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PROGRESS REPORT

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WITH IOWA STATE UNIVERSITY

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INTRODUCTION

This report is submitted to the Agency for International Development under Contract No. 2163 between Iowa State University and the Agency for International Development. Contributors to this report include Keith Rogers, Walter W. Haessel, Roger W. Hexem, Leo V. Mayer and Earl O. Heady. Foreign projects are reviewed tentatively pending the return of Earl O. Heady after a two month visit and review of research efforts in New Delhi, India.

The report below is divided into seven sections, each reviewing a specific research effort which is being carried on as part of the overall research project. Initially, progress is reviewed on the research projects located at Iowa State University and the degree of completion of each is indicated. Next, the research projects located at the University of Delhi and the National Council of Applied Economic Research in New Delhi, India are summarized.

Research Studies at Iowa State University

Four studies are being conducted at Iowa State University. One of these studies has been completed and is in the process of manuscript review and revision. This completed study is reviewed first with other ongoing projects following.

Estimation of the net cost of food shipments under P.L. 480

This study measures the net cost of food shipments under P.L. 480 programs in the context of the existence of excess productive capacity in the U.S. agricultural sector under current price and income support programs. The study focuses on the twin government programs of retiring cropland from production by federal payments and the exportation of major crops

under government programs which provide special financing. Both programs were activated in the United States during the decade after World War II. Retirement of large acreages of cropland began in 1956 with the inauguration of the Soil Bank Program. Programs of enlarging exports of major crops under special kinds of financing were initiated in 1954. Officially passed as Public Law 480 of the 83rd Congress, the Agricultural Trade Development and Assistance Act of 1954 provided that surpluses of farm commodities could be sold to foreign countries under special terms or, in some cases, simply donated to these countries. A later amendment to the program allowed sale of commodities for long term credit at low interest rates but with eventual payment in dollars.

Several types of government programs have been utilized in removing acres of cropland from production since 1956. Each program has generally placed the government in the role of land renter with rights of occupation retained by the owner or his agent. Under the various programs, total diverted acres increased from 13.6 million in 1956 acres to 63.3 million acres in 1966. The Feed Grain Program removed a large number of acres from production and facilitated the long downtrend in feed grain acreage. The Conservation Reserve Program also played a major role in removing cropland from production.

While land diversion programs removed a large amount of potential production, a significant part of what was produced still found no commercial market at existing levels of price support. To keep grain stocks from accumulating to unacceptable levels, a part of this production was moved into markets where nutritional demand existed but economic demand did not. Some went into domestic programs of supplementing diets of low income families, but a much larger portion was shipped into foreign markets under P.L. 480 programs.

The history of land diversion and export programs indicates that supply reduction and demand expansion represent complementary methods of handling excess production capacity of U.S. agriculture. The U.S. has developed a specific set of programs to provide its agricultural sector with a market for excess land resources in one instance, and in another instance price supported commodities produced in excess of domestic and commercial export demand. These two programs have jointly managed to slow the outflow of resources from the agricultural industry brought on by rapid introduction of new innovations which rapidly increased potential agricultural production.

To measure the net cost of food shipments under the two alternatives of land retirement or subsidized export shipments, a linear programming model was developed to simulate resource use of the agricultural sector. The major resource evaluated was cropland, since this resource forms a basic input in the crop production process and has been used as the major mechanism for controlling the aggregate supply of agricultural commodities. Also, through government programs for agriculture, the available supply of cropland has become institutionalized with production units having specific allotments for production of certain crops. When the available base or national allotments for certain crops have resulted in over production at supported price levels, the government has purchased excess acres of allotment from the producer to reduce aggregate production.

The degree of rigidity in the supply of land resources resulting from government programs for agriculture in the past several decades, has in effect placed a two-way restraint on the total land resources available for major crops. The limit of available cropland places one restraint on crop production for any given level of technology. This restraint takes the

form

$$x_1 + x_2 + \dots + x_n \leq L, \quad (1)$$

where x_i represents the amount of land used in the production of crop i ; ($i = 1, \dots, n$). Thus, land use in the production of crops cannot exceed total available crop land, L . Under conditions where land resources required for crop production are less than total land available, the inequality of this restraint holds and excess land resources remain idle.

With the institutionalization of land use in the United States, excess land resources are no longer forced to lie idle by the market when no economic demand for the potential production exists. Instead, land is removed from production under government programs. This new type of relationship in resource use must be accounted for in a model for evaluating land resource use in the United States. An additional land using activity must be defined so that

$$x_1 + x_2 + \dots + x_n + R = L, \quad (2)$$

where x_1, x_2, \dots, x_n denote acres of crops, and R is retirement of acres of cropland under government programs. These two kinds of activities must use all cropland available. If all land is required for crop production to meet potential demand, then retirement activities remain at zero level. However, if potential production exceeds demand, then retirement activities absorb the excess cropland.

Whether cropland is used for production of a crop or is retired under a government program, resource costs are associated with its use. These costs may be expressed in a cost function.

$$C = \sum c_i x_i + c_r R \quad (3)$$

which specifies that retiring each unit of cropland costs c_r , and each unit used for crop production costs c_i . To derive a net cost of using

cropland for production of an individual crop, Equation (2) can be solved for r and substituted into Equation (3) giving

$$C = \sum c_i x_i + c_r (L - \sum x_i), \quad (4)$$

and total cost becomes a function of the total supply of land and total acres of crop production. Equation (4) can be rearranged as

$$C = \sum (c_i - c_r) x_i + c_r L, \quad (5)$$

which denotes that the cost of each unit of x_i is the cost of crop production, c_i , less the cost of retiring the same cropland, c_r . Thus the net cost of producing an acre of crop is

$$NC = c_i - c_r. \quad (6)$$

The net cost per unit of production may be found by dividing Equation (6) by the yield per acre of the i -th crop.

The concept of net cost outlined above is an integral part of a linear programming model. The programming model used in this study represents a means of estimating the net cost of using marginal units of cropland for supplying food to other nations or of retiring the cropland from production under government programs. It provides estimates of the net cost of food shipments as provided to other nations under P.L. 480 programs and provides a basis for developing pricing policies for food aid extended for counterpart funds or more importantly under credit terms of the Food Aid of 1966.

The specified model

The linear programming model of this study divides the United States into 150 crop producing areas and 31 demand regions. The following activities are defined for the model:

1. Crop production--activities are defined for production of wheat, feed grains, soybeans and cotton in each production area to

- satisfy domestic demand in the 31 demand regions and commercial export demand; a separate set of activities is defined for production of wheat, feed grains and cotton for export under P.L. 480 programs.
2. Land retirement--activities are defined for retiring cropland from production in each of the 150 crop production areas if that cropland is not required to satisfy domestic demand, commercial export demand, or shipments of wheat, feed grains or cotton under P.L. 480 programs.
 3. Transportation--activities are defined for inland transportation of wheat, feed grains and soybeans from points of production to point of domestic utilization in each of the 31 demand regions or the port of commercial export.
 4. Shipping activities--activities are defined for shipment of each commodity--wheat, feed grains and cotton--from the United States to each recipient country under P.L. 480 programs.
 5. Shifting activities--activities are defined for shifting wheat from food use to feed use within each of the 31 demand regions.

The major restraints in the model are associated with cropland. The activities in the model, crop production and land retirement, each uses acres of cropland. In each of the 150 production areas, a restraint exists on the total acres of cropland available for production of major crops or for retirement under government programs. Per unit food aid costs are estimated for three types of land retirement programs. Each is designed to simulate a realistic type of government land retirement program which could be used to control the overcapacity to produce major

crops which exist at present price support levels:

1. Annual land retirement -- this set of programs simulates programs of land retirement for each of the major crops, wheat, feed grains and cotton. The distribution of land retired and the cost per acre were based on recent patterns and costs.
2. Long range land retirement -- this program assumes that all cropland in a production area is eligible for retirement under a single government program. Costs per acre for retiring cropland are estimated as the net revenue over cost of production for crops included in each production area.
3. Long range land retirement with restrictions -- this program assumes that retirement programs are limited to one-half of all cropland in any production area. Costs per acre are estimated as above.

Recipient Countries

Eleven countries were chosen based on past records of receiving food aid under P.L. 480 program and on their location throughout the world for estimation of net costs of food and shipments. An effort was made to establish a recipient country in all major areas of the world. The analysis assumes that as food shipments are expanded, each of the countries receives a fixed proportion of each increment of aid. These proportions are based on the programmed quantities of wheat, feed grains and cotton under agreements signed with these countries in the period 1966-68. An average of 323 million bushels of wheat were annually programmed for shipment under Title I of P.L. 480 during that period. India was scheduled to receive 52.6 percent and Pakistan 10.6 percent. India and Pakistan were also scheduled to receive the largest proportion of feed grain shipments, 62.0 and 6.4 percent

respectively. Cotton programmed for shipment under Title I of P.L. 480 was distributed somewhat differently. Korea was scheduled to receive 30.0 percent with India receiving 24.0 percent. Taiwan received 6.6 percent of these shipments. Altogether, an average of 91.8 million bushels of feed grains and 1.0 million bales of cotton were programmed under P.L. 480 programs in each year between 1966 and 1968.

One country was included in the analysis even though no commodities were programmed during the period 1966-68. Mexico was included to provide an estimate of the price differential resulting from international shipping costs for feed grains. Mexico has received a small amount of feed grains under P.L. 480 programs since their inception in 1954.

Guidelines for pricing P.L. 480 commodities

In this study per unit costs of P.L. 480 shipments have been estimated for wheat, feed grains and oilmeals under the assumption that each of the alternative land retirement programs could be used to reduce total production at some level of cost to the government. Costs of food aid shipments are based on actual costs incurred for commodities programmed under these programs during 1966-68; land retirement costs are based on expenditures of recent programs or estimated costs for prospective programs. Since these costs may change over time due to changes in price support levels, proportion of international transportation costs borne by the Commodity Credit Corporation, and world prices of these commodities, an attempt is made to develop a more generalized formulation to aid in future pricing of P.L. 480 commodities. To develop this type of guideline for pricing of future shipments, the estimated net cost for each commodity for each alternative land retirement program is compared with the gross CCC costs for the period 1966-68. This ratio.

$$\frac{\text{Estimated Net Cost of Food Aid}}{\text{Gross CCC Cost for Commodities}} (100) = \text{Pricing Coefficient} \quad (7)$$

provides a means of estimating future prices to be charged for P.L. 480 shipments given (1) the type of land retirement program actually in use at a particular time, and (2) the actual CCC costs of food aid commodities.

In the following Table, we have summarized the Pricing Coefficient (PC) for all the various land retirement programs examined in this study. The PC varies according to the level of shipment, the particular commodity shipped and the land retirement program. For wheat, the PC varies from 3.5% with an annual land retirement program and a shipment of 75 million bushels of wheat, to 87.4% with a long range retirement program and 525 million bushels. The PC for annual programs are considerably lower for all levels of wheat shipments than for other programs.

Pricing Coefficients for feed grains and cotton are generally higher than for wheat for a similar shipment level and land retirement program. For feed grains, these data suggest prices of 81.3 percent of the CCC cost when 1.5 million tons are shipped and a long range land retirement program is used to control aggregate production. For the same level of shipment, the data suggest feed grains shipments priced at 56.0% of their CCC cost if annual programs with direct payments are used to control production.

The PC for cotton with a 1.0 million bale shipment varies from 74.6% with a long range land retirement program to 51.5% with an annual land retirement program. These coefficients increase to 95.1% with the long range program when 7.0 million bales are shipped and 71.6% when annual programs are used with this level of shipment. During the period 1966-68, an average

Table 1. Estimated ratio of net cost of food aid to gross CCC costs for shipments of wheat, feed grains and cotton during 1966-68, under alternative supply control programs.^{1/}

Type of Land Retirement Program	Level of P. L. 480 Shipments ^{2/}						
	1	2	3	4	5	6	7
WHEAT							
Long Range Retirement No restrictions	60.9	69.6	74.3	75.7	78.3	82.2	87.4
Long Range Retirement 50% Restrictions	56.1	58.3	63.9	69.1	69.1	70.0	74.3
Annual Land Retirement Direct Payments	3.5	21.7	37.8	45.7	49.1	55.2	57.0
FEED GRAINS							
Long Range Retirement No Restrictions	81.3	81.9	82.4	83.4	86.5	87.0	87.0
Long Range Retirement 50% Restrictions	74.1	75.6	76.7	77.2	80.8	80.8	81.3
Annual Land Retirement Direct Payments	56.0	57.0	59.6	60.6	68.4	69.4	69.4
COTTON							
Long Range Retirement No Restrictions	74.6	76.9	76.9	80.2	82.8	85.1	95.1
Long Range Retirement 50% Restrictions	70.5	74.6	74.6	76.9	76.9	79.8	87.3
Annual Land Retirement Direct Payments	51.5	62.7	64.2	64.2	66.0	67.9	71.6

^{1/} Gross CCC costs in 1966-68 were \$2.30 per bushel of wheat, \$1.93 per bushel of feed grains, and 26.8 cents per pound of cotton (Table 9).

^{2/} Quantities are (mil. bu. wheat; mil. tons feed grains; mil. bales cotton):

Wheat	75	150	225	300	375	450	525
Feed Grains	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	1.0	2.0	3.0	4.0	5.0	6.0	7.0

of 1.0 million bales of cotton were programmed for shipment to recipient countries under P.L. 480 programs.

This study is now in final stages of completion with a preliminary draft of the manuscript completed. Upon further review and revision, the manuscript will be submitted to AID/Washington as one study of the overall project.

Other Projects Under Way

Three other major projects evaluating the interrelationship of agricultural and economic development, the role of food aid in this process and the theoretical concepts under which food aid can form a positive mechanism for development are included in the project. Each particular study is outlined below with the stage of completion and expected date of manuscript submittal included.

Intersectoral relationships in a five-sector, theoretical model of economic development

During the past thirty years, considerable effort has been expended on the analysis of the determinants of economic growth. One of the central, unresolved issues in this query is the nature of the interrelationships between agricultural development and industrialization. For many years industrialization was believed to hold the key to successful economic development. During the last decade, however, several theories and some empirical evidence have been presented which indicate a more significant role for the agricultural sector. Most of these theories have been based on dual economy models

This study investigates the theoretical interrelationships between agriculture and industry. A five-sector optimizing model of an

underdeveloped economy is formulated and extensively analyzed. The five sectors in the model include subsistence or traditional agriculture, commercial agriculture, manufacturing goods production, capital goods production, and a government sector. Three products are produced: agricultural goods which can only be consumed, manufacturing goods which can either be consumed or used as nondurable factors of production, and capital goods which can only be used as durable factors of production.

The factors of production included in the model are land, labor, capital and manufactured inputs. Production in the traditional agricultural sector requires land, labor and manufactured inputs while the commercial agricultural sector uses capital goods in addition to the factors employed in the subsistence sector. Manufactured goods and capital goods production do not require land as an input and employ only labor, manufactured goods, and capital as factors. Labor is assumed to be employed at a constant wage rate (measured in terms of manufactured goods) in the commercial agricultural sector, the manufacturing goods sector, and the capital goods sector. Any labor which cannot earn its marginal value productivity in these three sectors is employed in the subsistence sector at a lower wage rate.

The optimand is a quadratic function of aggregate levels of agricultural and manufactured goods consumption. This function approximates Engel's law in the sense that as per capita consumer income rises, the proportion of income spent on food (agricultural goods) declines. The government uses the instruments of fiscal spending to maximize this welfare function over a finite horizon.

Two formulations of the model are considered, with the role of the government being the principal difference between the two models. In the

first formulation, the government has control over only four investment alternatives. These four alternatives are investment in social overhead capital in either the subsistence or commercial agricultural sectors, and investment in private capital in either the manufacturing or the capital goods sectors. In the second formulation, the government's role is expanded considerably to include control over the allocation of private investment funds as well as public tax revenue,

These two versions of the model are extensively analyzed in an attempt to discern the economic and physical conditions that would tend to make it socially desirable to develop agriculture as compared to industry and vice versa. Similarly, an attempt is made to delineate the circumstances tending to make the development of subsistence agriculture socially more desirable relative to the development of commercial agriculture.

While the basic model does not include foreign trade, an attempt is made to investigate the impact of various types of aid on the closed system. In particular, the impact of food aid and capital goods is investigated. The implications for the optimal developmental process of alternative rates of population growth are examined.

Most of the theoretical model building has been completed with only some minor modifications necessary to investigate some of the aspects of aid and population growth remaining to be completed. A first draft of a preliminary report of study is nearly complete; the entire first draft will hopefully be completed by June 30, 1970

Factors affecting agricultural growth and development in less-developed areas

This study is designed to facilitate the understanding of the economic and social factors which interact to inhibit or to stimulate the

productivity of the agricultural sector in less-developed areas. An awareness of these friction points in the developmental process can enable national planners to design and implement more effective programs of public investment and government policy to augment agricultural productivity and to improve resource mobility and allocation.

Less-developed areas are characterized by their heterogeneity - variations in per capita resource endowments, in institutional structures conditioning economic activity, and in the attitudes and motivations of the economic agents participating in the economy. Yet, for all this heterogeneity, a number of factors commonly operative in each less-developed area can be abstracted and synthesized into a generalized, conceptual model of agricultural development. The weights or importance attached to individual factors varies for particular countries and for stages of economic development. However, all factors are operative to some degree in all countries.

The focal point of the study is the individual producer and the factors which influence his decision-making processes relative to resource allocation, private investment, and, to a lesser extent, consumption patterns. Two broad categories are employed: (1) subsistence-oriented producers; and (2) market-oriented producers. As the term suggests, subsistence-oriented producers gear production decisions to primarily accommodate consumption requirements. However, they do have limited contact with an exchange or money economy. Implicit in the study is a tracing of the evolution of a subsistence-oriented producer toward a market-oriented producer. The latter is presumed to be more economically-motivated and, hence, more responsive to economic pressures and incentives generated in the developmental processes.

The following factors are discussed in detail: (1) Land tenure systems; (2) Production techniques; (3) Rural credit institutions; (4)

Infrastructure of the agricultural sector; (5) Government policies; (6) Prices and other choice indicators; and (7) Values, attitudes and objectives of agriculturalists. Initially, each of these areas is essentially given a theoretical discussion. Following that and integrated with it will be references to the literature, i.e., the documentation of the discussion. Subsequent to this, the individually-studied components are integrated into a conceptual model within which the influence of the individual factors can be qualitatively observed. The conceptual model also elucidates the interrelationships among these factors as they affect agricultural productivity. From such a conceptual model the friction points previously referred to can be observed.

To date, the discussion of two of the seven factors cited above is yet to be completed. The integration process is expected to be rather time consuming. A first draft of the study report is anticipated to be completed by September 30. A completed report in final form for submission to A.I.D. is expected to be completed by December 31, 1970.

Interrelationships of consumer and producer behavior patterns and developmental effects of food aid

The process of economic development is a basic attempt to increase aggregate national income through increases in investment and production. Development is usually designed to increase living standards of the individuals of the society and directly improve general welfare. The level of welfare is intricately related to patterns of consumer demand, and consequently the impact which food aid has on a recipient economy is closely related to the methods of distribution and the associated groups of consumers which are direct recipients of the commodities. The current income

level of the individual has considerable importance in determining the allocation of marginal income, which in turn affects the demand and prices of alternative consumer goods. Through price responsiveness of producers, consumer demand patterns ultimately have an impact on long run domestic supply of products and demand for factors of production. For parallel reasons, the methods of distributing food aid in recipient countries have a direct influence on amount or quality of resources which can be created or developed for availability in expanding domestic production. Expansion of domestic production has a direct impact on prices. Through price and income responsiveness of consumers, production ultimately has an impact on long run consumer demand patterns and level of welfare. From both the consumer and producer standpoints, the manner in which the additional food is related to recipients has considerable importance in determining the effectiveness of food aid in stimulating development.

The primary objective of this study is to develop a partial equilibrium analysis of the interrelationships of consumer and producer behavior patterns and the developmental effects of food aid on agriculture and the general economy of recipient countries. As an integral part of the primary objective, the following secondary objectives are designed to develop individual areas of major concern to the study: to establish qualitative intersectoral linkages and measure income and price effects which precipitate from food aid transfers; to delineate alternative approaches for incorporating food aid into the recipient economy; to analyze the impact of alternative transfer methods on consumption and production; to determine the provisions which cause food aid to result in a dominate expansion of supply or demand; to evaluate the impact of food aid on con-

sumer and producer welfare; to develop principles and policy implications for various aspects of food aid programming.

The study has been developed in two major parts. The first facet of the study involves the formulation of a conceptual economic framework which incorporates the theoretical principles of consumption and production. This provides the organizational structure for analysis of food aid as one form of foreign assistance. The second and more important facet of the study involves the analysis of P.L. 480 provisions within a conceptual framework to determine the economic relationships which can be exploited to effectively utilize food aid in stimulating agricultural and economic development as a means of achieving improved welfare in developing nations.

Effectively, introduction of food aid into a recipient economy affects the individual consumer whether programmed through the recipient government or directly to the consumers. Consequently, the focus of the study centers around the individual consumer and his responses to alternative conditions under which food is received. The central analysis of consumer response examines variations in consumer behavior at three different income levels which were chosen to represent low (\$75), medium (\$250), and high (\$450) incomes for consumers in the recipient countries. Major attention is given to the development of average and marginal consumption responses at the three levels, as well as substitution effects of a shift in terms of trade between food and nonfood commodities. From these relationships, the impact of food aid will be related to various income groups within a country or to income levels of different countries. Due to the close interrelationship, conclusions can be drawn with respect to both food and nonfood demand.

The methods utilized in the distribution of commodity aid have a direct impact on the basic groups which effectively receive the commodities, and consequently have a significant impact on the ultimate role of the food aid because of the distinctive responsiveness associated with different income groups. Three major methods of distribution are examined which include grants, wages in kind, and open market sales. Each distributional method is associated with certain direct effects on the domestic supply and/or demand for both food and nonfood items, and consequently an impact on the market conditions. From the impact on food and nonfood demand, price policy mechanisms will be specified which can be used in connection with food aid programming without depressing domestic production.

Variations in consumer demand have a direct effect upon market prices and are related directly to domestic supply of both food and non-food commodities. On this basis the study turns to an analysis of production conditions in the recipient countries and producer response to alternative incentives. Analysis of producer response provides the basis for developing projects which utilize food aid to promote production and permanently affect the supply side of the equilibrium framework. Although the initial impact of food aid is a temporary shift in total supply, proper programming of food aid can achieve a simultaneous shift in domestic supply to meet any permanent shift in demand resulting from the availability of food aid.

The last part of the study involves the integration of alternative distribution methods with associated consumption and production responses and translation of the analysis into principles and policy implications relating to four basic types of questions. How can food be used in recipient countries? What effect will shipments of food commodities have

on the recipient economy? What contribution can these effects make to development of the agricultural sector and to general economic development? Under what conditions can food be used as a substitute for capital as a form of foreign assistance?

The economic literature abounds with basic principles and theories for development and the microeconomic theory of consumer and producer behavior under alternative conditions, and yet little of the theory has been applied to develop a basic framework and analysis of the impact of food aid on development. This study is designed to make a specific contribution by modifying the general economic principles and theories into a conceptual framework and applied analysis of food aid as related to the developing nations.

Currently the study is well over half completed. The first facet involving the development of the conceptual framework has been completed, and alternative aspects of food aid utilization are now being analyzed. It is anticipated that a preliminary draft of the study will be available for transmittal to AID by the end of October 1970.

Research Studies Located in India

Three research projects are in progress in India. Each is designed to provide specific information on the outlook for and programming of food aid shipments in future years. A major focus of two of these research projects is analysis of variables which affect the domestic production of food in India. Improved knowledge of Indian production prospects will allow more effective planning, both in terms of providing a supply of inputs for agricultural production and in terms of providing an offsetting

supply of food in times of depressed output. The third project is designed to provide additional information on the use of counterpart funds which have accumulated from past shipments of food, and which will continue to accumulate as a result of the repayment of past loans of counterpart funds to the Indian government. Each of these projects is discussed below.

Analysis of weather factors in establishment of buffer stock requirements

This project analyzes the problem of changes in food production resulting from fluctuations in weather and evaluates the need for buffer stocks of food grains. The analysis focuses on establishing an index of rainfall for each of the meteorological districts of India and will statistically relate these indices to food supply relationships. From these relationships, levels of food stocks will be estimated to protect against expected changes in food supply resulting from weather variability. Costs will be calculated for procuring and annually storing quantities necessary to cover differing proportions of the estimated fluctuations in food supply.

The study has proceeded by relating food production to weather in the following manner: Production of cereals can be expressed as a function of a number of controlled variables like fertilizer, pesticides, irrigation, prices etc., and an uncontrolled weather variable (X), comprised of the various natural factors like rainfall, temperature, day length, etc. Any variation in production can, therefore, be partitioned into two components - one arising out of the controlled variables and the other from the uncontrolled variable X. X varies according to some unknown natural law and thus causes undesired variation in yield and acreage and hence in production. However, if we can approximate the distribution of

X from its observed behavior, variation in production due to this variable can be estimated and planning can be made accordingly to meet expected fluctuations. The size of buffer stocks and a scheme to build it up can be worked out by application of probability theory, theory of games, etc., provided the distribution of X is known. Knowledge of the distribution of X can also help to work out crop insurance schemes and reorient irrigation policies. The first step, therefore, is to estimate the variable X.

A large number of studies has been carried out in many countries to examine the contribution of various natural factors involved in the production process. The two factors that appear most prominently in the available literature are rainfall and temperature. Fairly good data are available for these two variables in India. As a first approximation of X, both rainfall and temperature were considered. Further investigation showed that inclusion of temperature was not important in India as in some other countries. An analysis of data pertaining to some fifty meteorological stations of India, published in World Weather Records (U.S. Department of Commerce), indicated that month-wise variations in temperature over years (data series ranging from 30 to 90 years) were not significant except in some hilly areas. However, this was not true in case of rainfall. Since yearly variation in monthly temperature is very small and practically remains at a constant level in most regions, rainfall is the only factor that is used to construct the variable X.

A fairly long series of rainfall data for each meteorological division of India is used to construct X and to estimate its distribution.

Data from approximately 232 stations are available in the official rainfall series published in India of which 136 stations have data starting from 1875 (4 to 6 stations for each meteorological division). Most of the additional stations were set up after 1950 and do not provide long data series. After considerable evaluation it was found that the monthly normals based on 136 stations data did not differ significantly from the larger set of presently published data. Therefore rainfall data of these 136 stations were accepted for further work. From the time series data of rainfall for the 136 stations a weather index was obtained by taking a simple average of the station data for 1875-1966. After completion of the weather index, the next step was to relate it to the production of cereals in India.

Cereals production is a year round activity in India and the total production in any division is influenced by four monsoons: (1) South-west monsoon (June to September), (2) Post-monsoon (October to December), (3) Winter monsoon (January and February), and (4) Summer monsoon (March to May). Moreover, through a series of mutual adjustments over a period of time, each division in India has adopted a particular cropping pattern suitable for its soil-climatic characteristics. For some regions, total cereals production primarily depends on south-west monsoon, for other regions all four monsoons are important. Therefore, an aggregate rainfall index to correlate with the total cereals production was obtained by weighting suitably the rainfall during the four monsoon periods. To form a means of measuring change in the weather index, a relatively recent base period was chosen in which fluctuations in production caused by weather

are relatively moderate. The average of 1959-62 seems to be quite satisfactory in this regard.

When the above parameters have been established for a specific year or set of years these data will be formulated into a model which will provide a means to estimate the stocks of foodgrains required to cover various levels of expected variations in production. The needs for buffer stocks can then be translated into alternative procurement policies with regard to procurement pricing, food imports and other appropriate policy variables.

This project is being carried out by Mr. S. K. Ray located at the Economics Growth Center of Delhi University. It has important policy implications on future food aid and irrigation planning. The study has evoked active interest in USAID, Ford Foundation, and Government of India including the Irrigation Commission. When completed it will be of use to the Soil and Management division as well. The Government of India Irrigation Commission has suggested a more detailed study based on the methodology already developed. While the study is moving along rapidly an additional year of effort will be required for completion.

Food supply-demand projections and production input requirements for India

This project focuses on the interrelationships between food production and demand in India, and attempts to estimate the required levels of production inputs for each level of agricultural output. The project is located at the National Council of Applied Economic Research in New Delhi. The NCAER is using previous work on supply-demand as a basis to analyze the rapidly changing levels of production in Indian agriculture. With another record production of wheat expected in 1970, these rapidly changing con-

ditions have particular importance to the programming of U.S. agriculture both in terms of food aid shipments and in terms of domestic supply control programs. (The initial study reviewed in this report analyzes the interrelationships of these two aspects of U.S. policy.)

This project analyzes the changing conditions of Indian agriculture and projects supply and demand for the period 1970-1985, drawing together the implications of new technologies for increasing supplies of food and alternative levels of population and income growth for increasing the demand for food. On the demand side, the study evaluates the effects of changes in elasticities and income levels on the aggregate demand for food and attempts to specify the outcome of alternative allocation policies for income creating technologies. The income distribution policy of the Indian government is important in projecting demand for food. (Although it is outside the scope of this study, income distribution is also of great importance from the standpoint of governmental stability.)

On the supply side, the analysis focuses on the new technological innovations which crop breeders are developing and farmers are adopting. Estimates are made of the production effects these new inputs will provide. Further, the study draws upon new surveys on fertilizer response to work up estimates of the quantities of fertilizer which will be required to optimally use the new varieties of crops now being developed. Following the work on fertilizer, irrigation requirements, investment in equipment, investment in land development, and required overhead development of public waterways for the new varieties are also estimated. Given these major input requirements for new varieties of food grains, the analysis concentrates on evaluating foreign currency considerations implied in

these import requirements. From these derived estimates of foreign currency needs, the project interprets all of the above research in terms of the "food aid" needs or potentials with suggestions for new alternatives in food aid to meet changing agricultural conditions and prospects in Indian agriculture.

This project is proceeding toward completion and it is expected that an initial draft of the manuscript will be available on July 1, 1970 to Iowa State University. It will be made available to A.I.D./ Washington as soon after as review and revision permit.

Allocation and Utilization of Counterpart funds generated under the Food Aid Act of 1966

This project analyzes the use of counterpart funds and other provisions of the Food Aid Act of 1966. Under the revised Food Aid Act of 1966, food stuffs are provided to recipient countries under contracts for long term credit but this credit must be eventually repaid in dollars rather than local currency. The implications of this change to a nation in a weak dollar-currency position are not entirely evident although the continuous negotiation by the Indian government to refinance outstanding debt obligations implies some serious future balance of payments problems. Since the change to long term credit sales grew out of practical considerations of food supply and stock levels rather than an attempted movement toward a policy to stimulate economic development, a thorough analysis of the ultimate effects of this change in repayment provisions will be of use to a number of administrators both in India and the United States.

This study analyzes repayment provisions and the monetary effects of eventual repayment of past food aid loans. It has been divided into five chapters. Chapter I elaborates the problems connected with the use of counterpart funds and Chapter II evolves a theoretical structure by which the question of inflationary or deflationary impact of P.L. 480 counterpart funds can be evaluated for any period. This impact has been quantified for the period 1956-57 to 1968-69. The theoretical framework also helps identify the component which will go to swell the U.S. use rupee funds when the P.L. 480 imports have ceased.

Chapter III provides projections of U.S. rupee funds up to the year 2010 and tries to gauge the contribution of each component use. It also determines the magnitude of aggregate surplus funds (over and above U.S. needs). The consequences of using these surplus funds for in-country purposes are analyzed within the framework of the parameters of the Indian economy.

Chapter IV deals with the impact of changed terms of P.L. 480 aid on India's debt service ratios given a certain level of aid flow to India. The overall summary and conclusion are presented in the Chapter V.

Data for the present study have been collected from the G.O.I. file and from records of the U.S. authorities in India. The analysis is now in final stages of completion. It is expected that the researcher, Dr. Uma K. Srivastava will come to the U.S. on September 1, 1970, as provided for in this contract, and will finalize the draft of the manuscript for submittal to A.I.D./Washington. Dr. Srivastava will spend one year in residence at Iowa State University in Post Doctorate study as part of the

technical personnel improvement aspects of this project. Upon completing his year of study, he is expected to return to India and carry on a research program in agricultural economics.

Future Research Efforts

Most of the research projects reviewed above are scheduled for completion in the period July 1, 1970 to January 1, 1971. Since a substantial period of time remains under this contract, the project leaders are currently initiating negotiations for further research efforts under the contract. As part of this forward looking effort, Professor Earl O. Heady has spent two months in India (March - April 1970) and has located additional research personnel who may contribute further to the research effort if A.I.D./Washington is favorable to that development. Additional research personnel are also located at Iowa State University for extension of present projects and the initiation of new research projects if A.I.D./Washington project supervisors are in agreement. These aspects of the project will be taken up with A.I.D. Washington personnel upon the return of Professor Heady from his New Delhi visit. All future aspects of research will be discussed with these personnel before any actual commitments are made with research personnel in Iowa or New Delhi.