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Agricultural Planning: The Peruvian Experience

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THE ROLE of the agricultural sector in the economic growth of Peru is complex. The Peruvian government has pursued a protectionist policy with respect to domestic industrial production, but has preferred to rely on international suppliers in the case of wheat, beef, and dairy products. It is the national policy to provide the urban consumer with a low-cost food basket. In those instances in which domestic supply cannot meet domestic demand at prevailing market prices, the central government has followed a general policy of duty free imports.

Total public expenditure in agriculture through the budget of the central government averaged 930 million soles for 1964 and 1965.[1] Fiscal revenues from agricultural export taxes and import duties on agricultural inputs and capital goods averaged 725 million soles for

NOTE: The author served as a member of the Iowa Mission to Peru. He acted as advisor to the Agricultural Sector Planning Office (OSPA) of the Ministry of Agriculture and as technical director of a study on long-term demand and supply projections of major crop and livestock products sponsored by the Agricultural University of LaMolina, the United States Department of Agriculture (USDA), the Agreement on Technical Cooperation in Statistics and Cartography (CONESTCAR) and the National Planning Institute (INP). The author would like to acknowledge his indebtedness to his many Peruvian associates, in particular Carlos Amat y Leon, Rafael Otero M., and Jose Salaverry Ll. of the Agricultural University at LaMolina, Walter Petrovitch H. of the INP, Mario Cuneo M., Dr. A. Angulo A. OSPA and Roberto Valverde P. of the Agricultural Development Bank.

[1] Republic of Peru: Ministerio de Hacienda, *El Presupuesto Funcional de la República,* Lima, Peru, 1964 and 1965.

these years.[2] The above figures, in conjunction with figures for earlier years, show that producers of export crops have contributed the major share of the financial resources that the public sector allocated for agricultural development. Such funds were used principally in the promotion of food crop production.

The imposition of duties on food imports could generate sufficient revenue to double the financial resources currently allocated to agriculture. Our study shows (see Table 11) that if such funds were used exclusively in the promotion of domestic production of cereals, tubers, beans, and pulses, the productivity index of these food groups could increase by about 4 per cent per year. The funds currently projected available for the promotion of these food groups are so small that they fall short of inducing a 1 per cent increase in over-all productivity.

The Peruvian government has done little to encourage the expansion of export crops; in fact the principal export crops (cotton, sugar, and coffee) are subject to taxation, while food crops are not. Export crops generated 35 per cent of the gross value of agricultural production in 1964.[3] Prior to 1960 the value of production of export crops expanded at a rate of 8.3 per cent per year, but in the early 1960's this rate slowed down to 2.9 per cent because of increasing competition in slowly expanding international markets and worsening cost-price relationships at home.[4] The relative stagnation in the agricultural sector in the last few years stemmed principally from the slow rate of growth of the agricultural export sector. The above loss of potential export earnings was not critical, because of the rapid expansion of export earnings in minerals and fishmeal products.

The Ministry of Agriculture has traditionally favored a policy of expanding acreage in food crops at the expense of acreage in export crops. About 65 per cent of the land in food crops is grown by operators who farm less than 5 hectares.[5] Consequently the public sector in agriculture has chosen to work with small producers, an effort that in recent years has been intensified through the agrarian reform program. Commercial producers have been reluctant to shift toward food crops for

[2] Ministerio de Hacienda, Instituto Nacional de Planificación [INP] Dirección del Sector Público, *Recaudación de Impuestos y Otros Recursos,* Lima, Peru, 1967. (private communication)

[3] Convenio de Cooperacíon Técnica Estadística y Cartografía [CONESTCAR], *Estadística Agraria Perú 1964,* Lima, Peru, 1965, pp. 34–36.

[4] Republic of Peru: Ministerio de Agricultura, Oficina Sectorial de Planificación Agropecuaria [OSPA] *Diagnostico Agropecuaria,* Lima, Peru, 1966, p. 35.

[5] CONESTCAR: *Muestreo Agropecuario Nacional 1964,* Lima, Peru, 1967. (private communication)

immediate human consumption or for animal use because of the very limited domestic markets for these commodities. Production of feed grain for use in the livestock industry is of very limited importance in Peru, partly because domestic livestock production is not competitive with imports and partly because the periodicity in internal-cost inflation and devaluation makes it difficult to obtain long-run commitments from commercial producers to specialize in food grains or livestock production.

Existing price controls and enabling legislation are spread among national and municipal authorities and are designed almost exclusively to favor the urban consumer, thereby eliminating the price incentive to the domestic producer and defeating the public expenditure on agricultural research and extension.[6] Although the government has repeatedly expressed its concern about the slow rate of growth in domestic food production, the financial resources made available to the agricultural sector through the budget of the central government have remained a small and constant proportion of the total budget.

In more general terms, the Peruvian government in its effort to transform the nation into a modern industrial society is faced with the fact that its objectives for the agricultural sector conflict with those for other sectors. Cheap food increases the real income of urban wage earners and helps to expand fishmeal and mining exports. On the other hand, the marked rural poverty of the central and southern Sierra could gravitate into an explosive social disequilibrium unless many landless peasants are given a subsistence base. A stable exchange rate, in the face of internal cost inflation, provides a low-cost food basket for the urban consumer but may well dampen the expansion of export crops that could be used to finance capital imports for industrial development. Most important of all, the expansion of social services, transport, and energy development severely strains available public budgetary resources.

It is difficult to say at which stage of economic development the urban sector can afford a transfer of income to the rural sector. It is a decision that cannot be made in terms of economic efficiency only, but must rest on considerations of equity as well. Agricultural planners in Peru typically think that the latter should outweigh the former, but they do not have the power to reduce income and land distribution inequities more than marginally.

[6] Geoffrey Shepherd and Dale B. Furnish, *The Economic and Legal Aspects of Price Controls in Peruvian Agriculture,* Iowa Universities Mission to Peru in cooperation with the Agency for International Development, Lima, Peru, 1967, pp. 25 ff.

Because of a lack of technical expertise, the planning concept was limited to drastic changes in institutional structure or output targets. Neither had much relation to available public resources or other considerations such as political, technical, and historical feasibility. The first draft of the 1967–70 agricultural development plan did not go beyond a statement of general objectives justified in terms of observations on existing deficiencies in production, consumption, marketing, credit, etc., with little quantification of these deficiencies or attempt to establish their interconnection.[7] In constructing a planning methodology the learning process proved to be frustrating and very time consuming. The constant need to produce a preliminary planning document precluded the possibility of a systematic or comprehensive approach or of executing a broader economic analysis of the projected performance of the agricultural sector than contemplated by the planners.

In Peru the bulk of public expenditure in agriculture does not go directly into the creation of products, but into either the acquisition of knowledge or the redistribution of land. It is funnelled through some twenty agencies, each with its own special objectives and all competing for scarce financial and technical resources.[8] Most agencies have several regional offices, creating thereby an administrative structure that in theory is well adapted to handle the diversified needs of the agricultural producer in various parts of the country. In practice it has been very difficult to assess the product-creating effect of the various agencies, even in those few cases where the agency is directly concerned with the expansion of land resources or the improvement in the productivity of existing land. It is clear therefore that the product-investment nexus is not easily ascertainable in Peru.

Since most planning models are based on an implicit causality between investment and production and the control choices that can be derived therefrom, they may not be readily applicable to the case of Peru. I suspect that the Peruvian situation is rather typical of both developed and underdeveloped countries. In the latter the importance of public expenditure in agriculture can easily be overrated in relation to the impact of legislative, fiscal, monetary and price policies. In fact, an examination of the factors contributing to agricultural growth in Peru in the period 1950–64 would, on balance, give little reason to impute positive importance to either public expenditure or the set of

[7] Ministry of Agriculture, OSPA, *Peru's Agriculture: Summary of Diagnosis, Objectives, Strategy and Policy*, Lima, Peru, 1966.

[8] Oficina Nacional de Reforma de la Administración Pública, *Diagnostico y Reformas por Sectores, Sector Agrícola*, Lima, Peru, 1967, p. 355.

measures taken by the public sector relative to agriculture. The impact of planned public expenditure in agriculture is likely to remain relatively modest compared to autonomous increases in production or to those induced through expanding internal and external markets.

Agricultural planners in Peru are typically somewhat impatient with the role of free markets in achieving a satisfactory rate of growth in agricultural production. A more activist approach is preferred, putting great emphasis on public investment in agriculture. To the extent that such investment can be redirected at will, it is expected to play an important role in redressing regional imbalances in agricultural progress. Economic growth in other sectors has been largely restricted to the urban and coastal zone. The government has relied heavily on public expenditure in agriculture as the main instrument in achieving a more equitable pattern of development. Consequently both agrarian reform and promotion of agriculture were forcibly redirected to zones with the lowest economic potential.

In most underdeveloped countries the bulk of the increase in production is achieved through expansion of the land base rather than through yield increases. Peru is no exception. The Ministry of Agriculture, as well as the semiindependent public sector in agriculture, is staffed almost exclusively by technicians who received their academic training in the life sciences. This explains the widely held professional opinion that increased production is most readily achieved through increased yields. Agricultural planners are of the same background and have not fully adjusted to the need to consider a broader range of planning variables such as irrigation, colonization, and price policies.

The idea of planning implies that the planner may reasonably consider a number of alternatives. To the extent that agricultural planning focuses on the role of public expenditure in agriculture such planning is concerned with maintaining a reasonable degree of flexibility with respect to the total amount of expenditure made available for agricultural development from the budget of the central government or external sources. But, in fact, agriculture's share of the national budget throughout the period 1951–65 has been small and virtually constant.[9] It is true that public expenditure has grown more rapidly than the gross domestic income but, for public investment in agriculture to have a

[9] International Bank for Reconstruction and Development, *The Agricultural Development of Peru, Part 2, Detailed Report* (report of a mission organized by the Food and Agriculture Organization of the United Nations and the International Bank for Reconstruction and Development at the request of the government of Peru), Washington, D.C., 1959, p. 35; and *Presupuesto Funcional de le República,* Lima, Peru, 1958–65.

measurable impact upon agricultural growth, it must show a much sharper acceleration. The most important annual budget decisions are those that create new activities within the budget. It is essentially this component that gives some flexibility between years. Since such activities usually refer to new institutional activities (e.g., the creation of CONAP, CONESTCAR, ONRA, OSPA),[10] they are not variables that readily enter into a quantitative model of economic growth. Most growth models are relatively strong on behavioral relationships between major macroeconomic variables, but are relatively lacking in those variables that enter into public revenue and expenditure accounts, the structure of internal and external public debt, and the balance of payments. If a growth model is to be used for planning purposes, ideally it should provide suggested courses of action for the principal instrumental variables entering into the public accounts. In a second stage, the aggregated public accounts must be decomposed on a sectoral basis and subsequently on an agency basis. Presumably, there is an infinite number of ways to decompose a given total between the various public accounts. In practice the momentum of existing programs will, in the main, dictate the method of sectoral decomposition of planned total public expenditure. Peruvian agricultural planners have focused their attention almost exclusively on the role of public expenditure in relation to agrarian reform and the improvement of rural income levels in the Sierra, to the detriment of either commercial agriculture or the urban consumer.

The easy and arbitrary manner in which normative positions are taken with respect to both the ends and means of agricultural planning in Peru is very disconcerting to a visiting foreign adviser. At the same time, to assume that past policies are the norm for the future is equally dangerous. Paradoxically therefore, it is no simple matter to ascertain the objectives of agricultural planning. For example, it is not clear whether the government aims to tax private urban consumption expenditure to support agricultural development, or whether the agricultural sector is to be taxed in an indirect manner to support urban industrial development. A reading of the National Development Plan [11] would suggest the former, but a consultation of existing legislation [12] and budget allocations would suggest the latter.

[10] Corporación Nacional de Abastecimientos (CONAP), Convenio de Cooperación Técnica Estadística y Cartografía (CONESTCAR), Oficina Nacional de Reforma Agraria (ONRA), Oficina Sectorial de Planificación Agropecuaria (OSPA).

[11] Ministerio de Hacienda, INP, *Plan de Desarrollo Económico y Social 1967–1970,* Lima, Peru, 1967, p. 127.

[12] See, El Congreso de la República Peruana, *Ley de Creación del Ministerio de Agricultura No. 9711,* Jan. 2, 1943, Tit. 1; El Congreso de la República

Agricultural planners, perhaps because of their background in the life sciences, have been reluctant to study the financing of agricultural development. This emphasizes the need for agricultural economists with experience in macroeconomic analysis. Where a national planning institute exists, the above information can be adopted instead of having to be generated first hand. On the other hand carrying out the financial and macroeconomic analyses within the agricultural planning office would have the advantage of strengthening the stature of planners who in a hierarchichal sense take their directives from planners interested in more global objectives.

The financial resources available to the agricultural sector on current account are allocated principally through the budget of the central government. For many agencies this is the only source of funding. Other agencies derive considerable revenue from earmarked tax revenue. All the larger agencies in agriculture derive a considerable part of their revenue on capital account. External debts are important for the agencies in charge of agricultural credit, promotion, irrigation, and colonization. Internal debts are important principally for the agrarian reform agency and agricultural development bank. Given the limited availability of these resources much of the desired acceleration of the land reform process will depend on the possibility of attracting international financing.

To date, revenue and expenditure accounts are only partially available to the agricultural planners. The construction of such a set of accounts is a painstaking process complicated by the fact that expenditure and revenue data are itemized for control purposes rather than for programming or functional purposes. From a pragmatic point of view, the budgeting and the program evaluation processes are the most important and time-consuming components of agricultural planning. In both these areas substantial improvements in methodology are needed. Both budgeting and evaluation should order accounting data in such a way that a cost and output estimate can be assigned to the various proposed activities of the agency. The establishment of programming offices within each

Peruana, *Ley de Promoción y Desarrollo Agropecuario del Pais, Especialmente la Producción de Articulos Alimentosos y Normal Abastecimiento No. 16726,* Oct. 27, 1967 (general dispositions); Dale B. Furnish, *Investigaciones Legales de las Estructuras de Comercialización Agropecuaria en el Perú: Trigo;* and *Un Análisis de las Leyes Sobre el Ganado y la Carne en el Perú,* Iowa Universities Mission to Peru in cooperation with the Agency for International Development, December 1967; Raul L. Munoz Cabrera, *Investigaciones Legales de las Estructuras de Comercialización Agropecuaria en el Perú: Aceite y Grasas Comestibles,* Iowa Universities Mission to Peru in cooperation with the Agency for International Development, Lima, Peru, 1967 (unpublished).

agency has been only partially successful in reshaping agency accounts. In practice the programming offices have played an important role only in formulating the preliminary budget requests submitted to the Ministry of Finance. The constant scarcity of funds has put the programming offices under considerable pressure to overestimate the impact of their proposed activities and to underestimate the cost of carrying these activities out. Since the fiscal situation is so variable between years, few agencies document their needed financial resources beyond next year's budget request. Consequently, the problem of how to finance agricultural development on a longer run basis has never been studied in detail.

In the absence of functionally classified public expenditure data, no substantive generalization can be made about the cost of transforming traditional agriculture. Theoretical studies of agricultural development focus on the endogenous variables and their logical interrelationships. Certain exogenous variables like population, the subsistence wage rate, or technological progress have also been considered, but little or no attention has been given to instrumental variables. Yet, the main focus in agricultural planning should be precisely on instrumental variables corresponding to individual decision-making units. The reasons for this are as follows. First, planning necessarily takes place in a decentralized system where decision makers at the lower levels do not necessarily think in terms of the same performance concepts as decision makers at the top levels. Second, the performance concepts maximized at the lower levels of the hierarchy may be in direct conflict with over-all objectives. It is of course the function of the planners to resolve such conflicts. In a centralized planning system this would be carried on by decree. In the Peruvian decentralized situation it would have to be done through persuasion, a method with little chance of success under present conditions. Formally, the issue can be resolved through casting the planning process in mathematical form and optimizing a social welfare function. However, there is not enough agreement on the role of agricultural development in Peru to permit weighting of objectives.

Taking the above observations as a point of departure, we decided that the preliminary agricultural development plan should limit itself to determining in a systematic manner the feasible rate of growth, rather than the optimal rate of growth or optimal allocation of public expenditure.

To determine the feasible rate of growth in agriculture we studied the major exogenous and endogenous variables in agricultural development. The specific variables considered were population, gross domestic income, public revenue and expenditure accounts, balance of payments,

exchange rate, indexes of land productivity, trends in land use, agricultural labor force, intermediate inputs used in agriculture, prices paid and received by farmers, agricultural taxation, agricultural credit, proposed public land expansion and productivity programs (including their financial requirements), and other public expenditure in agriculture. The above variables were used to develop three alternative hypotheses concerning the rate of growth in agricultural production. By estimating the growth in demand, decomposed by region and rural and urban areas, we obtained targets that domestic development in supply had to meet if reliance on imports were to be reduced.

An increase in domestic supply comes about through an increase in either cultivated acreage or yield levels. In the Ricardian theory of economic growth an increase in cultivated acreage, barring technological progress, is associated with decreasing average yield levels.[13] In our study we assumed that yields were independent of the expansion in the land base since too little is known about the quality of Peruvian soils under actual and proposed cultivation.[14] Historically, cultivated acreage in food and export crops grew at the same rate as population, and it seemed reasonable to project a continuation of that tendency in the period 1967–70, allowing for a decrease in cultivated acreage in export crops. Total cultivated acreage was decomposed simultaneously by individual crops and by groups of crops in three regions (see page 435). Given the projected increase in cultivated acreage we considered the feasibility of the projected increases for each region. For this purpose the land use limits as given in the preliminary land inventory [15] and the proposed public investment in irrigation and colonization were consulted.

With respect to yield increases we explored three hypotheses. Under the first hypothesis the general yield index would increase at its historical rate, that is, zero per cent per year. Under the second and third hypotheses the general yield index was to increase annually by one per cent and two per cent, respectively. The projections were carried out in two stages. First, the general productivity hypothesis was adopted, and then the indexes of yields by groups or crops or individual crops were determined simultaneously by regions (see pages 422–23). The projected increases in yields were separated into two components, those induced by agricultural research and extension programs, and those due to autonomous

[13] H. Barkai, "Ricardo on Factor Prices and Income Distribution in a Growing Economy," *Economica (New Series)*, Vol. 26, pp. 240–250, August 1959.

[14] Oficina Nacional de Evaluación de Recursos Naturales [ONERN], *Capacidad de Uso de los Suelos del Perú*, Lima, Peru, 1965.

[15] J. C. Paez, *et al.*, Diagnostico Agrario, Ministerio de Agricultura, Servicio de Investigación y Promoción Agraria [SIPA], Lima, Peru, 1964 (mimeo.).

developments not related to activities in the public sector. The latter are captured in the main by a projection of trends in past yields. We also took account of the fact that induced productivity increases modify the past trends in yields. The projected yield levels for 1970, according to the three hypotheses, were compared with the impact that planned productivity programs [16] are expected to have in 1970. From this comparison it developed that the proposed programs, if fully funded, would be barely sufficient to accelerate the general yield index by one per cent per year (see Table 11).

Given the respective hypotheses relative to expansion in acreage and yield improvements, it is a simple matter to compute the projected expansion in production. Using enterprise budgets from the Agricultural Development Bank [17] and the Agricultural Promotion and Research Service [18] we computed the necessary labor requirements and intermediate inputs corresponding to the various production hypotheses. A previous detailed analysis on population growth by regions and by rural and urban areas yielded a provisional estimate of the growth in the agricultural labor force by regions. The projected growth in the available labor force was closely balanced with the projected labor requirements according to the production hypotheses.[19] Because of the limited acceleration in productivity and the typically low values for the input elasticities, commercial inputs like fertilizer and pesticides were projected to grow at approximately twice the rate of growth in production. Domestic, installed, manufacturing capacity can adequately cope with the projected expansion in commercial inputs. Subsequent sections deal in detail with the foregoing observations.

PROJECTED PERFORMANCE OF THE ECONOMY

During the period 1950–64 the Peruvian economy grew at a rate substantially higher than the average for Latin America. The gross domestic

[16] See, Ministerio de Agricultura, SIPA, *Proyectos de Incremento de la Producción 1967–1970: de Papa; de Cereales-Avena-Quinua-Trigo-Cebada; de Arroz; de Maíz; de Menestras,* Lima, Peru, 1967.

[17] Harry Higgins and Roberto V. Piedra, *Zonificación y Sectorización Territorial—Costos Básicos de Producción Agrícola 1965,* Oficina de Planificación, Banco de Fomento Agropecuario del Perú, Lima, 1966 (mimeo.).

[18] Paez, *op. cit.*

[19] It was assumed that yield-increasing techniques would not be labor increasing.

income doubled between 1950 and 1964.[20] The principal factor permitting such rapid growth was the rapid expansion of fishmeal and mineral exports. The dollar value of exports tripled between 1950 and 1964. Since 1950 public investment and expenditure has absorbed an increasing share of the gross domestic product (GDP), reaching 16.5 per cent of final demand in 1964. At the same time, the stability of the exchange rate in the presence of a moderate but continuous decline in the domestic purchasing power of the Peruvian sol periodically eroded the profitability of agricultural and industrial exports. This erosion was an important factor in the most recent devaluation (September 1967).

The growth in GDP between 1950 and 1964 was accompanied by substantial changes in its sectoral composition. During this period the industrial sector increased its relative share from 15.6 per cent to 19.3 per cent, while that of the agricultural sector diminished from 25 per cent to 17.4 per cent.[21] The agricultural sector and the population grew virtually at the same rate; all other sectors grew at least twice as fast. Per capita income increases, except for the agriculturally employed segment of the population, were well above the minimum designated desirable at the Punta del Este meetings of 1961. The contrast between a viable economic future in urban-based occupations and the relative stagnation of per capita earnings in agricultural employment led to an accelerated migration of rural dwellers to the cities. But the growth of industrial activity with its related service complex was largely restricted to the Lima metropolitan area. Economic growth in Peru, therefore, was unbalanced among sectors and among regions. Population movements between census years reflect this increased dualism of the Peruvian economy. We project that for the period 1960–70 the rate of growth of the urban population in the coastal area will be at least 4.8 per cent per year, while the annual rate of growth of the rural population in the Sierra is not likely to exceed 0.9 per cent for the same period. The mobility of Peru's most ample resource, unskilled young labor, will continue to be a major factor in transforming the traditional economy. Official planning documents, however, reflect the belief that economic growth should be shared more equitably among regions and between urban and rural population groups. Therefore, public investment and expenditure plans call for a juxtaposition of the expected resource allocation on the basis of a complementary relationship between growth in private and public activities. Under this principle the "Plan de Desarrollo

[20] Ministerio de Hacienda, INP, *La Evolución de la Economía en el Período 1950–1964*, Vol. I, Lima, Peru, 1966.

[21] *Ibid.*, Vol. 3.

Económico y Social 1967–1970" [22] gave first priority to public investment projects related to agricultural activities in the central and southern Sierra.

The Peruvian industrial sector (excluding mining and fishmeal) is primarily oriented towards internal final demands. To meet these demands it relies heavily on imports of intermediate goods, capital goods, and raw materials. A rapid and sustained rate of growth in this sector is possible only with an equally dynamic export sector. Although the Peruvian export sector is diversified, it is nevertheless restricted to raw materials, such as fishmeal, cotton, sugar, and mineral exports. Reduction in export earnings has caused a reduction in industrial growth. To the extent that public revenue relies heavily on import duties and transaction and profit taxes, it tends to be reduced with decreases in industrial activity. Pursuit of a countercyclical or expansionary economic policy during recessions would lead to a sizeable budget deficit that would have to be financed externally or through domestic inflation. The Peruvian government prior to 1963 followed the conservative alternative of trying to adjust expenditures to revenues.

In more recent years the government has pursued an expansionist policy in the public sector. Expansion was most rapid in health, education, communication, and transportation. Savings on current account decreased rapidly. Prior to 1962 a large share of capital expenditure was financed by means of savings on current account. Subsequently, savings on current account decreased rapidly as the growth in public revenue failed to keep pace with the growing pressure of current expenditures. This brought about an increased dependence on foreign public capital, which means of course a growth in the public external debt with increased future interest and amortization payments. Recent projections by the National Planning Institute indicate that, in the event of a decline in copper prices, amortization and interest payments will exceed the traditional upper limit of 15 per cent of export earnings.

If high levels of public investment are to be maintained, the government will have to slow down the growth of current expenditure and generate additional tax revenue in order to meet the financial needs of the growing capital accounts. Tax revenue increases were less than proportional to public expenditure and investment. To meet the growing financial demands of public expenditure and investment it has been fiscally expedient to increase indirect taxes notably import duties. With the growing amortization and interest payments on the foreign public debt, the need for internal financing of public investment will increase and the case for tax reform will strengthen.

[22] *Plan de Desarrollo Económico y Social 1967–1970.*

The principal variables of the public accounts also enter into the national income accounts and balance of payments accounts; for example, the national income, balance of payments, and the public sector accounts are interdependent systems of economic variables. Because of the interdependence of the major macroeconomic accounts a macroeconomic model must be designed to provide the required consistency among the accounts and must be supplemented by projections of the complete balance of payments and public sector accounts. A comprehensive forecast of the performance of the economy must be made to provide agricultural planners with an estimate of the probable financial resources available (historically the proportion of financial resources made available to public agencies in the agricultural sector through the central budget has averaged below 3 per cent), the expected rate of growth in per capita income, and a good indication of whether or not devaluation of the domestic currency should be taken into account.

The Peruvian national development plan is based upon projections of the major macroeconomic variables and the principal components of the public expenditure and investment accounts. The plan lists as general objectives the attainment of increased production and productivity, a more equitable income distribution, increased employment, and reduced dependence on external financial assistance and export markets. Simple historical projections revealed that the above objectives were mutually incompatible unless a strongly accelerated capital formation could be financed out of savings on current account. Taxes as a proportion of gross domestic income would have to increase sharply, mostly at the price of reduced growth in urban consumption expenditure. Imports of durable consumer goods would have to be decreased very substantially as would imports of intermediate inputs and raw materials after domestic industries were established. The establishment of domestic industries would entail a very sharp initial rise in capital goods imports, but these would level off after a five-year period. Under the plan the agricultural sector would receive priority, first, because its rate of growth lagged well behind the other sectors, and second, because expansion of agricultural production was considered the principal means by which rural income levels could be raised. The plan does not detail the economic and legal studies or the investment projects that support the feasibility of the broad strategies sketched in the above paragraphs. It is consistent, however, in that, within an integrated system of national income and public-sector accounts, certain variables can be predetermined if a corresponding number of variables can be adjusted accordingly.

In the light of past experience the supposed flexibilities in the composition of imports, capital formation, and public revenue are doubtful.

The National Planning Institute did not execute or sponsor studies that might have shown how the required flexibility could be brought about. The plan, therefore, presents little more than a normative projection of important macroeconomic and fiscal variables.

Within the Peruvian planning system the agricultural planning office (OSPA) takes its broad directives from the National Planning Institute (INP), but serves simultaneously as an advisory arm to the Ministry of Agriculture. In the latter capacity OSPA had to decide whether the projected income growth and public investment program of INP were sufficiently realistic. The rapid rate of growth in per capital income forecast by INP would, particularly when skewed towards the rural population, accelerate the demand for domestic and imported foods considerably. This in turn would justify a considerable public investment in agriculture, particularly in those regions where the population was predominantly rural. On the other hand, if income growth was relatively low and restricted to the urban areas, as it historically has been, and if the government were forced into an austerity program and devaluation, then both the expansion of demand and the priorities of public expenditure in agriculture would be drastically altered.

Agricultural planning cannot reach an acceptable level of reliability without considerable preliminary research. In Peru few of the necessary basic economic studies have been made, or at least are available. Few opportunities exist to carry out basic research within a planning office, where data must be available at short notice.

The work of the USDA/CONESTCAR contract team was designed to fill, in a modest way, the above gap. This group carried out comprehensive studies producing population, income, price, demand, yield, acreage, and import-export projections as well as Engel curves and gathering data for price elasticities. The agricultural planning office produced corresponding studies on required labor and nonlabor inputs, the required public credit, the required public investment and expenditure that corresponded to three comprehensive groups of supply projections, and the projected availability of public finances for the agricultural sector.

To make projections of the major macroeconomic variables, one of the Thorbecke-Condos macroeconomic models was used.[23] The variables

[23] Erik Thorbecke and Apostolos Condos, "Macroeconomic Growth and Development Models of the Peruvian Economy," in Irma Adelman and Erik Thorbecke (ed.), *The Theory and Design of Economic Development,* Baltimore, 1966. The authors present three alternative models; the one employed in the present study is identified as "Model A." The model was reestimated using 1963 constant price time series.

included in the model are presented below with their corresponding symbols:

X = gross domestic income (GDI)

X^d = disposable GDI

Z = terms-of-trade effects

C = total consumption

C^p = private consumption

C^g = public consumption

I = total gross investment

I^p = private gross investment

I^g = public gross investment

M = total imports of goods and services

E = total exports of goods and services

T = total tax revenues

T^d = direct tax revenues

T^i = indirect tax revenues

It should be noted that GDI is being used instead of GNP or gross national income.[24] This is justified by the importance of the terms-of-trade effects in the past evolution of the Peruvian economy and by the relatively small magnitude of net transfers.

The symbol Z refers to the terms-of-trade effects, defined as the product of the terms-of-trade index and the value of exports at 1963 prices, taking the existing terms-of-trade index in 1963 as a basis and measuring deviations either positive or negative from the 1963 level. Symbolically:

$$Z = \left(\frac{Px_n}{Px_o} \div \frac{Pm_n}{Pm_o} - 1 \right) Qx_n \, Px_o$$

where Px_n and Px_o refer to the unit value of exports in year n and in the base year respectively; Pm_n and Pm_o refer to the unit value of imports in year n and in the base year respectively. Qx_n refers to the volume of exports in year n.

[24] The relationships defining each of these concepts are: GDI = GNP + Z + Net transfers and GNI = GDI + Net transfers.

The model describes the structure of the economy by means of nine equations (for nine endogenous variables) of which four are identity equations defining X, X^d, I and T^i, respectively, and the remaining five are behavioral equations. C^p is regressed on disposable GDI, C^g on total tax revenues, and total tax revenues on GDI. The private investment function depends on exports (E_{-1}) and the terms-of-trade effects (Z_{-1}) both lagged one year. Thus, private investment is determined completely exogenously by the export sector. As the builders of the model point out, "This appears to be a reasonable hypothesis in the case of Peru, given (a) the relative importance of the export sector; (b) the very highly capital-intensive nature of the export sector; and (c) the virtual absence of a domestic capital goods producing sector." [25] Finally, imports are regressed on total consumption and total gross investment. The structural model is presented below:

$$(1)\quad X = C^p + C^g + I^p + I^g + E + Z - M$$

$$(2)\quad X^d = X - T^d$$

$$(3)\quad I = I^p + I^g$$

$$(4)\quad T^i = T - T^d$$

$$(5)\quad C^p = c_o^p + c^p X^D$$

$$(6)\quad C^g = c_o^g + c^g T$$

$$(7)\quad I^p = i_o^p + i_e^p E_{-1} + i_z^p Z_{-1}$$

$$(8)\quad M = mo + m_c(C^p + C^g) + m_i I$$

$$(9)\quad T = t_o + t_x X$$

Equations 1–4 are identities, and 5–9 are the postulated behavioral equations. The variables determined within the system of equations (endogenous variables) are X, X^d, I, T^i, C^p, C^g, I^p, M and T. The predetermined or exogenous variables are E, Z, I^g, T^d, and t_o, where the last three may be catalogued as potential policy instruments in the hands of the government.

The basic data used in the estimation of the model were taken from the INP national income accounts. Values are given in millions of soles at constant 1963 prices. The five behavioral equations were estimated on the basis of a sample consisting of yearly observations for the period 1950–65. Once estimated, the nine equations were solved for the endogenous variables in terms of the exogenous variables. The results are presented in Table 1. The reduced form shows explicitly how the value

[25] Thorbecke and Condos, *op. cit.*, p. 190.

of each endogenous variable is affected by each of the exogenous variables. Each coefficient appearing in the reduced form should be interpreted as the amount by which the respective endogenous variable will change with a one-unit variation in the corresponding exogenous variable. The high responsiveness of X to changes in the export sector variables is reflected in the relative magnitudes of the multiplier effect of a unit change in E and Z and that of I^g. This shows an important linkage between export growth and income growth.

The model appears to describe the evolution of GDI relatively well, since it signals all turning points correctly. It does show, however, a tendency to overreact to changes in the export sector. This is particularly clear for the recession of 1957–58 and the subsequent export boom of 1959–61. These overreactions are largely explained by the model formulation in which investment is solely dependent upon current and lagged exports earnings. Substantial private mining investments occurred precisely in the years in which the model overreacts. For example, in 1953–54 the Marcona mining complex was brought into production, followed by the Toquepala copper mines in 1957–58. The relatively poor prediction of GDI in 1965 and 1966 can be explained for the most part by the very large public foreign capital inflows for those years.

Similar developments must be allowed for when the model is used in projecting the major macroeconomic variables. Projections of the endogenous variables are linear combinations of the projections of the exogenous variables, in our case exports, the terms of trade, public investment, and direct tax revenue. It might have been possible to use the projections of the National Development Plan for this purpose. We did not do so because we felt the INP projection to be too optimistic.

The Peruvian export sector is quite diversified. In 1965 nine primary products accounted for 95 per cent of the total value of exports. (Agricultural exports constituted 23 per cent of all exports in 1965.) With the recent devaluation, cotton exports can be expected to increase moderately because of the drastic increase in the price-cost relationship for that crop. In the case of sugar and coffee, world production will continue to exceed world consumption for some years to come. Apart from this, there is the fact that Peru's foreign markets for these two products are in economically developed countries with low income elasticities and low population growth. Such markets offer little prospect of rapid expansion. A more detailed treatment of individual products may be found elsewhere.[26]

[26] René Vandendries, *El Comercio Exterior y el Desarrollo Económico del Perú*, Iowa Universities Mission to Peru in cooperation with the Agency for International Development, Lima, Peru, 1967.

TABLE 1

"Reduced Form" of the Thorbecke-Condos Model A

Endogenous Variables	Exogenous Variables						
	E	Z	E_{-1}	Z_{-1}	I^g	T^d	Constant Term
X	2.871	2.871	0.930	0.791	1.204	-1.416	21,697.43
X^d	2.871	2.871	0.930	0.791	1.204	-2.416	21,697.43
I	0	0	0.772	0.657	1.000	0	2,895.43
T^i	0.558	0.558	0.181	0.154	0.234	-1.275	-842.68
C^p	1.675	1.675	0.542	0.461	0.702	-1.410	22,894.54
C^g	0.537	0.537	0.174	0.148	0.225	-.265	-2,825.17
I^p	0	0	0.772	0.657	0	0	2,895.43
M	0.342	0.342	0.559	0.476	0.724	-.258	1,267.36
T	0.558	0.558	0.181	0.154	0.234	-.275	-842.68

We project that from 1966 to 1971 exports will accelerate annually from 3.5 per cent in 1967 to 4.5 per cent in 1971. A cumulative rate of 8.2 per cent is projected for 1972 and after, when, as anticipated, the Cerro Verde, Cuajones, and Michiquillay mines become productive.

The terms-of-trade effect was estimated by projecting export and import prices. Export prices characteristically have shown large fluctuations without a definite trend, but import prices have grown steadily. Export prices increased after the recession of the developed economies in the late 1950's and increased to a very high level in 1966 chiefly because of copper prices. We think this trend will level off. Import prices have risen at an average rate of 1.4 per cent per year, and we assumed that they will continued to grow at that stable rate.

Table 2 presents the projected values of the endogenous variables. The annual rate of growth in disposable income is projected at 3.4 per cent between 1966 and 1970, thereafter to accelerate rather sharply. The variables included in the model are not sufficient to project the public sector accounts. On the revenue side they omit nontax revenue and the capital account. On the expenditure side they omit current and capital transfers and the amortization and interest payments on the public debt.

Revenues on capital account were projected separately.[27] Nontax revenue was estimated through a linear regression for the period 1950–64. The total revenue projected for 1970 equals 31.7 billion soles (Table 3). Total public expenditure, by definition, equals total revenue.

From past performance agriculture can be assumed to be a relatively constant proportion of total public expenditure. On this basis public expenditure in agriculture can easily be predicted within a relatively narrow range. We considered three possible percentages. A pessimistic projection would allocate 2.8 per cent of public expenditure to agriculture. At the other extreme, we did not expect this allocation to exceed 3.3 per cent. The intermediate figure, 3 per cent, was thought to be the most probable. Under these hypotheses total public resources available to the agricultural sector in 1970 would range from a low of 889 million soles to a high of 1,047 million soles (see Table 4). The percentage composition of public expenditure within agriculture in 1970 was set equal to the percentage composition of 1966. This yielded a first approximation of projected financial resources available by activities in 1970.

[27] On basis of information furnished by the Dirección de Macroeconomía of INP.

TABLE 2

Projected Values of The Major Macroeconomic Variables, 1966–75

(in millions of soles at 1963 prices)

Variable	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
X	102,175.5	108,420.9	111,545.1	114,118.6	117,154.7	120,018.6	126,574.2	133,808.7	141,544.9	149,796.3
X^d	98,676.9	104,526.9	107,436.9	109,784.3	112,582.1	115,794.5	121,388.5	128,233.9	135,522.0	143,353.9
I	22,058.4	23,905.8	25,494.5	26,435.2	27,605.2	28,912.7	30,173.0	32,207.8	34,410.0	36,777.2
T^i	11,322.2	12,142.3	12,536.2	12,811.0	13,163.6	13,586.3	14,383.6	15,402.7	16,490.3	17,646.8
C^p	67,815.9	71,229.7	72,927.8	74,297.7	75,930.3	77,804.9	81,069.2	85,063.9	89,334.4	93,887.2
C^g	12,251.7	13,421.7	14,006.1	14,489.0	15,057.9	15,706.8	16,822.6	18,177.9	19,627.2	21,173.0
I^p	17,811.3	19,233.1	20,355.5	20,782.3	21,273.1	21,821.8	22,443.1	23,783.0	25,227.2	26,767.7
M	21,667.0	23,448.2	24,723.5	25,555.1	26,575.6	27,724.8	29,133.6	31,141.9	33,304.6	35,621.6
T	14,820.8	16,036.3	16,644.4	17,145.3	17,736.2	18,410.3	19,569.5	20,977.5	22,483.2	24,089.0
C	80,067.6	84,651.4	86,933.9	88,786.7	90,988.2	93,511.7	97,891.8	103,241.8	108,761.6	115,060.0

TABLE 3

Projected Revenue of The Public Sector by Major Sources, 1966–70

(in millions of 1963 soles)

Revenue Categories	1966	1967	1968	1969	1970
Total revenue	26,418.2	28,358.9	29,592.1	30,318.3	31,738.5
Current account	18,669.8	19,954.6	20,662.6	21,310.8	21,995.4
Direct taxes	3,498.6	3,894.0	4,108.2	4,334.3	4,572.6
Indirect taxes	11,322.2	12,142.3	12,536.2	12,811.0	13,163.6
Nontax revenue	3,849.0	3,918.3	4,018.2	4,165.5	4,259.2
Capital account	7,748.4	8,404.3	8,929.5	9,007.5	9,743.1
Public foreign capital inflow	5,916.0	4,774.0	5,715.0	5,007.0	5,364.0
Repayment of development loans	667.4	700.7	735.7	772.5	811.1
Public internal debt	1,165.0	2,929.6	2,478.8	3,228.0	3,568.0

TABLE 4

Public Financial Resources Projected for the Agricultural Sector in 1970, According to Three Public-Expenditure Hypotheses[a]

	Percentage of Public Expenditure in Agriculture		
	2.8	3.0	3.3
Agrarian reform and colonization	173.4	185.8	204.3
Agricultural research, extension and development	129.2	138.4	152.3
Irrigation	146.5	156.9	172.6
National fertilizer corporation	132.1	191.5	155.6
Agricultural development bank	207.1	221.9	244.0
Other	100.3	107.5	118.3
Total public resources in agriculture	888.6	1,002.0	1,047.1

[a]Based on projected public expenditure in 1970 of 31,738.5 million soles (at 1963 prices).

POPULATION GROWTH

Peru can be divided into three natural regions—the Coast, the Sierra, and the Selva. The composition and growth of population have been very different among these regions. The Sierra and Selva are predominantly rural, whereas the Coast is predominantly urban. The rapid growth of population in the first two regions has been fed by a sizeable emigration from the Sierra. Employment opportunities and per capita earnings are very different between these regions, in both the agricultural and nonagricultural sectors. Labor productivity in industrial and related activities is increasing substantially faster than in agriculture. Consequently, the differences in per capita income between the urban and rural population will increase rather than diminish. Such differences, although undesirable, are virtually permanent in a structural sense.

The stated objective of the agricultural development plan is to increase rural incomes in the Sierra through increasing yields of basic food crops. However, financial resources projected available fall short

of permitting more than a one per cent increase in yields of basic food crops. From the foregoing it follows that the increase in per capita rural incomes cannot exceed a moderate annual percentage, unless the current rate of rural-urban migration is at least maintained. A detailed computation of agricultural labor requirements by regions (for projected developments in crop and livestock production) revealed that the current rate of growth in rural population is almost exactly balanced by the projected rate of growth in labor requirements. The projected rate of growth in labor supply is net of migration. Using cross-sectional data we found a fairly close relationship between the level of agricultural productivity and the daily wage rate.

Any retention of agricultural labor supply, not related to labor requirements, will therefore lower the labor productivity and earnings of the agricultural worker. Almost inevitably the gap between the per capita incomes of the urban and rural population will increase. Peruvian planners do not want the public sector to play an entirely passive role in this process. The agrarian reform program is directly aimed at solving the problem of rural poverty. Until now, this process has been slow because the government, by law, cannot appropriate without adequate compensation. Projected available funds for land reform do not permit an acceleration of this fundamental program.

Population projections were carried out in two stages. Official projections were available for urban and rural population,[28] but not for population growth by natural regions. With respect to national population, demographers feel that the decline in mortality rates has entered a stage of deceleration. Nevertheless the average mortality rate for 1980 is projected at less than half the current rate of 14.2 per thousand. During the period 1940–61 the average rate of female reproduction was 3.2. There is no agreement among demographers on the future course of this critical determinant of population growth. The officially adopted population projection anticipates a decrease in the birth rate from 4.41 to 3.81 in the late seventies. Growth of total population is projected at 3.1 per cent annually during the next decade. This is certainly the lowest estimate admissible.

Because of the insufficiency of vital statistics in Peru it proved impossible to establish conclusive differences between urban and rural mortality rates. From 1961 census data, it was determined that rural

[28] See, Ministerio de Hacienda, INP, Dirección Nacional de Estadística y Censos, *Boletines de Análisis Demografico: No. 1—Población del Perú* and *No. 3—Población Urbana y Rural del Perú,* Lima, Peru, 1964–65.

fertility rates were considerably higher than urban fertility rates. Therefore, the projected decrease in the average national rate of fertility could only be sustained by projecting a balanced decrease between urban and rural fertility rates, although there are no *a priori* reasons supporting a decrease in rural fertility rates. The rates of rural-urban migration were estimated through an intercensal comparison. They show an acceleration between the two census years. To avoid the risk of obtaining too rapid a rate of urbanization, current rates of migration were assumed to remain constant for the next twenty years. The resulting projected annual rate of growth in rural population equalled 1.1 per cent as compared to 4.27 per cent for the urban population. Comparatively minor increases in migration rates would reduce the rate of rural population growth to zero.

The composition of the population by three natural regions was obtained on the basis of the census of 1940 and of 1961. Changes in composition among regions between the two census years were assumed to be linear and yielded the projected composition in 1970. Total projected population could then be distributed among regions. Changes in composition between urban and rural population for a given region were assumed to be linear between 1940 and 1961. Using the projected composition for 1970, we distributed the projected total for each region according to rural or urban areas (see Table 5). These projections indicated a very rapid urbanization of the coastal region. A later, independent estimate for the Lima metropolitan area reinforced this observation. Initially, however, we lowered the rate of urbanization on the Coast because of an anticipated shortage in the agricultural labor force. Consequently, the projected rate of growth in rural population tends to be biased upwards, and is larger than the official projection.

TABLE 5

Projected Population Growth for Urban and Rural Areas by Regions, 1960–70
(annual geometric rates)

	Coast	Sierra	Selva	Republic
Urban	4.8	2.5	5.8	4.1
Rural	2.9	1.0	3.9	1.8
Total	4.4	1.3	4.5	3.1

DEMAND PROJECTIONS

The dualistic pattern of economic growth in Peru has created a striking heterogeneity among regions and population groups in respect to the principal factors that determine demand. A demand forecast based on average national parameters would introduce a systematic error. Thus, for example, domestic demand for traditionally imported food products projected from disaggregated data is larger than if aggregate data are used. This error was avoided by disaggregating the forecast.

In the more-developed countries regional differences in per capita income are relatively small. Both the rural and urban population have equal access to a wide variety of food products. This tends to create a homogeneous consumption pattern throughout the country. In Peru, however, the rural population consumes a substantial proportion of what it produces. Generally a few staple crops constitute the bulk of the rural diet, e.g., rice on the Coast, tubers in the Sierra and bananas in the Selva.

Largely on the basis of secondary information [29] we obtained twenty-five typical household consumption profiles distributed by regions and population groups. We found that the differences in per capita consumption between the urban and rural population were large for food groups except for cereals (see Table 6). A regional comparison of per capita consumption of food groups yielded differences of a similar order. The heterogeneity with respect to individual foods was even more striking. However, urban consumption patterns tend to be fairly homogeneous among regions.

The average blue-collar and white-collar family in Peru spend close to 55 per cent of family income on food. We estimated that the urban expenditure-income elasticity for all food equalled 0.8, a relatively high figure when compared with results obtained in other countries. The multiplicity of qualities and forms in which food is marketed con-

[29] See, Carlos Collazos Chiriboga, *et al.*, *The Food and Nutrition Situation in Peru*, República del Perú, Ministerio de Salud Pública y Asistencia Social, and Interamerican Cooperative Service of Public Health, Lima, 1960; Ministerio de Hacienda—*Plan Regional para el Desarrollo del Sur del Perú, Patrones de Consumo en las Ciudades de Arequipa y Cuzco*, Vol. XV, Lima, Peru, 1959—INP, Dirección Nacional de Estadística y Censos, *Encuesta Sobre las Condiciones de Vida de la Familia en: Lima-Callao, Arequipa, Huancayo, Chiclayo e Iquitos, Abril 1964–Marzo 1965* (resultados finales), Lima, Peru, 1966 (private communication); and CONESTCAR, *Hoja de Balance de Alimentos 1964*, Lima, Peru, 1967.

TABLE 6

Indexes of Per Capita Consumption of Major Food Groups by Urban and Rural Areas in Three Natural Regions and Over-all, 1964

(total consumption in Republic = 100)

	Coast			Sierra			Selva			Republic		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Cereals	118	99	114	100	100	100	58	39	45	109	92	100
Tubers and roots	47	44	46	100	162	145	15	116	86	61	137	100
Beans and pulses	62	92	69	110	85	92	128	341	277	80	118	100
Fruits	91	43	81	–	99	28	291	705	580	105	95	100
Vegetables	112	54	99	276	54	113	63	12	27	155	49	100
Fats and oils	190	117	174	141	21	55	40	34	36	167	39	100
Dairy products	146	79	131	226	6	68	9	73	54	162	26	100
Meats	136	87	25	154	37	70	142	167	158	142	61	100

tributes to substantial price differentiation between income groups. Quantity-income elasticities are therefore substantially smaller than expenditure-income elasticities. The primary data underlying the econometric analysis of a number of household expenditure surveys were made available by the Ministry of Health and the Dirección Nacional de Estadística. A family of Engel curves was estimated for every basic commodity for each of the twelve cities for which data were available. Surprisingly, the double-logarithmic curve ranked above the other possible expenditure-income relationships in terms of a weighted criterion that included the coefficient of determination, the additivity property of individual product relations into group expenditure curves, and the additivity of individual product elasticities into a weighted group average. Constant-expenditure elasticities imply that the percentage composition of household expenditure changes with increasing per capita income. Nevertheless, when we made a detailed comparison for Lima between the household expenditure data of 1934 and 1964, we found that the percentage composition of the blue-collar and white-collar food budget had changed very little.[30] To assume that real income per capita had not risen for these numerically important income groups seemed unduly pessimistic. The difference must rather be sought in compensating changes in prices for food relative to nonfood.

A more precise formulation can be obtained as follows. With a double-logarithmic demand function the proportional rate of growth in food consumption will be a linearly weighted function of the proportional rates of growth in food and nonfood prices and per capita income in current prices. The weights are the respective price and income elasticities. From the above relationship the proportional rate of growth in food expenditure is easily derived by adding the proportional rate of growth in the price of food. Given that the expenditures on food and nonfood have increased at equal rates the following relationship must hold

$$p_f = \frac{1 + e_f + e_{nf} + E_f}{1 + e_f + e_{nf} + E_{nf}} p_{nf} + \frac{E_{nf} - E_f}{1 + e_f + e_{nf} + E_{nf}} y$$

where e indicates a direct price elasticity and E an income elasticity. The subscript f refers to food and the subscript nf to nonfood products. The lower-case letters p and y indicate the proportional rates of growth prices and per capita income, both in current prices. For Lima the total-expenditure elasticity on food equalled 0.79 and the

[30] The detailed data of the 1934 household expenditure survey were made available by the Dirección Nacional de Estadística y Censos.

TABLE 7

A Complete Scheme of Direct and Cross-Price Elasticities

	Prices		Expenditure Elasticities
	Food	Nonfood	
Food quantities	-.70	-.09	0.79
Nonfood quantities	-.31	-.91	1.22
Budget proportions	.51	.49	1.00

direct-price elasticity for all food equalled -0.7. The percentage of the total expenditure on food for Lima is 51. Thus, given that the weighted sum of the expenditure-income elasticities must equal unity, it follows that the expenditure-income elasticity for nonfood equals 1.22. No direct estimate of the price elasticity of nonfood was available, but this parameter can be deduced from the interrelationships that must hold among the direct and cross-price elasticities within a complete system of such parameters (Table 7).[31]

Substituting the appropriate parameters in the former formula gives

$$p_f = .3\, p_{nf} + .7\, y$$

In a purely inflationary situation food prices, nonfood prices, and per capita income in current prices should all increase proportionately and not affect the allocation of total income between food and nonfood expenditure. Since the complete scheme of elasticities was elaborated on the assumption that the consumer is not subject to money illusion, the above-derived equation should possess a similar quality. The reader may verify that if $p_f = p_{nf}$, then $y = p_f = p_{nf}$. When referring to personal disposable income the consumer price index for Lima-Callao has usually been suggested as the proper deflator. When considering the food and nonfood items we find that in the period 1950–54 to 1960–64 the consumer price index of food increased at 8.2 per cent annually, whereas the price for nonfood increased at 5.3 per cent annually. Suppose that real per capita incomes have increased for the blue- and white-collar workers in the Lima-Callao area over the years. This means that

[31] Ragnar Frisch, "A Complete Scheme for Computing All Direct- and Cross-Demand Elasticities in a Model with Many Sectors," *Econometrica*, Vol. 27, pp. 177–196, April 1959.

per capita income in current prices must have increased more than the weighted sum of the indexes of food prices and nonfood prices, i.e., we have respectively

$$p_f = .3\, p_{nf} + .7\, y \tag{1}$$

$$p_f > p_{nf} \tag{2}$$

$$y > .51\, p_f + .49\, p_{nf} \tag{3}$$

Since above equations are expressed in proportional growth rates we can write another equation, 2b from equation 2, as follows: $p_f + d = p_{nf}$, where d is the difference in the proportional rates of growth of nonfood prices and food prices respectively. If food prices have increased faster than nonfood prices, d should be negative. Similarly equation 3 can be transformed into an equality by adding a parameter z

$$y = .51\, p_f + .49\, p_{nf} + z \tag{3b}$$

If real per capita income has increased, the parameter z should be positive. After substituting equations 2b and 3b into equation 1 we obtain

$$z = -.92d$$

For the period 1950–54 to 1960–64 d equalled approximately -2.9, and consequently real per capita incomes in the Lima-Callao area must have increased at 2.7 per cent annually for that same period.

Consumption patterns for the Lima metropolitan area are such that a quantity-weighted index will give proportionately larger weights to tubers, fruits, and vegetables, all of which are minor expenditure components of the typical blue-collar and white-collar food budget. On the other hand, an expenditure-weighted index will give proportionately larger weights to meats and milk products, although in terms of quantities bought both groups are small relative to tubers, cereals, fruits, and vegetables. Since the retail price of meats and milk products is determined in international markets, an expenditure-weighted index for Lima-Callao is dominated by imported food products, particularly beef. On the other hand, a quantity-weighted index is dominated by domestically produced food.

The quantity-weighted index has increased less than the expenditure-weighted index. In other words, prices of domestically produced foods increased less on the whole than prices of imported foods between 1950–54 and 1960–64. The domestic price of the latter is determined by the strength of the Peruvian Sol relative to the U.S. dollar and by

the price trends, in terms of U.S. currency, in international markets. Trends in the dollar price of imported foods are best measured by taking the ratio of the value of food imports in current dollars to the value of imports expressed in 1963 dollars. This ratio has been virtually constant for the period 1950–64. Consequently, domestic increases in the price of imported foods stemmed principally from the periodic devaluations of the Sol (i.e., in 1953, 1957, 1958, and 1967). On the other hand, price increases for domestically produced goods reflect a purely inflationary component coupled with the effects of shifts of the aggregate demand and supply curves for domestic food. If, after separation of the inflationary component, the price of domestically produced food should show a long-run tendency to increase, it could be argued that the rate of growth in demand for domestic food, at given prices and marketing margins, was larger than the rate of growth in supply of domestically produced food. Evidently the proper choice of what represents the "purely inflationary component" is of critical importance in the above calculation.

When we take the consumer price index for Lima-Callao as equivalent to the purely inflationary component, we know that the consumer price index for domestically produced foods has increased between 7.3 and 8.2 per cent annually in the period 1950–54 to 1960–64. This range indicates a relatively small, but systematic increase in the deflated price of domestically produced food since the latter index rose more than the over-all consumer price index. The observed price increase may stem from increased marketing margins or lagging domestic production not compensated by imports. A comparison of the index of farm prices received for food and livestock products [32] and the Lima-Callao consumer food price index, indicates that, whereas the former index increased at 5.3 per cent annually between 1951–55 and 1960–64, the latter increased at 8.2 per cent annually between 1950–54 and 1960–64. The difference between these estimates is so large that it raises serious doubts as to the accuracy of the observations on farm prices received for food and livestock products. Ignoring the preliminary evidence on the growth of marketing margins, we will assume that the increase in the consumer price of domestically produced food was due to lagging domestic production. The direct price elasticity for all food in the Lima-Callao area was estimated to be -0.7. An increase of $.9 \times .7 = 0.63$ per cent in the growth rate of the domestic supply would have eliminated the observed increase in the deflated price of food.

[32] Ministerio de Hacienda, INP, Dirección Nacional de Estadística y Censos, *Indices de Precios al Consumidor–Lima Metropolitana–Callao,* Lima, Peru (published quarterly since 1935).

Thus, on the whole, it can be argued that, except for those commodities for which imports supplemented lagging domestic production, domestic supply must have responded adequately to domestic demand. This is true for corn, rice, barley, tubers, roots, fruits, vegetables, poultry meat, eggs, pork, and mutton. With the recent rate of growth in population at close to 3 per cent annually, and the demand for food quite elastic in respect to both income and price, the effective aggregate demand for food must have grown at least at 4.5 per cent annually. The above analysis would thus cast doubt on a large body of professional opinion within the Peruvian public sector which considers agricultural supply to be a major bottleneck in economic development, at least insofar as urban food provision is concerned. It also brings into question the accuracy of agricultural production statistics (and their derived consumption series), since they indicate a virtual stagnation in domestic food crop production in recent years. A passive supply projection using the more recent historical series (last six years) tends to be very gloomy with respect to the projected performance of the agricultural sector. When it takes into account a larger historical series (from 1950, for example), the projected performance is considerably more optimistic, but still underestimates the independently calculated rate of growth in demand.

According to our projections the GDI will increase at an annual rate of 5.1 per cent between 1960–64 (average) and 1970. The bulk of this income formation is projected as restricted to the urban areas. Growth of rural per capita income is primarily determined by the growth in value of agricultural production. We did not use historical rates of rural income formation but preferred a supply hypothesis that assumed a one per cent general productivity increase in agricultural production per hectare per year. Even so, rural per capita incomes are projected to increase only slowly, being virtually stagnant in the Sierra. The above projections are not very optimistic, because they offer little hope of having a measurable impact on rural poverty, particularly in the southern and central Sierra.

The Agricultural Planning Office (OSPA) drew up a set of comprehensive supply projections that showed a marked acceleration in gross agricultural production for food crops in general and for the Sierra in particular. These projections rationalize the philosophy behind the National Development Plan. The projections are not consistent, however, with a regional equilibrium of commodity flows. The considerable acceleration in rural demand would concentrate on those products in which supply would expand relatively least (livestock products, fruits, and vegetables). On the other hand rural demand would expand least

in those products in which supply would expand relatively most (tubers, roots, cereals). Rural consumers would compete with urban workers for a limited domestic supply of livestock products, fruits, and vegetables, using as payment the marketable surplus in tubers, roots, and cereals. The Sierra would become a net importer of livestock products and a net exporter of cereals—a reversal of traditional commodity flows.

We did not have the necessary price-quantity relationships to work out the precise equilibrium solution. For the larger cities the direct price elasticity for all food equalled −0.8. The direct price elasticity for cereals was −0.4 and for tubers and roots −0.7. Commercial margins for farm products are a multiple of the on-farm value. Consequently market demand at the farm level is quite price inelastic for crops like tubers, roots, and cereals. The projected surplus over home consumption and urban demand would actually yield a decreasing cash income. Undoubtedly, this would tend to defeat the government's effort to expand production beyond an economically justifiable limit. Table 8 presents the projected annual growth rates in per capita GDI used in the demand projections.

Table 9 presents the projected cumulative annual growth rates in quantitative demands for various food groups by the rural and urban population in each of the four regions between 1960–64 and 1970. It can be seen that the demand for food will grow almost explosively in both the coastal region and Selva, while the Sierra registers a substantially lower expansion. For the Republic, as a whole, demand in almost all food groups will expand at a rate well beyond 4 per cent per year. The agricultural sector must have a considerable capacity to expand production if it is to meet this challenge. Because of the pattern of income and population growth, the demand for the staple food crops of

TABLE 8

Projected Growth in Per Capita Gross Domestic Income, Urban and Rural, by Regions, 1960–64 (average) to 1970

(annual geometric rates)

	Coast	Sierra	Selva	Republic
Urban	3.9	1.8	2.7	3.2
Rural	2.0	0.5	2.0	1.0
Total	3.5	0.9	2.2	2.1

TABLE 9

Projected Cumulative Growth in Demand by Food Groups for The Rural and Urban Population, in Three Natural Regions, 1960–64 to 1970

(in per cent per annum)

Commodity Group	Coast			Sierra			Selva			Republic		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Cereals	6.2	3.7	5.8	3.3	1.3	1.8	6.6	5.2	5.8	5.3	1.8	3.6
Tubers and roots	3.2	3.7	3.3	3.3	1.2	1.8	3.4	4.2	4.2	3.2	2.1	2.5
Beans and pulses	6.4	4.5	5.8	3.3	1.2	2.4	6.8	4.9	5.1	4.9	2.7	4.0
Fruits	8.7	5.4	7.8	4.2	1.8	4.2	6.9	4.3	4.6	6.8	4.4	5.6
Vegetables	7.4	5.1	7.2	3.6	1.4	2.9	8.1	5.3	8.4	5.6	2.3	4.8
Fats and oils	6.6	3.1	6.1	3.7	1.3	2.6	7.6	4.6	5.4	6.1	2.5	4.6
Milk and dairy products	7.8	4.8	7.5	3.1	1.5	2.2	8.3	5.9	7.8	6.9	2.3	5.6
Meats	7.8	4.6	7.4	2.4	0.1	1.1	8.0	8.0	8.0	6.5	3.6	5.4

the Sierra grows relatively the least, while the demand for the typical food crops of the Coast and Selva will grow relatively the most. Consequently, in agricultural promotion programs consideration might well be given to a reallocation of resources determined by future deficits in domestic production. This would almost certainly increase the proportion of public expenditure allocated to the Coast, an increase that would be in the interest of the urban consumer. On the other hand, increased allocation of public expenditure in the Sierra is the only active instrument available to the government to alleviate rural poverty. Whether public expenditure should be used to promote urban or rural interests is essentially a political decision. In the past the government has tried to satisfy both the urban consumer and rural food producers. We predict a continuation of that compromise.

Projection of Land Productivity

Except for export crops, average yield levels have been virtually constant between 1950 and 1964. Percentage changes in annual productivity fell within a range of 0.5 per cent around a zero average. Considering that agricultural statistics in Peru contain a large error of observation, it would be defensible to maintain that neither group of crops showed significant productivity increases. This fact conditioned our assumptions concerning possible increases in the future. We consider that within the period 1960–64 to 1970 productivity increases cannot reasonably exceed a cumulative rate of 2 per cent per year. Individual crops may exceed this rate, as may groups of crops, but the rate of growth in the aggregate yield index will fall within the upper limit of 2 per cent. Indeed, it might have been more realistic to accept the historical rate of increase of close to zero per cent. The aggregate yield index and its components show, however, a relatively low value for the mid 1950's when compared to either the early 1950's or early 1960's. A yield index for the years 1956–64 would show an over-all productivity increase equal to approximately one per cent per year.

Reporting of agricultural statistics does not involve a direct field-sampling of yield levels. Estimates by districts for basic crops were reported annually by part-time field investigators. Both the number of field reporters and the means of transporting them were limited in relation to the magnitude of the task. Communicaton between workers in the field and in the Ministry of Agriculture lacked feedback. Certain obvious errors were corrected after receipt of field data but no trend analysis, comparisons with previous years, or secondary sources were consulted

in constructing the final series. Since the field staff was subject to a high rate of turnover and received little guidance or material support from headquarters in Lima, year-to-year reports show fluctuations that are unacceptable by any criterion. Aggregation of district data into departmental data still gives unacceptable results. A correlation analysis of yield trends between departments produced coefficients of determination very close to zero. A correlation analysis of yield trends between crops within the same department also gives nonsignificant results.

Analysis of each series at the departmental level was therefore not possible. Nor did we think that detailed considerations of each year at the national level would be useful. Instead, we choose to compare the beginning and ending five-year periods of the fifteen-year series 1950–64. We felt that a wider historical perspective was more likely to reveal true long-term trends. Standard linear-regression analysis on the same data resulted in coefficients of determination that, in the majority of cases, were not statistically significant, confirming implicitly that no statistically significant trends would be detected. In many cases, trend coefficients were obtained that indicated either rapid productivity increases or decreases. Despite their magnitude such coefficients would have been acceptable under the hypothesis that the true trend coefficient equaled zero.

The simplest hypothesis, for projection purposes, was that, for the majority of the eleven basic crops, yield productivity had not increased between 1950 and 1964 and that the next ten years would see a continuation of this stagnation. (For a few crops known to have been characterized by continuous adoption of yield-improving varieties and commercial inputs, a discretionary productivity increase could have been determined.) We did not seriously consider adopting this simple hypothesis because it appeared too pessimistic for use in long-term projections.

There remained two alternatives: (1) to take the basic data seriously and devise a method of analysis that would filter out the erratic nature of the data, or (2) to consult with agronomists and other experts and compile, in some systematic manner, their views on the probable improvements in yield levels. We explored both alternatives but adopted alternative one. In a series of meetings sponsored by the Agricultural Planning Office (OSPA),[33] technical experts of the Ministry of Agriculture set down their views on probable short-run yield improvements. These experts were drawn principally from the Agricultural Research,

[33] Ministerio de Agricultura, OSPA, *Previsiones del Desarrollo de la Oferta y de la Demande de los Productos Agropecuarios 1967–1970,* Lima, Peru, 1967 (mimeo.).

Extension, and Development Service (SIPA), the Office of Land Reform and Colonization (ONRA), the Agricultural Credit Bank (Banco de Fomento Agropecuario) and various organizations representing producer interests. The estimates presented by these technicians were uniformly optimistic. There are two explanations for this. First, many of the experts tended to confuse yield potential with probable yields. Their personal experience was mostly with experimental yield improvement, and it proved to be impossible to translate this knowledge systematically into a forecast of actual yield improvements. Second, some of the estimates were undoubtedly influenced by the desire to get additional funds for their respective agencies' growth. This created pressure to overestimate program impacts and to underestimate the costs of carrying out stated objectives.

As a substitute for the above procedure we explored three general yield hypotheses, i.e., the yield index of the eleven basic food crops was assumed to increase respectively at zero, 1, or 2 per cent per year. The projections were carried out in two independent stages. The first stage was the selection of one of the above three general productivity hypotheses. The second stage consisted in projecting the component crops of the yield index. Once the general yield index is selected, these component projections can be used to compute the projected yield level of individual crops or the projected yield index of groups of crops.

The important feature of this method is that once the general productivity hypothesis is chosen, all yield levels are simultaneously determined. This does not mean that all yields will increase proportionately. On the contrary, some will increase substantially more than the average, while others may actually decrease. However, all individual crop yields are assumed to vary positively in accordance with the magnitude of the general productivity hypothesized. Hence, under the 2 per cent general productivity hypothesis all crop yields will increase faster (or decrease less) than under the one per cent hypothesis. There is good reason to be suspicious of any long-run productivity increase exceeding a rate of 4 per cent per year for any particular crop. For groups of crops the long-run productivity increase cannot reasonably exceed 2–3 per cent per year. On the other hand, with a great many crops using a minimum level of commercial inputs, one should be skeptical of long-run productivity decreases exceeding more than 2 per cent per year for particular crops or zero per cent for groups of crops.

With the method of simultaneous projections adopted, it was not necessary to invoke the above qualitative considerations. Projected rates of yield increases all fell within preestablished limits. While the projected

yield increases may have a margin of error, we think it the best possible estimate in view of the nature of the basic data.

Division of Peru into three regions based on ecological criteria—the Coast, Sierra, and Selva—is also useful for analyzing the development of agricultural supply in the last two decades. Yields for the same crop have increased at different rates in the three regions, and are likely to continue to do so for the next ten years. The explanation must be sought in the radical differences between these regions in respect to socio-economic conditions, natural productivity of the land, transportation costs, and government involvement in agriculture. Most of the above differences have a persistence that will carry them well beyond the horizon of the development plan.

There are activities such as agricultural extension and development, agrarian reform and agricultural credit that are in the domain of public policy and can therefore be redirected at will. However, the Peruvian government has not disposed of the necessary funds, nor even chosen to reallocate what funds are available, in such a fashion that increases in productivity of the existing land base would be maximized. In our projections we assume a continuation of that choice, since the need for productivity increases will continue to be small relative to the social necessity of agrarian reform and to competing activities in irrigation and colonization. On balance, therefore, a historical projection is likely to capture the principal effects of the conditions that influence land productivity. Furthermore, the strategic issues in agricultural development planning and foreign aid are centered around the relationship of cost of productivity increases to cost of land expansion. In this study, national production was estimated as the sum of independent projections in yield and acreage, where possible, on a regional basis.

Yield levels were first projected at the national level only. The national yield projections were then translated into projected yield levels by natural regions. The three general hypotheses as to projected increases in over-all productivity at the national level could then be translated into a set of specific yield projections for eleven basic crops by three natural regions (see Table 10).

Table 11 is based upon the detailed project plans of the agricultural promotion service (SIPA) for the year 1970.[34] From this it can be seen that the land area involved in extension programs is approximately 8 per cent of the projected total cultivated area for that year. The area per farm unit subject to extension will average 1.2 hectares, indicating that the extension effort is to be directed largely towards small farmers. If

[34] See, SIPA, *Proyectos de Incremento de la Producción 1967–1970.*

TABLE 10

Projected Growth in Yields Per Hectare of Eleven Basic Crops by Natural Regions, 1960–64 to 1970, According to Three General Productivity Hypotheses[a]

(in per cent per annum)

	Coast			Sierra			Selva			Republic		
	H_1	H_2	H_3	H_1	H_2	H_3	H_1	H_2	H_3	H_1	H_2	H_3
Tubers and roots												
Potatoes	2.5	2.9	3.9	-0.7	0.5	1.5	–	–	–	-0.5	0.6	1.6
Sweet potatoes	3.6	4.6	5.1	2.1	3.1	3.1	0	0	0.6	3.3	4.2	4.7
Manioc	-1.1	-1.0	0	-0.6	-0.1	0.4	-2.6	-2.2	-1.6	-2.2	-1.8	-1.4
Cereals												
Wheat	1.6	1.1	2.9	-0.1	1.1	2.1	–	–	–	-0.1	1.1	2.1
Barley	-1.1	-0.6	0.9	-1.5	-0.4	0.6	–	–	–	-1.5	-0.4	0.6
Corn	2.2	2.6	3.9	-0.2	0.6	1.6	-0.9	0	1.0	1.1	1.7	2.9
Rice	-0.2	0.8	1.8	1.3	1.3	1.3	0.6	1.6	2.6	-0.1	0.9	2.0
Beans and pulses												
Beans	1.8	1.8	2.1	1.3	1.4	2.5	-0.3	0	0.7	1.2	1.4	1.9
Horse beans	0.4	1.4	2.2	–	–	–	–	–	–	0.4	1.4	2.2
Industrials												
Cotton	1.4	1.6	1.8	2.1	2.3	2.7	-2.4	-2.7	-2.8	1.4	1.6	1.7
Sugar cane	1.1	2.8	3.5	–	–	–	–	–	–	1.1	2.8	3.5

[a] H_1, H_2, and H_3: zero, 1, and 2 per cent, respectively, annual increase in productivity per hectare over planning period.

TABLE 11

Projected Impact of Agricultural Productivity Programs on Yield Levels by 1970

Basic Food Crops	Land Area (thousands of hectares)			Yield Per Hectare (kilos)			On-Farm – Value of Productivity Programs (millions of 1963 soles)
	Without Promotion	With Promotion	Total	Without Promotion	With Promotion	Weighted Average	
Cereals							
Corn	396.7	39.4	436.1	1,534	2,519	1,600	67.6
Rice	96.4	13.8	110.2	4,103	4,759	4,185	19.8
Barley	179.0	7.1	186.1	907	1,794	941	10.1
Wheat	142.7	7.9	150.3	976	1,856	1,018	12.3
Quinua	20.3	2.9	23.2	994	1,596	1,069	5.1
Total cereals	835.1	71.1	905.9	1,588	2,770	1,669	114.9
Tubers and roots							
Potatoes	262.6	26.9	289.5	5,678	9,485	5,996	159.6
Sweet potatoes	12.4	0	12.4	15,736	–	15,736	–
Manioc	64.8	0	64.8	9,602	–	9,602	–
Oca-olluco	29.6	0	29.6	2,933	–	2,933	–
Total tubers and roots	369.4	26.9	396.3	6,484	9,485	6,662	159.6
Beans and pulses							
Beans	49.1	6.8	55.9	1,046	1,393	1,088	9.0
Broad beans	34.8	2.0	36.8	1,214	1,774	1,244	2.1
Horse beans	1.0	2.8	3.8	1,052	1,544	1,415	6.1
Peas	25.1	0.9	26.0	1,173	1,572	1,187	1.0
Chick peas	7.5	0.7	8.2	758	994	778	1.0
Lentils	2.3	0.3	2.6	934	1,288	975	0.5
Total beans and pulses	119.8	13.5	133.3	1,101	1,470	1,138	19.7
Total basic food crops	1,324.3	111.5	1,435.5	2,910	4,233	2,998	294.2

Source: Ministry of Agriculture: Servicio de Investigacion y Promocion Agraria (SIPA), "Proyectos de Incremento de la Produccion" (varios productos), Lima, 1967.

these programs are not carried out, the yield level of cereals projected for 1970 would have to be lowered by 5 per cent, that of tubers and roots by almost 3 per cent, that of beans and pulses by a little over 3 per cent and that of all basic food crops by 3 per cent. Since 1960–64 is the base period of the above projection, the induced acceleration in yield increases through public productivity programs is less than 0.5 per cent annually. In terms of 1964 farm prices the additional farm value produced in 1970 would equal 294 million soles.

The financial resources projected necessary to carry the programs out in 1970 equal 162 million soles in terms of 1964 prices (see Table 12). These figures suggest that the cost and return relationships in productivity programs are satisfactory. Additional food production can therefore be obtained in a straightforward manner through funds allocated in agricultural research and extension. The Peruvian government however has not put a high priority on this objective.

In order to achieve an annual 2 per cent increase in the yield index of eleven basic crops, approximately 460 million soles would have to be allocated to the agricultural research and extension service in 1970. Available expenditure in 1970 for all programs of the Agricultural Extension and Research Service (SIPA) is projected to be within a range of 130–150 million soles (see Table 4). However, only a fraction of this will be allocated to cereals, tubers, roots, beans, and pulses since the momentum of other existing programs will also have to be maintained.

TABLE 12

Projected Financial Resources Required in 1970 to Achieve Productivity Levels According to Stated General-Productivity Hypotheses

(in millions of 1964 soles)

Projected Public Expenditure	Cereals	Tubers	Beans and Pulses	Total
Required to achieve Hypothesis 2	125.8	75.8	4.9	206.5
Required to achieve Hypothesis 3	276.7	160.1	23.1	459.9
By Agricultural Extension Service	77.7	47.8	36.1	161.6
Available	–	–	–	52.5

TABLE 13

Projected Financial Resources Needed for Eight Productivity Programs of The Agricultural Extension and Research Service by 1970

(in millions of 1964 soles)

	Total	Administration	Investigation	Extension	Crop Development	Livestock Development
Cereals	77.7	14.7	18.4	30.9	13.2	–
Tubers	47.8	8.3	9.3	17.4	12.7	–
Beans and pulses	36.1	5.5	7.4	11.6	11.7	–
Fruits	51.5	9.1	19.1	11.2	12.0	–
Vegetables	14.0	2.0	2.5	4.2	5.3	–
Poultry	30.7	4.1	3.0	8.7	0.7	14.2
Beef and milk	55.2	7.1	15.0	3.0	2.0	28.2
Sheep and Alpaca	24.4	3.5	2.9	7.4	0.7	10.0
Total products	337.5	54.4	77.4	94.5	58.3	52.3
Total SIPA	462.3	74.6	106.1	129.4	79.9	71.7

Source: See Table 11.

The financial resources required by all of the planned programs of SIPA in 1970 would equal 462 million soles (see Table 13). Cereals, tubers, beans and pulses constitute only 35 per cent of the total SIPA budget. Since the financial resources available for SIPA will probably not exceed 150 million soles, the proposed programs cannot be executed on the scale originally planned. Assuming a proportional cutback in all programs, the expenditure available for those in cereals, tubers, beans, and pulses is projected not to exceed 52.5 million soles, indicating that allocated public expenditure is too small to have a notable impact on productivity improvement. Of the total funds available to SIPA approximately 28 per cent are put into extension, the rest being used for research, development, and administration. On a regional basis plans are for approximately 40 per cent to be allocated to the Sierra, 24 per cent to the Selva, and the remaining 36 per cent to the Coast (see Table 14).

As projected,[35] the allocation of funds among programs, activities, and

[35] Ministerio de Agricultura, SIPA, Oficina de Planeamiento, Programación y Presupuesto, *Gastos Según Programas Por Departamentos, Julio 1962–Junio 1966*, Lima, Peru, 1967 (memorandum submitted to the Agricultural Sectoral Planning Office).

TABLE 14

Projected Percentage Composition of Expenditure on Extension and Development Programs by Regions in 1970

	Coast	Sierra	Selva	Republic
Administration	27.2	39.5	33.3	100.0
Research	14.0	44.6	41.4	100.0
Crop development	74.0	21.3	4.7	100.0
Livestock development	27.9	41.4	30.7	100.0
Extension	36.1	52.3	11.6	100.0
Total	35.1	40.9	24.0	100.0

Source: See Table 11.

regions is not necessarily optimal, because of the extent to which such allocations are necessarily governed by political and professional interactions. We are now completing a regional linear-programming model for potatoes in order to determine the optimum allocation of public investment funds consistent with (1) a maximum increase in production for a given total public expenditure in extension and development programs, and (2) projected changes in demand, supply, and costs of production. By comparing the actual allocation with the optimal allocation we hope to obtain a dollar estimate of the potential monetary benefits foregone under the present allocation. The recently introduced Agricultural Promotion Law calls specifically for land use zoning along the foregoing lines. By systematically executing similar studies on other crop and livestock programs we hope to obtain a more rational allocation of agency funds among the various programs. However, this still leaves unsettled the strategic planning decision concerning the balance between administration, research, development, and extension.

PROJECTED LAND EXPANSION

The land and water available in Peru are adequate to the needs of domestic production. Other Latin American countries, however, possess a much more accessible agricultural-resource base than Peru. Agricultural land under cultivation in 1964 equalled 2.1 million hectares. Half of this

was in the Sierra, one-third in the Coast, and the rest in the Selva.[36] The land/man ratio in Peru is low when compared to other countries, developed or underdeveloped. One of the first tasks of the Agricultural Planning Office (OSPA) was to elaborate an inventory of land expansion projects. This was released by the Peruvian government as part of a plan to increase cultivated area by one million hectares by 1975.[37] There does not appear to be a strong need for such a drastic increase. In fact the rate of actual land expansion created through public investment is lower now than in the preceding fifteen years.[38] We feel that the concept of land/man ratio must be interpreted very cautiously. In itself, it does not indicate land scarcity or land surplus.

Livestock contributes only 25 per cent to the gross value of agricultural production. Sheep, hogs, and poultry are of minor importance. Most of the cattle and sheep are raised and fattened on the natural pastures of the Sierra highlands. Only the poultry industry has created a derived demand for feeds such as corn, but this crop must compete with the byproducts of rice, wheat, and cotton. Apart from export crops, cultivated land in Peru produces crops destined for direct human consumption. A relatively small acreage is therefore sufficient to meet the needs of domestic demand.

The land/man ratio is a fairly stable coefficient for a given country. This coefficient is subject to a secular trend, which while it cannot always be easily explained, is certainly predictable. Cultivated land expands because there is a demand for food and industrial crops. Whether this demand is generated domestically or externally makes little difference. The demand is met either through productivity increases on existing land or through expansion of the land base. In most underdeveloped countries increased demand for agricultural products has been met traditionally through expansion of the land base. Peru is no exception. Large areas, particularly in the Selva, have only recently been explored, and a land inventory for Peru is of necessity subject to constant upward revision. Coupled with the absence of hard knowledge about unexplored areas, there exists the uncertainty about the agricultural potential of traditional production areas. The report of a recent study by ONERN on Puno mentions that the agricultural potential of the *Altiplano* for crop use has been considerably underestimated.[39]

[36] CONESTCAR, *Estadística Agraria Perú 1964*, Lima, Peru, 1965.

[37] Ministerio de Agricultura, OSPA, *Inventario de Proyectos para Incrementar el Area Cultivada en un Millón de Hectareas*, Lima, Peru, 1965.

[38] José A. Salaverry Llosa, *Superficie Agropecuaria—Uso Actual y Potencial*, CONESTCAR, Lima, Peru, 1967 (mimeo.).

[39] ONERN, *Programa de Inventario y Evaluación de los Recursos Naturales del Departamento de Puno*, Vol. 5, Lima, Peru, 1965.

It is generally conceded that Peruvian agricultural statistics underreport the actual acreage under cultivation, particularly for the Sierra and the Selva.[40] Even in the coastal area land growth has been considerably underestimated, and it is only in the last two years that comprehensive cartographic surveys have revealed true land use. It is not therefore a question of whether Peru's land potential is exhausted, but rather of whether, in meeting growing demand, economic conditions will dictate a new trend towards productivity increases or a continuation of the former pattern of new land development. The public sector can have an influence in determining which direction will be taken, but it cannot by its own efforts insure the final outcome in terms of production achieved.

With respect to the land/man ratio there is an historical trend from which we decided not to deviate too radically. A geometric projection taking 1953 and 1962 as base years would have put the land/man ratio for the eleven basic crops at 0.1385 in 1970. The actual value adopted equals 0.1272 (see Table 15). This more conservative estimate resulted from the following considerations. The area for industrial crops in the coastal region has shown a considerable slowing down in its rate of expansion; in fact we project this area in 1970 to be slightly smaller than its 1960–64 average size. On the other hand, coastal population is growing well above the national average. This will cause a rapid expansion in the market for domestically grown food crops in the coastal region, an expansion accelerated by adverse market conditions for export crops. Hence, it seemed reasonable, in view of the substitution of food crops for cotton in land utilization, to set the land/man ratio for food crops in the coastal region at slightly below the indication of its historical trend. On the other hand, there was no need to deviate from the historical trend in regard to cotton, whose falling land/man ratio reflects a considerable decline of the relative importance of this crop.

Cultivated acreage in the Sierra is almost exclusively allocated to food crops. Certain valleys produce a substantial quantity of products that are consumed in the urban centers of the coastal region and the Sierra.[41] Nevertheless, in the absence of statistics on interregional trade movements, it seemed prudent to assume that in the Sierra cultivated acreage would expand almost proportionally to population. This puts no undue

[40] See Eduardo Watson Cisneros, *Situación de las Estadísticas Agropecuarias en el Perú,* CONESTCAR, Lima, Peru, 1964; and Shane Hunt, *Peruvian Agricultural Production 1944–1962,* Report submitted to the National Income Accounts Division of the Central Reserve Bank of Peru, Lima, 1963.

[41] Ministerio de Agricultura, SIPA, Oficina de Estudios Economicos, *Abastecimiento y Promedio de Precios de Productos Agrícolas en las Campãnas Agrícolas 1956–1965,* Lima, Peru, 1966.

TABLE 15

Historical and Projected Land/Man Ratios by Regions

(in hectares per person)

Land/Man Ratio	Coast			Sierra			Selva			Republic		
	1951–55	1960–64	1970	1951–55	1960–64	1970	1951–55	1960–64	1970	1951–55	1960–64	1970
Total population into:												
Total transitory crops	.1245	.1206	.0889	.1738	.1701	.1698	1.0366	1.1152	1.1030	.1508	.1438	.1272
Food crops (except fruits & vegetables)	.0486	.0479	.0457	.1727	.1687	.1695	.8827	.9811	1.0409	.1221	.1132	.1069
Industrial crops (except coffee)	.0759	.0727	.0432	.0011	.0014	.0003	.1539	.1341	.0621	.0287	.0306	.0203
Rural population into:												
Total transitory crops	.4302	.4982	.4099	.2411	.2459	.2556	1.3785	1.5511	1.5986	.2644	.2810	.2712
Food crops	.1681	.1977	.2107	.2396	.2438	.2551	1.1738	1.3645	1.5086	.2141	.2213	.2280
Industrial crops	.2621	.3005	.1992	.0015	.0021	.0005	.2047	.1866	.0900	.0503	.0597	.0432

strain upon known, available land resources. Given the fact that agricultural statistics tend to underreport actual acreage in production, the adopted estimate is conservative.

In the Selva cultivated acreage is determined almost wholly by regional population growth. The export potential of the Selva in food crops is dubious and historically has been nonsignificant. The construction of new penetration roads, notably the Carretera Marginal, will foster a great deal of spontaneous and government-directed colonization. Therefore, even with the high rate of population growth in the Selva region, it appears quite feasible to maintain historical land/man ratios, except in cotton. Using the above independent regional considerations, we computed the dependent national average. In the ratio for food crops we found an almost linear decrease, but there was a drastic reversal for industrial crops when the projected period (1960–64 to 1970) is compared with 1951–55 to 1960–64.

In the foregoing determination we were guided by the growth in total population by regions, and we expressed implicitly that the three natural regions of Peru are, on balance, self-sufficient with respect to production of the eleven basic food stuffs included in our study. This is only approximately true with respect to the urban population but substantially true for the rural population, as the regional consumption and production patterns of the above crops show.

Given that the Sierra region is predominantly noncommercial in food crop production and, on balance, has tended to have reduced yield levels, it appears reasonable that the cultivated acreage in that region should increase at a rate not less than that of rural population. Census data show that a very high proportion of the rural population, almost regardless of age, is classified as agriculturally active.[42] In other words, the agricultural labor force in the Sierra is nearly identical with its rural population. The land/man ratio projection (with respect to the rural population) adopted for the Sierra can be seen to correspond closely to its historical tendency. The populations of both the coastal region and Selva have rapidly become more urban. *Ceteris paribus,* the land/man ratio when divided into rural population will tend to increase. This tendency is less for the Coast than for the Selva because of the stagnation in export crops.

Until 1962, statistics on cultivated acreage were collected and published by the Dirección de Economía Agraria, an entity within the Min-

[42] Ministerio de Hacienda, INP, Dirección Nacional de Estadística y Censos, *Sexto Censo Nacional de Población, 2 de Junio 1961, Resultados de Primera Prioridad,* Lima, Peru, 1964.

istry of Agriculture. The Agricultural Census of 1961 [43] revealed considerable differences between the estimates of the DEA and those of the Ministry of Agriculture, and this led to a complete revision of the Census estimates. In 1963 a cooperative agreement was signed between the Ministry of Agriculture and the Agricultural University at La Molina creating CONESTCAR.[44] This office was charged with reporting agricultural statistics, executing periodic agricultural censuses, and doing the cartographic work basic to crop area estimation. The DEA did not publish estimates for 1963, but CONESTCAR obtained provisional estimates by means of a linear regression on the DEA 1959–62 series. A subsequent subsample of the census data led to comprehensive revisions in many series for the period 1960–64.[45] Data for 1965 and 1966 have not yet been published. The 1964 revisions, for such basic food crops as potatoes and corn, are a compromise between the low census estimates and the higher estimates of the Ministry of Agriculture. Cartographic surveys for the coastal valleys have substantially improved crop area estimation. However, to date, no such substantial improvements have been introduced into the methods of measuring yields per hectare. With respect to the Sierra and Selva region, data reporting has been reorganized since 1964, but it has not necessarily been improved.

In our projections we have made uniform use of the five-year time series published by CONESTCAR in its *Estadística Agraria 1964*. Time series prior to 1960 are identical to those used by the National Planning Institute in elaborating national income accounts. These series were prepared by the Planning Office in the Ministry of Agriculture in the light of the results of the 1961 Census and of additional information made available from the Caja de Depositos, SIPA and the Superintendencia de Abastecimientos.[46] It is evident that the adjustments are somewhat arbitrary since they were made after the fact and on the national level only. With the existing acreage-reporting system, it is virtually impossible to measure reliably (i.e., within a 3 per cent margin) increases in cultivated acreage. Observations are necessarily fairly gross. A comparison of acreage reports from SIPA and CONESTCAR for the same region shows little or no directional correlation.

Our work on demand has given us good reason to believe that the current CONESTCAR series for the period 1960–64 underestimate the

[43] Ministerio de Hacienda, INP, Dirección Nacional de Estadística y Censos, *Primer Censo Nacional Agropecuario,* Lima, Peru, 1965.

[44] Convenio de Cooperación Técnica, Estadística y Cartografía.

[45] CONESTCAR, *Muestreo Agropecuario Nacional,* Lima, Peru, 1964.

[46] Ministerio de Agricultura, Oficina de Planeamiento, Comisión Análisis de Tendencias del Desarrollo Agropecuario, *Anexo Estadística,* Lima, Peru, 1965.

actual expansion in domestic agricultural production for that period. Projections to 1970 based upon these series tend to be unduly pessimistic and have given rise among foreign and Peruvian economists to an undue tendency to consider the agricultural sector stagnant. The last figures published by the DEA related to 1962, and the first original figure emanating entirely from CONESTCAR will relate to 1965. Apart from the difficulty of reporting relatively small changes in acreage between years, there is the problem of establishing a comprehensive base estimate. The diverse and scattered nature of cultivated acreage in Peru is such that only a comprehensive aerographic survey could provide the necessary base. For fully 70 per cent of the cultivated acreage of Peru such an estimate is still lacking. Crop area estimation for 1965 must therefore be guided by previous results, with a good chance that in the process of "guestimating" many small figures, the aggregated total will show surprising stability. Without the comprehensive 1964 publication of CONESTCAR the present projections would have been difficult if not impossible. It is equally true, however, that no matter how efficiently and comprehensively elaborated, bad field data will produce information of doubtful value independently of its level of aggregation.

Climatic factors in Peru are a very important and much ignored determinant of cultivated acreage. They affect all crops, if not equally, certainly to a considerable extent. The availability of water in the coastal region depends on precipitation in the Sierra where a drought inevitably creates scarcity of water for irrigation in the former region. A three-year moving average of annual discharges of the fifteen major rivers along the Peruvian coast revealed a remarkably consistent seven-year cycle. The relationship between inadequate precipitation and cultivated acreage is quite direct, e.g., for rice in the coastal region and for potatoes in the Sierra. While cyclical climatic factors are so marked that they affect all crops to some extent, it does not necessarily follow that they determine long-run trends in acreage or overshadow such trends as a factor in food supply projection. If this were so, a projection of supply would be dependent upon an accurate long-range weather forecast. Nevertheless, in the years covered by the Agricultural Development Plan a cyclical increase in water availability in the Sierra and in the coastal region is projected. Hence, the rather optimistic production projections of the plan might be borne out because of essentially exogenous developments.

Year-to-year fluctuations in reported acreage are relatively large. A standard linear or geometric regression yields coefficients of determination which, while statistically significant, are too low to be acceptable for forecasting. Other series (e.g., fruits and vegetables) constructed by

the Ministry of Agriculture on the basis of judgment yield higher coefficients of determination, but were excluded from the present analysis. Because components of the projections were unreliable, nothing could be gained by grouping individual projections, summing the groups and obtaining a group total. The total estimated acreage might accidentally yield a land/man ratio in line with historical trends, but this could not be guaranteed. Second, even if the total estimated acreage behaved according to expectations, this would not guarantee that its components would. Such a guarantee could be made only if a simple trend analysis consistently revealed high coefficients of determination. Since our ideas on projected total acreage were relatively firm, we adopted a method for imposing a restriction upon the total cultivated acreage by regions by simultaneously determining the historical evolution in the composition of acreage by groups of crops, and crops separately.

The projections, then, took place in two independent stages: the first, to determine the total acreage, and the second to determine the composition of the total acreage. Hence, we could introduce a number of hypotheses on land development and rapidly calculate the acreage of each crop, by region, using the independent estimate on composition. The composition of cultivated acreage within a given region has remained remarkably stable over the years; in other words expansion of cultivated acreage has been roughly proportional for all crops.

To obtain a more exact idea of the trends governing the relative composition of crop acreage we adopted the following procedure. Individual crops were put into groups. The cereals group comprised rice, corn, wheat, barley, quinua, and cañahua. The bean and pulse group comprised beans, horse beans, broad beans, chickpeas, peas, and lentils. The tuber and roots group comprised white and yellow potatoes, sweet potatoes, manioc, oca, olluco and mashua; and the industrial crops group sugarcane, cotton, and tobacco. Projections for coffee, fruits, and vegetables were not included as part of the simultaneous acreage projections.

The acreage of each crop and each group of crops was listed for the quinquennium 1951–55 and the quinquennium 1960–64, using adjusted DEA data for the first period and CONESTCAR data for the second. The acreage of each crop was listed separately by regions as well as by the national total. Then the percentage composition of each group within a given region was determined. The national totals were not computed, since the composition of these totals in the set of projections is derived from separate projections of total acreage and its composition by regions. To obtain two points for projections we computed the average composition for each of the two above-mentioned five-year intervals. In each case

the sum of the components must equal 100 per cent. Assuming the composition of acreage to change linearly, it follows that by a simple linear extrapolation, the 1970 composition can be determined. Given the projected total acreage for a food group, it is then very simple to compute the projected acreage for each crop.

The above procedure for separate crops can also be applied to groups of crops. It has the advantage of permitting the analysis of composition to be carried out separately from projecting the total cultivated acreage grown. In general, accuracy in the projection of total cultivated acreage is more critical to the over-all conclusions of the study than accuracy in the projection of acreage of any single crop. The method used allowed us to concentrate on the strategic decision concerning the projected man/land ratio and to use this as an imposed condition within which group- and crop-acreage estimates were accommodated. No conventional methods of statistical analysis were used in acreage projections, primarily because time series data in Peru are subject to error. We could have applied traditional regression analysis on the relative composition of acreage. While individual percentage trends might not necessarily sum to 100 per cent, a number of trials indicated the differences to be very small.

Table 16 indicates that the average annual expansion in land under cultivation between 1960–64 and 1970 should equal 37,680 hectares. Approximately 35 per cent of this expansion is projected to take place

TABLE 16

Projected Average Annual Increase in Cultivated Area by Crops in the Three Regions, 1960–64 to 1970

(in thousands of hectares)

Crop	Coast	Sierra	Selva	Republic
Cereals	7.73	9.17	2.86	19.76
Tubers and Roots	0.56	6.16	3.46	10.18
Beans and Pulses	2.07	1.64	0.63	4.34
Fruits	1.84	0.45	2.22	4.51
Vegetables	0.81	0.64	0.06	1.51
Total food crops	13.01	18.06	9.23	40.30
Industrial crops	-3.22	0.17	0.43	-2.62
All crops	9.79	18.23	9.66	37.68

in the coastal region. We believe that, because of the substantial elasticity in the use of available land resources, the projected increases in both the Sierra and Selva could take place without major direct public investment. Between 1950 and 1964 land under cultivation in the coastal region expanded by 273,000 hectares.[47] Irrigation of newly created land accounted for 75,000 hectares. An almost equal expansion was achieved by improving the irrigation systems on existing land. Water storage and utilization of underground water permitted an increase in cultivation of 85,000 hectares. River defense work, drainage projects, and small irrigation projects created an additional 35,000 hectares.[48] The figures on newly irrigated land and improved land do not include many small private projects.

Virtually all large-scale irrigation projects and improvements in the irrigation systems of adjoining valleys were financed by the public sector. The costs of building or improving irrigation systems were relatively low. A detailed study of the expenditure accounts of the Ministry of Development revealed that for fifteen completed large-scale coastal irrigation projects the installed cost per irrigated hectare equalled 22,000 soles (in 1963 prices, see Table 17). Improvements of existing irrigation systems cost on an average 6,500 soles per hectare (in 1963 prices). The average period of construction for these fifteen projects was eleven and four-tenths years.[49] Public investment in irrigation has fluctuated considerably because of the tendency to initiate projects in bunches.

Nevertheless, public investment in irrigation has shown a marked tendency to decline in relation to total public investment and even more so in relation to total government expenditure. Future irrigation works will all be large scale and their estimated cost per hectare, including the improvement of existing irrigation systems, will vary from 40,000 soles per hectare to 26,000 soles per hectare depending on the proportion of new and improved land (see Table 18).[50]

McGaughey's studies on the profitability of proposed irrigation projects show that with an annual rate of discount of 10 per cent, the resulting benefit-cost ratios are less than 1.8 and as low as 0.6. A first comparison with benefit-cost ratios obtained in productivity programs indi-

[47] Llosa, *op. cit.*

[48] Mario Cúneo Mimbela, *Plan de Desarrollo Agropecuario—Programa Irrigación*, Ministerio de Agricultura, OSPA, Lima, Peru, 1967.

[49] José A. Salaverry Llosa, *Inversiones en Obras, Estudios, Irrigaciones y Mejoramiento de Riego 1944–1966*, CONESTCAR, Lima, Peru, 1967 (mimeo.).

[50] Stephen McGaughey, *Evaluación de Proyectos, Información Requerida, Criterios y Prioridades*, Iowa Universities Mission to Peru in cooperation with the Agency for International Development, Lima, Peru, 1967 (mimeo.).

TABLE 17

Area and Construction Costs of Completed Coastal Irrigation Projects

Project	Area (in hectares) Planned New	Planned Improved	Realized New	Realized Improved	Project Cost[a]	Cost Per Hectare[b] New Land	Cost Per Hectare[b] Improved Land
Canal Internacional	1,500	–	1,120	–	21.5	19.2	–
Margen Izquierda Rio Tumbes	2,300	–	2,300	–	6.0	2.6	–
San Lorenzo	45,000	31,000	33,000	31,000	815.6	30.0	5.0
Canal Huallabamba	3,400	–	2,550	–	4.3	1.7	–
Derivacion Chotanochancay	–	60,000	–	18,000	190.0	–	10.6
La Esperanza	8,000	–	2,250	–	13.6	6.1	–
El Imperial Canete	8,156	–	6,117	–	200.0	32.7	–
Represa Turpo-Chinc	–	25,000	–	12,500	7.0	–	0.6
Represa Anacocha	–	23,600	–	11,800	2.1	–	0.2
Cabeza De Toro	6,500	–	4,875	–	15.5	31.8	–
Choclococha	–	26,000	–	10,300	190.1	–	18.5
La Joya	12,000	–	7,500	–	194.2	25.9	–
La Ensenada-Majia	2,000	–	1,500	–	26.5	17.7	–
Caplina	2,500	–	750	–	0.3	0.4	–
Canal Azucarero	2,500	–	750	–	3.7	5.0	–
All fifteen projects	88,856	165,600	51,712	83,600	1,690.3	22.2	6.5

Source: Jose Salaverry Llosa, *Inversiones en Obras, Estudios, Irrigaciones y Mejoramiento de Riego, 1944–1966*, CONESTCAR, Lima, Peru, 1967.

[a]In millions of constant 1963 soles. [b]In thousands of constant 1963 soles.

TABLE 18

Area and Construction Costs of Proposed Coastal Irrigation Projects

Projects	Proposed Area (hectares)			Construction Cost Per Hectare (1965 soles)	
	Total	New	Improved	Individual	Weighted Average
Large irrigation					
(1) Olmos	86,751	86,751	–	49,300	–
(2) Choclococha	36,500	8,500	28,000	25,900	–
(3) Tumbes	19,460	12,315	7,145	28,900	–
(4) Moquequa	6,750	3,080	3,670	49,300	–
(5) Majes	57,000	57,000	–	64,900	–
Small irrigation					
(6) Pampa Dorada	1,185	1,185	–	105,800	–
(7) Majes	3,310	1,780	1,530	77,600	–
(8) Camana	1,815	210	1,605	26,700	–
(9) Tamba	2,270	505	1,765	30,000	–
(10) Ibera	880	880	–	23,000	–
(11) Chococo	1,523	–	1,523	18,600	–
(12) Anaura	1,175	–	1,175	6,400	–
(13) Huansocolla	925	–	925	15,000	–
All projects	219,544	172,206	47,338		47,304
Alternative project groups					
A (no's 1–3)	142,711	–	–	–	40,500
B (no's 1–3;8–13)	151,301	–	–	–	39,900
C (no's 7–13)	11,900	–	–	–	37,300
D (no's 2,3,8–13)	64,550	–	–	–	26,037
E (undetermined)	–	–	–	–	–

Source: Stephen McGauhey, *Iowa Universities Mission to Peru*, Lima, 1967.

cates that a dollar of public expenditure on improving yields will give the greater return.[51] However data on cost and returns for productivity programs are not yet as reliable as similar data for irrigation projects. We are fairly certain that the stated returns on productivity programs are too optimistic. On balance, therefore, one cannot recommend public investment in productivity programs over irrigation projects with any degree of certainty. However, there are secondary considerations that favor productivity programs. The programs are divisible and can be located anywhere in the Republic, whereas irrigation projects are tied to a specific location in the coastal region and have a long gestation period. Irrigation projects require a substantial commitment of public investment over a considerable period of time. Because of the large initial capital requirements of such projects and the limited internal sources of finance for them, the Peruvian government will have to rely on external financing if it wants to pursue a vigorous land expansion policy in the coastal region. International agencies have financed a large number of feasibility studies in recent years, but have been reluctant to finance the foreign exchange cost of any large-scale project.

Public investment projected available for irrigation activities in 1970 equals 157 million soles. Assuming that most feasibility studies will have been completed by 1970, substantially all funds will be available for newly irrigated or improved land. At the average cost of 30,000 soles per hectare for current projects in their terminal stages, the projected funds would create an additional 5.3 thousand hectares of cultivation in 1970. Since irrigated land is at least double cropped, the projected increase will bring a minimum of 8,000 hectares under cultivation. Water storage, underground water utilization, and small irrigation projects could easily generate another 3,000 hectares of cultivation in 1970. The projected total increase of 11,000 hectares offsets the needed increase of 9,800 hectares in cultivated land in the coastal region.

PROJECTED FEASIBLE GROWTH IN PRODUCTION

Given the projected yields and acreages by crops and regions, it is a simple matter to determine the projected rates of growth in production (see Table 20). We used 1964 farm prices as specified by regions in

[51] See pp. 426–27 and Delbert A. Fitchett, *Investment Strategies in Peruvian Agriculture: Some Recent Experiences in Development Planning,* Memorandum prepared by the Rand Corporation for the Agency of International Development, Santa Monica, California, 1967.

TABLE 19

Total Public Expenditure on Land Expansion Activities in the Coastal Zone, 1950–65

(millions of constant 1963 soles)

Year	Total	Irrigation	Improvements	Drainage	River Defense	Dams	Ground Water	Studies
1950	85.0	79.0	2.0	–	0.7	–	–	3.3
1951	203.7	199.4	–	–	0.5	0.1	–	3.7
1952	191.8	183.8	1.4	–	1.4	0.1	–	5.1
1953	187.4	172.8	7.4	1.1	0.2	0.6	–	5.3
1954	54.0	42.9	5.5	1.5	0.4	0.4	–	3.3
1955	101.9	98.8	0.9	0.8	1.3	–	–	0.1
1956	142.3	123.0	1.4	3.5	2.5	6.6	–	5.3
1957	160.4	106.0	4.4	0.6	–	45.8	0.2	3.4
1958	170.6	153.9	1.8	–	10.0	–	0.2	4.7
1959	59.4	40.3	17.8	–	0.3	–	–	1.0
1960	13.5	6.5	–	–	6.2	–	–	0.8
1961	9.3	1.1	4.8	–	1.2	1.2	–	1.0
1962	42.3	20.6	14.9	4.6	0.5	0.6	–	1.1
1963	84.8	38.3	0.2	2.0	0.4	–	–	43.9
1964	97.5	55.5	2.6	1.9	0.5	4.2	2.8	30.0
1965	139.6	79.2	6.6	3.8	2.0	–	–	48.0

Source: See Table 17.

TABLE 20

Projected Growth in the Value of Agricultural Production by Groups of Crops for the Three Natural Regions, 1960–64 to 1970, According to Three Yield Hypotheses

(cumulative annual rates)

	Coast	Sierra	Selva	Republic
Hypothesis 1 – 0 yield increase per year				
Food crops	4.4	1.3	4.1	2.6
Industrials	0.6	3.4	3.6	1.3
All crops	1.9	1.4	5.0	2.0
Hypothesis 2 – 1 per cent yield increase per year				
Food crops	4.9	2.3	4.6	3.3
Industrials	1.0	3.4	3.6	1.5
All crops	2.3	2.3	5.2	2.6
Hypothesis 3 – 2 per cent yield increase per year				
Food crops	7.0	3.0	5.7	4.2
Industrials	2.2	3.5	3.6	2.4
All crops	3.9	3.0	5.8	3.4

the *Estadística Agraria 1964* to determine the growth rates in value aggregates.

The value of all crops produced in the Republic is expected to grow between 2 and 3.4 per cent annually, barring exogenous factors such as major devaluations and the effects of the weather cycle. Projected public funds for agricultural research and promotion will not be sufficient to attain a yield increase of 1 per cent per year (hypothesis 2). Hence, food production is expected to grow at approximately 3 per cent per year. Both the Coast and Selva are projected to achieve substantial rates of growth in food production, but in the Sierra expansion in food crop production is not expected to exceed 2 per cent annually.

In general the rates of growth in food production tend to be very close to the projected rates of growth in population by regions and for the Republic. Unless public investment in agriculture is increased beyond projected levels, food production will continue to expand at about the same rate as population growth. Prior to 1960 traditional export crops were the most dynamic component in the growth of agricultural pro-

TABLE 21

Projected Increase in the Level of Agricultural Production Between 1960–64 and 1970

(millions of 1964 soles)

	0 yield	1 per cent yield	2 per cent yield
Yield effect	185	561	1988
Acreage effect	1626	1626	1626
Total increase	1811	2187	3614

duction. We project a reversal of that situation for the period 1960–70. It should be kept in mind however that the devaluation of 1967 has resulted in a change of the cost-price relationships in the export sector. Hence, beginning in 1968, production of exports will be larger than previously anticipated. This might raise the projected rate of growth in export production for the period 1962–70 to 3.5 per cent.

It can be seen from Table 21 that the bulk of the increase in the value of agricultural production will be forthcoming through land expansion rather than through yield increases. Currently projected productivity programs could permit an increase of 90 million soles beyond the minimum expected increase of 185 million soles. But of the 162 million soles required for these programs we expect only 50 million to be available.

Apart from the acceleration in productivity, it is expected that the major part of the increase in agricultural production will be forthcoming from the Coast and will be in food crop production (see Table 22). It

TABLE 22

Projected Percentage Composition of the Increase in Value of Crop Production between 1960–64 and 1970 According to an Average of Yield Hypotheses 1 and 2

	Coast	Sierra	Selva	Republic
Food crops	38.6	25.8	11.0	75.5
Industrials	13.0	1.1	10.4	24.5
Total	51.6	26.9	21.4	100.0

is expected that the recent devaluation will accentuate the importance of the coastal region as a contributor to agricultural growth, because of the anticipated acceleration in export production.

PROJECTED INPUT REQUIREMENTS

In a systematic approach toward determining agricultural input requirements the classical factors of production, land, labor, and capital, as well as commercial inputs must be considered. In certain cases other physical factors impose narrower constraints, for example, water availability on the Coast and transportation facilities in the Selva. In the Peruvian case there is a substantial elasticity in the availability of land, labor, and capital (including those of manufactured origin).

It is only in the last two years that a systematic attempt has been made to study the effect of commercial inputs upon yield levels under empirical conditions. Data obtained for the southern Sierra indicate that a moderate application of a balanced fertilizer will, on the average, double the current yield level for potatoes and cereals (see Table 23). The distributions of response coefficients are characteristically skewed to the

TABLE 23

Characteristic Response Coefficients[a] Obtained Under Empirical Conditions with Uniform Levels[b] of Fertilization in the Southern Sierra, 1966

Crop	Number of Observations	Mode	Median	Arithmetic Average	Average Increase in Yield Per Hectare (kilos)
Potatoes	1038	1.50	1.43	2.18	4894
Corn	773	1.50	2.31	1.83	846
Wheat	151	1.50	1.73	2.04	798
Barley	322	1.50	1.76	1.83	736

Source: Data supplied by Corporacion Nacional de Fertilizantes.

[a]Response coefficient is yield per hectare obtained without fertilizer divided by yield per hectare obtained with fertilizer.

[b]Application equals 50-30-50 for potatoes and 51-30-0 for cereals.

right, so that the average exceeds the median. The most frequent response coefficient indicates that recommended fertilization increases current yield levels by half. When the average-response coefficient was used, the benefit-cost ratio of the fertilizer application equalled 9.1 for potatoes and 2 for cereals. However the typical, or most frequent, benefit-cost ratio was 4 for potatoes and 1.1 for cereals. It follows from the foregoing data that, for a substantial number of producers, fertilization of cereals offered no economic incentive, whereas the fertilization of potatoes was generally profitable. To the extent that supervised credit is an essential component of public productivity programs, the figures indicate that a substantial number of producers will not be able to repay their credit, even though on the average the program results in substantial productivity increases. Traditionally, public agricultural credit has been extended with a view to sound banking principles rather than to the objective of increasing land productivity. A shift towards the latter objective in credit availability is a prerequisite for the success of productivity programs in food crop production.

Preliminary input-output relations for the principal crops were obtained by the Agricultural Planning Office from comprehensive cost-of-production studies by SIPA [52] and the Agricultural Development Bank.[53] Both studies specified typical costs of production according to yield levels. For a given projected yield level the corresponding input structure was determined through graphical interpolation. This assumes that in achieving a higher yield level producers will follow the established cultivation practices corresponding to that level. The expansion path in input use is therefore not necessarily optimal in the sense that the producer minimizes his cost for a given output. An increase in yield is generally obtained through a number of qualitative changes, such as the simultaneous introduction of improved seed and fertilization. Therefore a producer effectively changes his production function while moving towards higher yield levels. Such shifts in the production function can frequently be effected at very little money cost to the producer. Therefore it has been found rather consistently that the average cost of production is declining with higher yield levels. Using the projected yields by crops and by regions according to three general productivity hypotheses, we computed the required outlay in terms of fertilizer, pesticides, seed, equipment, and labor. From Table 21 we find that hypothesis three gives a yield-increasing effect of 1,803 million soles over hypothesis one (3,614 minus 1,811). Comparing the input requirements

[52] Paez, *op. cit.*
[53] Higgins and Piedra, *op. cit.*

TABLE 24

Projected Annual Cumulative Growth Rates in Input Requirements, 1962–70, According to Supply Hypotheses 1 and 3

	Crops					
	Food		Industrial		Total	
Input	Hyp. 1	Hyp. 3	Hyp. 1	Hyp. 3	Hyp. 1	Hyp. 3
Fertilizer	6.8	12.0	-1.4	.6	3.3	6.9
Pesticides	5.8	8.9	1.2	4.4	3.3	6.5
Seed	3.1	4.8	-2.8	-1.6	2.7	4.3
Equipment	3.5	3.7	-3.6	-3.6	1.0	1.1
Labor	3.8	3.8	-3.1	-3.1	1.1	1.1

for hypotheses one and three, we found that the above increase of 1,803 million soles could be obtained for an additional outlay of fertilizer, pesticides, and seed totalling 357 million soles. The marginal benefit-cost ratio to the producers would therefore equal 5.1. Table 24 presents the projected annual growth rates in input requirements according to supply hypotheses one and three. Since hypothesis one is likely to be exceeded by a small margin only, the projected rate of growth in demand for commercial inputs will not exceed 4 per cent annually. On the other hand the growth rate in labor requirements equals only 1.1 per cent annually. This figure corresponds exactly with the officially projected rate of growth in the rural population.

Comment

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Professor Van de Wetering's paper is a contribution to the literature on agricultural planning. As recent surveys by Gittinger and Ojala have indicated,[1] there are few available source materials on how developing

[1] J. P. Gittinger, *The Literature of Agricultural Planning*, National Planning Association, Washington, D.C., September, 1966, and E. M. Ojala, "The Program-

countries have actually formulated their plans for the large and difficult agricultural sector. Therefore, this detailed and thorough presentation of the Peruvian approach should be most helpful to practicing planners and to teachers of planning.

There are two aspects of the paper in particular that elicit comment. The first is Van de Wetering's explicit treatment of the relationship between agricultural planning and the over-all macro framework. Indeed, this entire volume, which stresses the broad interactions, is a refreshing change from earlier "fundamentalist" literature. The second appealing feature is his technique, which can be characterized as emphasizing consistency, efficiency, and sensitivity.[2] Van de Wetering's continued concern with commodity and regional balances and with the sensitivity of results to varying assumptions is highly commendable.

In spite of these considerable merits, several aspects of the paper left me uneasy. One of the major difficulties, especially for readers who are not intimately familiar with Peru, is in distinguishing "what was" from "what should have been." Quite clearly, Van de Wetering was an insider in the process and hence his description of what took place is first-rate. Rarely, however, does he take issue with the methodology that was used or the conclusions that were reached. Thus it is impossible to tell whether or not he personally agrees with all of the main themes in the paper. (The strong equity-over-growth bias that runs throughout is a good case in point.) My major comments and criticisms, therefore, may be on issues which were outside the control of the planners (e.g., Van de Wetering) and perhaps of the entire agricultural ministry. Yet they should have been addressed in the paper.

The most serious of these issues is the question of priorities. Specifically, the absence of any discussion on priorities is the main defect of the paper. The significant priorities involve not only intersectoral questions, e.g., agriculture versus manufacturing, but intrasectoral issues as well, e.g., export crops versus domestic food crops. To a large extent my comments will focus on these matters. To a lesser extent they will raise questions about agricultural policy which also received only summary treatment in the paper.

In terms of general approach, I believe it fair to characterize the Peruvian formulation as highly autarkic. Self-sufficiency in food seems to have dominated the entire planning effort to 1970, and the effects

ming of Agricultural Development," in H. M. Southworth and B. F. Johnston (ed.), *Agricultural Development and Economic Growth*, Ithaca, N.Y., 1967, pp. 548–586.

[2] See D. E. Bell, "Allocating Development Resources," in C. J. Friedrich and S. E. Harris (ed.), *Public Policy, IX*, Cambridge, Mass., 1959, pp. 84–106.

of an increased agricultural growth on the expansion of exports appear to have been minimized. This seems a bit curious, especially in light of several of the author's own statements. Exports appear to have played an important role, especially for the agricultural sector. Since, in addition, export crops grew at more than 8 per cent annually prior to 1960, and since fishmeal exports are currently less encouraging, it seems questionable whether the discrimination against export crops through export taxes and through relative neglect in terms of planned inputs is the correct strategy. In any event, it would have been useful if Van de Wetering had discussed this rather crucial priority issue, because virtually all of the projections in his paper are dependent upon it.

A second interesting feature of the Peruvian approach to agricultural planning is its strong demand orientation. In this context, a comparison between Peruvian and (say) Indian and Pakistani planning could not be more striking. For in the latter countries, the planning has started with inputs and the supply potential in agriculture, and has then related this growth in agricultural output to various macrovariables such as GNP, exports, etc. In the Peruvian case, however, projections were begun with the assumption of growths in regional income and population. Through the extensive use of income elasticities, commodity projections were made on a regional basis. These estimates were then conceived of as being what was "required" from agriculture.

In principle, there need be little cause for concern or comment as to whether agricultural planning begins with demand or supply considerations. That both are important and must be analyzed is obvious. In practice, however, there are several aspects of this particular demand formulation that caused me concern. First, there are suggestions, often quite explicit, that not only should the country as a whole be self-sufficient for the major commodities, but that each of the regions should be as well. Van de Wetering states, for example (page 420), that "in agricultural promotion programs consideration might well be given a reallocation of resources determined by future deficits in (regional) domestic production." Surely this is carrying the autarkic and regional-balance priority too far. Surely the possibility of solving imbalances by fiscal rather than production means ought to have been discussed more fully. (One might even argue that one of the principal objectives of agricultural planning in Peru ought to be increased economic integration of the regions.) Probably it is this demand orientation and methodology that explain why the principal attention, as noted above, is on food crops rather than on export commodities. Second, it is obviously difficult in this formulation to estimate the growth in per capita incomes, especially for the more rural

areas, until there is some estimate of the growth of agricultural output. This reconciliation never comes about, at least not explicitly, within the paper. Third, the what-is-required-from-agriculture approach may have been a contributing factor in leading the Peruvian planners to focus on "feasibility" rather than "optimality" for agriculture, *i.e.*, ". . . the preliminary agricultural development plan should limit itself to determining in a systematic manner the feasible rate of growth, rather than the optimal rate of growth or optimal allocation of public expenditure" (page 394). This is not to say that supply considerations do not enter, but they are brought in at a very late stage and then only in deciding whether the various regional demands can be met. And nowhere in any real sense are there discussions of farmer acceptance of various programs, of increasing innovation in rural areas, and of other general problems of production within a decentralized decision-making framework.

A third feature of the Peruvian plan is the size and structure of the public program for agriculture. By international standards the 3 per cent total spent on agriculture is *very* low.[3] Indeed, to have struggled with the lengthy discussion of the macromodel only to find that the maximum range of public expenditure to be considered for agriculture was 2.8–3.3 per cent was a little like finding the baby gone with the bathwater. In short, this narrow range eliminated at the outset a number of the more interesting comparisons. It would have been most interesting, for example, to have known what a 5 or a 10 per cent allocation might have meant for agriculture and what effect this would have had in turn on the more macrovariables.

Given this 3 per cent total, and given the sizeable proportion of funds committed for land-expanding activities, the author is undoubtedly correct in stating that "public expenditure is too small to have a notable impact on productivity improvement." His discussion highlights the problems, not only of a small total, but also of a governmental bias for extensive rather than intensive approach. In this regard, Peru seems typical of many of the developing countries.

Even with the limited financing for yield-increasing programs, however, I would have liked to know more about how the various productivity programs (especially research and promotion service) were assessed and how each was expected to contribute towards the increased output shown in Table 11. In particular, additional information on the

[3] In Pakistan, for example, approximately 15 per cent of the development expenditure goes to agriculture directly. If "irrigation" also is included the proportion is raised to about 25 per cent.

choice of the "input package" would have been interesting for comparative purposes. The recent literature which has stressed physical complementarity among agricultural inputs has argued an important principle. But what a country or an agricultural ministry does in "package selection" when faced with financial, administrative, and organizational shortages seems to me to be the crux of the agricultural planning function.[4] On this point the discussion is brief, although Van de Wetering's major point, *viz.*, that the proposed agricultural program, regardless of how allocated, is much too small to alter significantly the future pattern of agricultural productions, comes through clearly.

Finally, the paper as presently cast is primarily concerned with the setting of targets. Unquestionably this is an important aspect of planning. But planning ought, in my opinion, primarily to be a framework for policy making. And on the important policy questions Van de Wetering says relatively little. How, for example, is the switch from export to food crops to be accelerated? Through price incentives? Input subsidies? Tax policy? To ask for further discussion and analysis of these policy questions after the lengthy and detailed material already presented by Van de Wetering may be unkind; yet I am sure he would agree that the policy aspects of a plan are far more important for its success than is the setting of targets.

Notwithstanding the above comments, this paper does add significantly to one aspect of the literature on planning. In large part, the comments that I have put forth simply ask for additional analyses or take as variables certain parameters that Van de Wetering, as an insider, may have found as fixed.

[4] For further discussion on this point see J. W. Mellor, "Production Problems and Issues in Agricultural Development," *Journal of Farm Economics*, December 1966, pp. 1195–1202, and this writer's comments thereon, pp. 1207–1209.