AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

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1. SUBJECT CLASSIFICATION
   A. PRIMARY: ECONOMICS
   B. SECONDARY: AGRICULTURAL MARKETING

2. TITLE AND SUBTITLE
A PROGRAMMING MODEL OF PHILIPPINE AGRICULTURE

3. AUTHOR(S)
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4. DOCUMENT DATE: MAY 1974
5. NUMBER OF PAGES: 47 PAGES
6. ARC NUMBER: ARC RP-338.1-K96

7. REFERENCE ORGANIZATION NAME AND ADDRESS
U.S. DEPT. OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
WASHINGTON, D.C. 20250

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT
The paper is a descriptive presentation of the programming model develcped for Philippine agriculture, which (model) gives a set of activities for 7 regions delineated according to agro-climatic conditions. The model analyzes the agricultural sector in sufficient detail so as to obtain feasible adjustments in production patterns, resource requirements, marketing and processing needs by region.

10. CONTROL NUMBER: PN-AAB-022
11. PRICE OF DOCUMENT

12. DESCRIPTORS
AGRO-CLIMATIC CONDITIONS, 7 REGIONS, PRODUCTION PATTERNS, RESOURCE REQUIREMENTS, MARKETING, PROCESSING

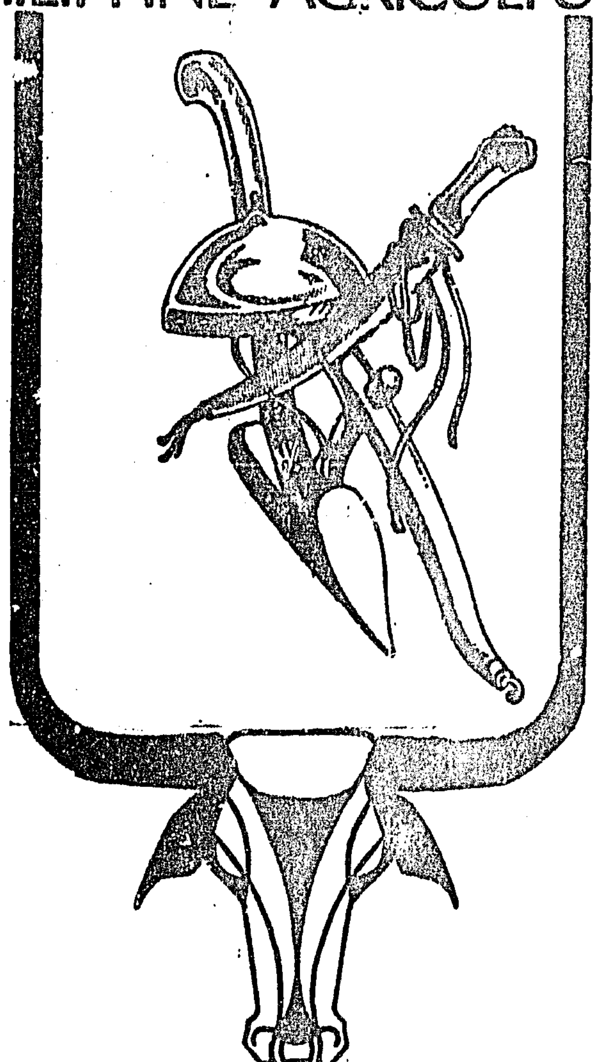
13. PROJECT NUMBER: 931-17-190-533
14. CONTRACT NUMBER: PASA RA (AJ)13-71
15. TYPE OF DOCUMENT: RESEARCH STUDY

AID 590-1 (4-74)

AGRICULTURAL
DIVERSIFICATION
AND
MARKETS IN THE PHILIPPINES

(PROJECT ADAM) NSDB-BAECON 7202Ag

A PROGRAMMING MODEL OF PHILIPPINE AGRICULTURE



DAVID E. KUNKEL

MAY 1, 1974

AN NSDB/USAID–ASSISTED JOINT RESEARCH UNDERTAKING OF THE
BUREAU OF AGRICULTURAL ECONOMICS (DANR), COLLEGE OF AGRICULTURE (UPLB),
AND THE ECONOMIC RESEARCH SERVICE (USDA)

A PROGRAMMING MODEL OF PHILIPPINE AGRICULTURE

Part I. A Programming Model for Planning in Philippine Agriculture

Part II. The Data Set and Level of Technology

Part III. Policy Issues and Economic Alternatives for Philippine Agriculture

Part I

A Programming Model for Planning in Philippine Agriculture

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DEK: 5-28-74

PART I: A PROGRAMMING MODEL FOR PLANNING IN AGRICULTURE

This statement describes the way we are undertaking an economic analysis of the central problems in agricultural development in the Philippines. Agriculture plays an important role in the economy by serving as a source of (a) basic food items; (b) industrial raw materials; (c) foreign exchange; and, (d) income and employment for rural people. Because of the complexity of the agricultural sector, it is necessary to have an analytical framework which can take account of the interaction and competitive relationships that exist.

The efficient allocation of the economy's limited resources requires an analysis of the efficiency of the various programs in attaining the several policy goals and objectives. The existing programs and those planned are considered together as a particular policy mix to determine the most efficient use of the country's limited resources. The analysis is premised on the assumption that there exists a good potential for increasing agricultural production of most of the commodities that are presently produced and of others that may be developed.

A programming framework provides the best means for obtaining an integrated picture of Philippine agriculture within which realistic production and market opportunities are identified. This framework permits the specification of alternative activities which compete for the use of resources that are limited in supply. A set of activities are then chosen which are optimum for the objectives given. By first specifying values of instrumental variables (i. e. these things that can be changed by governmental action such as price supports, fertilizer subsidies) that constitute a particular policy, various policy options can be analyzed to determine their effect on income, employment and foreign exchange earnings.

OVERVIEW OF THE MODEL

The use of a programming model is based on the assumption that production and marketing processes can be aggregated into a relatively small number of activities. This type of study is best illustrated by Day, Singh and Mudah for the Punjab in India; Bolton for Vietnam (South); and Duloy and Norton for Mexico.[1/] For those unfamiliar with programming there are a number of texts that can be consulted.[2/]

With this type of analysis, it is possible to trace out the consequences of various policies at both the farm and intermediate levels of production, and handle the following characteristics of Philippine

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[1/] These are best illustrated by the following studies: Richard H. Day and Indirjet Singh "A Micro Econometric study of Agricultural Development", Social Science Research Institute paper #7120, University of Wisconsin 1971; Muhinder S. Mudahar. Dynamic Models of Agricultural Development with Demand Linkages, Occassional Paper #59, Department of Agricultural Economics, Cornell University, 1973; William Bolton, "Application of an ERS production distribution model to the South Vietnam agriculture sector". 1971 (draft paper) and, John H. Duloy and Roger D. Norton, "CHAC A Programming Model of Mexican Agriculture; A. S. Manne eds. *Multi-level planning: Case studies in Mexico*, (Amsterdam: North Holland; 1973).

[2/] R.G. Agrawal and Earl O. Heady. *Operations Research Methods for Agricultural Decisions*, (Ams.: Iowa State U. Press, 1973)
Robert Dorfman, P.A. Samuelson and R.M. Solow. *Linear Programming and Economic Analysis* (New York: McGraw Hill, 1958).

agriculture: (1) the interdependence of farm production decisions with consumption decisions; (2) the multi-product characteristics of agriculture; (3) technological change; (4) the learning and adoption of new products and production techniques; (5) linkage between farm production and agricultural related industries; (6) the relationship to foreign exchange requirements for imports and exports; and, (7) investment requirements.

The various goals for agriculture that have been stated are self-sufficiency in rice, corn, and feedgrains, maximizing the contribution to GNP, obtaining the maximum amount of foreign exchange, and a less unequal income distribution including land reform. These goals often are in conflict and thus need to be analyzed to determine the trade-offs among them.

The potential production of all crops, livestock, and inland fisheries is related to both domestic and export markets and the optimum mix determined. The analysis takes the form of describing a recent period for which we have data, 1970-72 crop years. A projection of an equilibrium situation a few years hence will then be made with a consideration of the policies required to achieve the national goals. For practical purposes and for making the required projections of population, income and demand, 1980 has been adopted as the appropriate planning horizon.

Activities are provided for 13 of the principal crops now grown and 4 main livestock products. These are given in Table 1 as well as the policy objective for those crops and other crops. Various experimental field trials have also shown import substitution prospects for some crops not now produced which may be added to the analysis later.

Each region is represented by a set of production activities that are suited to it. These areas are linked together through marketing and processing activities on a regional or national basis. Specific demand constraints for a commodity or group of commodities are incorporated on the national level.

Because of economic and environmental requirements some crops can be grown more productively in some specific locations than in others. Thus, to the extent possible homogenous agro-economic areas based on environmental and economic factors for each region have been specified. This allows us to identify areas within which only particular types of crops and other agricultural activities can take place. On a regional basis for the whole Philippines, the overall goal is the analysis of the majority of the agricultural sector in sufficient detail to obtain feasible adjustments in production patterns; resource requirements, marketing, and processing needs at the regional level.

Commodity	Included in the model	Policy Objectives
A. Production of Staple Foods		
1. Rice	X	- Self-sufficiency in order to conserve foreign exchange.
2. Corn	X	
3. Sorghum		
4. Meat		
a. Poultry	X	
b. Swine	X	
c. Beef and carabeef	X	- To increase farm income of small producers.
5. Fish	?	
6. Fruits and vegetables		
a. Tomatoes	X	
7. Other crops		
a. Camote	X	
b. Cassava	X	
c. Mongo	X	
d. Coffee	X	
B. Industrial Raw Materials		
1. Feed grains		- To support the industrial needs of agricultural based industries (food mills, processors, manufacturers) for creating employment opportunities and at the same time conserve foreign exchange.
a. Corn	X	
b. Sorghum		
2. Cassava	X	
3. Other crops such		
a. Wheat		
b. etc.		
C. Production of Export Crop		
1. Traditional export crop		
a. Sugar	X	
b. Coconut	X	
c. Pineapple		
d. Banana	X	
e. Logs and lumber		To earn foreign exchange needed for development.
f. Abaca	X	
g. Tobacco	X	
2. Potential export crop		
a. Papaya		
b. Mango	X	
c. Melon		
d. Castor oil		
e. Palm oil		
f. Rubber		
g. Garlic and other spice		
h. Sunflower		
3. Processed export		
a. Canned		
b. Dried		- To provide employment.
c. Dehydrated		
d. etc.		

Objective Functions

Philippine agriculture is best characterized as having a perfectly competitive structure where producers are price takers and equate marginal costs to product pr

cross price elasticities,

tions can be specified.[3/]

$$p = a + \hat{B}q$$

where:

$$\text{commodity prices} = p = \begin{bmatrix} P_1 \\ \vdots \\ \vdots \\ \vdots \\ P_j \end{bmatrix} \qquad \text{Quantity} = q = \begin{bmatrix} q_1 \\ \vdots \\ \vdots \\ \vdots \\ q_j \end{bmatrix}$$

and Constants

$$\hat{B} = \begin{bmatrix} b_1 & & \\ & \ddots & \\ & & b_j \end{bmatrix} \qquad a = \begin{bmatrix} a_1 \\ \vdots \\ \vdots \\ \vdots \\ a_j \end{bmatrix} \qquad \iota = \begin{bmatrix} 1 \\ 1 \\ \vdots \\ \vdots \\ 1 \end{bmatrix}$$

For simplicity, the supply function though much more complicated and based on the production activities in the model, can be characterized as a cost function for each commodity.

[3/] The approach used here is patterned after Duloy and Norton, "CHAC a programming model of Mexican Agriculture" in I. M. Goroux and A. S. Manne eds., Multi-level planning: Case studies in Mexico (Amsterdam: North Holland, 1973).

$$C(q) = \begin{bmatrix} C_1(q_1) \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ C_j(q_j) \end{bmatrix}$$

The appropriate objective function for representing the competitive case is:[4]

$$Z = q' \left[a + 0.5 \hat{B} q \right] - \iota' \left[C'(q) \right]$$ [5]

The objective function Z can be further broken down into consumer surplus (CS) and producer (PS).

In the single product case with linear supply and demand curves, the consumer surplus (CS) is the area AEP in figure 1, or ½ the area ACEP

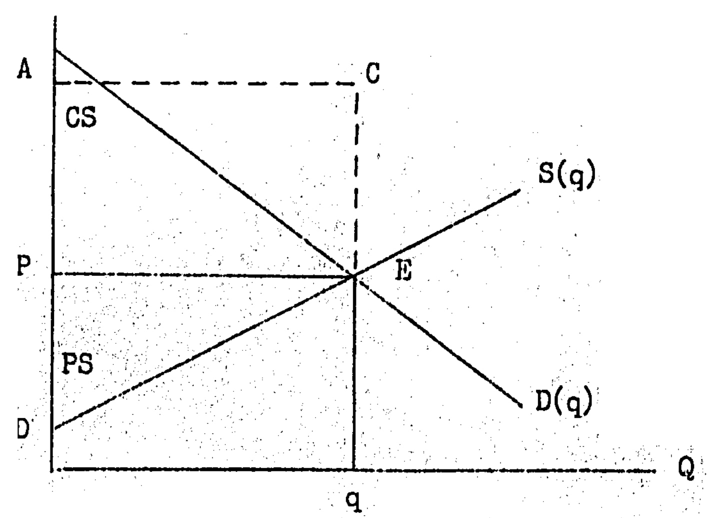

Figure 1.

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[4] See Don Yaron and E.O. Heady, "Approximate and Exact Solution to non-Linear Programming Problems with Separable Objective Function". Journal of Farm Economics, Vol. ___ No. ___ (1962), pp. 57-70 and P. A. Samuelson, "Spatial Price Equilibrium and Linear Programming" American Economic Review, Vol. 42, No. 3 (June 1952), pp. 283-303.

[5] This is equivalent to the competitive equilibrium since,
$dz/dq = a + Bq - C'(q) = 0 \quad d\left[\iota'(C'(q))\right]/dq = d\left[\underline{C}(q)\right]/dq = C'(q)$
$p = C'(q)$
or price equals marginal cost. $C'(q)$ is a $J \times 1$ vector of marginal costs.

Since cross elasticities are zero:

$$CS = \tfrac{1}{2}q' \ (a - P) = -0.5q' \ \hat{B}q$$

The producer surplus is the area FED. Equivalently, it can be expressed as:

$$PS = q'P - \iota' C(q)$$

Thus Z is the summation of the producer and consumer surplus.

$$Z = PS + CS$$

$$= -0.5q' \ \hat{B}q + q'p - \iota' C(q)$$

$$= -0.5q' \ \hat{B}q + q' \ (a + \hat{B}q) - \iota' C(q)$$

$$Z = q' \ (a + 0.5 \ \hat{B}q) - \iota' C(q)$$

In certain cases, the monopolistic case is more appropriate and it is useful to consider policies that maximize agricultural sector income. In this case, the demand curve becomes the marginal revenue curve. Thus the objective function becomes

$$Y = q' \ [a + \hat{B}q] - \iota' C(q)$$ 6/

This can either be used as the objective function for evaluation of policies, such as supply controls, on producer income or used as a constraint.

Though policies for increasing employment are most appropriately analyzed by using the above framework and analyzing the effect of different policies on both income and employment, it is also possible to maximize employment subject to some minimum income constraint.

6/ $$dy | dq = a + 2 \ \hat{B}q - C'(q) = 0$$

$$= a + 2 \ \hat{B}q = C'(q)$$

or

Marginal Revenue Product = Marginal Cost

This objective function is stated,

$$N = q'L$$

where, L is a J x 1 vector of total labor requirements.

THE ACTIVITY SET

Activities in the programming model represent the range of choices at the farm, regional, and national level. Activities representing the farm level are developed for the various enterprises to be included in the model according to land capability class and availability of irrigation water. These are distinguised where relevant by type of technology and time period. These production activities transform the production inputs into either final output or intermediate outputs which are used in other activities.

Intermediate activities are used to transform output at the farm level into final form used for consumption. These are usually specified at the regional or national level for such activities as rice and corn milling, livestock production, cane milling, etc.

Input supply activities are provided for fertilizer, chemicals, and short-term capital. Labor supply activities represent on-farm and non-farm agricultural labor supply throughout the year, by region

Sales and revenue activities are formulated to represent linear demand functions (see figure 2). The approach uses the grid methods to approximate the quadratic function $q'\hat{B}q$ and 0.5 $q'\hat{B}q$ specified earlier as part of the objective function. The demand tableau is illustrated for the demand function of a single commodity.

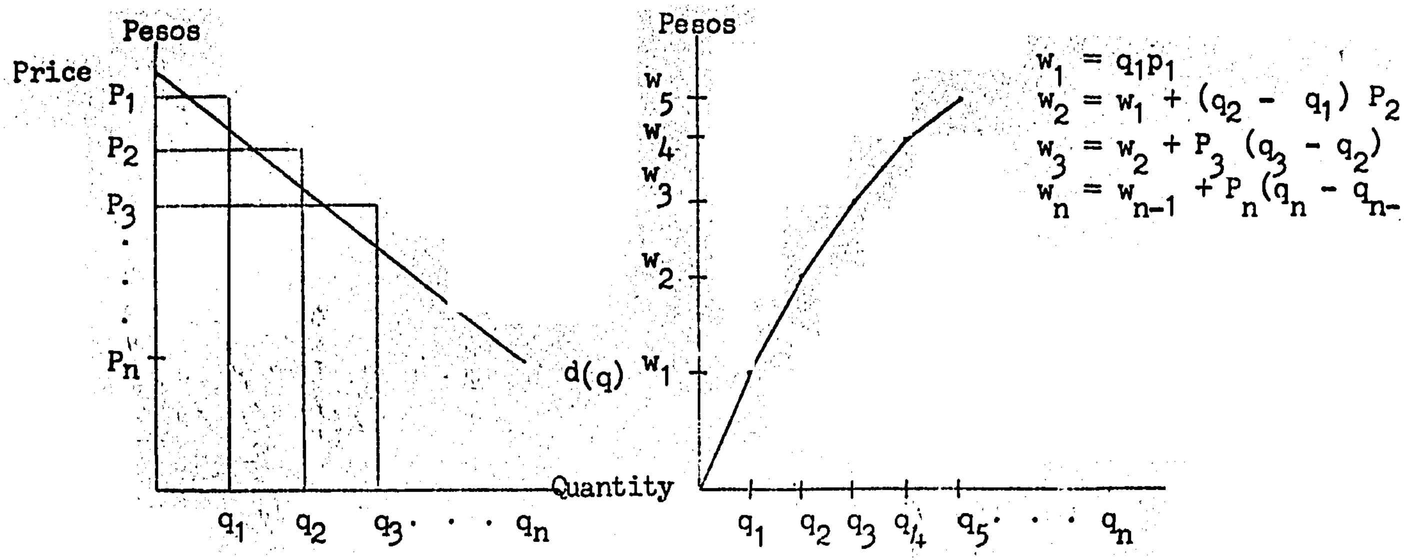


Figure 2

Single Commodity Demand Tableau							
Rows/Activities	1	2	3 ...	n	output		
Objective function	w_1	w_2	$w_3 \cdots$	w_n		$>$	0
Commodity balance	q_1	q_2	$q_3 \cdots$	q_n	$-Q$	$\leq$	0
Convex combination	1	1	1 ...	1		$\leq$	1

Because $q'\hat{B}q$ is a convex function, the solution will never use more than two of the activities in the demand set of a particular commodity and with the use of separable programming this can be limited to only one.

Since it is difficult to handle cross price elasticities without substantial nonlinearization, those commodities which are close substitutes, such as rice and corn, are grouped together. Substitution is allowed within limits at fixed ratios maintaining the convexity of the objective function.

THE CONSTRAINT SET

The resources available limit what can be produced in the agricultural sector and can be broken down into land, labor, capital, and demand.

LAND - Land is broken down when necessary by type of land and time of use (bi-monthly)

$$\sum_{j \in p} a_j^{r,c,t} X_j \leq L_j^{r,c,t} \qquad \begin{array}{l} r = 1,\ldots 6 \\ c = 1,\ldots 6 \\ t = 1,\ldots 6 \end{array}$$

The amount of land available in the r^{th} region, c^{th} land class, and in time t is less than or equal to the amount used in all production activities.

LABOR - the amount of labor available for use in crop production may be constraining during peak periods of use.

$$\sum_{j \in p} l_j^{r,t} X_j - lf^{r,t} \leq 0 \qquad \begin{array}{l} r = 1,\ldots 6 \\ t = 1,\ldots 6 \end{array}$$

The amount of labor used in the r^{th} region and the t^{th} time period is less than or equal to amount supplied from family and hired resources.

CAPITAL INPUTS - this category covers such items needed in the production process as fertilizer, chemicals, and machinery service as well as other cash inputs.

$$\sum_{j \in p} c_j^{r,m,t} X_j - S^{r,m,t} \leq 0$$

The use of machinery service in the r^{th} region is less than or equal to the supply.

$$\sum_{j\epsilon p} C_j^{r,f} X_j - \sum_{j\epsilon F} S_j^{r,f} X_j \leq 0 \qquad f = 1,\ldots 3$$

The use of fertilizer nutrients is less than or equal to the supply of fertilizer nutrients from all types of fertilizers in each region.

$$\sum_{j\epsilon p} C_j^c X_j - S^c \leq 0$$

The quantity of chemicals used is less than or equal to their supply in monetary terms.

$$\sum_{j\epsilon p} C_j^r X_j + \sum_{j\epsilon c} S_j + \sum_{j\epsilon H} IH_j^r \leq C$$

The amount of operating capital needed by each production activity plus the amount used for cash inputs plus the amount paid to hired labor must be less than or equal to the amount of short-term capital available.

CAPACITY CONSTRAINT

These serve much the same function as the land constraints at the primary production level.

$$\sum_{j\epsilon M} M_j^{rp} X_j \leq \bar{M}^{rp}$$

The amount of rice, corn, sugar cane, and coconuts milled is less than or equal to the amount of milling capacity in the region.

ANIMAL POWER

$$\sum_{j\epsilon p} N_j^{rt} X_j \leq \bar{N}^{rt}$$

The amount of animal power used by the production activities is less than or equal to the supply.

COMMODITY BALANCE CONSTRAINTS

Palay - rough rice

$$\sum_{j\in r} q_j^{rp} X_j + \sum_{j\in M} M_j^{rp} X_j = 0$$

The amount produced in region r is equal to the amount milled rice.

Milled rice

$$\sum_{j\in M} q_j^{rm} X_j + q^{rps} = 0$$

The amount of milled rice produced is equal to the amount sold.

Regional rice balance

$$-\sum_{r=1}^{6} q_r^{PS} \quad q_s^{*p} - q^X + q^I = 0$$

The amount produced equals the amount sold minus exports plus imports where q_s^* represents the separable demand function and requires an additional constraint.

Corn

$$-\sum_{j\in p} q_j^{rc} X_j + \sum_{j\in m} M_j^{rc} X_j + q^{rc} = 0$$

The amount of corn produced equals the amount milled sold plus the amount for other uses.

$$-\sum_{r=1}^{6} q_r^{cs} + q_s^{*c} = 0$$

The amount of milled corn produced equals the amount consumed where q_s^{*c} represents the separable demand function.

$$-\sum_{r=1}^{6} q_r^c + \sum_{j\in F} f_j^c X_j + q^{cx} - q^{cI} = 0$$

The amount of corn used for other purposes equals the amount fed to livestock plus the amount exported minus imports.

By products of rice, corn, sugar cane and coconuts

$$-\sum_{j\in B} m_j^B X_j + \sum_{j\in F} f_j^B X_j + f^{BI} - f^{BX} \leq 0 \qquad B = 1,\ldots 9$$

The amount of by-products used for feed or exported are less than or equal to the amount produced plus imports.

Sugar

$$-\sum_{j\in p} q_j^{rs} X_j + \sum_{j\in m} m_j^{rs} X_j = 0$$

The amount of sugarcane milled equals the amount produced.

$$-\sum^{6} q_r^{sg} + q^{*sg} + q^{*sgX} = 0$$

The amount of sugar produced is equal to the amount consumed plus exports where q^{*sg} is the separable demand function for sugar.

Livestock (Pork, beef, poultry, eggs)

$$-\sum_{j\in l} q_j^l X_j + q^{*l} - q^{lI} + q^{lx} = 0 \qquad l = 1,\ldots 4$$

The amount of livestock products produced is equal to consumption plus imports minus exports. q^{*l} represents the separable demand function for livestock.

Products Consumed Directly without Processing

$$\sum_{j\in p} q_j^d X_j + q^{*d} - q^{dI} + q^{dX} = 0 \qquad d = 1,\ldots 11$$

FARM INCOME

Using the matrix notation for demand that was developed earlier, farm income is given by:

$$q'p - \sum_{j\in p} C_j^p X_j^p - \sum_{j\in m} C_j^m X_j^m - \sum_{j\in l} C^l X_j - \sum_{j\in s} C^s X_j - \sum_{r=1}^{6} \Delta P_r Q_r \leq Y$$

$$\left[\text{Total Revenue}\right] - \left[\begin{array}{c}\text{miscellaneous cash}\\ \text{production costs}\end{array}\right] - \left[\text{milling cost}\right] - \left[\begin{array}{c}\text{livestock}\\ \text{production costs}\end{array}\right] - \left[\begin{array}{c}\text{Input cost}\\ \text{including labor}\end{array}\right] - \left[\text{Regional price differentials}\right] \leq \left[\begin{array}{c}\text{Farm}\\ \text{Income}\end{array}\right]$$

This equation may also be used as an objective function to maximize income to agriculture.

FARM PROFITS

Farm profits are obtained by adding back in the charge for family labor to farm income.

$$Y + \sum_{j \in Lf} C^{Lf} X_j \geq P$$

LABOR

$$\sum_{\substack{j \in P \\ j \in m}} l_j^T X_j \geq L$$

The total labor used by both primary production and intermediate production activities is greater than or equal to some specified level. This can also be used as an objective function subject to an income constraint.

OBJECTIVE FUNCTION

$$q'(a + .5 \hat{B}q) - \sum_{j \in p} C_j^p X_j^p - \sum_{j \in m} C_j^m X_j - \sum_{j \in l} C_j^l X_j - \sum_{j \in s} C^s X_j - \sum_{r=1}^{6} \Delta P_r Q_r$$

This function represents the sum of consumer and producer surplus and is the same as the farm income function except for the demand term.

Part II

The Data Set and Level of Technology

Contents

Revised
DEK/LJA : 5-27-74

Part II: THE DATA SET AND LEVEL OF TECHNOLOGY

I. INTRODUCTION

Our approach has been to concentrate on a data base that will make it possible to analyze problems that are capable of being solved in the Philippines with the facilities and personnel available. The analytical framework provides a means by which the need for additional data is identified. In addition, as new and improved data become available, they can be incorporated in the model to provide empirically based up-to-date policy guidance.

II. DEFINITION OF REGIONS

An important consideration in the definition of regions is the existing climatic patterns in the Philippines. The most recent climatic classification has seven types[1/] which are described briefly below and illustrated in Figure 1.

Type A - Long dry season during the low sun period of 5-6 months and a very pronounced wet season. Maximum rainfall occurs in the high sun months with 6-7 months of over 2.4" rain per month. High seasonal temperature extremes are common. Crops are grown mostly in the wet season with irrigation required for dry season production.

1/ Huke, Shadows on the Land, 1972 in Philippine Almanac.

Type B - This climatic type in the same as type A except the dry season is reduced from 5-6 months to 4 months with less than 2.4" rainfall per month. This moderation is mostly due to higher elevation.

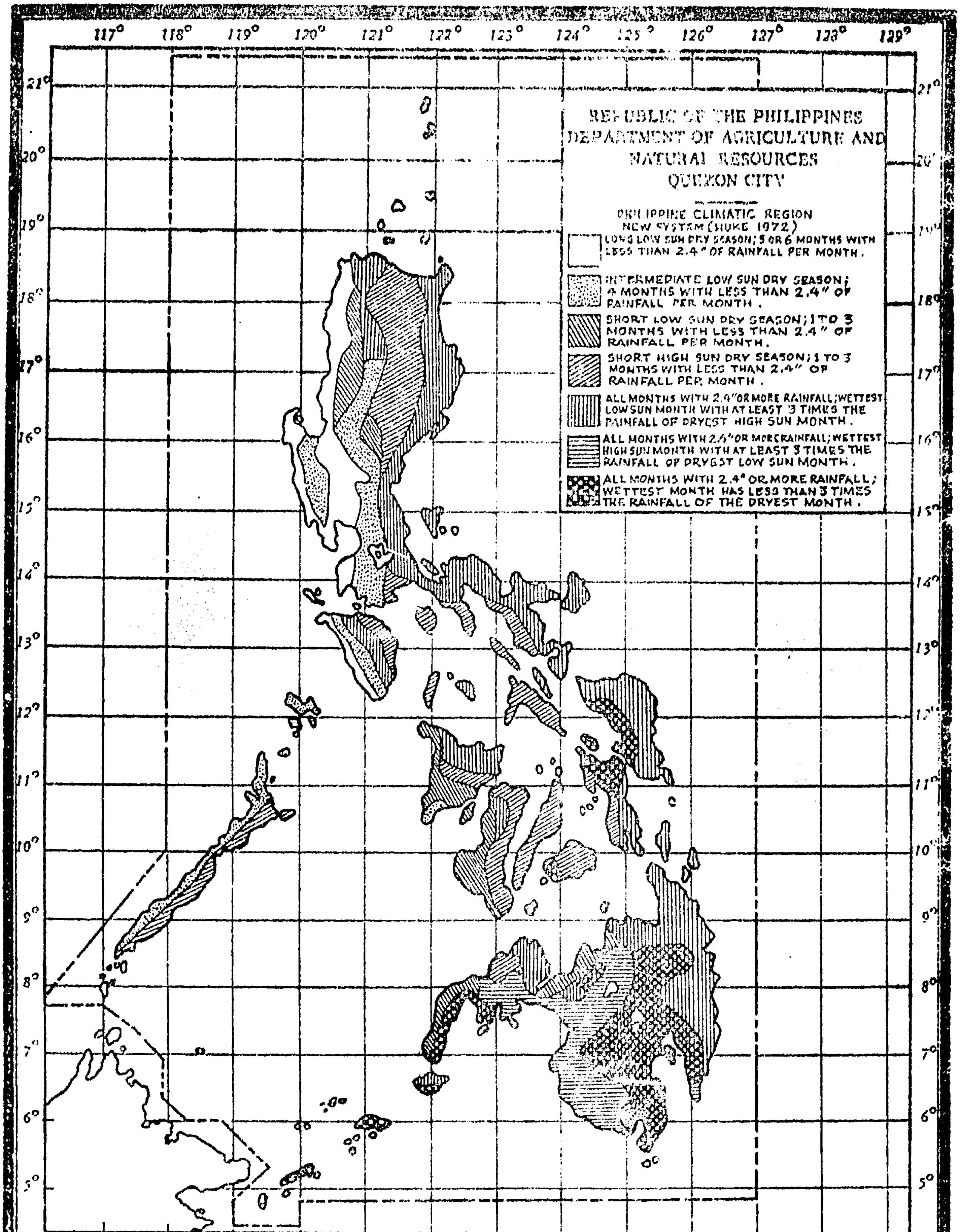
Type C - This climatic type has a short dry season of 2 to 3 months with less than 2.4" rainfall per months. Though most crop production occurs during the wet season it is possible to obtain a second crop without irrigation. Irrigation is still very beneficial in reducing variability and increasing yields.

Type D - This is the same as Type C except the dry season of 1-3 months duration occurs during the higher sun months.

Type E - All months with more than 2.4" rainfall per month. Maximum rainfall occurs after the autummal equinox during the low sun period and is at least 3 times the rainfall of the dryest month. This climatic type permits production throughout the year though irrigation is still beneficial in the dryest months. About 22% of the country is in this classification. Much of this area is also subject to typhoons during critical months of the wet season.

Type F - is similar to type E but the heaviest rainfall occurs following the vernal equinox, this climatic type is found only in Mindanao. Rainfall is at least 2.4" per month with wettest high sun month at least 3 times dryest low sun month.

Type G - Rainfall is evenly distributed throughout the year and the climate is very regular. This climate type covers 15% of the area of the country mostly in Mindanao.



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND
NATURAL RESOURCES
QUEZON CITY
PHILIPPINE CLIMATIC REGION
NEW SYSTEM (HUKE 1972)
LONG LOW SUN DRY SEASON; 5 OR 6 MONTHS WITH LESS THAN 2.4" OF RAINFALL PER MONTH.
INTERMEDIATE LOW SUN DRY SEASON; 4 MONTHS WITH LESS THAN 2.4" OF RAINFALL PER MONTH.
SHORT LOW SUN DRY SEASON; 1 TO 3 MONTHS WITH LESS THAN 2.4" OF RAINFALL PER MONTH.
SHORT HIGH SUN DRY SEASON; 1 TO 3 MONTHS WITH LESS THAN 2.4" OF RAINFALL PER MONTH.
ALL MONTHS WITH 2.4" OR MORE RAINFALL; WETTEST LOW SUN MONTH WITH AT LEAST 3 TIMES THE RAINFALL OF DRYEST HIGH SUN MONTH.
ALL MONTHS WITH 2.4" OR MORE RAINFALL; WETTEST HIGH SUN MONTH WITH AT LEAST 3 TIMES THE RAINFALL OF DRYEST LOW SUN MONTH.
ALL MONTHS WITH 2.4" OR MORE RAINFALL; WETTEST MONTH HAS LESS THAN 3 TIMES THE RAINFALL OF THE DRYEST MONTH.
117° 118° 119° 120° 121° 122° 123° 124° 125° 126° 127° 128° 129°
21° 20° 19° 18° 17° 16° 15° 14° 13° 12° 11° 10° 9° 8° 7° 6° 5°

II.B. The regional grouping that has been adopted is a combination of the 11 standard administrative divisions into 7 groups. Climatic types and existing land use patterns have influenced the regrouping as well as being important in the original designation of regions. Taking account of political subdivisions facilitates the use of the results for regional policy formation. On the other hand, some aggregation of the number of administrative regions has been made in order to keep the model to manageable size. Because of the block independence of the model, further disaggregation can be made in those areas which require more detailed analysis, or separate detailed models which use the shadow prices generated from the national model may be constructed.

Region 1-2 - Central Luzon and Ilocos. This region is almost entirely within climatic type A and B where crop production is only possible during the wet season without irrigation. The population pressure is high and little additional land can be cultivated. Thus increases in production must come from increased inputs and additional irrigation. The principal crops grown are rice, sugarcane, tobacco, vegetables including green corn, rootcrops and fruits. This region is also the most developed region and is a major supplier of the Manila market.

Region 3 - Cagayan Valley. This region is all within climatic type D which has a short dry season of 1-3 months. This allows the production of two crops during most years though irrigation is required to obtain two sure crops of rice. This area has been relatively isolated because of the mountains which cut it off from the rest of Luzon and the only port facility is located at the northern tip. Some lands still suitable for cultivation exist and population pressure is somewhat less. The major crops are rice, corn, tobacco, dry beans, peanuts, and camote.

Region 4-6 - Southern Tagalog and Western Visayas. These regions are more heterogenous with regards to climatic type having some of climatic type of A through D but are dominated by type B, C, and D with an intermediate to short dry season. Although rice is the primary crop in terms of area, 80% of the country's sugarcane production comes from this region. In addition coconuts, fruits, vegetables, corn and rootcrops are important.

Region 5 - Bicol. Bicol is almost entirely within climatic type E which, though not having a dry season has a high seasonal variation in rainfall. The area is also subject to high incidence of typhoons. Major crops are rice, coconuts, corn, citrus, rootcrops, pilinuts, and vegetables.

Region 7-8 - Eastern and Central Visayas. This region falls mostly within climatic types D and E with either a short dry season or pronounced seasonal variations of rainfall. There is a small area of type B with evenly distributed rainfall throughout the year. This area is also subject to frequent typhoons. Major crops are corn, rice, coconuts, rootcrops, sugarcane, abaca, bananas.

Region 10 - Northern Mindanao. This region falls mostly within climate types E, F, and G which have rainfall throughout the year though with some seasonal variations. Typhoons are infrequent. Major crops are corn, rice, coconut, pineapple, rootcrops, citrus, abaca, coffee and cacao, sorghum, bananas.

Region 9-11 - Southern and Western Mindanao. This area is dominated by climatic types F and G with even rainfall throughout the year although there are some areas with types F and E. Typhoons are very rare. Major crops are corn, rice, coconuts, banana, pineapple, coffee, rubber, citrus, ramie.

III. PRODUCTION ALTERNATIVES

The major crops grown were specified in the discussion of the regions. These crops compete over time as well as for land during a given time. In order to determine the sequence of land use, cropping calendars for each of the 13 principal crops by region are being assembled from the Bureau of Plant Industries (BPI) and BAEcon. Of the livestock products only beef production occupies a significant area of land in direct production activities. Hogs and chickens have indirect land requirements for feed production.

Classes of Land. A land capability classification covering most of the Philippines has been completed.[2/] The capability classes are based on soil and slope characteristics. There are six major categories which are of interest in the production of crops (see table 1). These have

2/ Data are incomplete for some part of Mindanao and mountainous region of Luzon.

Table 1. Area and Value of 13 major crops included in the programming analysis and percentage of national value by region, 1969/70 - 1971/72.

	Crop Area Philippines	Value of Production: Philippines	Ilocos Region & Central Luzon	Cagayan Valley	S. Tagalog and W. Visayas	Bicol Region	Eastern Visayas	N & E Mindanao	S & W Mindanao	Total
	(1000 Ha.)	(1000000 ₱)	(percent)							
Palay	3147.4	2561.5	50.6 a/	12.3	24.1	8.9	5.8	6.3	12.0	100
Irrigated	1400.0									
Rainfed	1363.5									
Upland	383.9									
Corn	2414.6	763.5	3.4	11.8	18.1	3.7	8.8	8.7	45.5	100
Fruits										
Banana	235.6	749.8	6.3	4.2	35.7	3.6	24.3	12.9	13.0	100
Mango	42.2	121.1	30.4	1.5	50.7	0.2	6.4	2.0	8.8	100
Root crops										
Camote	134.0	232.4	23.0	12.1	8.2	21.3	19.8	8.6	7.0	100
Cassava	82.2	142.1	7.1	1.2	13.6	12.9	16.3	21.2	27.7	100
Vegetables										
Eggplant	17.6	33.0	47.0	2.2	22.1	11.5	5.4	4.2	7.6	100
Tomato	16.8	77.1	38.5	2.2	31.4	10.8	3.4	2.0	11.7	100
Beans and Peas										
Mongo	37.6	27.9	34.8	7.9	33.3	1.1	5.7	2.2	15.0	100
Commercial crops										
Coffee	54.3	226.1	5.0	11.4	30.0	3.6	0.7	18.4	30.9	100
Coconut	2019.0	1282.3	0.8	0.2	15.4	3.3	39.4	13.8	27.1	100
Sugarcane	360.3	1927.8	11.4	0.8	75.7	0.4	11.4	b/	0.3	100
Tobacco										
Native	49.4	76.8	23.6	44.5	5.5	1.6	4.8	3.4	16.6	100
Virginia	31.8	48.4	95.4	2.1	2.5	-	-	-	b/	100
Abaca	157.8	99.8	-	-	2.8	35.9	26.9	15.2	19.2	100
Total 13 crops	8800.6	8369.6								
Total Philippines	9072.4	9092.1								

a/ The total of the 3-year and 2-year average values of Ilocos Region and Central Luzon, respectively.
b/ Less than .01 percent.

been broken down, where relevant, into irrigated and non-irrigated lowland and upland. The irrigated area has been adjusted to correspond with the Bureau of Agricultural Economics figures on absolute area of irrigation. They are not in complete agreement with the National Irrigation Administration or World Bank estimates.

The crops that are most suited to each land class have also been identified. These together with the cropping calendar determine the feasable set of cropping activities for each region and are summarized in table 2.

Degree of water control. The degree of water control and the amount of water available throughout the year is an important determinate of the number of crops that can be grown within a year as well as the productivity level. With most of the existing irrigation systems, water control is not sufficient for the individual farmer or group of farmers to allow them to determine when water is to be used. Thus the most important factor is the availability of water for one crop or for a second crop. One of the important investment decisions is between improving existing systems and investing in large scale systems with storage. These alternatives appear to be partially complementary rather than fully competitive.

Degree of mechanization. The main areas of mechanization have been sugar and rice, principally in the land preparation phase. Alternative methods of mechanization for these crops are specified for both partially and fully mechanized land preparation using both four-wheel tractors and 2-wheel tractors. The evidence is inconclusive as to whether any increase in productivity results from mechanization.

IV. TECHNICAL PRODUCTION COEFFICIENTS

The technical production coefficients or input-output coefficients for the different cropping activities are derived from several different sources. Rice and corn production coefficients are derived from farm management surveys by the Bureau of Agricultural Economics and the U.P. Los Baños. The BAEcon data are based on a nationwide survey for the first and second semesters of crop year 1972. Since tabulations are by region the coefficients reflects differences in practice among regions. Sugarcane coefficients are being developed from a farm survey by the Philippine Sugar Institute (Philsugin) in 1969. Data for other crops are more limited. The regional BAEcon data are being combined with Census data and information from the Bureau of Plant Industry, U.P. and other sources.

Data for livestock and poultry coefficients are also limited. The Development Bank of the Philippines has developed some farm level coefficients for small scale and commercial production in connection with its IBRD livestock loan program. Data from Bureau of Animal Industry, feed mixers who are also involved in farm production, and from older studies are being used to obtain coefficients for production.

All cropping activities are specified on a per-hectare basis whereas livestock activities are specified per unit of output since little land is involved except for beef cattle operation.

<u>Yields</u>. It was hoped when the project started that data from the 1971 census of Agriculture would be available, but it has been delayed. We are using the 1960 census for information on yield differentials on

different types of land. Levels are obtained from the BAEcon's data on crop production for the 3 crop years 1970-72 along with other analysis of yield response to fertilizer. Representative municipalities for each capability class in each region have been selected from Census data and yields compared to obtain the relative differences.

Labor and animal power. Labor and draft animal requirements are specified in days per hectare by operation. These are then related to time period by use of the cropping calendar in order to specify requirements throughout the year on a bi-monthly basis. It was felt that a monthly specification was more detailed than required while a quarterly basis would not fit most of the crop growing seasons which are from 3½ to four months. For some operations standard labor requirements were used but, for others, particularly those representing higher management levels, it was found that higher levels of inputs were used on all operations.

Mechanized services. These are specified on a per hectare basis and are provided by input supply activities. For example, it requires 3 days of hand tractor service for 1 hectare of land preparation versus ½ day for a 4-wheel tractor.

Land. The amount of each class of land required is also specified on a bi-monthly basis by region. It is not assumed that particular classes of land are contiguous, but only that they have similar productivity levels. Since the activities are specified on a per hectare basis the usual coefficient will be one except in cases where there is intercropping.

<u>Variable inputs</u>. The amount of fertilizer required in the production activities is specified in terms of nitrogen, phosphorous, and potassium. These are derived from budget studies, and for rice from yield response functions estimated from farm level data.[3/] Chemicals are specified in peso terms due to the large number and type of farm chemicals used in crop production. All other cash expenses are also specified for each activity.

V. SOURCES OF VARIATION IN COEFFICIENTS

The major sources of variation in coefficients are due to differences in land and water. Differences are also identified for different levels of mechanization and different levels of technology. These have been developed by subdividing some of the farm management surveys into different yield groups and looking at the characteristics of those groups. Though this identifies the inputs that were used to obtain different yields each of the groups embodies a different management factor which is not specified. It is certain that not all farms have the management capability to attain the higher level technology, and thus some constraint is required to limit those in the higher levels of technology.

VI. INTERMEDIATE PRODUCTION ACTIVITIES

Production activities in this group are required for those commodities which require some processing before they are consumed.

[3/] Atkinson, L.J. and D.E. Kunkel "Some exploratory notes on the nature of the Green Revolution in the Philippines."

These are rice, corn, and sugar cane and the processing of various coconut products.

Rice and corn milling. Rice and corn mills are of several different types and capacities. Information on rice milling rates, costs and labor requirements by types of mill and region have been developed by both ADAM and the research division from a survey undertaken by BAEcon.

Information on corn milling rates, costs, and labor requirements are available from a study done by the U.P. Los Baños Department of Agricultural Economics. The existing capacity in each region by type of mill has been obtained from previous studies and the National Grains Authority registration of rice and corn mills.

Sugarcane Milling. Sugar cane (expressed in tons of cane at the farm level) is processed in modern sugarmills with normal factory capacities ranging from 1,300 to 10,000 metric tons of cane per day. Presently, there are 38 sugarmills, of which 17, accounting for more than 50% of the capacity one located in Negros Occidental where climatic conditions are well-suited for sugar cane culture.

The mill sector exerts a significant influence on the farm output because: 1) Scheduling the transport of cane from the farm to the mill is normally arranged by mill management through the provision of rail cars or of delivery dates to the planters. Normally, the mill requires a planter to load 7 tons of cane per rail car; 2) The milling schedule is seasonal. Under Philippine conditions, the milling season starts in the middle of November and ends in May. The usual

Table 2. Land Capability Classification, Philippines

	A, Bw	Bs	Be	C	D	X	LS, M, N, Y	Total
				1000 ha.				
Lowland Irrigated:								
Adjusted[a/]	761.2	88.9	45.2	6.9	-	-	-	902.2
NIA System[b/]	(330.2)	(53.1)	(13.0)	(1.6)	-	-	-	(397.9)
Lowland Rainfed	2,718.8	1,008.7	-	-	-	-	-	3,727.5
Upland	-	-	2,142.3	2,526.4	3,190.2	-	-	7,858.9
Total Area	3,480.0	1,097.6	2,187.5	2,533.3	3,190.2	427.4	15,214.3	28,130.3

Source: Data Provided by the Bureau of Soils, The characteristics of each class are given in "Recommended Land Use," a typewritten report of the Bureau of Soils.

a/ Calculated by multiplying the irrigated area of NIA systems by a factor derived from dividing total irrigated area as estimated by BAEcon with irrigated area under NIA systems.

b/ Based on NIA report dated Oct. 31, 1973.

duration of operations is expressed in grinding days per month (see table 2 and 3). The efficiency of the boiler section of the mill measured by the amount of filter cake production affects the sugar recovery rates significantly.

Table 3. Average Number of Grinding days per month.

Months	Grinding Days
November	10
December	20
January	23
February	23
March	24
April	24
May	11
Total	135

The integration of the farm-sugar cane mill interdependence is accomplished in the model through the imposition of milling (grinding) constraints and the inclusion of production activities transforming tons of sugar cane into exportable (A) and domestic (B) sugar and its concomitant by-products. The data-base is the mill operation reports published by the Philippine Sugar Association and the Philippine Sugar Quota Administration. Presently, ADAM personnel are estimating the normal recovery rates by mill districts from the latter reports.

Copra Processing

Coconuts are normally transformed into coconut meat on copra by drying in half shells. This process is done in small "tapahans" (small huts with shallow excavations), or sometimes the copra meat is merely sun dried. Once dried, the copra is removed from the shell at the farm. The oil recovery rates of copra produced under such conditions are usually low which prompts the copra buyers to deduct 20% of the total farm produc as losses. New, direct processing of coconuts without drying is being introduced in a new plant. The new process may be significant by 1980.

The bulk of the copra (87%) is, on the average, exported and the remainder is converted by domestic manufacturers into coconut oil. In 1972, 953,000 long tons of copra were exported. This represented 55% of total coconut products exported (1,739,100 long tons).

Presently, there are 197 coconut oil mills with a daily rated capacity of 7,648 metric tons (in terms of copra). In 1972, 945,557 metric tons of copra were processed by these mills. In the same year, these mills sold 744,575 and 400,000 long tons abroad and the domestic market respectively.

The main implications as far as the model is concerned are:

1) Both export and domestic demand functions for coconut must be integrated into the model.

2) A set of copra drying and oil processing activities must also be included in the model.

Most of the data requirements are being obtained from the United Coconut Association of the Philippines and the Philippine Coconut Administration.

VII. RESTRICTIONS ON RESOURCE AVAILABILITY

Labor force. The amount of labor available may be constraining during certain periods of the year. Agricultural labor force estimates are available from the 1970 census of population, but little attention was given to family and hired labor. There is also a quarterly survey of employment which provides figures on employment in agriculture. Some analysis of this survey has been made for which a national breakdown is given.[4/] The Bureau of Census has provided from the survey regional labor force estimates for hired, self employed, and family labor by sex and age group for agriculture. Additional information is available from the IAS surveys on family size and number of persons engaged full and part time in farming. These data provide the estimate of the labor force in agriculture in each category by region. These are then, converted into the number of full time man-day equivalent available bi-monthly by region. (see table 3)

Land. The bi-monthly land constraints are based on absolute area of cultivatable land in each land class obtained from the Bureau of Soils. The amount of irrigated land is based on the estimated area that can grow one crop and two crops as reported by farmers in the BAEcon's Integrated Agricultural Survey. The procedure was to locate the NIA irrigation systems by land class and then allocate the remaining areas on a percentage basis. Areas capable of producing more than one crop were assumed to be primarily NIA areas.

4/ Ranoa, Milagros, "The Workforce in the Philippine 1958-68." Proceedings of Workshop on Manpower and Human Resources, Oct. 1972.

VIII. PRODUCT DEMAND

In addition to demand studies that have been completed earlier, studies by project ADAM are underway using both time series and cross section data. The time series analysis is an econometric model developed by Richard Foote and covers the demand for major crop and livestock products. Because of problems with the data for some products, aggregation of some commodity groups and estimation of total demand for other commodities for all uses, it is necessary to use cross section data for obtaining demand functions for some individual commodities. The data for the cross sectional demand analysis are from surveys conducted by L.B. Darrah and E. Dosayla.

Rice. The demand function from Foote's analysis is satisfactory and is consistent with the results in the cross section analysis.

Corn. The demand for corn comes from three sources: mature corn for food, mature corn for livestock feed and green corn for food. The demand for corn for livestock feed is derived from the demand for livestock products and is transmitted through the technical coefficients. The largest demand is for mature corn for food which is converted into grits, the size of rice, and then is used like rice. Corn grits are the staple food in some parts but are considered to be inferior to rice; some substitution still does occur when price ratios change. Green corn is eaten as a vegetable, primarily as a snack between meals and thus is really a separate commodity. Demand function estimates for corn are being made from the cross section data for food and for green corn.

Livestock and poultry. Foote's demand model includes pork, poultry meat, and eggs, but the time series data on the amount of production is not very good. A gap exists between the production data and figures from consumption surveys on amounts consumed. The consumption surveys may also have an upward bias. The procedure that has been adopted is to make estimates of demand functions for each of these commodities for Manila, urban other than Manila, and rural. Data from the Bureau of the Census and Statistics on income and family size will then be used to obtain per capita consumption estimates by each class and these will then be projected to 1980 using a projection program developed by Richard Phillips.

Other vegetable and fruits. Demand estimates are being made using the cross section food consumption surveys.

IX. PRODUCT PRICES

Domestic prices are based on market prices at the national level, In order to minimize fluctuation average prices for the three year period 1969/70-1971/72 from AMNEWSS and Central Bank sources are used. Regional price differentials are calculated from price differences reported from the major trading centers; where such reports are not available relevant transportation rates are used.

Export prices for most commodities except coconuts are taken as given since it is assumed that the Philippines is a price taker. In th case of coconuts, because the Philippines is a major supplier, some type of demand function needs to be specified.

Import prices are related to Manila wholesale prices. In some cases where the restriction of imports has resulted in prices higher than world prices, prices have been adjusted to account for this and the difference taken as a cost to consumers.

I

Policy Issues and Economic Alternatives for Philippine Agriculture

Contents

DEK-LJA: 5-22-74

Part III. POLICY ISSUES AND ECONOMIC ALTERNATIVES FOR PHILIPPINE AGRICULTURE

I. Introduction

Any analysis which is to obtain an integrated picture of Philippine agriculture has to consider what the overall policy goals are and what options can be used to obtain these goals. The discussion that follows will first consider the major goals for Philippine agriculture in the next few years; next, what policies can be used to reach these goals and the constraints that keep them from being operative; and, finally, the way the programming model is to be used in evaluating these policies and goals.

II. Policy Goals

1. Achieve self-sufficiency in agricultural products at least in regard to staple commodities such as rice and corn;
2. Increase national income, raise income of rural people and increase employment in agriculture; and
3. Improve foreign exchange position by reducing agricultural imports and increasing agricultural exports.

Though these goals are quite clear, (a) they need to be related to the development of the rest of the whole economy; and (b) they need to be evaluated for consistency with each other. For example, the attainment of self-sufficiency may be at the expense of increased earning of foreign exchange or increasing income. A narrow definition of self-sufficiency, such as self-sufficiency in rice, corn and feed grains may not be so economically desirable as the broader view that the overall value of agricultural exports exceed the value of agricultural imports by as much as possible. There also may be a trade-off between increasing rural income and increasing aggregate production. Thus, these objectives and goals need to be analyzed to determine what trade-offs occur.

111. Policies

The Philippine government is presently pursuing the following general policies or objectives:

1. Increasing agricultural production from existing resources
2. Modernization of agriculture through the adoption of new technology
3. Diversification of production to achieve self-sufficiency and increase exports
4. Implementing reforms at all levels of society.

Increased agricultural production - The concerted drive to attain higher output per hectare or per unit of other resources must be based on the availability of the means to do this economically. Perhaps then what will be required are new varieties of crops and new breeds of livestock which must be profitable to the farmer, and measures that will reduce the risk arising from the adoption of these varieties or breeds. Moreover, programs aimed at increasing agricultural output must be evaluated in terms of the total costs and benefits obtained by the farmer as well as by society. A major aim may therefore be the selection of a crop and livestock production pattern that will be optimum for the Philippines under a given set of conditions.

Modernization - The cost of adoption of improved cultural practices, the use of new varieties of crops, the raising of better types of livestock should be related to the size of economic returns. The adoption of mechanical technology in agriculture may also be economical if it removes bottlenecks such as seasonal constraints of labor and of animal power.

Diversification - Diversification of production is desirable to reduce risks and to achieve the more complete utilization of land, labor and other resources, as well as to increase output. However, diversification of agricultural products on a national level need not result in diversification at the farm level; in fact it may lead to increased specialization. Diversification at the national level should be based on comparative advantage for both domestic and export possiblities. On the other hand, diversification at the farm level should be based on costs and returns.

Reforms - Reform, by its very connotation, is an external factor in the government program. But as implemented under the Martial Law administration, reform is expected to be both external and internal. In agriculture, reform has taken place in the agrarian sector through the land reform program. It is hoped that this policy will enhance the individual's contribution to economic development. Reform is now a significant variable in the production function and efforts need to be made to develop specific hypotheses on the probable change in the current production coefficients in order to analyze their effects.

IV. Constraints on Agricultural Development

In order to obtain growth in agricultural income, output and employment there must be relaxation of the constraints. The main constraints facing Philippine agriculture are: the availability of new technology which is profitable to the farmer; the scarcity of capital inputs in the form of irrigation development; the lack of appropriate agricultural machinery, agricultural processing facilities, and other infrastructures; and the low level of demand for agricultural commodities. The rate at which the constraints that are binding are relaxed will affect the outcomes of different policies. An important point is that constraints are often not so binding as they appear.

It is difficult to predict the degree these major constraints will be overcome in the future; thus alternative rates of development will be specified. The first assumption is a balanced growth approach, with the economy continuing to grow at about the some general rate as in the past and investment in agriculture is also at past rates. The second is also a balanced growth assumption but the general economy grows at a more expansive rate (8-9 percent) and increased investment in agriculture also occurs. The third assumes unbalanced growth in agriculture with the economy developing fairly rapidly (7-8 percent) but investment in agriculture is lagging.

V. Policy Instruments Available for the Implementation of Agricultural Policy

The main instruments available for implementing policy are price intervention; subsidies for inputs such as credit and fertilizer;

controls, taxes, or subsidies on imports and exports; changes in the wage rate; increasing the rate of investment in irrigation, research and extension; and institutional changes via regulation or development of new institutions such as Samahang Nayon (Barrio Association), corporate, contract, or food bowl farms.

Each of these measures may be used with different policies. Because the outcome is dependent upon the combination of several policies, it may be difficult to measure the effect of a given policy or of a particular instrument.

VI. Specific Policy Issues that can be Examined by the Programming Analysis.

The programming model provides a useful format within which to examine the interaction of different policies and the effect of making changes in a particular one. In the study of Mexican Agriculture, it was found that "the impact of a simultaneous change in several policy measures cannot be approximated just by adding up the impact of each measure taken in isolation. Due to the interaction effects, a piecemeal analysis of agricultural policies can be quite misleading. All items in the full policy package (interest rate, export subsidies, water rates, etc.) must be analyzed simultaneously[1/]". With this in mind, several policy sets that are of importance in Philippine agriculture are presented. As other important problems arise, analysis of these can be developed with the model.

1/ L.M. Goreux, A.S. Manne, ed., Multilevel Planning case studies in Mexico. p. 11.

<u>Base period analysis</u> - In order to make a comparative analysis, it is necessary to establish base period results with which to compare alternative formulations. The initial base period will use the average of the three-year period 1969/70 - 1971/72. The initial runs will be made using prices of both inputs and outputs, resource levels and demand levels that prevailed during the period. Results will be compared with actual outcomes and changes made in the model if results are not consistent.

The base period analysis for 1980 will specify demand levels based on a balanced growth assumption about the whole economy and investments in agriculture. It will also assume the continuation of the policies that have prevailed since the imposition of Martial Law. Specifically, this means a consumer oriented price policy for food grains; subsidies for fertilizer and credit; irrigation development at the World Bank investment rates; technology changing at about the same rate as in the past; the continuation of land reform and development of accompanying institutions; and the maintenance of foreign exchange rate parity at international rates.

<u>Effect of more rapid growth rate of GNP</u> - The same assumptions as in the base period would obtain except that in some options the demand functions would be shifted to reflect the higher income level.

<u>Effect of different irrigation policies</u> - Policy issues in this area involve both the more rapid development of all irrigation systems and the trade offs between large scale irrigation projects versus the rehabilitation of existing facilities.

The main target variables to be examined are the effect on rice production, income, employment and investment requirements.

Effect of changes in employment-labor force - wage policy. - The areas to be examined under this topic are the effect of changing wage rates including the reservation wage of family labor, of labor intensive technique, and of mechanicazation on employment, income and output.

Effect of changes in international trade policy - Major factors to be considered under this topic are relative comparative advantage of Philippine products, changes in export taxes, import taxes and quotas, and self-sufficiency. Of considerable importance is the policy toward production inputs such as machinery and fertilizer that are imported.

Effects of reform programs - It is most difficult to quantify the effects that reform programs - land, marketing, financial institutions - will have on variables that are included in the model. For example, the effect of land reform on productivity is uncertain. There is no conclusive evidence that it will increase productivity, though a number of people think it will. To the extent that some of the probable effects can be estimated those will be explored.

The effects of large scale organizations - There have been a number of recent proposals to allow contract farms, corporate feed grain production, and other large scale operations in livestock and other crops to undertake production in various parts of the Philippines. The effect of these can be incorporated if details of their investments, inputs, and outputs can be obtained.

Evaluation of the impact of various regional development programs - There are a number of programs and proposals of regional development which are being undertaken by various agencies. There has been little attempt to assess their overall impact on development or whether the investment and resource requirements needed to carry out these programs will be sufficient if they are all undertaken at the same time.

In addition, the analysis must also use various combinations of policies to examine further questions such as the relative cost of achieving output increases from more use of fertilizer and chemicals versus the development of irrigation facilities or both.