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A National Food-Crop Policy Model for Indonesia

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Abstract
From the implementation of the New Order government's first five-year development plan (Repelita I) in 1969 until the mid-189s, the overriding objective of Indonesian food policy was to increase rice production so as to make the country self-sufficient, at a relatively high level of consumption, in its basic staple food. The goal of rice self-sufficiency was pursued through a centrally directed program of production and area targets, subsidized distribution of inputs with extension services, investment in irrigation and marketing infrastructure, and aremunerative floor price to farmers. With the achievement of rice self-sufficiency in 1985, the focus of Indonesia's food policy was broadened to include the promotion of secondary food-crop production. But the basic mechanism of centrally directed supply targets and input distribution remained the means of encouraging diversification of the food-crop sector.

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Introduction

From the implementation of the New Order government's first five-year development plan (Repelita I) in 1969 until the mid-1980s, the overriding objective of Indonesian food policy was to increase rice production so as to make the country self-sufficient, at a relatively high level of consumption, in its basic staple food. The goal of rice self-sufficiency was pursued through a centrally directed program of production and area targets, subsidized distribution of inputs with extension services, investment in irrigation and marketing infrastructure, and a remunerative floor price to farmers. With the achievement of rice self-sufficiency in 1985, the focus of Indonesia's food policy was broadened to include the promotion of secondary food-crop production. But the basic mechanism of centrally directed supply targets and input distribution remained the means of encouraging diversification of the food-crop sector.

Today, Indonesia is pursuing economic reforms directed at moving away from an administered economy to one more responsive to domestic and international market forces. For the agricultural sector at the national level, these reforms suggest a reduction in agricultural input subsidies, a relaxation of commodity production targets, and a better integration of the agricultural sector with both international commodity markets and other economic sectors. This liberalization of the agricultural economy will occur against the backdrop of two conflicting sectoral realities: (1) rice self-sufficiency, still Indonesia's preeminent food-policy objective, is tenuous and must be pursued vigorously if domestic production is to keep pace even with slowing domestic consumption; and (2) rising Indonesian incomes are changing the structure of consumer demand and creating different food-crop requirements, in particular, a derived demand for secondary crops as animal feeds, which results from the increased production of livestock products. More broadly, although agriculture's share of GDP was reduced to about 50 percent during the 1970s and early 1980s and to about 25 percent in 1988, this sector still remains the largest source of employment for unskilled labor, providing incomes to more than half of the population. Continued growth in the agricultural sector during the 1990s, therefore, is necessary to help absorb Indonesia's ever-increasing labor force and to promote a stable transition to an industrialized economy.

What is now needed by Indonesia's food policymakers and policy analysts are flexible analytical tools to provide guidance in managing the transition of the agricultural economy to a more nearly market-oriented structure. To be useful in this regard, a set of planning tools is required that explicitly and consistently takes into account the intercommodity and intersectoral effects on the food sector of economic interventions and their removal. In what follows, a simulation model of Indonesia's food-crop sector is introduced and described. The simulation uses a demand system to model consumption and an area and productivity (yield) model to determine food-crop supply. Through a national income formulation, developments in the food-crop sector are linked simultaneously to the determination of national income. In addition, the model includes a component determining feed demand directly from developments in the livestock sector. The simulation model is used to derive a baseline scenario for the Repelita V period (1989-1993) to be used as a benchmark for conducting subsequent policy analysis. The potential impact of policy changes can then be assessed by looking at changes from the baseline.

A National Food-Crop Policy Model

Model Overview

The national model is built on a spreadsheet (Lotus 1-2-3) and is in a format easily accommodating changes in behavioral parameter estimates and in other economic behavior assumptions. This flexibility is incorporated, in part, to reflect Indonesia's rich accumulation of applied econometric research on commodity and input markets and the consequent range of parameter estimates available (Ellis 1988). It is not unusual for econometric estimation models with differing structures, specifications, and underlying data sources to generate different behavioral parameters. The problem for policy analysts and policymakers is to discern what reliable projections can be made concerning the consequences of certain courses of action from a wide range of behavioral parameter estimates. Flexibility of analytical tools is imperative in such an environment. The spreadsheet format also facilitates updating of the model's projection base year.

The present version of the National Food-Crop Policy Model (NFCPM) for Indonesia is a price-exogenous adaptation of a multicommodity, multisector, real-price driven econometric simulation model developed by Altemeier, Tabor, and Daris (1989). Demand for eight food crops--rice, wheat, corn, cassava, soybeans, mungbeans, peanuts, and sugar--is estimated as a function of private expenditures and real food-crop prices. Agricultural commodity supply is also modeled for eight food crops (wheat is not grown in Indonesia, but rice is catagorized according to dryland or wetland production) and is defined as the product of area harvested and yield per hectare. Area harvested is estimated as a function of current- or previous-period crop prices (depending on crop-specific characteristics) and previous-period area harvested. Yields are derived from a profit-maximizing relationship between output prices and input prices. To determine a domestic market deficit or surplus, supply available from production is adjusted for intermediate use (seed use, waste, feed, and industrial use) and for human consumption. Market deficits or surpluses are closed by trade and/or changes in stock levels.

The model is simultaneous in that agricultural sector income is linked to the determination of private consumption expenditures, which in turn drive staple-food demand. The value of food-crop sector income is endogenously calculated by the model as the value of food-crop sector product at wholesale prices, less expenditures on fertilizer. Food-crop sector income is added to the product from other sectors of the economy to yield total GDP, which then determines private consumption expenditures. A flowchart of the model can be found in Figure 1.

Supply Component

Crop production components in the model are for wetland rice, dryland rice, soybeans, corn, cassava, peanuts, mungbeans, and sugar. Farmers are assumed to follow a two-stage decision making process. In the first stage, they choose which commodity to produce by allocating their land to

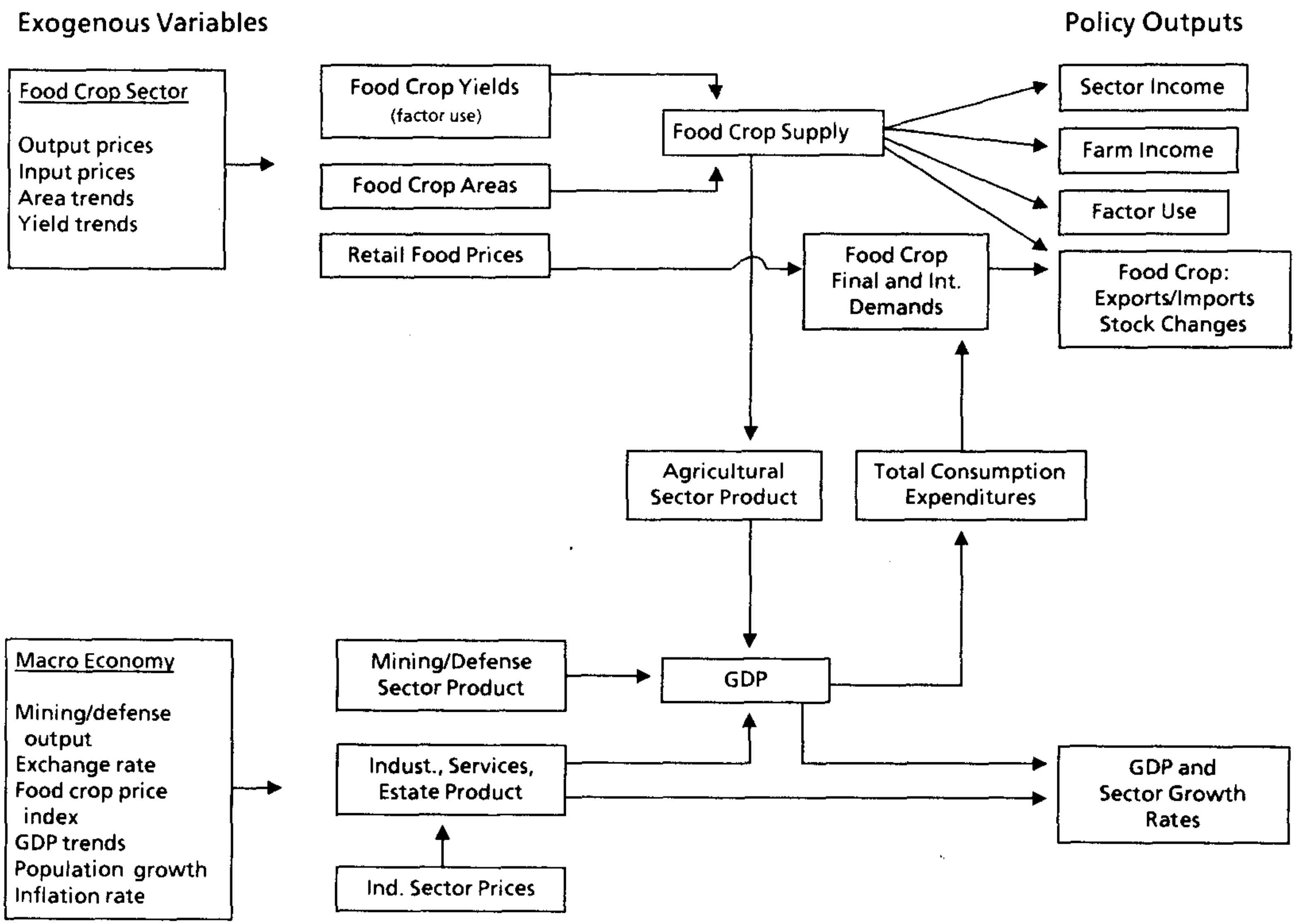

Figure 1. Structure of the National Food-Crop Policy Model for Indonesia

various crops. In the second stage, they apply variable production factors such as labor and fertilizer to determine a yield per hectare for the chosen commodity. For each commodity, then, domestic production is defined as the product of area and yield (see Appendix for variable definitions):

$$\ln X_{si} = \ln Y_i + \ln A_i. \tag{1}$$

Area allocated to food-crop production is a function of real own-crop prices, real prices of other land-competing crops, and previous-period area achievements. The area allocation process is thus modeled to behave like a Nerlovian adjustment process. The typical form of the area-response equation used incorporates a single-period lagged expectation, as follows:

$$\ln A_{it} = a_{it} + \sum_{j=1}^{m} b_{ij} \cdot \ln P_{j(t-1)} + c_i \cdot \ln A_{i(t-1)}. \tag{2}$$

Whether current- or one-period lagged prices are used as a proxy for expected price depends upon when in the calendar year the main planting time occurs and how long the crop cycle is. For example, because the main rice planting period is October and November and the main harvest time is April, lagged prices are used in the rice equations. Because the main corn planting period is September and October and the main harvest time is January, lagged prices are used in the corn equation as well. Equations for longer-duration crops such as sugarcane and cassava also employ lagged prices. Soybeans, on the other hand, have a growing time of only three months and are harvested continually throughout the year.

Current-period prices are therefore used for soybeans. The lagged area variable is highly collinear with government area targets and must be interpreted accordingly. Finally, the intercepts are functions of time and shift according to exogenous nonprice factors such as public investment in new irrigation systems and rehabilitation.

Yields per hectare are defined as a function of output price (p), input prices (q) for variable inputs labor and fertilizer, and time:

$$\ln Y_{it} = a_{it} + d_i \cdot \ln p_{it} + \sum_{j=1}^{n} e_{ij} \cdot \ln q_{jt}. \tag{3}$$

The yield elasticities are derived from a profit-function approach modeling the crop productivity relationship. According to the assumption of profit maximization, farmers apply labor and fertilizer so as to maximize profits. This second stage of the production process is thus modeled as the yield resulting per hectare if farmers, having already allocated their lands to various commodities, maximize profits. Including a time-dependent intercept, y_{it}, in the yield equations allows explicit treatment of exogenous efficiency gains that can result from, for example, newly disseminated technology or enhanced human capital.

Factor demands per hectare are also defined as a linear function of input and output prices and time:

$$\ln R_{ijt} = r_{ijt} + \sum_{k=1}^{n} u_{ik} \cdot \ln q_{jkt} + n_{ij} \cdot \ln p_{it}. \tag{4}$$

The factor-demand elasticities, like the yield elasticities, are derived from a profit-function model. Including a time-dependent intercept allows for the impact of behavioral changes in input use due to new technology and enhanced human capital. In the future, labor use per hectare is likely to fall for most crops as the mechanization of agricultural tasks spreads, but fertilizer use per hectare is likely to increase as a result of exogenous factors such as the spread of rice-intensification programs such as SUPRA INSUS, which promotes diversified fertilizer use.

Food Demand Component

Food-crop demand per capita is modeled as a linear function of own and other staple-food prices and an endogenously determined estimate of real total expenditures:

$$\ln X_{dit} = x_{it} + f_i \cdot \ln \hat{TEXPC}_t + \sum_{j=1}^{m} g_{ij} \cdot \ln p_{jt}. \qquad (5)$$

Elasticity values are derived under the assumption of subutility maximizing, two-stage (staple foods and other goods) expenditure budgeting. That is, in the parameter estimations, household consumption is assumed to be determined first by allocating the budget between staple foods and other goods, and then by allocating within each class of commodities. Private consumption expenditures per capita, which with prices drive demand, are defined as a function of an endogenously defined estimate of per capita GDP (described further below):

$$\ln \hat{TEXPC}_t = a_0 + a_1(\ln \hat{GDP}_t - \ln POP_t). \qquad (6)$$

Feed-Demand Component

In countries where long time series of quarterly livestock data are not available, as is the case in Indonesia, two alternative approaches can be employed to estimate the livestock sectors' total use of food crops as animal feeds. One approach considers the demand for feed derived from consumption of livestock products. The other uses historical and expected trends of growth in the animal population to estimate growth of feed requirements. The latter approach is particularly appropriate when supply factors dominate demand factors in determining the rate of growth of the livestock sector, as appears to be the case in Indonesia. This animal-population approach is therefore the one adopted in the national model.

In the animal-population approach, the number of animals in each feed-using livestock group needs to be determined for a base year. Because the livestock portion of the national model is intended to project the use of food crops as animal feeds, only population groups utilizing food crops in their feed rations need be included. Field observations and general knowledge indicate that dairy cattle, hogs, poultry, and ducks are the main users of food crops in their feed rations. Because feeding practices depend upon type of operation, the animal populations must also be disaggregated by husbandry method. Hogs are disaggregated into those belonging to modern and smallholder operations. Smallholder hog producers are categorized according to whether they are confined or extensive operators. Chickens are categorized as commercial layers, broilers, or village-level producers (i.e., ayamkampung). Village chickens are divided further according to whether they belong to intensive or extensive enterprises. Duck and dairy-cattle operations are fairly homogeneous throughout Indonesia and are not disaggregated.

To project feed use by animal population, the number of animals in the livestock sector must be projected. There are numerous approaches to projecting animal populations. Rates of increase in the population can be estimated on the basis of past trends; for example, from simple linear trends estimated from the annual time-series data. Linear trends are less appropriate when there is either considerable intervention by the government or other exogenous factors affecting the development of the particular livestock industry. For example, in an attempt to attain self-sufficiency in milk production, the government is currently conducting a major campaign to import improved dairy-cattle breeding stock. Improved hog-breeding stock is being imported, as well, to shorten fattening periods. Further, the commercial poultry industry in the 1990s is likely to be driven more by how quickly export opportunities can be exploited than by past trends in population growth. In these markets, discerning future population growth requires judgement about the impact of factors besides past trends in population growth.

The number of animals must be translated into feed requirements and ultimately into feed use. The current version of the livestock model includes estimated annual per-animal feed requirements, expressed in kilograms, for each of the disaggregated livestock groups included in the model. The composition of the gross feed-ration figures is also included. Once future animal populations have been determined, projections of feed use can be made simply by multiplying the feed requirement and composition figures by the appropriate animal-population figure. This type of projection model framework is implemented easily in a spreadsheet format.

By developing the model on a computer spreadsheet, alternative animal-population growth rates, per-animal feed-use requirements, and feed ration compositions can be incorporated easily into the projection analysis.

National Income Component

In the income component of the model, the economy is partitioned into three sectors. National income is defined as the sum of income generated in (1) the food-crop sector, (2) the mining and defense sectors, and (3) all other products and services sectors:

$$GDP = GDP_1 + GDP_2 + GDP_3. \qquad (7)$$

The food-crop sector income is derived directly from the supply side of the model. Food-crop sector product is defined as the value of food-crop sector output valued at real wholesale crop prices, less the cost of fertilizer:

$$GDP_1 = \left(\sum_{i=1}^{m} p_i \cdot X_{si} - q_j \cdot \sum_{i=1}^{m} r_{ij} \cdot A_i\right) \cdot CORR \; (j = \text{fertilizer}). \qquad (8)$$

The endogenously determined sector income thus includes all wages, rents, profits, and interest generated from farm production minus the cost of chemical fertilizers, the predominant agricultural input used from outside the sector. The parameter CORR is a constant correction factor accounting for differences between the endogenously determined food-crop sector product and the figures from national statistical yearbooks. The CORR parameter reflects, largely, the value of horticultural production not accounted for in the model but included as part of food-crop sector income in the national accounts. National product generated from the estate sector and from livestock production is not included in this parameter.

The "mining and quarrying" and "administrative services and defense" subsectors from the national accounts are combined to comprise the mining and defense sector. The value of extractive earnings, and thus mining sector output, depends heavily on world petroleum prices, as do the budgetary funds available for administrative and defense activities. Consequently, the GDP from this sector is defined exogenously in the model.

The difference between total GDP and the sum of the food-crop sector product and the mining and defense sector product equals, by definition, the value of goods and services produced in other sectors of the economy. This other, or residual, sector is composed mainly of industrial, services, and estates production. In a real-price model with an exogenous inflation rate, price changes in the food-crop sector must be offset by price movements for products in this other-goods sector. The price relationship between the food-crop and other sectors affects the real growth potential in both sectors. Further, because many products in the other sector are tradeable, the real exchange rate will have an impact on nonfood-crop production. Production in the industrial, estates, and services sector, then, is defined as a function of exogenous technical change, relative intersectoral prices, and the real Rp/US$ exchange rate:

$$GDP_3 = G_t + h \cdot \ln (\hat{P}_z / \hat{P}_f) + \epsilon(\ln EXC + \ln \hat{P}_z). \qquad (9)$$

Intersectoral real-price relationships are formed by determining nonfood-crop prices as a function of an index of food-crop prices. The food-crop price index is defined as a share-weighted sum of commodity prices:

$$\ln \hat{p}_f = \sum_{j=1}^{m} \hat{W}_j \cdot \ln(p_{j(t)} / p_{j(\text{base year})}), \qquad (10)$$

with W(j) being

$$\hat{W}_j = X_{dj} \cdot P_j / FEXP_{(t-1)}.$$

The aggregate price index, P_a, is defined as the geometric index of food and nonfood prices:

$$\ln (\hat{P}_a) = S_f \ln\hat{P}_f + (1 - S_f) \ln\hat{P}_z$$

$$\hat{S}_f = [FEXP/TEXP]_{(t-1)}.$$

Because this is a real-price model, $P_a = 1$ by definition, so it is possible to derive nonfood prices from food prices and the relative expenditure shares:

$$\ln \hat{P}_z = \hat{V} \cdot \ln \hat{P}_f,$$

which is determined by the relative share of food expenditures (FEXP) in total expenditures:

$$\hat{V} = -S_f/(1 - \hat{S}_f).$$

Model Closure

In a model such as the one described above, either agricultural output prices or trade quantities can be set exogenously, in addition to the exchange rate, input prices, population growth rates, and mining/defense sector output. In the present version of the model, trade or stocks are allowed to adjust and clear commodity markets. Agricultural production and beginning stocks provide total domestic supplies. Consumption by humans and intermediate uses (feed, seed, waste, and other nonfood uses) are subtracted to yield a domestic market surplus or deficit, which is closed by trade or stock adjustments. If there are limits on imports or stock adjustments, both can be allowed to adjust.

The nature of the adjustment process varies by commodity and reflects crop-specific trade. Wheat imports, although controlled by BULOG, are physically conducted by private flour mills holding stocks for inventory purposes. These levels historically have represented about 25 percent of annual flour production. Thus the baseline holds stocks at 25 percent of flour production and endogenizes wheat imports. Rice-trade policy during the Repelita V period is likely to be one of nonentry into world markets as long as domestic stock levels are within BULOG's operational bounds--that is, between 1.0 and 2.5 million metric tons. When stock levels fall out of this range, BULOG will either import or export until stocks are again within an acceptable range. Thus, rice stocks adjust first to domestic surplus or deficit, and trade occurs only if a stock bound is reached. Sugar production is now consistently below domestic consumption, so imports are necessary every year. Stock levels are quite high at present, and it is assumed that over the Fifth Plan period they will be reduced by 25,000 metric tons per year to keep imports at a reasonable level. After the stock adjustment, imports clear the sugar market. Stock levels are far less significant for other crops, and trade is assumed to clear all other markets.

The intermediate use of agricultural commodities is modeled very simply. Feed use is determined as the derived demand from livestock population projections, as described previously. Other nonfood uses (waste and industrial uses) are fixed percentages of annual production. The use rates employed in the model are those found in the food balance sheets published by the Central Bureau of Statistics (CBS). Seed use is determined by average per-hectare application rates and cultivated area. Per-hectare seed application rates are taken from the annual cost-of-production surveys published by CBS.

Parameters and Assumptions

The model described above is in constant elasticity form. The current model uses 1988 as the base year for projections. The food-crop sector is defined as the production and use of rice, wheat, corn, cassava, soybeans, peanuts, and mungbeans measured at wholesale prices. Sugar is also included in the model because it is an important competitor for land use with food crops, but it is not included in the calculation of sector product. Agricultural area parameters are based on a time-series analysis of area and price developments. Yield and factor demand elasticities are based on econometric estimations of profit function relations using farm survey data from 1986. The estimation of supply parameters is discussed more fully in Altemeier et al. (1988). Commodity-demand parameters are derived from an Almost Ideal Demand System (AIDS) model estimated from 17 years of expenditure and wholesale price data. The demand results are reported in Tabor et al. (1989). Nonfood-crop sector output is defined as total GDP less petroleum/defense sector output and agricultural sector output. A time series of (deflated) exchange rates and the consumer price indices reported by CBS were used in the estimation of nonfood-crop GDP parameters. The elasticity values used in the present model are reported in Tables 1-3.

In the parameter estimations, homogeneity in production-factor demand and aggregation, as well as homogeneity and symmetry of commodity demands, was imposed. Some of these restrictions do not hold exactly for the demand parameters in Tables 1-5 because wheat was not included in the AIDS estimation model. Demand parameters for wheat are taken from Meyers (1988) and added to the demand system without making adjustments to the other parameters. Therefore, own- and cross-price elasticities of demand in the current version of the model do not sum to zero. Because the model is based on real prices, the homogeneity condition still holds. The lack of symmetry in commodity demand should not significantly affect model simulation results or the usefulness of the model, especially if it is used properly as an analytical tool rather than as a basis for forecasting.

In the livestock component of the model, animal population data are taken from the Directorate General of Livestock (DGL) of the Ministry of Agriculture. The DGL has been conducting a census of livestock animal populations since 1970. Data describing feeding practices were derived

Table 1. Behavioral parameters assumed in model simulations: Area response elasticities

	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar
Rice	0.157	0.475	0.000	0.000	0.000	0.000	0.000	−0.162
Corn	−0.079	0.000	0.687	−0.030	−0.157	−0.050	−0.674	0.000
Cassava	−0.004	0.000	−0.042	0.093	−0.149	0.000	0.000	0.000
Soybean	−0.019	−0.006	−0.203	−0.069	1.106	−0.279	0.000	0.000
Peanut	0.000	0.000	0.000	−0.121	−0.115	0.597	0.000	0.000
Mungbean	0.000	−0.113	0.000	0.000	0.000	0.000	0.655	0.000
Sugar	−0.155	−0.259	−0.160	0.000	−0.059	0.000	−0.098	0.200
Lagged area	0.000	0.000	0.680	0.870	0.290	0.770	0.750	0.500

Table 2. Behavioral parameters assumed in model simulations: Factor demand elasticities

	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar
Per ha. yield wrt								
Commodity price	0.30	0.29	0.60	0.27	0.19	0.09	0.19	0.30
Fertilizer price	-0.03	-0.01	-0.07	-0.05	-0.04	-0.01	-0.01	0.00
Wage rate	-0.27	-0.21	-0.53	-0.22	-0.15	-0.08	-0.18	0.00
Fertilizer demand wrt								
Commodity price	0.63[a]		C.96	1.28	1.09	0.26	0.52	
Fertilizer price	-0.47[a]		-0.17	-0.66	-0.84	-0.74	-0.40	
Wage rate	-0.16[a]		-0.78	-0.62	-0.25	0.48	-0.12	
Labor demand wrt								
Commodity price	1.58[a]		2.46	1.59	0.88	0.52	1.67	
Fertilizer price	0.00[a]		-0.26	0.06	-0.05	0.07	-0.05	
Wage rate	-1.57[a]		-2.20	-1.65	-0.83	-0.59	-1.61	

[a]All rice.

Table 3. Behavioral parameters assumed in model simulations: Demand parameters

	Rice	Corn	Cassava	Soybeans	Peanuts	M'beans	Sugar	Wheat
Rice	-0.1591	0.3865	0.4288	0.2139	0.4125	0.4055	0.1571	0.2000
Corn	0.0451	-0.2608	0.0556	0.0274	-0.1189	-0.1695	-0.0806	0.0500
Cassava	0.0356	0.0395	-0.3904	-0.0289	-0.1024	0.0904	-0.0005	0.0200
Soybean	0.0230	0.0253	-0.0374	-0.7786	0.4828	-0.1391	0.2256	0.0200
Peanut	0.0247	-0.0610	-0.0740	0.2690	-0.7379	0.4026	-0.0196	0.0000
Mungbean	0.0069	-0.0245	0.0184	-0.0219	0.1136	-0.6799	0.0100	0.0000
Sugar	0.0239	-0.1049	-0.0010	0.3190	0.0497	0.0899	-0.2919	0.0200
Wheat	0.0300	0.0000	0.0200	0.0200	0.0000	0.0000	0.0200	-0.3800
Expenditure	0.2940	0.3880	0.2610	0.4580	0.6420	0.6140	0.5190	0.4750

from field surveys undertaken by Center for Agro-Economic Research and CARD research staff and from secondary data sources. The derivation of animal requirement and feed ration composition figures is described in detail in Rachmat, Waluyo, and Sudaryanto (1990).

Policy Applications

Baseline Simulation

As discussed previously, Indonesia has embarked on a program of economic liberalization. For a model like the one described above to be useful for analyzing economic policy reform during the Repelita V period, it is necessary to simulate a baseline or benchmark from which the potential impacts of policy changes can be judged. For a price-exogenous model, this involves making assumptions about future domestic commodity prices. Given the nature of the issues likely to confront Indonesia's policymakers during the Fifth Plan, an appropriate baseline would be one reflecting the consequences of a continuation of past agricultural policies and programs--that is, a high level of input subsidies and insulation of domestic markets from international markets--in the pursuit of self-sufficiency and public investment in the food-crop sector.

The recently released Fifth Plan calls for food self-sufficiency from 1989 to 1993. The price-endogenous model built by Altemeier et al. was used to simulate the domestic food-crop prices resulting from pursuit of the stated goal of overall self-sufficiency during Repelita V. The food self-sufficiency objective was represented in the model as a series of "feasible" target self-sufficiency ratios (domestic production over total demand) for individual food crops if stated policy goals are actively pursued. The trade ratios actually used represent a more modest set of goals than those found in the plan itself. Setting trade ratios exogenously and simulating for prices allows movements of domestic prices different from world prices, thus providing a degree of protection for Indonesia's farmers in the future, as in the past. Exogenous growth rates in crop areas and yields were also set relative to the likely impact of historical trends and planned levels of public investment and extension activities to be carried out over the period. The exogenous area and yield growth assumptions used in this price simulation exercise are found in Table 4.

The resulting annual changes in real commodity prices for the Repelita V period are reported in Table 5. The price results indicate that steady increases in real food-crop prices are necessary to achieve a somewhat more modest set of self-sufficiency targets than those implied in the Fifth Plan, despite the substantial increase in prices that occurred during the 1986-88 period. In particular, rice prices must continue to rise if the tenuous self-sufficiency in Indonesia's basic staple food is to be maintained. Assuming a constant real exchange rate, comparison of the domestic price projections with results from price projections found in the most recent CARD/FAPRI world agricultural outlook publications indicates that Indonesia's domestic prices could be increasing in the face of falling real agricultural commodity prices in world markets. If so, Indonesia would have to continue insulating its domestic markets from international markets during the Repelita V period to achieve targeted production levels.

Table 4. Exogenous growth parameters

	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar
Area (%/yr)	0.75	0.50	0.00	-0.50	2.50	0.50	0.50	1.00
Yield (%/yr)	1.00	0.75	1.25	1.75	0.70	0.50	0.50	1.00

Table 5. Simulated real price growth (%/year)

	1989	1990	1991	1992	1993
Rice	2.5	2.1	2.0	2.0	1.9
Corn	1.4	1.5	1.4	1.4	1.4
Cassava	0.9	1.3	1.7	2.2	2.6
Soybeans	0.3	0.4	0.3	0.3	0.4
Peanuts	1.5	1.4	1.4	1.3	1.3
Mungbeans	0.1	0.1	0.2	0.2	0.0
Sugar	0.0	0.5	0.5	0.5	0.5
Wheat	1.0	-1.0	-1.0	-1.0	-1.0

The next step in the analysis is to insert the price projections from the Altemeier model into the price-exogenous model described above to simulate a baseline for the Repelita V period. In theory, this could result in the same production and consumption levels as those of the price-endogenous model. The price-endogenous model, however, employs a somewhat different parameter base, does not include wheat, and specifies cultivated area as a function of current real prices only. The exogenous growth rates in cultivated area and yield that are used in the baseline simulation are those used in the price simulation summarized in Table 4. Population is projected to grow by 2.1 percent per annum during the period. Real rural wages, fertilizer prices, and real exchange rates are assumed to remain unchanged after 1989. Finally, the petroleum and defense sector and the exogenous component of the industrial and services sector GDP equation are assumed to grow at 5 percent per annum.

The results of the baseline simulation, along with base-year data (1988), are summarized in Table 6. With real prices of all food commodities rising and with some help from slightly declining real wheat prices, production growth in the sector is fairly high, and Repelita V trade targets are attained or exceeded. For example, Indonesia becomes a net exporter of corn and is essentially self-sufficient in peanuts and mungbeans by the end of the plan period; the high level of cassava exportation is maintained to meet Indonesia's EC quota; rice production stays in balance with rice consumption; and imports are unnecessary. The sugar balance deteriorates as specified, with production levels falling to about 75 percent of domestic consumption.

Table 6. Repelita V baseline simulation, 1989-1993

		Rice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar	Total
Real wholesale	1988	404	186	107	664	1,429	970	621	
price		203	159	63	630	619	735		
Real farmgate	1989	414	189	108	666	1,450	971	621	
price		208	161	64	632	573	736		
(1986 Rp/kg)	1993	448	200	117	675	1,530	976	634	
		225	171	69	641	663	740		
Growth rate 1988-93 (%/year)		2.10	1.42	1.74	0.34	1.38	0.12	0.40	
Cultivated area	1988	10,090	3,203	1,268	1,143	582	316	328	16,930
(1000 ha)	1989	10,443	3,277	1,292	1,174	604	342	320	17,451
	1993	10,852	3,608	1,291	1,324	715	388	309	18,487
		1.47	2.41	0.36	2.98	4.19	4.13	-1.15	1.78
Yields (MT/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	3.03	2.26	13.31	1.14	1.01	0.79	6.09	
		1.50	1.94	2.10	0.67	0.60	0.49	1.00	
Net exports	1988	-35	-33	2,475	-373	-28	0	-256	
(1000 MT)	1989	-275	-66	2,539	-381	-25	7	-164	
	1993	0	24	2,518	-532	5	-6	-475	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (Billions 1986 Rp.)	19,682	20,966	25,281	5.13
Farm income (Billions 1986 Rp.)	8,468	8,941	11,124	5.61
Other sector GDP (Billions 1986 Rp.)	64,845	66,852	78,609	3.92
Overall GDP (Billions 1986 Rp.)	105,561	109,903	130,736	4.37

What is disconcerting in the model results is that real price increases in food commodities constrain growth in overall GDP. The GOI's targeted GDP growth rate of 5 percent per annum is not attained on average over the period. Furthermore, the targeted growth rate of 10 percent per annum for the industrial and services sector is far from being reached. As long as Indonesia continues to pursue a high-price agriculture, high growth rates in other sectors of the economy may be difficult to achieve. This result points to a possible inconsistency between agricultural production targets and the government's goal of attaining employment growth through industrial growth.

Alternative Food-Crop Price Scenario Simulations

The baseline simulation described above suggests that high agricultural commodity prices are necessary to achieve a set of agricultural production targets even more modest than those implied by Repelita V. Results from the macro component of the model further suggest that high agricultural prices make attainment of policy goals in other sectors of the economy difficult. Therefore, a logical application of the model is a simulation of the implications of different agricultural commodity prices during the Fifth Plan period. Two scenarios are implemented. The first is a policy of no real-price increases for food crops after 1989. The second consists of dropping all barriers to food-crop trade after 1989, thus allowing world prices to determine domestic prices. World agricultural commodity market price projections from the CARD/FAPRI models, FAO, and the World Bank are used in the second simulation. The results from the first and second simulations are summarized in Tables 7 and 8, respectively.

The constant real-price simulation indicates a deterioration in the agricultural trade position. Imports of rice, corn, soybeans, peanuts, and sugar increase significantly over the plan period. Because of exogenous yield and area increases, food-crop sector GDP and farm income grow at over 3 percent per year during Repelita V. The performance of the nonagricultural sectors improves over the baseline scenario although overall GDP growth remains about the same because higher industrial growth is offset by lower food-crop sector growth.

The world price scenario results are quite interesting. Production of highly protected crops such as soybeans, peanuts, and sugarcane falls dramatically. On the other hand, performance of cassava, a crop whose price had been below prevailing world levels, is strong. Although real output-price growth is lower than that indicated in the baseline scenario, rice also does very well as a result of favorable relative price movements. Rice production benefits at the expense of sugar and soybeans; and, in fact, Indonesia is exporting sizable quantities of rice by the end of Repelita V. Corn and cassava also benefit from the cross-effects of lower sugar and soybean prices, as well as from lower peanut and mungbean prices.

Under the world price scenario, the performance of the industrial and services sector is robust, and overall GDP grows slightly more than 5 percent per annum. The agricultural price index falls substantially, unleashing the productive capacity of industry. A major drawback of a

Table 7. Constant real price simulation, 1989-1993

		Rice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar	Total
Real wholesale	1988	404	186	107	664	1,429	970	621	
price		203	159	63	630	619	735		
Real farmgate	1989	414	189	108	666	1,450	971	621	
price		208	161	64	632	573	736		
(1986 Rp/kg)	1993	414	189	108	666	1,450	971	621	
		208	161	64	632	628	736		
Growth rate 1988-93 (%/year)		0.50	0.24	0.18	0.06	0.30	0.02	0.00	
Cultivated area	1988	10,090	3,203	1,268	1,143	582	316	328	16,930
(1000 ha)	1989	10,443	3,277	1,292	1,174	604	342	320	17,452
	1993	10,789	3,466	1,297	1,345	679	418	313	18,307
		1.35	1.59	0.46	3.31	3.13	5.72	-0.96	1.58
Yields (MT/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	2.96	2.19	13.04	1.14	1.01	0.79	6.09	
		1.05	1.23	1.67	0.61	0.50	0.47	1.00	
Net exports	1988	-35	-33	2,475	-373	-28	0	-256	
(1000 MT)	1989	-275	-76	2,540	-381	-25	8	-164	
	1993	-1,122	-411	2,311	-486	-42	28	-453	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (Billions 1986 Rp.)	19,682	20,962	22,853	3.03
Farm income (Billions 1986 Rp.)	8,468	8,938	9,948	3.27
Other sector GDP (Billions 1986 Rp.)	64,845	66,855	81,649	4.72
Overall GDP (Billions 1986 Rp.)	105,561	109,903	131,348	4.47

Table 8. World price simulation, 1989-1993

		Rice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar	Total
Real wholesale		404	186	107	664	1,429	970	621	
price		203	159	63	630	619	735		
Real farmgate	1989	414	189	108	666	1,450	971	621	
price		208	161	64	632	573	736		
(1986 Rp/kg)	1993	426	179	124	370	581	508	484	
		213	153	73	351	252	385		
Growth rate 1988-93 (%/year)		1.05	-0.79	2.97	-11.05	-16.47	-12.15	-4.87	
Cultivated area	1988	10,090	3,203	1,268	1,143	582	316	328	16,930
(1000 ha)	1989	10,443	3,277	1,292	1,174	604	342	320	17,451
	1993	11,504	4,633	2,043	619	233	159	284	19,476
		2.66	7.66	10.02	-11.55	-16.70	-12.89	-2.81	2.84
Yields (MT/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	2.98	2.12	13.53	1.02	0.93	0.70	6.09	
		1.12	0.61	2.43	-1.61	-1.14	-1.93	1.00	
Net exports	1988	-35	-33	2,475	-373	-28	0	-256	
(1000 MT)	1989	-275	-66	2,539	-381	-25	7	-164	
	1993	2,279	756	10,275	-1,484	-721	-223	-567	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (Billions 1986 Rp.)	19,682	20,966	24,478	4.46
Farm income (Billions 1986 Rp.)	8,468	8,941	10,411	4.22
Other sector GDP (Billions 1986 Rp.)	64,845	66,852	83,616	5.22
Overall GDP (Billions 1986 Rp.)	105,561	109,903	134,939	5.03

world price policy like the one simulated is the short-lived decline in farm income occurring in the first year of implementation. Although income does recover by 1993, a short-run decrease would make the world price scenario somewhat difficult to implement in practice because farm groups might perceive that the government had stopped supporting rice production. But various measures such as allowing rice prices to remain above world prices for one or two years would cushion this short-run impact considerably. What is crucial to note, however, is the importance of the intercommodity effects of price-policy changes and the implication that a liberalization of agricultural trade must be sectorwide rather than crop-specific to achieve desired outcomes, such as trend self-sufficiency in rice and increased corn production. From a methodological standpoint, this result demonstrates the necessity of using multimarket analytical tools such as the National Food-Crop Policy Model when examining food-price policy.

Food-Crop Diversification Scenario

The diversification of food-crop production is an often-discussed objective of Indonesian food policy. Diversification is viewed as a key to raising the incomes of Indonesia's myriad small farmers, particularly in upland areas, and to unleashing the country's latent potential in agribusiness. Food-policy analysis, however, suggests that the diversification objective must be pursued cautiously, that careful attention must be paid to underlying comparative advantages, and that judicious use must be made of available policy instruments if Indonesia is to benefit fully from diversification of food-crop production.

The national model can be used to illustrate the potential pitfalls of using certain policy instruments to pursue food-crop diversification. A scenario consisting of raising corn and soybean prices relative to rice prices and enforcing area targets for corn and soybeans is simulated over the Repelita V period (1989-1993). Specifically, real corn and soybean prices are assumed to increase by 2 percent per annum, and real rice and other crop prices are assumed to remain constant during the simulation period. Area targets are implemented by increasing, relative to baseline assumptions, the exogenous growth in cropped areas by 0.5 percent and 0.25 percent per annum for corn and soybeans (trend area growth for soybeans is already quite high in the baseline), respectively. Exogenous rice area growth is reduced to accommodate implementation of the corn and soybean targets. All other price and area assumptions are the same as in the baseline simulation.

The consequences of the diversification scenario described above are predictable and are summarized in Table 9. Annual corn and soybean production growths average about 6 percent through Repelita V. The trade balances improve dramatically as well--corn exports reach 750 thousand tons in 1993, and annual soybean imports fall by over 100 thousand tons, despite strong demand growth. The cost of this strong corn and soybean growth, however, is the loss of rice self-sufficiency. Indonesia imports about 2.5 million tons of rice in 1993, and production growth falls off to less than 2 percent per annum. This result indicates that there is a tradeoff between rice self-sufficiency and diversification if the latter food-policy objective is pursued through a strategy of differential output pricing and area targets.

Table 9. Diversification simulation, 1989-1993

		Rice	Corn	Cassava	Soybeans	Peanuts	Mungbeans	Sugar	Total
Real wholesale	1988	404	186	107	664	1,429	970	621	
price		203	159	63	630	619	735		
Real farmgate	1989	404	190	108	677	1,450	971	621	
price		203	162	64	642	573	736		
(1986 Rp/kg)	1993	404	206	117	733	1,530	976	634	
		203	176	69	695	663	740		
Growth rate 1988-93 (%/year)		0.00	2.00	1.74	2.00	1.38	0.12	0.40	
Cultivated area	1988	10,090	3,203	1,268	1,143	582	316	328	16,930
(1000 ha)	1989	10,420	3,293	1,292	1,197	601	340	320	17,464
	1993	10,528	3,806	1,276	1,504	677	372	316	18,479
		0.85	3.51	0.13	5.64	3.06	3.28	-0.73	1.77
Yields (MT/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.83	2.09	12.16	1.11	0.99	0.77	5.85	
	1993	2.94	2.30	13.31	1.16	1.01	0.79	6.09	
		0.88	2.29	2.10	0.98	0.60	0.49	1.00	
Net exports	1988	-35	-33	2,475	-373	-28	0	-256	
(1000 MT)	1989	-275	30	2,642	-336	-27	9	-164	
	1993	-2,478	746	2,836	-230	-28	-2	-442	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (Billions 1986 Rp.)	19,682	20,515	22,951	3.12
Farm income (Billions 1986 Rp.)	8,468	8,741	10,172	3.74
Other sector GDP (Billions 1986 Rp.)	64,845	67,404	81,731	4.74
Overall GDP (Billions 1986 Rp.)	105,561	110,005	131,527	4.50

The simulation results suggest that the objective of food-crop diversification is best pursued with policy instruments not biased against rice production. Such a strategy would include dissemination of productivity-enhancing technologies (e.g., higher-yielding soybean seed), public investment in infrastructure enhancing cropping intensities (e.g., water pumps to allow additional cultivation of corn in the late dry season), and price changes resulting from shifts in underlying demand (e.g., the derived demand for corn as an animal feed resulting from increased production of chicken meat and eggs). In summary, diversification of Indonesia's food-crop sector would be a logical and natural outgrowth of continued funding of agricultural research, investment in rural infrastructure, economic liberalization allowing unfettered development of private agribusiness (e.g., a repeal of KEPPRES 50, the presidential decree limiting the size of poultry operations), and growth in per capita income.

Livestock-Projection Model Results

Indonesia's livestock sector is poised to grow rapidly during Repelita V. Overall economic growth is now projected to exceed 5 percent per annum through the mid 1990s (ADB, 1990), which should have the effect of raising domestic demand for livestock products, particularly for chicken meat and eggs. In addition, with the deregulation of trade in livestock products, domestic production may surge if export markets are developed. In turn, rapid growth of the livestock sector may have important implications for the food-crop sector, through the feed linkage. Most food crops consumed in Indonesia are utilized in some form by

Indonesia's livestock sector although often as by-products (e.g., rice bran and wheat pollards) and are therefore not in direct competition with food crops for human consumption. But corn and soybeans used by the livestock sector compete directly with human food supplies.

For the baseline projection exercise, animal-population growth estimates from the Directorate General of Livestock are used. Historical populations of the major feed-using livestock groups for 1986-88 and projections for 1989-93 are found in Table 10. The feed requirements per animal and the composition of feed rations, in addition to other assumptions, are shown in Table 11.

The resulting projections of aggregate feed use for several major feedstuffs are found in Table 12. The baseline figures shown in Table 12 suggest rapid growth in the use of corn and soybeans (utilized as soymeal in feed concentrate), with growth rates of over 8 percent per annum in the use of each commodity as animal feed. During Repelita V, according to the projections shown in the table, feed use of corn and soybeans would amount to roughly 15 and 40 percent of domestic production, respectively. The growth in feed use of corn and soybeans is projected to outpace the growth in production of the two commodities during Repelita V (projected to be about 3.4 percent per year for corn and 3.3 percent per year for soybeans--see Table 6). This result suggests increased import levels of soybeans and a decreased exportable surplus of corn.

Tables 13 and 14 indicate the underlying structure of feed demand in Indonesia and reveal that the commercial poultry industry is the primary user of corn and soybeans as feedstuffs. Roughly 60 percent of corn feed demand and 80 percent of soymeal demand comes from the commercial poultry

Table 10. Livestock population projections (1000 animals)

	1986	1987	1988	1989	1990	1991	1992	1993
Dairy cattle								
Calves	31	32	36	40	45	49	55	60
Young cows	48	50	56	62	68	76	84	93
Adults	143	150	168	186	205	227	252	278
Total	222	232	260	288	318	352	390	432
Hogs (modern)								
Piglets	112	114	116	120	123	126	130	134
Young hogs	174	177	181	186	191	197	202	208
Hogs	336	342	349	359	369	379	390	401
Total	622	634	646	664	683	702	722	742
Hogs (smallholder)								
Confined	3,636	3,708	3,781	3,887	3,996	4,108	4,223	4,341
Extensive	1,399	1,426	1,454	1,495	1,537	1,580	1,624	1,670
Total	5,594	5,705	5,818	5,980	6,148	6,320	6,497	6,679
Poultry								
Commercial layers								
Growers	19,345	16,484	21,231	21,231	21,231	21,231	21,231	21,231
Layers	19,345	16,484	21,231	21,231	21,231	21,231	21,231	21,231
Eggs (tons)	250,700	259,000	275,200	294,189	314,488	336,187	359,384	384,182
Total	38,689	32,968	42,461	42,461	42,461	42,461	42,461	42,461
Broilers	173,795	218,183	235,661	258,756	284,114	311,957	342,529	376,097
Village								
Intensive	16,299	16,841	17,400	18,235	19,110	20,028	20,989	21,996
Extensive	146,692	151,565	156,599	164,116	171,993	180,249	188,901	197,968
Total	162,991	168,405	173,999	182,351	191,104	200,277	209,890	219,965
Ducks								
Growers	13,501	13,013	12,589	13,079	13,590	14,120	14,670	15,242
Layers	13,501	13,013	12,589	13,079	13,590	14,120	14,670	15,242
Eggs (tons)	117,000	121,800	117,900	121,673	125,566	129,584	133,731	138,011
Total	27,002	26,025	25,177	26,159	27,179	28,239	29,340	30,485

Table 11. Livestock feed demand projection assumptions

	Pop. Comp. (%)	Feed Req. (kg/anml /yr)	Pop. Growth (%/yr)	Feed Composition (%)						
				Corn	Rice Bran	Rice	Soymeal	Gaplek	Wheat Pollards	Other
Dairy cattle			10.67							
Calves	14	402			0.6		0.6		0.05	0.29
Young cows	21.5	913			0.63				0.05	0.32
Adults	64.5	2,519		0.08	0.6				0.05	0.27
Hogs (modern)			2.8							
Piglets	18	33		0.48	0.15		0.22			0.15
Young hogs	28	219		0.47	0.37		0.03			0.13
Hogs	54	657		0.45	0.47		0.02			0.06
Hogs (smallholder)			2.8							
Confined	65	400		0.05	0.46		0.01		0.02	0.46
Extensive	25									
Poultry										
Commercial layers			9.8							
Growers	50	19		0.38	0.23		0.19			0.2
Layers	50	40		0.4	0.23		0.15			0.22
Eggs		3	6.9	0.4	0.23		0.15			0.22
Broilers	100	2.3	9.8	0.54	0.09		0.18		0.02	0.17
Village			4.8							
Intensive	10	22.5		0.24	0.53		0.1			0.13
Extensive	90	4.75		0.05	0.7	0.1				0.15
Ducks			3.9							
Ducklings	50	9		0.05	0.7	0.05		0.1		0.1
Layers	50									
Eggs		4.7	3.2	0.05	0.7	0.05		0.1		0.1

Table 12. Feed use by the livestock sector, Repelita V baseline projection (1000 tons)

	1986	1987	1988	1989	1990	1991	1992	1993	Annual Growth (%) Replta V
Corn	888	963	1,015	1,083	1,156	1,235	1,320	1,411	8.6
Rice bran	2,315	2,395	2,468	2,588	2,715	2,850	2,993	3,146	6.3
Rice	97	101	102	107	111	116	121	126	5.4
Soy meal	243	267	283	304	326	350	376	405	9.4
Gaplek	55	57	55	57	59	61	63	65	4.3
Wheat pollards	58	61	65	70	75	80	86	93	11.1
Other	1,243	1,292	1,342	1,407	1,477	1,551	1,631	1,716	6.5

Table 13. Structure of corn feed demand, Repelita V baseline projection (1000 tons)

	1986		1987		1988		1989		1990		1991		1992		1993	
	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%
Dairy cattle	29	3	30	3	34	3	37	3	41	4	46	4	51	4	56	4
Hogs (modern)	119	13	121	13	124	12	127	12	131	11	134	11	138	10	142	10
Hogs (smallholder)	73	8	74	8	76	7	78	7	80	7	82	7	84	6	87	6
Comm. poultry	517	58	582	60	623	61	674	62	730	63	791	64	857	65	928	66
Village poultry	123	14	127	13	131	13	137	13	144	12	151	12	158	12	166	12
Ducks	27	3	29	3	28	3	29	3	30	3	30	2	31	2	32	2
Total	888		963		1,015		1,083		1,156		1,235		1,320		1,411	

Note: Percentages indicate proportion of total livestock demand in given year.

Table 14. Structure of soybean meal demand, Repelita V baseline projection (1000 tons)

	1986		1987		1988		1989		1990		1991		1992		1993	
	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%	(t)	%
Dairy cattle	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
Hogs (modern)	6	3	6	2	7	2	7	2	7	2	7	2	7	2	8	2
Hogs (smallholder)	15	6	15	6	15	5	16	5	16	5	16	5	17	4	17	4
Comm. poultry	185	76	207	78	221	78	240	79	259	79	280	80	304	81	329	81
Village poultry	37	15	38	14	39	14	41	14	43	13	45	13	47	13	49	12
Ducks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	243		267		283		304		326		350		376		405	

Note: Percentages indicate proportion of total livestock demand in given year.

industry. Because commercial poultry is expected to grow most rapidly during Repelita V, the relative shares of use for corn and soymeal are projected to increase over the period. The dominance of the commercial poultry industry in the utilization of feedstuffs and the generally high level of use by the livestock sector suggests that policymakers should be attentive to developments in the poultry industry when assessing future food crop needs. Future feed demand is likely to be met increasingly by imports; thus, at least for soybeans, trade policies should be deregulated to assure timely provision of supplies to the livestock sector at competitive costs. In addition, given Indonesia's comparative advantage as a corn, poultry, and hog producer (Kasryno 1989), increased domestic corn production to meet domestic feed needs would be an economically efficient way of adding value to a primary agricultural commodity and of promoting agribusiness development.

The importance of the poultry sector in determining future feed-demand levels is shown in Tables 15 and 16, which illustrate the implications for use of corn and soymeal as animal feeds under alternative livestock development scenarios. A doubling of the growth rate (to 20 percent) of the commercial poultry industry (including both layers and broilers) and an acceleration of village layer operations (to reach 20 percent of the total village chicken population) each produce annual growth in the feed use of corn and soymeal of well over 10 percent. These scenarios, respectively, generate feed demands over several hundred thousand tons of corn and 100 thousand tons of soymeal greater than levels in the baseline scenario. Faster growth of modern hogs (to a 10 percent annual rate) or accelerated modernization of dairy herds would have a

Table 15. Corn feed use during Repelita V under alternative livestock growth scenarios (1000 tons)

	1989	1990	1991	1992	1993	Annual Growth (%) Repelita V
Baseline	1,083	1,156	1,235	1,320	1,411	8.6
20 percent commercial poultry growth	1,125	1,249	1,391	1,552	1,736	14.4
10 percent modern hog growth	1,092	1,175	1,265	1,363	1,468	9.7
Poultry and hogs	1,134	1,268	1,421	1,595	1,793	15.3
Accelerated dairy modernization	1,122	1,199	1,283	1,373	1,470	9.7
Accelerated intens. *ayam buras*	1,224	1,304	1,390	1,482	1,582	11.7

Table 16. Soymeal feed use during Repelita V under alternative livestock growth scenarios (1000 tons)

	1989	1990	1991	1992	1993	Annual Growth (%) Repelita V
Baseline	304	326	350	376	405	9.4
20 percent commercial poultry growth	319	360	407	460	521	16.5
10 percent modern hog growth	304	327	352	379	408	9.6
Poultry and hogs	319	361	408	462	524	16.7
Accelerated dairy modernization	335	361	389	419	452	12.4
Accelerated intens. *ayam buras*	365	391	418	447	479	14.1

relatively small incremental impact on demand for these crops. Although the modern hog industry's feed rations are fairly corn intensive, the animal population base is relatively small, and thus more rapid growth does not have a great impact on overall corn-feed use. Dairy operations in Indonesia use very small amounts of corn and soybeans in their feed rations and instead utilize mainly by-products and fodder. Although this behavior could change in the future as dairy production intensifies, it still will not likely result in a great increase in overall feed use.

Conclusion

The above applications of the National Food-Crop Policy Model for Indonesia illustrate the usefulness of addressing policy issues with flexible analytical tools. The model provides a broad range of relevant outputs that policymakers can use in assessing the impact of changes in economic policy on the food-crop sector. The multimarket nature of the model, in particular, allows for the incorporation into food-policy analysis of the important cross-price effects characterizing Indonesian agriculture. The impact on other sectors of the economy is also accounted for in the model through macrolinkages.

Analytical model building for food-policy analysis is a dynamic process. The national model is structured so that the underlying data base can be changed easily to reflect new information and changing economic structures. In an economy of rapid change due to economic growth and market deregulation, as is the case in Indonesia, to keep analytical tools for policy analysis current and reliable, flexibility is of utmost importance.

APPENDIX
VARIABLE DEFINITIONS FOR MODEL EQUATIONS

A	Food-crop harvested area (1000 ha)[a]
EXC	Foreign exchange rate (Rp/US$)
GDP	Gross national product (Rp. billions)[a]
GDP_1	Gross food-crop sector product (Rp. billions)[a]
GDP_2	Gross mining and defense sector product (Rp. billions)
GDP_3	Gross industrial, services, and estate sector product (Rp. billions)[a]
p	Real food-crop commodity wholesale prices (Rp/kg)
P_f	Food commodity price index
P_z	Other goods (GDP_3) commodity price index
POP	Population growth rate
q	Real food-crop production input prices (Rp/unit)
R	Variable input demands (various units)[a]
S	Food and nonfood budget shares[a]
TEXP	Total real consumption expenditures (Rp. billions)[a]
TEXPC	TEXP per capita (Rp)[a]
W	Individual food-crop commodity expenditure shares*
X_s	Food-crop supply (1000 MT)[a]
X_d	Food-crop demand (1000 MT)[a]
Y	Yield per hectare (MT/ha)[a]

[a]Endogenously determined by the model.

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