 1.960 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Beef | | |
| INDEPENDENT | | |
| Constant | 0.690 | 0.248 |
| Log Producer Price of Beef (in local currency) | 1.813 | 0.093 |
| DIAGNOSTIC | | |
| R-Square | 0.943 | |
| Durbin-Watson | | |

**Table 17. Parameter Estimates of the Price Transmission for Pork**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Pork | | |
| INDEPENDENT | | |
| Constant | -0.082 | 0.192 |
| Log World Price of Pork (in local currency) | 0.959 | 0.085 |
| DIAGNOSTIC | | |
| R-Square | 0.847 | |
| Durbin-Watson | 2.14 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Pork | | |
| INDEPENDENT | | |
| Constant | 0.253 | 0.128 |
| Log Producer Price of Pork | 1.708 | 0.054 |
| DIAGNOSTIC | | |
| R-Square | 0.977 | |
| Durbin-Watson | 2.010 | |

**Table 18. Parameter Estimates of the Price Transmission for Chicken**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Chicken | | |
| INDEPENDENT | | |
| Constant | -0.048 | 0.121 |
| Log World Price of Chicken (in local currency) | 0.956 | 0.054 |
| DIAGNOSTIC | | |
| R-Square | 0.932 | |
| Durbin-Watson | 1.890 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Chicken | | |
| INDEPENDENT | | |
| Constant | -0.079 | 0.093 |
| Log Producer Price of Chicken (in local currency) | 1.401 | 0.042 |
| DIAGNOSTIC | | |
| R-Square | 0.980 | |
| Durbin-Watson | 2.110 | |

**Table 19. Parameter Estimates of the Price Transmission for Wheat**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Wheat | | |
| INDEPENDENT | | |
| Constant | 0.656 | 0.215 |
| Log World Price of Wheat | 0.647 | 0.133 |
| Log Exchange Rate | 0.985 | 0.092 |
| DIAGNOSTIC | | |
| R-Square | 0.877 | |
| Durbin-Watson | 2.060 | |

**Table 20. Parameter Estimates of the Price Transmission for Corn**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Corn | | |
| INDEPENDENT | | |
| Constant | -0.037 | 0.310 |
| Log World Price of Corn (in local currency) | 1.495 | 0.183 |
| DIAGNOSTIC | | |
| R-Square | 0.744 | |
| Durbin-Watson | 1.610 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Corn | | |
| INDEPENDENT | | |
| Constant | 0.945 | 0.200 |
| Log Producer Price of Corn | 1.300 | 0.07 |
| DIAGNOSTIC | | |
| R-Square | 0.940 | |
| Durbin-Watson | 1.923 | |

**Table 21. Parameter Estimates of the Price Transmission for Rice**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Rice | | |
| INDEPENDENT | | |
| Constant | -0.283 | 0.267 |
| Log World Price of Rice (in local currency) | 0.467 | 0.115 |
| DIAGNOSTIC | | |
| R-Square | 0.418 | |
| Durbin-Watson | 1.34 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Rice | | |
| INDEPENDENT | | |
| Constant | 0.846 | 0.314 |
| Log Producer Price of Rice | 1.311 | 0.187 |
| DIAGNOSTIC | | |
| R-Square | 0.681 | |
| Durbin-Watson | 1.564 | |

**Table 22. Parameter Estimates of the Price Transmission for Beans**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Beans | | |
| INDEPENDENT | | |
| Constant | -0.666 | 0.236 |
| Log World Price of Beans (in local currency) | 1.362 | 0.097 |
| DIAGNOSTIC | | |
| R-Square | 0.895 | |
| Durbin-Watson | 2.200 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Beans | | |
| INDEPENDENT | | |
| Constant | 0.835 | 0.211 |
| Log Producer Price of Beans | 1.299 | 0.060 |
| DIAGNOSTIC | | |
| R-Square | 0.95 | |
| Durbin-Watson | 1.894 | |

**Table 23. Parameter Estimates of the Price Transmission for Bananas**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Bananas | | |
| INDEPENDENT | | |
| Constant | -1.378 | 0.232 |
| Log World Price of Bananas (in local currency) | 1.051 | 0.062 |
| DIAGNOSTIC | | |
| R-Square | 0.926 | |
| Durbin-Watson | 1.940 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Bananas | | |
| INDEPENDENT | | |
| Constant | 2.039 | 0.374 |
| Log Producer Price of Bananas | 1.543 | 0.121 |
| DIAGNOSTIC | | |
| R-Square | 0.876 | |
| Durbin-Watson | 1.876 | |

**Table 24. Parameter Estimates of the Price Transmission for Sugar**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Sugar | | |
| INDEPENDENT | | |
| Constant | -3.461 | 0.429 |
| Log World Price of Sugar (in local currency) | 0.474 | 0.146 |
| DIAGNOSTIC | | |
| R-Square | 0.313 | |
| Durbin-Watson | 1.860 | |
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Sugar | | |
| INDEPENDENT | | |
| Constant | 4.828 | 0.158 |
| Log Producer Price of Sugar | 1.345 | 0.064 |
| DIAGNOSTIC | | |
| R-Square | 0.951 | |
| Durbin-Watson | 2.034 | |

**Table 25. Parameter Estimates of the Price Transmission for Soy Oil**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Soy oil | | |
| INDEPENDENT | | |
| Constant | 0.888 | 0.276 |
| Log World Price of Soy oil (in local currency) | 0.847 | 0.111 |
| DIAGNOSTIC | | |
| R-Square | 0.718 | |
| Durbin-Watson | 1.98 | |

**Table 26. Parameter Estimates of the Price Transmission for Plantains**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| PRODUCER TO RETAIL | | |
| DEPENDENT | | |
| Retail Price of Plantains | | |
| INDEPENDENT | | |
| Constant | -0.125 | 0.186 |
| Log Producer Price of Plantains | 2.517 | 0.126 |
| DIAGNOSTIC | | |
| R-Square | 0.945 | |
| Durbin-Watson | 2.096 | |

**Table 27. Parameter Estimates of the Price Transmission for Sorghum**

| VARIABLE | Coefficient | Standard Error |
|---|---|---|
| WORLD TO PRODUCER | | |
| DEPENDENT | | |
| Producer Price of Sorghum | | |
| INDEPENDENT | | |
| Constant | 1.885 | 0.192 |
| Log World Price of Sorghum | 1.390 | 0.081 |
| DIAGNOSTIC | | |
| R-Square | 0.927 | |
| Durbin-Watson | 1.874 | |

# APPENDIX D.

# Elasticities

**Table 28. Marshallian and Expenditure Elasticities for Meat**

| | Demand Elasticities with the Price of | | | |
|---|---|---|---|---|
| | Beef | Pork | Chicken | Expenditure |
| Beef | -0.988 | -0.089 | -0.088 | 1.165 |
| Pork | 0.179 | -0.5306 | 0.098 | 0.254 |
| Chicken | -0.279 | 0.041 | -0.544 | 0.782 |

**Table 29. Hicksian Elasticities for Meat**

| | Demand Elasticities with the Price of | | |
|---|---|---|---|
| | Beef | Pork | Chicken |
| Beef | -0.1127 | 0.065 | 0.048 |
| Pork | 0.369 | -0.4971 | 0.128 |
| Chicken | 0.309 | 0.1443 | -0.453 |

**Table 30. Marshallian and Expenditure Elasticities for Staple Crops**

| | Demand Elasticities with the Price of | | | | |
|---|---|---|---|---|---|
| | Wheat Flour | Corn | Rice | Beans | Expenditure |
| Wheat Flour | -0.470 | 0.431 | -0.123 | 0.063 | 0.100 |
| Corn | -0.100 | -1.211 | -0.176 | -0.227 | 1.712 |
| Rice | -0.293 | 0.081 | -0.298 | -0.102 | 0.613 |
| Beans | -0.245 | -0.301 | -0.264 | -0.556 | 1.366 |

**Table 31. Unconditional Hicksian Elasticities for Staple Food Crops**

| | Demand Elasticities with the Price of | | | |
|---|---|---|---|---|
| | Wheat Flour | Corn | Rice | Beans |
| Wheat Flour | -0.444 | 0.465 | -0.103 | 0.081 |
| Corn | 0.352 | -0.617 | 0.172 | 0.093 |
| Rice | -0.133 | 0.293 | -0.174 | 0.013 |
| Beans | 0.114 | 0.172 | 0.014 | -0.300 |

**Table 32. Marshallian and Expenditure Elasticities for Other Food Crops**

| | Demand Elasticities with the Price of | | | | |
|---|---|---|---|---|---|
| | Soy Oil | Plantains | Bananas | Sugar | Expenditure |
| Soy Oil | -1.075 | 0.103 | 0.3019 | -0.278 | 0.959 |
| Plantains | 0.370 | -0.871 | -0.526 | 0.172 | 0.888 |
| Bananas | 0.517 | -0.279 | -1.001 | -0.165 | 0.943 |
| Sugar | -0.344 | 0.022 | -0.141 | -0.677 | 1.108 |

**Table 33. Hicksian Elasticities for Other Food Crops**

| | Demand Elasticities with the Price of | | | |
|---|---|---|---|---|
| | Soy Oil | Plantains | Bananas | Sugar |
| Soy Oil | -0.649 | 0.233 | 0.554 | 0.148 |
| Plantains | 0.764 | -0.751 | -0.293 | 0.566 |
| Bananas | 0.936 | -0.151 | -0.754 | 0.254 |
| Sugar | 0.148 | 0.1725 | 0.1504 | -0.185 |

**Table 34. Differentiated Elasticities in Meat Products by Income and Location**

| INCOME | | | |
|---|---|---|---|
| QUINTILE 1 | With Respect to the Price of | | |
| | Beef | Pork | Chicken |
| Beef | -1.560 | -0.210 | -0.180 |
| Pork | -0.256 | -0.743 | -0.070 |
| Chicken | -0.394 | -0.136 | -0.800 |
| QUINTILE 2 | | | |
| | Beef | Pork | Chicken |
| Beef | -1.440 | -0.140 | -0.110 |
| Pork | -0.079 | -0.631 | -0.139 |
| Chicken | -0.130 | 0.014 | -0.714 |
| QUINTILE 3 | | | |
| | Beef | Pork | Chicken |
| Beef | -0.1246 | -0.070 | -0.060 |
| Pork | -0.002 | -0.611 | -0.126 |
| Chicken | -0.068 | 0.029 | -0.711 |
| QUINTILE 4 | | | |
| | Beef | Pork | Chicken |
| Beef | -0.992 | 0.138 | 0.063 |
| Pork | 0.038 | -0.586 | -0.073 |
| Chicken | -0.071 | 0.043 | -0.682 |
| QUINTILE 5 | | | |
| | Beef | Pork | Chicken |
| Beef | -0.981 | 0.213 | 0.109 |
| Pork | 0.141 | 0.578 | 0.017 |
| Chicken | -0.050 | 0.018 | -0.627 |
| LOCATION | | | |
| RURAL | | | |
| | Beef | Pork | Chicken |
| Beef | -1.590 | -0.150 | -0.030 |
| Pork | -0.140 | -0.690 | -0.110 |
| Chicken | -0.190 | -0.040 | -0.680 |
| URBAN | | | |
| | Beef | Pork | Chicken |
| Beef | -1.090 | 0.190 | 0.019 |
| Pork | -0.080 | -0.640 | -0.120 |
| Chicken | -0.080 | 0.020 | -0.670 |

**Table 35. Group Differentiated Elasticities of Staple Food by Income and Location**

| QUINTILE 1 | With Respect to the Price of | | | |
|---|---|---|---|---|
| | Wheat | Corn | Rice | Beans |
| Wheat | -0.528 | 0.214 | -0.302 | -0.258 |
| Corn | 0.255 | -1.214 | -0.0002 | -0.156 |
| Rice | -0.209 | 0.076 | -0.346 | -0.280 |
| Beans | -0.177 | -0.332 | -0.282 | -0.806 |
| QUINTILE 2 | | | | |
| | Wheat | Corn | Rice | Beans |
| Wheat | -0.519 | 0.161 | 0.241 | -0.166 |
| Corn | 0.285 | -1.209 | 0.110 | 0.019 |
| Rice | -0.203 | 0.021 | -0.300 | -0.208 |
| Beans | -0.118 | -0.300 | -0.201 | -0.684 |
| QUINTILE 3 | | | | |
| | Wheat | Corn | Rice | Beans |
| Wheat | -0.537 | 0.175 | -0.214 | -0.111 |
| Corn | 0.268 | -1.189 | 0.141 | 0.080 |
| Rice | -0.226 | 0.016 | -0.280 | -0.171 |
| Beans | -0.078 | -0.214 | -0.134 | -0.556 |
| QUINTILE 4 | | | | |
| | Wheat | Corn | Rice | Beans |
| Wheat | -0.550 | 0.196 | -0.199 | -0.063 |
| Corn | 0.278 | -1.114 | 0.174 | 0.156 |
| Rice | -0.230 | 0.055 | -0.260 | -0.115 |
| Beans | -0.015 | -0.144 | -0.099 | -0.471 |
| QUNITILE 5 | | | | |
| | Wheat | Corn | Rice | Beans |
| Wheat | -0.571 | 0.191 | -0.177 | -0.01 |
| Corn | 0.263 | -1.113 | 0.193 | 0.201 |
| Rice | -0.225 | 0.101 | -0.226 | -0.051 |
| Beans | -0.033 | -0.135 | -007 | -0.403 |

**Table 35 (continued)**

| LOCATION | | | | |
|---|---|---|---|---|
| RURAL | | | | |
| | Wheat | Corn | Rice | Bean |
| Wheat | -0.513 | 0.199 | -0.214 | -0.110 |
| Corn | 0.278 | -1.220 | 0.032 | -0.135 |
| Rice | -0.180 | 0.105 | -0.253 | -0.124 |
| Beans | -0.090 | -0.314 | -0.293 | -0.673 |
| URBAN | | | | |
| | Wheat | Corn | Rice | Bean |
| Wheat | -0.471 | 0.399 | -0.125 | 0.050 |
| Corn | 0.270 | -1.100 | 0.182 | 0.174 |
| Rice | -0.210 | 0.130 | -0.230 | -0.070 |
| Beans | 0.039 | -0.040 | -0.113 | -0.377 |

**Table 36. Group Differentiated Elasticities of Other Food Crops by Income Groups and Location**

| QUINTILE 1 | With Respect to the Price of | | | |
|---|---|---|---|---|
| | Bananas | Soy oil | Sugar | Plantains |
| Bananas | -0.675 | 0.224 | -0.746 | -0.141 |
| Soy oil | 0.322 | -1.114 | -0.512 | -0.143 |
| Sugar | -0.225 | 0.041 | -0.779 | 0.078 |
| Plantains | -0.146 | 0.123 | -0.515 | -0.682 |
| QUINTILE 2 | | | | |
| | Bananas | Soy oil | Sugar | Plantains |
| Bananas | -0.438 | 0.128 | -0.447 | -0.041 |
| Soy oil | 0.332 | -1.057 | -0.388 | -0.044 |
| Sugar | -0.208 | 0.081 | -0.642 | 0.085 |
| Plantains | -0.115 | 0.118 | -0.342 | -0.561 |
| QUINTILE 3 | | | | |
| | Bananas | Soy oil | Sugar | Plantains |
| Bananas | -0.423 | 0.129 | -0.359 | -0.025 |
| Soy oil | 0.369 | -1.046 | -0.245 | -0.005 |
| Sugar | -0.188 | 0.083 | -0.546 | 0.106 |
| Plantains | -0.083 | 0.127 | -0219 | -0.526 |
| QUINTILE 4 | | | | |
| | Bananas | Soy oil | Sugar | Plantains |
| Bananas | -0.431 | 0.136 | -0.271 | -0.032 |
| Soy oil | 0.385 | -1.035 | -0.123 | 0.012 |
| Sugar | -0.177 | 0.097 | -0.433 | 0.119 |
| Plantains | -0.072 | 0.139 | -0.122 | -0.514 |
| QUINTILE 5 | | | | |
| | Bananas | Soy oil | Sugar | Plantains |
| Bananas | -0.455 | 0.126 | -0.154 | -0.055 |
| Soy oil | 0.401 | -0.983 | 0.008 | 0.03 |
| Sugar | -0.174 | 0.098 | -0.312 | 0.124 |
| Plantains | -0.075 | 0.137 | -0.028 | -0.517 |

**Table 36 (continued)**

LOCATION

RURAL

| | Bananas | Soy oil | Sugar | Plantains |
|---|---|---|---|---|
| Bananas | -0.585 | 0.143 | -0.331 | -0.137 |
| Soy soil | 0.169 | -1.029 | -0.494 | -0.197 |
| Sugar | -0.200 | 0.096 | -0.705 | 0.003 |
| Plantains | -0.206 | 0.149 | -0.423 | -0.723 |

URBAN

| | Bananas | Soy oil | Sugar | Plantains |
|---|---|---|---|---|
| Bananas | -0.441 | 0.129 | -0.331 | -0.034 |
| Soy oil | 0.334 | -1.011 | -0.256 | -0.032 |
| Sugar | -0.178 | 0.094 | -0.469 | 0.124 |
| Plantains | -0.143 | 0.109 | -0.288 | -0.578 |

**Table 37. Elasticities of Price Transmission Equations from the World to the Producer Price**

| Producer Price | World Price |
|---|---|
| Beef | 1.317 |
| Pork | 0.959 |
| Chicken | 0.956 |
| Wheat | 0.973 |
| Corn | 1.495 |
| Rice | 0.467 |
| Beans | 1.362 |
| Bananas | 1.051 |
| Sugar | 0.474 |
| Soy oil | 0.847 |
| Sorghum | 1.390 |

**Table 38. Elasticities of Price Transmission Equations from the Producer to the Retail Price**

| Retail Price | Producer Price |
|---|---|
| Beef | 1.813 |
| Pork | 1.701 |
| Chicken | 0.401 |
| Corn | 1.300 |
| Rice | 1.311 |
| Beans | 1.300 |
| Bananas | 1.543 |
| Sugar | 1.344 |
| Plantains | 2.517 |

**Table 39. Elasticities of Price Transmission Equations from the World to the Retail Price**

| Retail Price | World Price |
|---|---|
| Wheat | 0.674 |
| Soy oil | 0.847 |

# APPENDIX E.

## Statistics

**Table 40. Descriptive Statistics of the Model Simulation**

| ENDOGENOUS VARIABLE | ACTUAL | | PREDICTED | |
|---|---|---|---|---|
| | Mean | Std. Error | Mean | Std. Error |
| CATTLE | | | | |
| Number Slaughtered | 68.589 | 7.075 | 68.382 | 6.261 |
| Average Weight | 457.538 | 29.058 | 456.320 | 24.829 |
| PIG | | | | |
| Number Slaughtered | 115.208 | 14.766 | 114.520 | 13.112 |
| Average Weight | 131.425 | 20.505 | 131.245 | 19.587 |
| POULTRY | | | | |
| Production, Whole Birds | 81.852 | 21.059 | 82.576 | 19.416 |
| MEAT DEMAND | | | | |
| Share of Beef | 0.324 | 0.061 | 0.325 | 0.061 |
| Share of Chicken | 0.552 | 0.088 | 0.551 | 0.088 |
| CROP DEMAND | | | | |
| Share of Wheat | 0.293 | 0.087 | 0.295 | 0.072 |
| Share of Rice | 0.225 | 0.042 | 0.230 | 0.027 |
| Share Sugar | 0.295 | 0.084 | 0.291 | 0.078 |
| Share of Soybean Oil | 0.074 | 0.025 | 0.070 | 0.019 |
| FEED DEMAND | | | | |
| Corn | 289.336 | 34.441 | 282.777 | 42.264 |
| Soybean Meal | 124.316 | 36.675 | 125.382 | 27.217 |
| PRODUCTION | | | | |
| Wheat Flour Production | 207.845 | 87.347 | 204.975 | 86.729 |
| Area Planted with Sugar | 98.988 | 8.056 | 98.943 | 6.237 |
| Yield of Sugar | 24.788 | 1.379 | 24.816 | 1.399 |

**Table 41. Model Statistics of Fit**

| VARIABLES | MEAN ABSOLUTE | | |
|---|---|---|---|
| | Mean % Error | % Error | RMSE % |
| CATTLE | | | |
| Number Slaughtered | -0.041 | 4.911 | 5.414 |
| Average Weight | -0.169 | 2.446 | 3.041 |
| PIG | | | |
| Number Slaughtered | -0.356 | 2.906 | 3.750 |
| Average Weight | 0.011 | 2.678 | 3.339 |
| POULTRY | | | |
| Production | 1.696 | 6.901 | 8.705 |
| MEAT DEMAND | | | |
| Share of Beef | 0.267 | 3.543 | 4.412 |
| Share of Chicken | -0.102 | 2.403 | 2.816 |
| CROP DEMAND | | | |
| Share of Wheat | 4.835 | 13.007 | 21.089 |
| Share of Rice | 4.467 | 12.594 | 15.054 |
| Share Sugar | 0.165 | 12.839 | 15.054 |
| Share of Soybean Oil | -0.106 | 22.104 | 28.808 |
| FEED DEMAND | | | |
| Corn | -2.445 | 6.379 | 7.457 |
| Soybean Meal | 4.136 | 14.928 | 19.714 |
| PRODUCTION | | | |
| Wheat Flour Production | -0.757 | 8.297 | 12.979 |
| Area Planted with Sugar | 0.155 | 3.273 | 4.020 |
| Yield of Sugar | 0.123 | 1.261 | 1.737 |

**Table 42. Theil Forecast Statistics**

| VARIABLES | Corr | Bias | Reg | Dist | Var | Cov |
|---|---|---|---|---|---|---|
| CATTLE | | | | | | |
| Number | 0.850 | 0.003 | 0.004 | 0.992 | 0.047 | 0.949 |
| Average Weight | 0.866 | 0.008 | 0.001 | 0.992 | 0.084 | 0.908 |
| PIG | | | | | | |
| Number | 0.951 | 0.023 | 0.039 | 0.938 | 0.123 | 0.854 |
| Average Weight | 0.975 | 0.002 | 0.008 | 0.990 | 0.040 | 0.958 |
| POULTRY | | | | | | |
| Production | 0.953 | 0.014 | 0.011 | 0.976 | 0.065 | 0.921 |
| MEAT DEMAND | | | | | | |
| Share of Beef | 0.973 | 0.003 | 0.026 | 0.971 | 0.002 | 0.995 |
| Share of Chicken | 0.985 | 0.002 | 0.007 | 0.991 | 0.000 | 0.998 |
| CROPS DEMAND | | | | | | |
| Share of Wheat | 0.912 | 0.006 | 0.038 | 0.956 | 0.164 | 0.830 |
| Share of Rice | 0.517 | 0.027 | 0.024 | 0.949 | 0.157 | 0.816 |
| Share Sugar | 0.836 | 0.008 | 0.033 | 0.959 | 0.012 | 0.980 |
| Share of Soybean Oil | 0.577 | 0.043 | 0.052 | 0.904 | 0.070 | 0.887 |
| FEED DEMAND | | | | | | |
| Corn | 0.876 | 0.099 | 0.312 | 0.589 | 0.130 | 0.771 |
| Soybean Meal | 0.747 | 0.002 | 0.000 | 0.998 | 0.150 | 0.848 |
| PRODUCTION | | | | | | |
| Flour Production | 0.960 | 0.015 | 0.013 | 0.972 | 0.001 | 0.985 |
| Sugar Area | 0.868 | 0.000 | 0.034 | 0.965 | 0.200 | 0.800 |
| Yield of Sugar | 0.949 | 0.004 | 0.040 | 0.955 | 0.002 | 0.994 |

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