Agricultural Pricing Policy and Income Distribution in a Multi-Objective Framework: A Dominican Republic Example

Elizabeth B. Erickson*

Robert M. House**

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*Consultant to the Office of International Cooperation and Development USDA and Assistant Professor in the Department of Economics, University of Akron.

**Agricultural Economist, National Economics Division; Economics, Statistics, and Cooperatives Service, USDA, Washington D.C.

Introduction

Government intervention to affect agricultural pricing takes place in many less-developed countries. Such action has many objectives. These have been reviewed by numerous authors (for example, Krishna 1967, Mellor 1976, Arkin 1976, Sadan 1976) and include inter- and intra-year price stabilization, returns to increased production, import substitution, and lowered consumer food cost. Until recently these objectives have not often included equity issues like income distribution within the agricultural sector, between agriculture and the rest of the economy or the meeting of basic human needs. Now the position of those in poverty, both in an absolute sense and relative to others in society, has become an added area of concern.

To meet these objectives prices may be supported above or below free market equilibrium, or at some long-run estimate of normal free-market level. In each case, decision makers need to decide on the price level they will attempt to achieve.[1]

Considerable work has been done in developed countries on estimating the multiple outcomes of pricing policies (for example, Ippolito and Mason 1978, Turnovsky 1976, Walter 1977), but much less has been attempted for less-developed countries. Efficiency/social welfare effects have been evaluted for less-developed countries using consumer and producer surplus (for example, Haessel and Vickery 1975, Barker and

Hayami 1976, Bale and Greenshield 1978). Equity and income distribution effects have been estimated for some developed countries (e.g. Schultze 1971 for the U.S. indicating price supports as regressive), but authors examining this issue in less-developed countries have concentrated on the price-stabilization case (eg. Lipton 1970, Bale 1979).[2] These studies also relate to a single policy objective. Decision makers in less-developed countries need to know the likely outcomes of their pricing decisions in terms of the trade-offs and complementarities among multiple objectives, including those related to the situation of the poor. These relationships must also be expressed in terms which assist the pricing decision.

The purpose of this paper is twofold. First, to estimate empirically for the Dominican Republic tradeoffs and complementarities when income effects are taken into account in their agricultural pricing policy; second, to present these results in a form which may readily be used by the decision-makers. Although the numerical results form a special case, both the method and some of the relationships observed are of more general significance.

Dominican Republic Pricing Policies and Goals

In the Dominican Republic , INESPRE (Instituto Nacional de Estabilizacion de Precios) acts to support prices of corn, peanuts, rice and beans: all presently imported corps. Immediate objectives of the

agency (as suggested by its name) are to reduce intra-year price variation. A second objective is to set domestic prices to encourage production and reduce imports, while maintaining 'reasonable' consumer prices.[3] Pricing policy is also expected to complement other government objectives such as increased employment, and more equal income distribution. These last two objectives have been important in stated Government policy over the past five years, and seem to be of relevance to the new government (Secretaria de Estado de Agricultura 1976).

INESPRE controls imports[4] and sets producer prices which can be above import equivalent, although at this point not high enough to guarantee domestic self-sufficiency. Consumers usually pay the support equivalent price.[5] In summary, the stated pricing policy is one in which prices would be chosen which are above free-market equilibrium.

Description of the Model

Simulation of alternative pricing policies for INESPRE has involved the use of CEMI - a price-endogenous linear programming (LP) model of the Dominican crop sector.[6] Market equilibria for each crop (including intervention) are determined through maximization of the sum of producer plus consumer surplus (see Duloy and Norton 1975, McCarl and Spreen 1980).

Much pricing policy analysis has involved models, either single or multiple equation, using time series data. Such data are not available

for any reasonable time period for the Dominican Republic. A sector LP model does not require such data. Further, it includes detailed specification of product and factor markets; production units and resource constraints are specified for various farm size groups. As a result, indirect supply changes due to support pricing can be taken into account for crops, factors and disaggregate income categories. This type of interaction is not dealt with in any partial single crop analysis.

The supply side of the agriculture sector model is divided geographically into three zones (Zone A, North; Zone B, Southwest; Zone C, Southeast). Production units are specified for four farm size groups (small, 8-79 tareas; medium, 80-499 tareas; large 500 plus tareas; collectives).[7] The ten major annual crops of Dominican agriculture are included in the model along with one interplanted combination of crops (rice, red beans, corn, interplanted red beans and corn, cassava, industrial tomatoes, sweet potatoes, tobacco, peanuts, pigeon peas, and black beans). Production activities are specified for either irrigated or nonirrigated land type. Up to six different production techniques are specified for each combination of crop and zone. Each production technique is specified for as many as four different planting dates depending on the crop, zone and agroclimatic conditions. The production credit market is specified with three sources of supply (government, private institutions, private noninstitutional) at different interest rates. The labor market has family labor (assumed to have a reservation wage 50 percent of the hired wage rate), small farmer hiring out (75

percent of hired wage) and landless laborers. Land is constrained at the 1975 level. The demand side of the model consists of a downward sloping curve for each commodity, each approximated linearly with fifteen demand curve segments. Demand curves are bounded at the bottom by export prices and at the top by either import or INESPRE support prices.[8] A foreign exchange accounting row for factor inputs, product exports and imports is also included. More details of the model are provided in equation form in the Appendix.

Simulation of Rice and Bean Price Increases

Rice and beans are major crops in the Dominican Republic with some price support but continuing imports.[9] Price increases have been under consideraton by INESPRE for either or both crops in order to reduce imports. These two crops therefore seemed appropriate for analysis.

To describe briefly the process used for the price policy simulations: first the model, CEMI, is used to generate a base year pattern of production, prices, consumption, imports and exports which forms the starting point for the analyses. The base year used is 1975.[10] Then the model is altered by respecifying the upper price bound to establish a higher support price for rice and/or beans. This new version is then solved and the resulting levels of production, consumption and factor use simulate the equilibrium situation under the altered policy. Further price changes are then made, the model resolved,

and in this fashion a series of policy simulation solutions is generated. The stepwise increases in INESPRE price move first toward domestic self-sufficiency, then into a situation in which domestic production is greater than consumption and the surplus must be stored (or exported below cost).

Rice and beans prices in RD$[11] per pound are presented in Table 1a for the base year solution (BY) and the thirteen simulations. Three series of simulations were run:
rice price increases (R1-R5), bean price increases (H1-H4) and joint rice and bean price increases (RH1-RH4).[12]

Evaluation of Price Policy Simulations

For analysis of rice and red bean pricing a basic set of policy objectives was chosen. These are: a) increased production of rice and/or beans, b) self-sufficiency in beans and rice, c) foreign exchange savings, d) higher agriculture sector income, e) higher small farm income, f) more equal income distribution, g) greater employment in agriculture, h) improved efficiency of agriculture, and i) holding consumer food price increases to a minimum. Alternate price policy simulations are compared and judged on how well they perform with respect to these objectives.

Performance on these general policy objectives is measured for

Table 1.a : Price Policy Simulations from 1975 Base Year

	BASE	RICE SERIES					BEAN SERIES				JOINT SERIES			
	BY	R1	R2	R3	R4	R5	H1	H2	H3	H4	RH1	RH2	RH3	RH4
Rice Price	.114	.12	.13	.14	.15	.16	.114	.114	.114	.114	.12	.13	.14	.15
% Increase	-	5.60	14.00	23.00	32.00	41.00	0.00	0.00	0.00	0.00	5.60	14.00	23.00	32.00
Bean Price	.25	.25	.25	.25	.25	.25	.27	.29	.31	.33	.27	.29	.31	.33
% Increase	-	0.00	0.00	0.00	0.00	0.00	8.00	16.00	24.00	32.00	8.00	16.00	24.00	32.00

agriculture sector model simulations by the values of specific target policy variables. There are usually several target variables in the model which indicate performance with respect to any particular policy objective.

It is not the purpose of this paper to examine in detail the effect of the price changes on each objective, looking at various measures and examining in detail why these results occurred, although some of the major findings will be discussed in the course of the analysis. This description can be found in House and Erickson 1980. Instead, a set of summary target variables are used to examine the interrelationships among objectives for alternative pricing strategies.

Policy Objectives and Target Variables

The set of variables which were chosen as summary measures for this analysis are presented in Table 1. Rows 1 and 2 are production levels for rice and beans for each of the simulations. The measures of self-sufficiency are the levels of imports for rice and beans (Rows 3 and 4). Foreign exchange is measured in Row 5. Sector income (SI) measures total farm income from all agricultural sources. Row 6 lists the proportional change in SI over the base year. Similarly, the addition to small farm income (SFI) is measured as the percentage addition over the base year (Row 7).

Table 1
Target Policy Variable by Price Policy Simulation

Target Policy Variables	Units	Alternative Price Policy Simulations												
		BY	R1	R2	R3	R4	R5	H1	H2	H3	H4	RH1	RH2	RH3	RH4
Production															
Red Beans	10^6 lbs	53.9	49.5	45.9	45.9	49.7	49.7	56.9	65.8	83.9	85.0	54.8	54.8	68.2	69.6
Rice		461.0	487.2	509.6	573.3	604.3	604.3	461.6	436.3	428.9	427.8	478.6	492.3	559.1	579.8
Self-Sufficiency															
Red Beans	10^6 lbs	-14.4	-18.9	-22.5	-22.5	-18.6	-18.5	-11.0	-1.7	0.	0.	-13.1	-12.8	0.	0.
Rice		-94.0	-66.1	-41.2	0.	0.	0.	-93.4	-118.	-126.	-127	-74.8	-58.5	0.	0.
Foreign Exchange Savings	10^6 RD$	0.	2.0	3.9	3.8	1.5	1.5	0.9	0.7	-2.9	-3.2	2.5	4.5	8.1	6.1
Sector Income	% Change	0.	1.0	1.9	3.2	4.0	5.2	0.5	0.5	1.1	1.9	1.0	2.4	3.8	5.6
Small Farm Income	% Change	0.	2.3	2.5	4.4	2.3	6.9	2.1	0.4	1.4	4.1	1.7	3.8	4.0	6.6
Employment	10^6 DA	20.81	21.15	21.41	21.97	22.89	22.29	20.94	21.19	21.78	21.82	21.10	21.39	22.16	22.35
Labor/ Capital	Days/RD$	.62	.61	.60	.58	.56	.56	.62	.63	.64	.64	.61	.60	.56	.56
Cost of Subsistence Consumption	% Change	0.	0.9	2.3	3.7	5.1	6.5	0.4	0.8	1.1	1.5	1.3	3.1	4.8	6.6

The effects of price changes on income distribution among small, medium, large and collective farms are also important, and were measured from the results of the simulations. Analysis of these results determined an unusual and important result: none of the simulations significantly affected the distribution of farm sector income among the four farm groups. Even though large farms often received more of the farm income benefits of a price increase, the income gains were only a small proportion of their existing income base. The smaller absolute gains of small farms were a much greater proportional increase in income. Since income distribution does not change significantly in these simulations it is not used as a target variable for tradeoff analysis.

Employment is measured by the number of man days used across all farm sizes (Row 8). This measure covers demand for labor from all sources thus including employment of landless laborers as well as small farmers. As a surrogate for the income situation of the poor this could be misleading if large farms met additional labor requirements with family labor. In fact this is generally not the case. The labor/capital ratio calculation is taken as an efficiency measure (Row 9). Assuming that the Dominican economy is relatively labor rich and capital poor and that the present system overuses capital, a shift towards greater relative labor use is an improvement in performance. Change in cost of subsistence consumption (Row 10) is a welfare measure which takes into account the effect of the price increases on the real incomes of rural and urban subsistence consumers.[13]

As can be seen in Table 1, examination of price policy impacts requires analyzing the performance of ten target variables across fourteen model solutions. This process can be simplified by recognizing that subsets of the target variables are highly intercorrelated. Factor analysis is a useful ad hoc technique for describing these variable interrelationships since it clarifies the correlations in such a multivariate system.[14]

The "common factor analysis" model was applied and two factors were identified which explain 88 percent of the total variance of the system of ten target variables. The rotated factor loadings, which measure correlation between a factor and a variable, are presented in Table 2 and plotted in Figure 1. The factor loadings indicate which subsets of variables are correlated - both positively and negatively - and which variable subsets are uncorrelated.

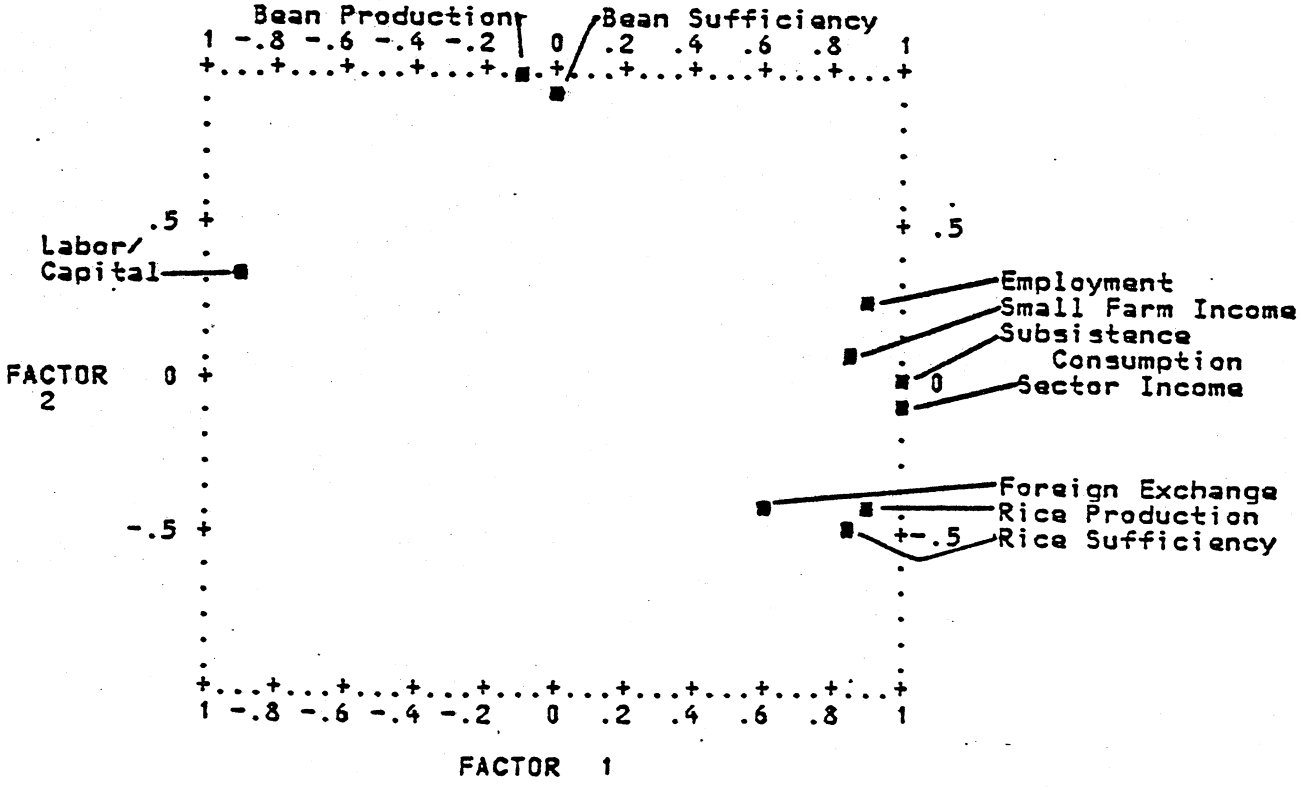
Eight of the ten variables are highly associated with Factor 1 which is plotted on the horizontal axis of Figure 1. The figure gives a good graphic idea of the relative correlations among target variables. It is evident that rice production, rice self-sufficiency, and foreign exchange balances are a highly correlated subset of variables. They are strongly correlated with another set of target variables consisting of sector income, small farm income and employment. These six variables are in turn correlated fairly negatively with the labor/capital ratio and positively with increases in the cost of subsistence consumption.

Table 2

Rotated Factor Loadings by Target Policy Variables

	Factor 1	Factor 2
Bean Production	-0.077	0.989
Rice Production	0.889	-0.416
Bean Sufficiency	0.008	0.921
Rice Sufficiency	0.869	-0.470
Foreign Exchange	0.597	-0.391
Sector Income	0.987	0.012
Small Farm Income	0.866	0.097
Employment	0.903	0.263
Labor/Capital	-0.914	0.361
Subsistence Consumption	0.987	-0.063

Figure 1 ROTATED FACTOR LOADINGS BY TARGET POLICY VARIABLES



These measures indicate that the price policy stimulation of rice production has both benefits and costs. On the plus side there is a strong positive influence on foriegn exchange, sector income and small farm income, as well as rural employment. On the minus side, the policy of increasing rice prices leads to increases in consumer food costs, and a decreased labor intensity of production which is at odds with the relative factor supplies of labor and capital in the Dominican Republic.[15]

These are the basic target-objective tradeoffs associated with policies of increasing rice production. It is interesting to note that the labor/capital ratio is inversely related to employment. This indicates that both labor and capital use rise, with capital use rising more than labor.

The remaining policy variables, bean production and bean self-sufficiency, are highly associated with Factor 2 (which by definition is completely uncorrelated with Factor 1). Rice production, self-sufficiency and foreign exchange balances are all moderately negatively affected by price policy stimulation of red bean production. The labor/capital ratio and employment show a modest positive influence from policies raising red beans prices. The remaining target objectives are largely unaffected. When bean prices are increased, more beans are produced and labor use increases, but rice production falls and the foreign exchange situation worsens.

This basic difference in response to rice price increases compared

with bean price increases can be explained to a large extent by differences in crop substitution. Expansion of one crop's production, unless unutilized land is brought into production, comes from reduction in other crops or more intensive land use. As price rises, rice production increases occur at the expense of small reductions in several crops, including beans, and a substantial decrease in tobacco. Bean price increases lead to somewhat similar crop substitutions: rice production drops somewhat, but tobacco falls more. 16/ Corn planting rises because of intercropping. However, a given area of land freed from tobacco production generates a much greater production increase in rice than beans. The marginal increases in planted land are, in a sense, used more efficiently in rice than bean production. Bean yields are relatively much lower than rice yields (little is fertilized), and despite more intensive multiple-cropping (two or three bean crops per year), the effects of the yield difference predominate.

Reduction of Target Variables

To use the simulations to assist in pricing policy decisions it should be possible to compare quantitatively the various effects of each alternative price change. It would be helpful to first reduce the number of variables which need to be compared. The previous section has shown that there are a number of close interrelationships among target variables. A more detailed look at the objectives which they measure indicates that a number of objectives are really interrelated and represent intermediate goals rather than final objectives. In other

cases target variables are alternative measures of the same concept. The ten target variables can be divided into three conceptually interrelated groups. Production increase, self-sufficiency in rice and beans, and foreign exchange savings logically form one group. Increased production of import substitutes is essentially a way of saving foreign exchange. This is also true of the goal of self-sufficiency, although in this case there may be an added motive, that of security from dependence on overseas markets.

Change in sector income, in small farm income, in employment, and in subsistence consumption costs form a group which describes income effects. They are measures of welfare change for low-income rural and urban households. Because income distribution among farm size groups is not significantly changed over the range of price policies simulated, percentage change in sector income is a reasonable indicator of percentage change in small farm income. In the context of the LP model, this more aggregate sector income measure is not affected by the arbitrary shifts of crops (and thus income), that occur between farm sizes in some solutions and thus provides a clearer measure of small farm income trends. Percent change in consumer subsistence costs is the most direct available measure of change in level of living of poor consumers. The income of rural non-farm poor and small farmers is also likely to be affected by change in rural employment. However, employment is usually used as an indirect indicator of changes in farm income when no direct measure exists. In this case, there is a direct measure so employment is

considered a secondary measure. The labor/capital ratio is the only direct measure of efficiency in production although increased employment is a partial surrogate for this objective.

It is thus possible to reduce the target variables to be considered to four measures: change in foreign exchange, change in sector income, change in subsistence consumption cost and change in the labor/capital ratio. The income objective requires two measures because of the inverse relation between increases in small farm income and increases in consumption cost. Raising prices adds to small farm income, but also reduces the real income of those buying food at the higher prices. 17/

Price Simulations by Foreign Exchange Ranking

Of these targets, it is likely in the Dominican Republic that foreign exchange saving is the pre-eminent objective of pricing policy although constrained by consideration of small farm income and consumer subsistence cost. Efficiency on the other hand can really only be considered a secondary objective. Pricing intervention which is justified in terms of reduced imports can not at the same time be considered as directly promoting efficiency - it could only be justified in those terms if a primary goal were removal of market imperfections. Solutions can then be ranked by performance on the selected pre-eminent objective. Data from Table 1 are presented in this way in Table 3. Simulations are ranked as foreign exchange savers, and grouped by high, medium, low and negative values. Measures of the other primary

Table 3 Major Variables by Price Policy Simulation

Simulations by Foreign Exchange Ranking		Change in Foreign Exchange from Base million pesos	Change in Small farm income % Change Sector Income	Change in Subsistence Consumption Cost %	Labor/Capital Ratio	Employment million 10^n man-days
'High' more than $6 million	RH3	8.1	3.8	4.8	.564	22.155
	RH4	6.1	5.6	6.6	.556	22.354
'Medium' $2-6 million	RH2	4.5	2.4	3.1	.595	21.386
	R2	3.9	1.9	2.3	.597	21.411
	R3	3.8	3.2	3.7	.577	21.968
	RH1	2.5	1.0	1.3	.606	21.104
	R1	2.0	1.0	0.9	.613	21.154
'Low' less than $2 million	R5	1.5	5.7	6.5	.563	22.289
	R4	1.5	4.9	5.1	.563	22.289
	H1	.9	.5	0.4	.617	20.942
	H2	.7	.5	0.7	.634	21.185
	BY	0	0	0	.620	20.807
'Negative'	H3	-2.9	1.1	1.1	.636	21.776
	H4	-3.2	1.9	1.5	.637	21.823

objectives (the two income measures) are also presented. In a similar fashion the effects on secondary goals like efficiency, measured by the labor/capital ratio, and additionally by change in employment could also be presented.

A first examination of Table 3 makes clear the range of the alternatives. The highest foreign exchange saver is the 24 percent increase in rice and bean price, RH3. This defines the 'high' end of the range of simulations and would probably be recommended if foreign exchange were the only criterion. When other primary objectives are included the choice is not so clear. Compared to the base year, small farm income change with RH3 is only 3.8 percent (the highest possible being over 5.5 percent) and there is significant increase (4.0 percent) in subsistence consumption cost. At the bottom of the 'low' foreign exchange saving group, base year prices (BY) provide a very different alternative with no increase in subsistence consumption costs, (the highest ranking in that objective), but also no change in small farm income and no improvement in foreign exchange balances. These two alternatives, RH3 and BY, define a rational range to be considered by decision makers. The simulations with negative effects on foreign exchange, i.e. the highest bean price increases, can be eliminated. (Given that a major objective of pricing policy is improvement in foreign exchange, alternatives which worsen these balances would not be considered.)

To make an initial comparison of the remaining alternatives, the characteristics of those with 'low', 'medium', and 'high' foreign exchange savings can be examined. Those in the 'high' foreign exchange group are the highest joint rice and beans prices tested (RH3, RH4). They have high subsistence consumption costs and fairly high increases in small farm income. Those simulations in the 'low' group include the lowest bean price increases (H1, H2) and the highest rice price increases (R4, R5). They have, therefore, among the smallest and largest changes in small farm income and consumption costs.

Low foreign exchange savings occur because of crop substitution and inventory accumulation. In the case of beans, savings in exchange are offset by increases in rice imports and reduction in tobacco exports, falling to levels below base year at high bean prices. At high rice prices, production is above self-sufficiency. Increases in inventory do not save further foreign exchange, but crop substitution reduces exports, again especially of tobacco. The 'high' savings group simulations with joint price increases do not have inventory accumulation, but do reach self-sufficiency in both products.

The 'medium' group includes the rest of the simulations, which give a broad range of foreign exchange savings. Impacts on subsistence consumption costs and small farm income also vary greatly depending on the pricing policy involved. There is no consistent relationship with foreign exchange values.

The "Policy Frontier Function"

To see underlying relationships between the target variables and the pricing alternatives, each set of simulations is graphed for each principle pair of target variables: foreign exchange versus subsistence consumption cost (Figure 2), foreign exchange versus small farm income (Figure3) and small farm income versus subsistence consumption cost (Figure4). For each price series the three graphs present the tradeoffs and complementarities among the three principle target variables. 18/

Figure 2 shows that as prices rise within each set of simulations both the foreign exchange variable and subsistence consumption variable increase, but beyond some point consumption cost increases continue while foreign exchange shows diminishing returns - increases remain constant and/or fall. Increased foreign exchange earnings end first for beans (after H1), then for rice (after R3) and finally for joint beans and rice price increases (after RH3).

Given that foreign exchange is the major goal and that increased consumption cost is not a benefit, a decision-maker is unlikely to choose any pricing policy which increases consumption cost without increasing foreign exchange. That is, the significant points are those which represent simulations that give the highest change in foreign exchange for any change in subsistence consumption cost. These then describe a 'policy frontier', in this case described by solutions BY, H1, R1, R2,

Figure 2 Foreign Exchange Savings and Subsistence Consumption Cost Increase: Price Simulations and 'Policy Frontier'

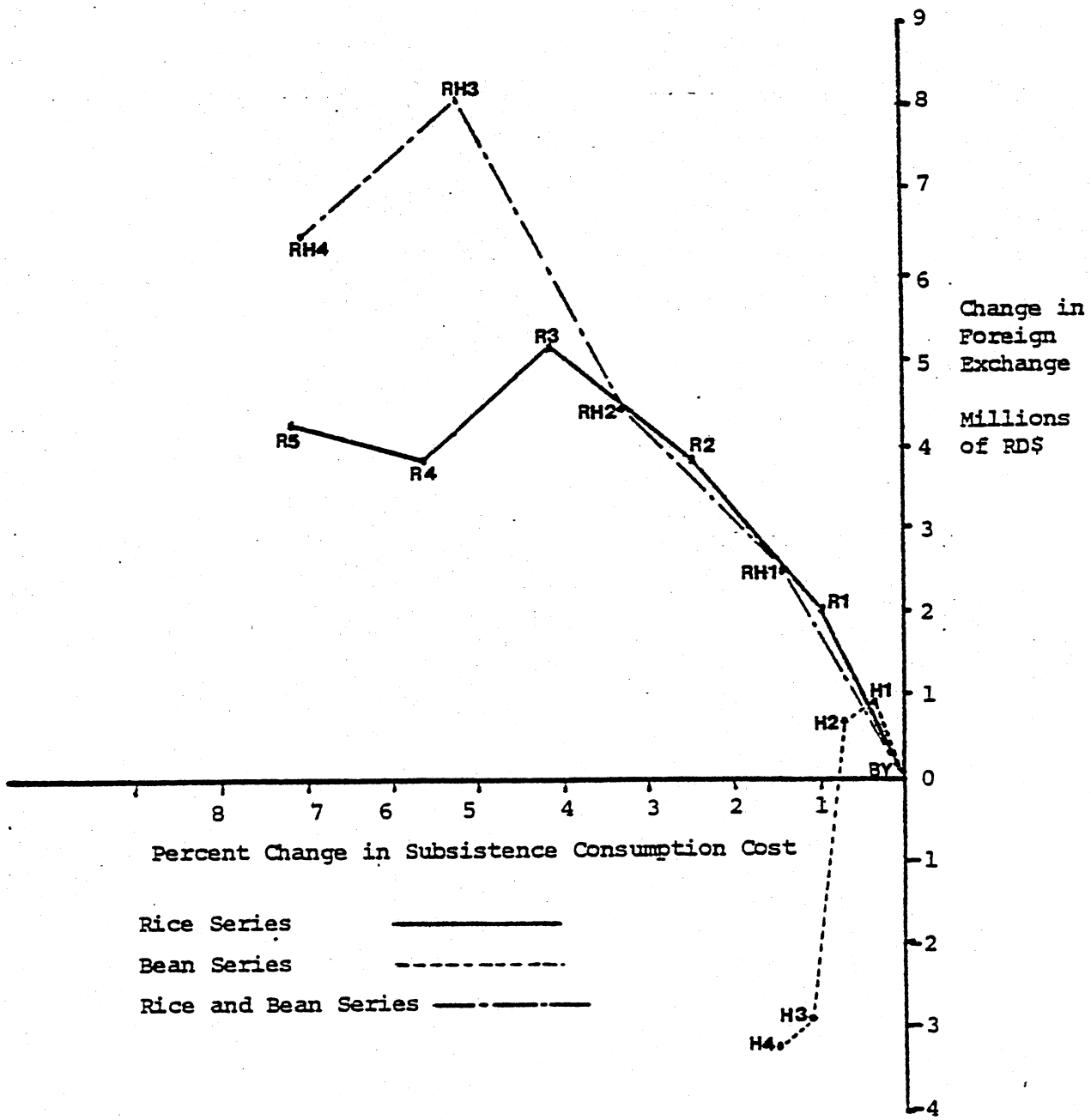


Figure 3 Foreign Exchange Savings and Small Farm Income Increase: Price Simulations and Policy Frontier

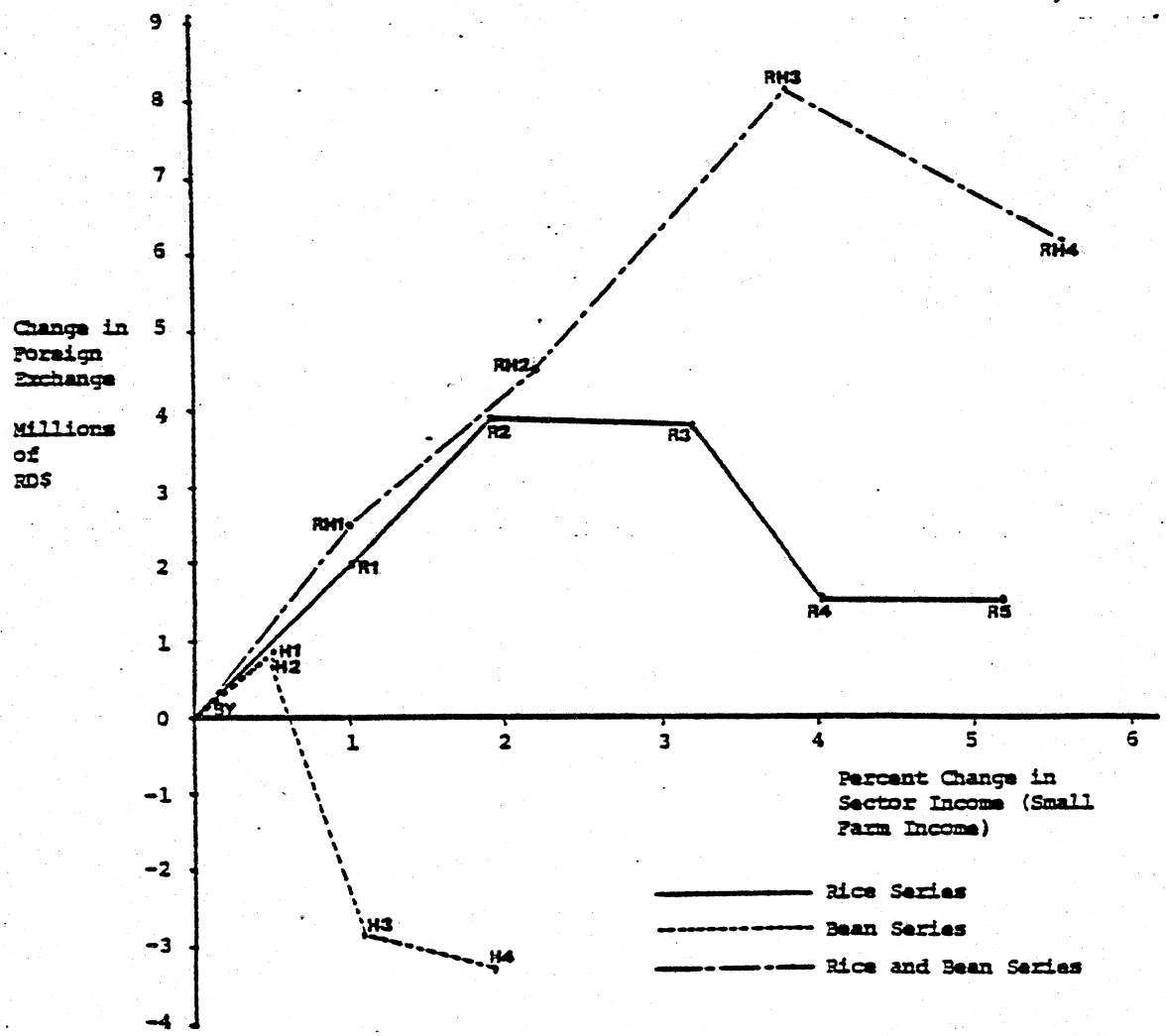
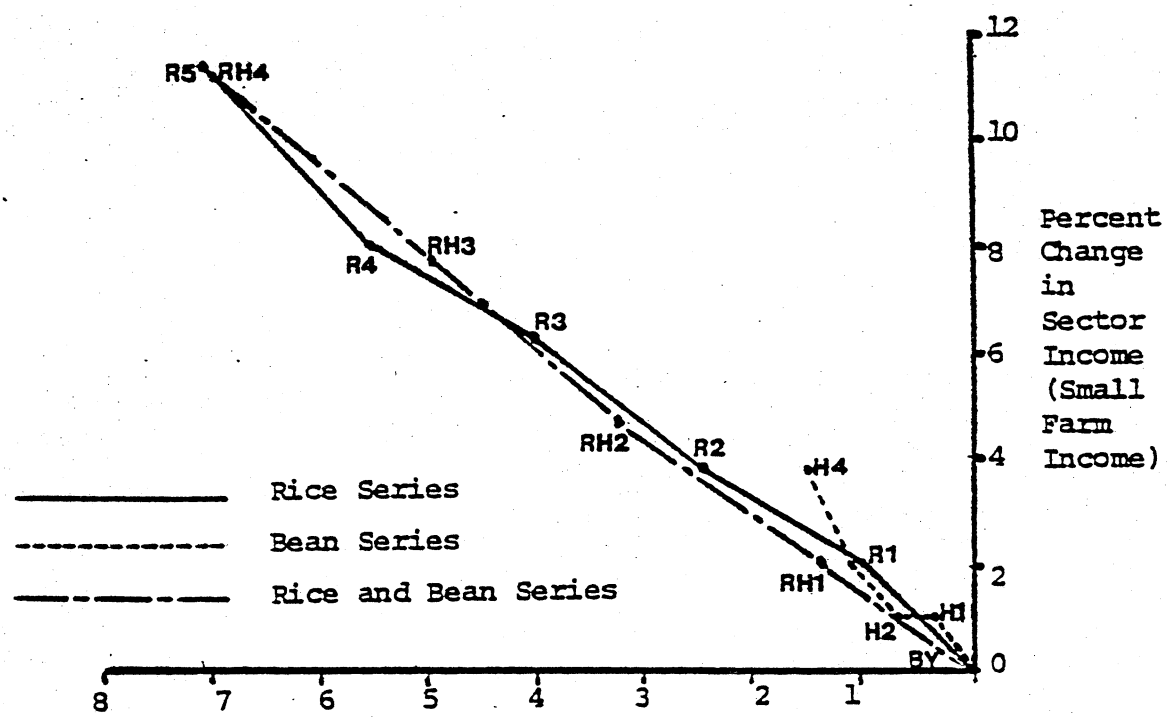


Figure 4 Small Farm Income Increase and Subsistence Consumption Cost Increase: Price Simulations and 'Policy Frontier'



RH2, RH3, and RH4. More generally, this becomes a 'policy frontier function' with the points indicated on the graph. Between points marked for present solutions the function gives estimates of the effect of pricing policies between those explicitly simulated. For example, for a two percent rise in subsistence consumption cost, the highest increase in foreign exchange to be earned is RD$3.25 million on the 'frontier' function. This would be achieved using rice and beans price increases between RH1 and R2.

A similar 'policy frontier function' of points significant to decision makers can also be defined based on the requirement that the highest change in foreign exchange would be desired for any given increase in small farm income. Figure 3 shows that for each set of simulations foreign exchange and small farm income first rise together, but beyond some point foreign exchange increase diminishes while small farm income increase continues to rise with rising prices. The change in direction occurs first for beans, then for rice, and finally for rice and beans. The 'frontier' function is formed by the RH (joint) price increase series in this case.

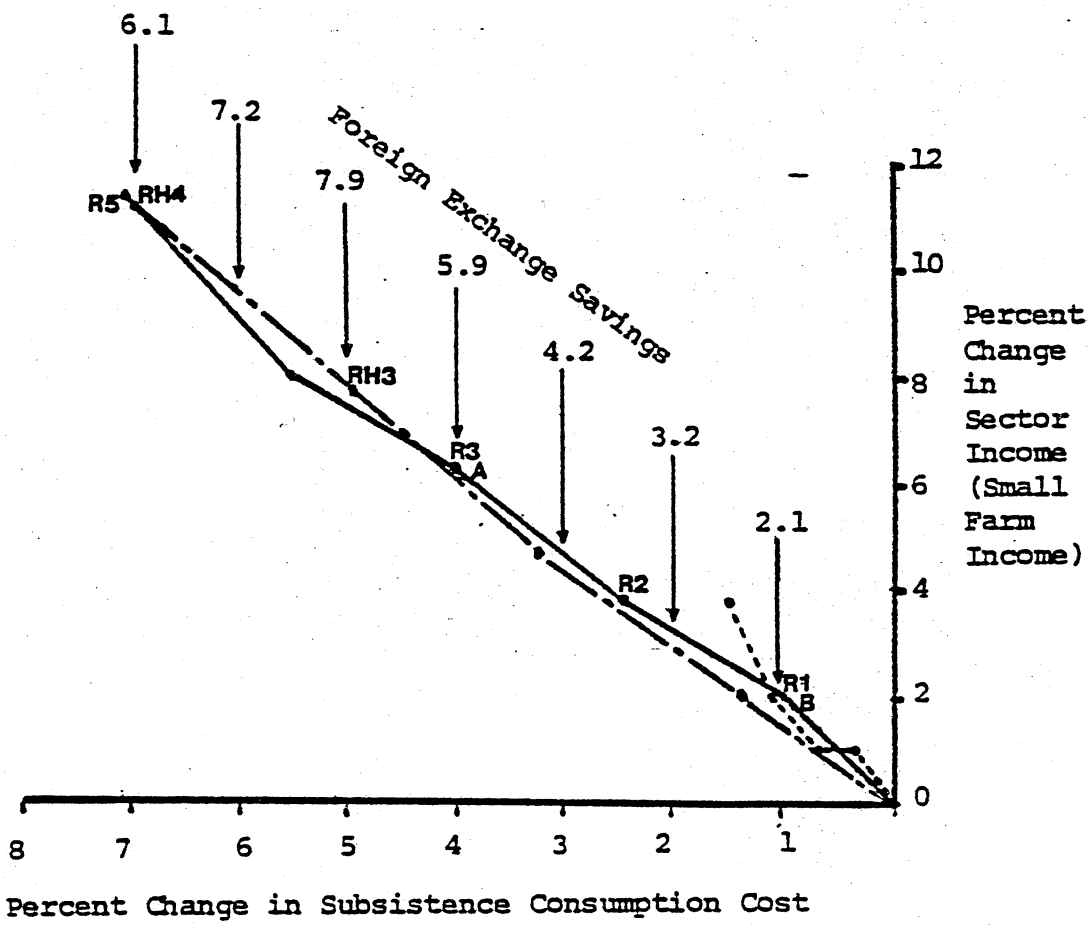
Finally there is the relationship between increase in small farm income and subsistence consumption cost shown in Figure 4. This remains a continuous negative relationship, though one which has slightly different slopes for each set of simulations. As rice has a greater impact on production and on subsistence consumption cost than beans, the

slope of the joint rice and beans relationship is very similar to that for rice. Foreign exchange is not invloved so the pre-eminent objective, is not represented. A 'frontier' function involves only the two other primary objectives. A decision-maker could require highest small farm income for a given consumption cost or alternatively the lowest consumption cost for a given increase in small farm income. In the first case this would be read from the highest line in the graph (joining H1, R1, R2, R3, RH3, RH4), [19] and in the other the lowest line (H2, RH1, RH2, R4, R5) in the diagram. Fortunately, there is in fact very little distance between the two frontiers and either could reasonably be used.

These three 'frontier' functions allow decision makers to see tradeoffs more clearly, not only among those pricing increases actually simulated, but at least suggestively for pricing levels between. Information from Figures 2, 3 and 4 can be brought together in a single graph, Figure 5. Starting with the upper 'frontier' of Figure 4 we can mark the corresponding maximum increase in foreign exchange for each change in subsistence consumption cost, reading off the frontier in Figure 2. For example, for 2 percent consumption cost increase, the highest increase in foreign exchange on the frontier function would be RD$3.2 million: for 3 percent, RD$4.2 million and so on. These values are marked on Figure 5.

This graphical formulation is a simple way of adding a third policy variable dimension to the two dimensional Figure 4 (i.e. adding an axis

Figure 5 Overall 'Policy Frontier Function' With Foreign Exchange Savings, Small Farm Income Increase and Subsistence Consumption Cost Increase



rising perpendicular to the page). It shows the tradeoffs clearly and in a form which allows application of methods of weighting objectives and lexicographic preference schemes which may be reasonably familiar to the decision-maker. Concern with consumption cost increases might be expressed as a requirement that increases be no greater than some designated level. If this maximum were, for example, two percent, then using Figure 5, the decision-maker can determine, by examination of the graph to the right of that level, that increases in small farm income can be no higher than 3.5 percent and foreign exchange savings could be only RD$3.2 million. Table 4 lists the highest values for foreign exchange saving and small farm income for a given series of alternative consumption cost increase maxima . The pricing strategies these represent are also listed. The decision-maker can then look at the benefits and costs of alternative maxima. A minimum requirement for small farm income increase can be dealt with similarly. Figure 5 can obviously also be used to determine the feasibility of joint requirements on producer income and consumption cost, and where limits are feasible, indicates the strategy which maximizes foreign exchange, subject to these requirements.[20]

The decision-maker may also wish to include the secondary goals, employment and labor/capital ratio. A similar set of graphs could be developed for foreign exchange versus employment, or foreign exchange versus the labor/capital ratio. A look at the data in Table 3 indicates that employment and foreign exchange first vary directly as prices are

Table 4

Effects of Subsistence Consumption Cost Change

Maximum Subsistence Consumption Cost Change Allowed	Highest Foreign Exchange Possible	Small Farm Income Increase	Pricing Policy
Percent	million pesos	Percent	
1	2.1	1.9	R1
2	3.2	3.5	Between R1 & R2
3	4.1	5.0	Between R2 & R3
4	5.9	6.5	R3
5	7.9	7.8	RH3
6	7.9	9.8	RH3
7	7.9	4.2	RH3

increased, but that in each simulation series foreign exchange increases finally diminish as employment contiues to rise. Similarly, capital intensity first increases with foreign exchange and then varies inversely.

Summary and Conclusions

The pricing policy alternatives tested for rice and beans gave results indicating for the Dominican case some significant tradeoffs and complementarities between income and other objectives. First, increasing rice and or beans prices by up to 40 percent does not have regressive effects on overall producer income distribution. This is essentially because most large farmers are not involved significantly in the production of these staples. Second, that certain price increases likely cannot be justified in terms even of the foreign exchange saving objectives of the government. Essentially all bean price increases are in this category whereas all rice price increases are not. Beans are a less technically efficient crop in the sense that greater cropland and production substitution is needed to increase its supply. Moderate rice and joint rice and bean price increases, on the other hand, do allow increased foreign exchange savings and increases in small farm income, although also increasing subsistence consumption cost.

For the price policies simulated, the specific tradeoffs are shown in Figure 5. The price levels and policies ultimately chosen depend on the

subjective weighting of objectives by decision-makers. However, it is interesting to note that price increases up to 24 percent for rice and/or beans which encourage substantial increases in rice and bean production, and some increase in small farm income, cannot be said to have a very major effect on subsistence consumption cost (less than five percent). Further, since the model is static it does not include the likely shift to more productive techniques which would in turn generate more cash income. Such supply shifts and associated income gains could offset even the modest cost increases estimated (see Krishna 1967). Not all these results could be expected, a priori. Though only applicable directly to the Dominican case, the analysis suggests conditions under which similar results could occur.

With respect to the second, more methodological objective of this paper, two points are significant. First, the type of model used (which allows for changes in relative prices, as well as shifts among crops, regions and farm-size groups) included indirect effects which would not be captured in a more partial framework: for example, aspects of crop substitution and employment effects. Second, the procedures for presenting the multivariate results are useful. They allow development of an understanding of the tradeoffs and complementarities by the decision-maker and provide a system helpful in making the final pricing decision. The results of the factor analysis can be used to gain a basic understanding of the general impacts of price supports on important policy variables, and then the'policy frontier function' concept can be

used to select specific pricing strategies which are consistent with decision-maker wishes and economic feasibility.

FOOTNOTES

[1] We shall assume here that they have the means of acting in the market to attain this price, although this may in fact be the most difficult task. Most countries concentrate on a few basic commodities which have controllable marketing channels (Sadan 1976).

[2] Although in evaluating price increases in corn in Mexico using CHAC, Duloy and Norton suggest that income distribution might be improved as a result of the price increase (Duloy and Norton 1973).

[3] A more detailed description of INESPRE and its operations may be found in Mann 1977, who also lists further sources.

[4] They also intervene in domestic marketing.

[5] INESPRE does not have any serious program of subsidizing consumers by intervening to lower market prices at the consumer level. There is an occasional program of direct sales to low income urban dwellers.

[6] CEMI (a name taken from Dominican mythology) consists of over eight hundred equations in more than two thousand variables (for more detailed specifications see Erickson, House and Nunez 1980). The basic model type is similar to the World Bank CHAC model for Mexico (Duloy and

Norton 1973).

[7]One hectare equals 15.9 tareas. Collective farms in the model are rice farms under the Dominican Agrarian Reform Institute (IAD) Programs.

[8]The import price or INESPRE support price really defines the elastic segment of the supply curve. It is modeled as part of the demand structure for convenience.

[9]Corn and peanuts are the other two major crops with potential supports.

[10] Production coefficients were calculated from data collected from 1800 farms in a Cost of Production/Farm Survey, taken for 1975-76. Other Dominican sources were used for constraint and demand data (see Erickson, House and Nunez 1980).

[11]Dominican Pesos. One $RD = one $US at the official exchange rate.

[12]Alternatives with lower prices than the base year were not evaluated because for the base year, the INESPRE prices were considered equivalent to the import price.

[13]A legitimate question is whether consumer surplus would be a more appropriate indicator of social welfare changes. However, it is a measure of Pareto efficiency across all consumer groups, and does not look at the equity issue of impact on low income consumers.

[14]As a general reference, see for example, Rummel, 1970, pages 323-448.

[15]However, simulations leading to lower labor/capital ratios yielded greater absolute employment gains.

[16]Crop substitution for domestic crops is limited, as the price endogenous model shows. Reduction in supply of a domestic crop can increase its price, which changes its relative profitability. This would not occur for crops like tobacco - an export crop in the perfectly elastic range of its demand curve.

[17] It might be perferable to have a single level of living variable showing the net effect of these two opposing real income measures. With further calculation this net change in level of living could be estimated. However, the necessary data are not presently available. In fact this may not be of concern to the decision-maker, who for social and political reasons may prefer the two separate measures.

[18] The subsistence consumption cost variable's axis is reversed to remind us that increases in this variable are undesirable.

[19] H3 and H4 represent negative foreign exchange savings and are not included.

[20] This frontier function was developed assuming the pre-eminance of the foreign exchange objective. However, such analysis is equally valid using another primary objective as the most important. For example, consumption cost can be minimized for given minimum requirements of foreign exchange savings and/or small farm income increases.

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APPENDIX

Description of Agricultural Sector Analysis Model (CEMI) in Summary Equation Form

The structure of the model can be described in summary form by eight sets of equations. The 'units of analysis' which are used as subscripts in these structural equations are given below.

Units of Analysis	Subscripts and Indices.
Zone	z = 1,...,3
Farm Size	s = 1,...,4
Crop	c = 1,...,11
Land Type	i = 1,2
Production Technique	t = 1,...,6
Planting Date	p = 1,...,4
Month	m = 1,...,12
Credit Source	f = 1,...,3
Demand Curve Segments	d = 1,...,15

Since land and labor utilization are specified by month the planting date index is redundant and is omitted from the equations below. The objective function is equation (1) where the

$$(1)\quad \text{Maximize}\quad B = \sum_c \sum_d D_c K_{cd} + \sum_c E_c P_c - \sum_z \sum_s \sum_m F_{zsm} W_F - \sum_z \sum_s \sum_m H_{zsm} W_H - \sum_z \sum_s \sum_c \sum_i \sum_t \sum_m \sum_f A_{zscitm} C_{zscitm} T_{sf} - \sum_z \sum_s \sum_c \sum_i \sum_t \sum_m A_{zscitm} V_{zscitm}$$

Maximand, B, is the sum of producer plus consumer surplus.

$D_c K_{cd}$ is the sum of gross producer plus net consumer surplus. P_c are commodity prices; E_c and I_c are quantities of exports and imports, respectively. F_{zsm} and H_{zsm}, respectively, are the quantities of farm family and hired labor utilized. Corresponding wages in RD$ per day are W_H, the hired wage rate, and W_F, the opportunity cost of farm family labor (which is assumed to be $W_H/2$). A_{zscitm} are land areas (in million of tareas) under cultivation with particular production techniques in months m. C_{zscitm} are production credit requirements per tarea for corresponding production activities at interest rates T_{sf}. V_{zscitm} sum up the remaining variable production costs per tarea (e.g. costs of fertilizer and pesticides).

The commodity balance equations, (2), state that domestic production plus imports must be greater than or

$$(2)\quad I_c - D_c - E_c + \sum_z \sum_s \sum_i \sum_t \sum_m A_{zscitm}\, Y_{zscitm} \geq 0$$

equal to domestic demand plus exports. [2] Y_{zscitm} are production per tarea by specified production activity. Equations (3) require that labor use not exceed farm

$$(3)\quad \sum_s \sum_c \sum_i \sum_t A_{scmitm}\, L_{zscitm} - \sum_s R_{Fzsm} - R_{Hzm} \leq 0$$

family, R_{Fzsm}, and hired, R_{Hzm}, labor availability. L_{zscitm} are monthly labor requirements by production activity. Equations (4) require that monthly land use be

$$(4)\quad \sum_c \sum_t A_{zscitm} \leq R_{Azsim}$$

no greater than corresponding supply, R_{Azsim}. C_{zscitm} are per tarea credit requirements by production activity. Equations (5) require that credit requirements not exceed

$$(5)\quad \sum_i \sum_t \sum_m A_{zscitm}\, C_{zscitm} \leq R_{Czscf}$$

credit availability, R_{Czscf}. Equations (6) are cropping flexibility constraints. They require that crop production

(6) $\sum_{sctm} \sum \sum \sum A_{zscitm} \leq R_{A*zc}$

areas not exceed zonal crop area limits, R_{A*zc}, that are a specified percentage greater than observed base year zonal crop areas. The foreign exchange balance, FX, generated by the model is calculated as in equation (7) where II_{zscit} are the values

(7) $FX = \sum_{c} E_c P_c - \sum_{c} I_c P_c - \sum_{zscit} \sum \sum \sum \sum A_{zscit} \; II_{zscit}$

of imported inputs associated with crop production (e.g. fuel, fertilizer, a percentage of machinery costs, etc.). Equations (8) are the familiar requirements that all variables have nonnegative values.

(8) $D_c, E_c, I_c, F_{zsm}, H_{zsm}, A_{zscitm} \geq 0$

Although not presented here, each commodity has an appropriate convex combination constraint to ensure a solution on the production frontier.