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MAY 16 1978

ACTION MEMORANDUM FOR THE ASSISTANT ADMINISTRATOR FOR DEVELOPMENT SUPPORT

THRU: DS/PO, Robert Simpson

FROM: DS/AGR, Leon F. Hesser

SUBJECT: Approval for Project Implementation of "Technology, Policy and Rural Incomes"

Problem: Your authorization is needed for implementation and funding of the attached Yale University, unsolicited research proposal, "Technology, Policy and Rural Incomes."

Discussion: The project has been developed by Robert Evenson and Hans Binswanger of Yale University to assess the regional impacts of various changes in technology and policy on rural incomes. It was approved by the Research and Development Committee at its March 8, 1977 meeting. The Research Advisory Committee approved at the March 31, 1978 meeting. The Environment Threshold Decision was approved April 20, 1978.

This research proposal from Yale University is the product of original thinking, has significant scientific and technical merit, and will contribute to AID's research program objectives. The proposal has been reviewed by DS/AGR and meets the requirements of an unsolicited proposal contained under AID PR7-4.530 1(e). Therefore, it is recommended that a contract be awarded to Yale University without consideration of other sources.

Recommendation: That you approve the project and awarding of the contract to Yale University and sign the attached PAF.

Approved: _____

Disapproved: _____

Date: _____

DS/AGR/ESP:CInfanger:jh:
5/8/78

Clearance:
DS/PO, K. Milow _____ Date _____
DS/RES, M. Rechigl _____ Date _____
DS/AGR, M. Mozynski MM Date 5/8/78
ASIA/TR, C. Martin _____ Date _____
DS/AGR/ESP, W. Merrill _____ Date _____

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS PART I

1. TRANSACTION CODE: [A] A = ADD, C = CHANGE, D = DELETE — PAF

2. DOCUMENT CODE: 5

3. COUNTRY/ENTITY: DS/AGR

4. DOCUMENT REVISION NUMBER: [ ]

5. PROJECT NUMBER (7 digits): 931-1168

6. BUREAU/OFFICE: A. SYMBOL: DSB; B. CODE: 08

7. PROJECT TITLE (Maximum 40 characters): Technology, Policy and Rural Incomes (Formerly-Regional Impacts of Agr. Dev.)

8. PROJECT APPROVAL DECISION — ACTION TAKEN: [ ] A = APPROVED, D = DISAPPROVED, DE = DEAUTHORIZED

9. EST. PERIOD OF IMPLEMENTATION: YRS. 02 QTRS. 1

10. APPROVED BUDGET AID APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	PRIMARY TECH. CODE D. LOAN	E. 1ST FY __ F. GRANT	E. 1ST FY __ G. LOAN	H. 2ND FY __ I. GRANT	H. 2ND FY __ J. LOAN	K. 3RD FY __ L. GRANT	K. 3RD FY __ M. LOAN
(1) FN	1811	052		243.7					
(2)									
(3)									
(4)									
TOTALS									

A. APPROPRIATION	N. 4TH FY __ O. GRANT	N. 4TH FY __ P. LOAN	Q. 5TH FY __ R. GRANT	Q. 5TH FY __ S. LOAN	LIFE OF PROJECT T. GRANT	LIFE OF PROJECT U. LOAN
(1)					243.7	
(2)						
(3)						
(4)						
TOTALS						

11. PROJECT FUNDING AUTHORIZED (ENTER APPROPRIATE CODE(S)) 1 = LIFE OF PROJECT, 2 = INCREMENTAL, LIFE OF PROJECT

	A. GRANT	B. LOAN
	X	

C. PROJECT FUNDING AUTHORIZED THRU: FY 80

12. INITIAL PROJECT FUNDING ALLOTMENT REQUESTED ($000)

B. ALLOTMENT REQUEST NO. _____

A. APPROPRIATION	C. GRANT	D. LOAN
(1)		
(2)		
(3)		
(4)		
TOTALS		

13. FUNDS RESERVED FOR ALLOTMENT

TYPED NAME (Chief, SER/FM/FSD)

SIGNATURE

DATE

14. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [ ] LOCAL [ ] OTHER _____

15. FOR AMENDMENTS, NATURE OF CHANGE PROPOSED

FOR PPC/PIAS USE ONLY	16. AUTHORIZING OFFICE SYMBOL	17. ACTION DATE MM DD YY	18. ACTION REFERENCE (Optional)	ACTION REFERENCE DATE MM DD YY

AID 1330-1 (7-76)

Project Authorization and Request
For Allotment of Funds Part II

FILE COPY

ENTITY: DS/Bureau

PROJECT: Technology, Policy and Rural Incomes

PROJECT NUMBER: 931-1168

I hereby authorize grant funds not to exceed $243,700 for a 25 month contract to be negotiated with Yale University Economic Growth Center for research on "Technology, Policy and Rural Incomes. This research will involve the empirical validation of a set of analytical models, using data from India, Philippines and Bangladesh, which will permit estimation on a regional basis of the effects of technical change and various policies on the welfare of rural households. This is a new project for AID funding which builds upon considerable research already carried out by the principal investigators and others. It will be funded entirely in FY 78, and no extensions are anticipated. This project was revised and endorsed by R and DC during their meeting on March 8, 1977 and reviewed and endorsed by the RAC in their March 31, 1978 meeting.

Sander Levin
Assistant Administrator
for Development Support
Date: _____

Clearances:
DS/AGR/ESP:W.C.Merrill _____
DS/AGR:L.Hesser _____
DS/RES:F.C.Quinn _____
DS/PO/PA:K.Milow _____
DS/RFS:MRechigl _____

References:
1. Research Project Statement: "Technology, Policy and Rural Incomes, Dated January 25, 1978.
2. Minutes of RAC Meeting - March 1978.
3. Minutes of R and DC Meeting - March 1977
4. A/AID's approval memo dated _____ 1978

RESEARCH PROJECT PAPER

January 25, 1978

A. Project Summary

1. Basic Identification and Fiscal Data

Project Title: Technology, Policy and Rural Income:

New Project

Contractor and Address: Economic Growth Center
Yale University - 27 Hillhouse Avenue
New Haven, Conn. 06520

Principal Investigator: Robert E. Evenson, Prof. of Economics, Yale University in collaboration with Hans P. Binswanger, Associate, Agricultural Development Council

Duration: April 1, 1978 - March 31, 1980

Total Estimated Cost $228,820

Funding by Fiscal Years:	Current Year	4/1/78 - 9/30/78	$ 72,845
		10/1/78 - 9/30/79	$112,850
		10/1/79 - 3/31/80	$ 43,125

A.I.D. Project Manager & Lee Martin

Sponsoring Office: DSB/AGR/ESP

2. Abstract

Available data show that for much of Asia, the wage rates of rural laborers and the incomes of small farmers have not risen substantially and in many cases have actually fallen over the past two decades. A number of "green revolution" and "mechanization" studies based primarily on farm level data have failed to provide comprehensive explanation for the phenomena of worsening poverty. These studies were not designed to consider economy-wide market interactions in a comprehensive way. They can not systematically show how such factors as labor force growth, inter-regional and inter-sectoral migration, mechanization subsidies and different types of technical change affect rural employment and wage rates. This project proposes to construct and estimate a Distributional Analysis model for rural incomes in India. It will integrate farm level economic behavior with economy-wide market forces.

The Distributional model proposed is designed to simulate the market outcomes which result from changes in a number of regional and national policy instruments and related exogenous forces. The market outcomes will be expressed in terms of quantities and prices of products produced and in terms of quantities of inputs employed and prices of inputs. Because these market outcomes can be translated into incomes of rural households given information on the ownership of agricultural inputs, (chiefly labor, land and power) it will also be possible to simulate income distributional outcomes in the model. The outcomes for landless laborers and small farmers dependent on labor income will be given particular attention.

The policy instruments and exogenous forces to be considered in the analysis include population and labor force growth, intersectoral and interregional labor force migration, technical change, employment schemes and input subsidies on power, fertilizers and credit. The distributional outcomes for all of India and its main regions of a number of policy mixes will be analyzed.

This project is designed primarily to complement the existing body of micro farm level studies by providing a broader economic framework in which to interpret their results.

B. Expanded Narrative Statement

1. General Background and Rationale

The income distribution problem in rural areas can be discussed in terms of four dimensions: 1) distribution among farm size classes, 2) distribution between cultivators and landless laborers, i.e., according to land and asset ownership, 3) distribution between agricultural regions, and 4) distribution between producers and consumers.

The first dimension, distribution among farm size classes, has been extensively studied in India and many other developing countries. It has been investigated in both static and dynamic situations. The green revolution impacts on income by farm size in India, in particular have been the subject of a number of studies. Policy and institutional interventions such as subsidized credit to small farmers and the Small and Marginal Farmer Development Program in India have been designed in part on the basis of these studies to improve market and technology access to small farmers.

The second dimension, distribution between cultivators and landless laborers has also been subject to study. Micro-level studies summarized by Mellor (1976) and the macro-studies collected in Bardhan and Srinivasan (1974) show that in regions where the green revolution had its major impact on crop yields, the demand for labor increased and real wages rose. They also indicate, however, that landowners benefitted from the green revolution to a much greater extent than did laborers. In addition, the macro evidence on agricultural wage rates for most of India and other countries in South and Southeast Asia reveals an alarming picutre of constant or falling real agricultural wage rates and a rapidly rising ratio of landless agricul-

tural workers to cultivators. The green revolution has produced departures from this trend only in a few regions.

The Second Asian Agricultural Survey of the Asian Development Bank and the recent study of "Food Needs of Developing Countries" by the International Food Policy Research Institute document the broad trends in population growth and food supply for Asia. Demographic projections indicate that population pressure will continue to be maintained in the near future. Larger numbers of households, including small tenant farmers will be dependent on agricultural labor incomes in the future. Agricultural employment and agricultural wage rates will become increasingly important policy issues. Many of the micro studies of employment and income distribution between laborers and landowners have concentrated only on farm level effects and have not attempted to study broader labor market forces such as population growth, labor absorption in the nonagricultural sector etc

The third dimension, distribution between agricultural regions has received less systematic study. The pattern of technical change actually realized and the government development programs have had differential regional impacts. The rice and wheat varieties of the green evolution have outyielded traditional varieties only in a few favored regions. The agricultural research programs of India and other countries are not designed to produce an even flow of technonogy for all regions. Similarly the IADP program in India and many other rural development programs have been available only to certain favored regions. The cumulated effects over a period of years of even small regional differences can be quite severe in terms of employment and wages. The bulk of the adjustment to these effects is borne by agricultural labor which faces the option of

accepting low wages and employment rates or bearing migration and search costs to find employment in another area.

The tendency for most micro studies to neglect the impacts of new technology or of other programs on farms not directly influenced by the technology or other programs has led to misinterpretation of the evidence. The impact of the green revolution, for example, was not confined to farms adopting new technology. Because it increased supply it reduced market prices (as long as aggregate demand was not perfectly elastic) and this price change affected producers in the lagging regions adversely. (Evenson 1973)

The fourth distributional dimension is between producers and consumers of agricultural products. Farmers are both producers and consumers but landless laborers and the urban population are not. The gain from agricultural price reductions arising from agricultural growth depends on the share of income spent on food and is highest for the poorest groups in the population. This dimension of the problem has received some attention (Hayami and Herdt 1976) but a full analysis of the distributional impact of the green revolution on consumers has not yet been made.

For many reasons the analysis of rural income distribution has relied mainly on field level surveys such as the Indian Farm Management studies, special "Green Revolution Surveys" and Special "Tractor Surveys." The USAID Poor Rural Households Project continues in this tradition. Field level surveys are most powerful in documenting changes in the distribution of income across farm size groups--and to a lesser extent--between landowners and laborers (often these surveys did not include landless labor households).

Comparison of survey results over time and space has been a useful source of insight into some of the income distributional impacts of technologies and policies. The surveys have also been used to document and sometimes econometrically estimate the characteristics of innovation such as economies of scale or labor saving biases (Yotopoulos and Lau (1973) Sidhu (1974), Binswanger (1978), Binswanger and Shetty (1977).) Finally they provide the data required for econometric estimation of output supply and factor-demand elasticities.

The main difficulty with field level surveys lies in relating their findings to regional and economy wide phenomena which are largely exogenous to the farm or region where the surveys are undertaken. For example, it is impossible to determine on the basis of surveys alone to what extent the apparently unfavorable distributional impact of the green revolution on laborers relative to landowners has been caused by the characteristics of the technology, by general labor force growth, by interregional or intersectoral migration, by subsidization of labor displacing inputs such as tractors or by the rising agricultural output prices (resulting from rapid population growth and price support or trade policies).

This project proposes to capitalize on available field level data and micro-evidence by using it for the basic documentation of the distributional situation and as data input for econometric estimates The resulting estimates and facts will be used in a Distributional Policy Analysis Model which is designed to do what the farm level surveys cannot, namely to link the returns to labor, land and capital at the farm level—and the income distribution at the regional level—with regional and national

developments such as population or labor force growth and other regional or national policies. This project proposes to put special emphasis on the analysis of income distribution problem associated with the landowner-laborer dichotomy and on the regional income distribution problem.

2. Research Purposes and Products

1. Purposes: This project has two related purposes:

A. To construct and estimate the parameters econometrically with Indian Data a Distributional Policy Analysis Model designed to simulate the effect of macroeconomic developments and policies on the quantities and prices of commodities produced and factors of production used in agriculture. The markets considered will be:

Agricultural Output
Labor
Power (Bullocks and Tractors)
Fertilizer (and related chemicals)
Land

The model will be designed to be applied either to small regions or to aggregates of several small regions linked by national markets for agricultural output, wage labor, power and fertilizers.

B. To simulate the market outcomes (prices and quantities) of selected exogenous changes in regional and national policy instruments. These market outcomes will then be related (via data on asset holdings and food - nonfood expenditures) to the income distribution impacts on various groups in society, in particular, landless laborers, small farmers and large farmers;

The exogenous changes and policies which will be specifically considered are:

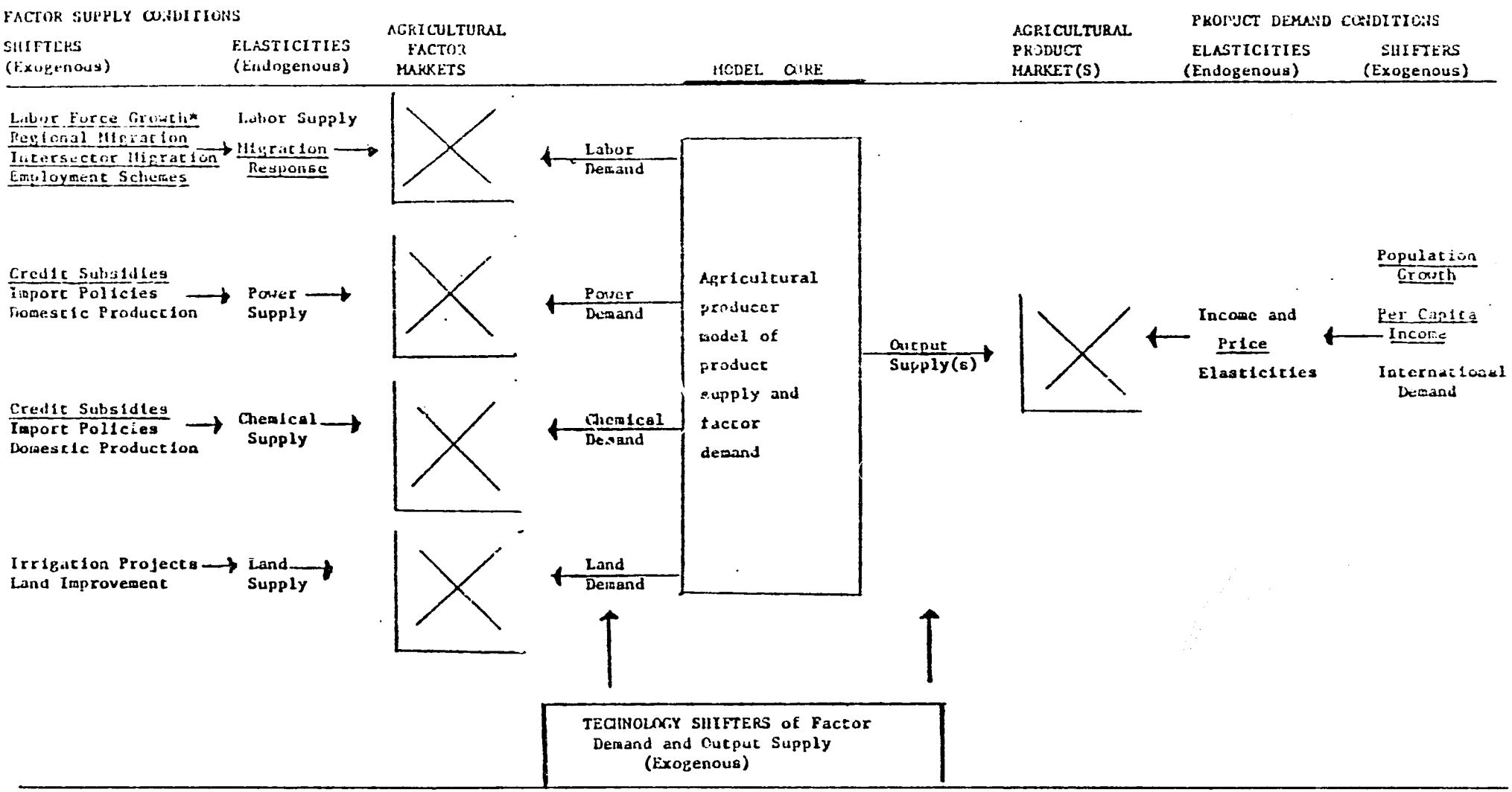
- various forms of technical change
- population growth and demographic trends and policies
- labor force growth
- employment guarantee schemes and rural works
- input subsidies on power and fertilizer

Figure 1 provides a schematic summary of the Distributional Policy Analysis Model. (Section 6 discusses the model in detail.) The model has five markets; an output market and four input markets (labor, land, power, chemicals). Each market has a demand and a supply function. Each demand and supply function has both endogenous (price) and exogenous or shifter components.

The "core" of the policy model is the producer model which is an econometric model of producer behavior and contains output supply and factor demand functions. It implicitly also contains production and technology parameters. Technology parameters are viewed as exogenous shifters. The parameters of the core component model will be estimated utilizing Indian Farm Management Studies farm level data and secondary District Level Data.

The full policy model contains, in addition to the core component, output demand functions and factor supply functions. Each of these functions contains endogenous price components and exogenous shifter components. With the exception of migration response estimates, the parameters of these non-core components will not be estimated as part of this project. A number of studies are available (documented in section 6) from which the neces-

Figure 1: Distributional Policy Analysis Model: Schematic Representation



Note: The core model and underlined items will receive particular emphasis in estimation and policy simulation

sary estimates can be drawn. Estimates of labor supplied via migration response will be made in the proposed study.

The specification of the shifters is an important part of the analysis since it is through the shifters that policy impacts are incorporated into the model. The output demand function is shifted by growth in the consuming population, by changes in the income of consumers and by international trade changes. Labor supply to agriculture is shifted by changes in the size of the working population and by interregional and intersectoral migration factors. Land supply is shifted by irrigation projects, land clearing projects and urban development. The supply of power and chemicals is shifted by credit subsidies, and by import policies.

The estimated model will be extended beyond the simple form portrayed in Figure 1 in two ways. The model will consider several agricultural outputs and will have a multi-regional dimension (see section 6). The model, when fully estimated, is capable of showing the market outcomes in terms of changes in output prices and quantity and in the quantities employed and prices paid to each input of a given shift or of a set of simultaneous shifts. Simultaneous shifts in technology, size of the population and size of the labor force can be considered for example. Market outcomes in turn can be translated into distributional effects given information on the weights of food expenditures in consumers' budgets and on the distribution of ownership of factors of production.

2. Products

This project will produce:

1. The estimated Distributional Policy Model for India

2. Simulated market outcomes from a selected set of policy influenced shifts.

The model itself and its individual components can be considered to be products: building the model and its blocks will result in new estimates of parameters with policy interest such as a complete set of output supply and input demand elasticities for different regions. The estimated total factor productivity series for Indian Districts will also be of particular interest. Further, it can be used for the simulation of policy effects other than those considered in this project.

The simulated market outcomes from a selected set of shifts will be the principle product of the project. Particular emphasis will be put on policies underlined in Figure 1. The shifts to be analyzed will be designed to reflect real policy options.

This project will also support two satellite projects (discussed in detail in Appendix D) applying the Distributional Model to the Philippines and to Bangladesh.

The products of the project will be discussed in appropriate publications.

3. Relevance and Significance of Proposed Work to USAID

a. Significance. The importance of the welfare of the lowest income households in the developing countries is clearly established. USAID has, by Congressional mandate and by broader international policy consensus, an obligation to support development programs with the objective of improving the welfare of the poorest households. Program impacts on factor and household incomes are complex in nature. Our understanding of these impacts in their entirety is far from complete. A number of useful studies have been made and in certain contexts they provide useful insights.

The value of a more integrative approach toward understanding the relationship between population and labor force growth, capital investment, new technology, development policies and real incomes is perhaps higher today than in the past. The Second Asian Agricultural survey conducted by the Asian Development Bank reported evidence that real wages for agricultural workers have declined in large parts of Asia in recent years. Studies of possible food grain imports in Asian developing regions (IFPRI and F.A.O.) also indicate growing food deficits and raise the real possibility that the welfare of the poorest families in Asia will decline over the next decade or two. The coming decades will be a period when sound knowledge of the distributional impacts of regional and national policies and projects will increase in value.

b. Side Effects of the Proposed Research

1. The research proposed does not have direct environmental effects per se.

2. The proposed research has implications for a range of USAID concerns. By its integrative nature it addresses questions relating to effects of population growth, status of the poor and to a lesser extent the role of women.

3. The proposed research does not involve human experimentation.

4. Relation to Existing Knowledge

Most of the current evidence on the impact of regional and national economic and technology policies and trends on rural income distribution

comes from comparison/ farm level surveys over time and space and partial analysis of available wage rate statistics. (For reviews see Mellor 1976, Bardhan and Srinivasan 1974 and Binswanger and Ruttan, 1978, Chapter 13.) This project will explore these links in a more systematic way and help clarify many of the questions which cannot be answered from such comparisons alone. The project will draw on the farm level surveys in several ways. It will use data from such surveys for the estimation of the model core, it will test model predictions against the reality described in the farm level surveys. It will disentangle the individual contributions of simultaneous influences of several policies and trends on the micro level changes in income distribution described in the farm level literature. As against the /distributional questions across farm size classes emphasized in that literature, the current project will put more emphasis on labor incomes, on regional income distribtuion issues and on the effects of food price changes on income distribution.

The project will also draw parameter estimates from the Indian literature on determinants of consumer demand, labor supply, tractorization and fertilizer use. The Indian planning literature and its projections will also be used as starting points for the policy simulation. (For details of this literature see table 1 in section 6B.)

Finally the project will draw on and contribute to the following bodies of literarure:

1. Productivity measurement and /induced innovation literature.
2. Cost and Profits function literature.
3. The employment literature with particular reference to mechanization.

4. The intersectoral literature

The two researchers on this project have contributed to all four of these related bodies of literature and this project proposes an extension and integration of their prior work.

The productivity measurement and induced innovation literature has been well summarized in a recent volume based on the Airlie House Conference on International Agricultural Research (Arndt, Dalrymple and Ruttan, eds., 1976). Both researchers participated in the conference and both have a number of additional publications in this field (e.g., Evenson and Kislev, 1975; Boyce and Evenson, 1975; Binswanger and Ruttan, 1978). The focus of the work of Evenson and Binswanger has been on the effect of economic variables and policies on the rate and direction of technical change. In the current project these rates and directions will be taken as given and the focus is instead on the distributional consequences of technical change.

The development of modern costs and profits function theory and the empirical applications of the theory is important to the project. The basic work of Diewert, 1973, 1974; and Lau, 1969; has been extended by Binswanger, 1974a, 1974b and Binswanger and Ruttan, 1978. In this proposal (see section 6) this methodology will be utilized to measure output supply, input demand and factor productivity.

The literature on employment and mechanization is almost entirely survey based. Binswanger (1978) has recently reviewed the mechanization studies on the Indian subcontinent and the effects of tractors on growth and employment. Krishna (1975) and Hayami and Herdt (1974) provide further and more complex analyses of the distributional

effects of mechanization and technical change.

Welch (1974), Welch and Evenson (1975) and Evenson (1976) have initiated theoretical work more clearly spelling out the relationship between technology and factor demand in a two-factor model with an unrestricted production function. This work clarifies certain basic relationships, particularly regarding the role of product demand conditions. Recently, Binswanger (1976) has extended the Welch-Evenson work and related it to his own intersectoral work on the Japanese economy (Binswanger, 1974).

This proposed research will represent a continuation of the major research interests of Evenson and Binswanger. It has a policy analysis component which will bring some of this prior work to bear more directly than in the past on contemporary policy questions.

5. Relation to Other Projects

This project is related to two USAID sponsored projects. Much of the data base to be used in this project and some of the conceptual development emerged from project AID/CSD-2492 "Employment and Unemployment in the Developing Countries," a project of the Economic Growth Center. The project report, Labor in Indian Agriculture by Robert Evenson, discusses a number of the issues to be dealt with in the current project.

The Poor Rural Households project recently funded by USAID is related to the present project in that this project will stress the relationship of market or economy-wide effects to the micro-effects. The Poor Rural Households project is primarily concerned with micro-effects and this project should be complementary to it.

6. Research Project Design and Methods

This research project has four distinct phases:

Phase I: Development of the Distributional Policy Analysis Model in Detail

Phase II: Estimation of the Core Component, the Producer Model

Phase III: Assembly of Non-core Components including elasticities and projections

Phase IV: Policy Simulation

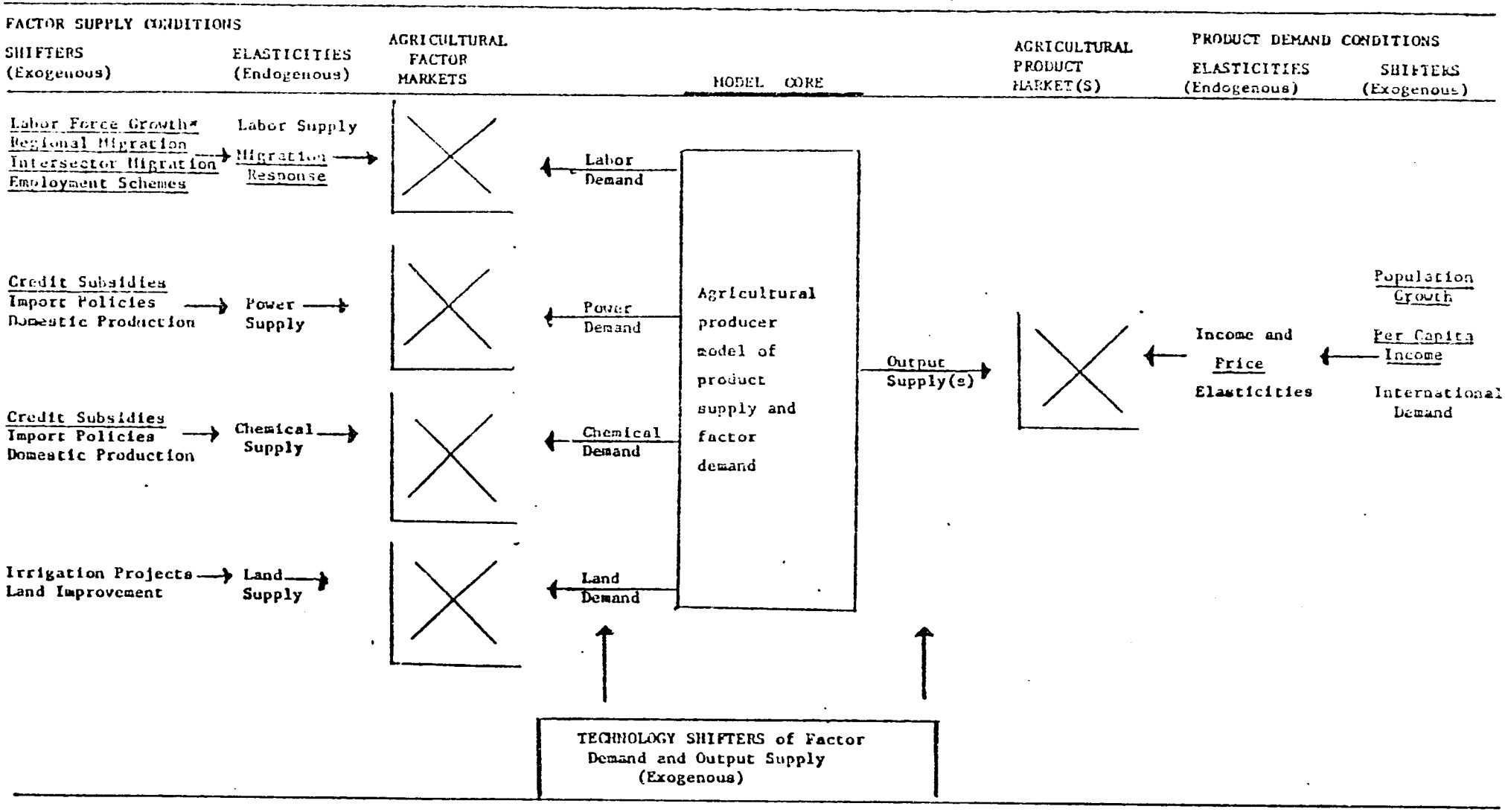
Methodological and data issues will be discussed by phase. The project also has two "satellite" projects in which these methods will be applied to Philippine and Bangladesh experience as part of doctoral dissertations at Yale. These satellite projects are discussed in detail in Appendix D.

6a. Phase I. Development of the Distributional Analysis Model

Figure 1 (repeated here for convenience) provides a schematic summary of the Distributional Analysis Model. The full model encompasses markets for factors and markets for agricultural outputs. These markets are connected through the "core" producer model. Farm producers--through their profit maximizing behavior--demand factors (or inputs) and supply outputs or products. The core producer model describing the agricultural sector thus provides the demand functions in the factor markets and the supply functions in the product markets. Supply relationships in the factor markets and demand relationships in the product markets are the non-core components of the Distributional Analysis Model.

Each supply and demand relationship in each market has endogenous

Figure 1: Distributional Policy Analysis Model: Schematic Representation



Note: The core model and underlined items will receive particular emphasis in estimation and policy simulation

components and exogenous or "shifter" components. In the factor markets, factor prices and factor quantities are endogenous. In the product markets, product prices and product quantities are endogenous (prices are actually exogenous to the farm producer, but are endogenous or determined within the markets). The exogenous or shifter components are not determined within the markets per se. Population growth, consumer income growth and international demand for products are thus exogenous to the domestic agricultural product market. Similarly, labor force growth and intersectoral migration forces are exogenous to the agricultural labor market.

The model is dynamic in the sense that it can be cast in terms of short-term growth rates of all dependent and independent variables. Appendix A develops an analysis of a simple version of the model with one aggregate product and two factors of production. This project will extend this analytic model to a somewhat more complex form involving two producing regions and a third factor of production. This development will incorporate factor mobility in the form of interregional labor force migration directly into the analysis.

Appendix B develops a more general econometric version of the Model Core with emphasis on its estimation. The details of the functions and of their estimation are presented, and related to the theory of production and profits.

The agricultural sector is linked to the rest of the economy via the non-core components of the model.

The exogenous shifters play a critical role in the policy model. Both the producer core and the non-core components have shifters. Within the core, fixed factors of production and rates of technical change are shifters. "Neutral" technological change can be expressed as a shift in all input demand functions by the same proportion while labor-saving or biased technical change shifts (reduces) labor demand by a larger proportion than for other factors. Technological change also shifts the supply function for products.

The non-core output demand and input supply functions shift exogenously due to regional or economy-wide factors some of which are in partial or full control of policy makers. Population growth shifts output demand curves and eventually the labor supply. But labor supply is also affected by spontaneous or policy-induced migration between regions of the economy and between agriculture and the nonagricultural sector. An agressive employment policy in the urban sector or a massive rural employment guarantee scheme as practiced currently in Maharashtra and contemplated for India as a whole will shift the labor supply curve to agriculture backwards. Land supply can be expanded by irrigation and the power and fertilizer supply curves are partly under the control of government via subsidy, import or domestic production policies. The quantitative effects of policies on the output demand and factor supply curves will not be econometrically estimated within this project. They can be taken from knowledge of past trends, from planning documents and from studies by other researchers. For example, the effect of an employment guarantee scheme on labor supply can be estimated from plan documents and from the evidence arising out of the planning commission appraisals

of the Maharashtra Employment Guarantee Scheme. Demographic and labor force projections have also been made by the planning commission and other researchers and they will form the basis for alternative population and labor-force scenarios (see section 6e for details).

The justification for using market equilibrium models in an economy which is characterized by many market imperfections and institutional impediments is the medium to long run character of the analysis to be done. We will focus on a 10 to 15 year horizon. The major supply and demand shifts to be analyzed are likely to work themselves through even imperfect markets in less than ten years. Furthermore, recent experience and studies from India, Bangladesh and Indonesia suggest that even within labor markets, increases or decreases in labor force or labor demand affect wage rates more rapidly than expected despite customary modes of payment fixing rigorous harvest shares and other labor contract details. Often wage rate changes occur by shifting to other modes of payment (cash-share-kind) or other sources of labor (temporary migrants) [Clay , 1976; Kaplana Bardhan, 1977]. Clay has, for example, shown that between 1966 and 1972 rural wage rates in Bangladesh declined by 40 percent and shows in detail the institutional adjustments which accompanied the decline which was consistent with a labor demand and supply framework. Market imperfections affect sectoral and regional migration more permanently. We will take this into account in the model by allowing different regional labor markets to maintain different wage rates to some extent.

The basic model presented in Appendix A shows the power of analytical solutions to relatively simple aggregate models in increasing and understanding of complex distributional impacts. We certainly want to pursue

this analytical analysis further with some more complex models. In particular we will consider the following analytical extensions:

(a) one commodity - one region - several factors

(b) one commodity - two regions - two factors

However, models of this type become extremely complex and yield few clear analytic results when expanded. We will therefore resort to numerical techniques to extend the model further. The following extension will be built and used in numerical investigations using specific parameter estimates.

(c) one commodity - several regions - several factors

(d) several commodities - one region - several factors

(e) several commodities - several regions - several factors

The commodities will be agricultural commodities such as foodgrains and cash crops or cereals, pulses and cash crops. We will not explicitly take into account feedback loops with the nonagricultural sector. However, Binswanger (1976) has already worked on such a general equilibrium extension with two sectors of the economy, three factors of production, and one region, which takes feedback loops of agricultural incomes on nonagricultural demand and incomes and back to agricultural prices into account. A few of the general equilibrium predictions--as always--differ from the partial equilibrium ones. To implement the general equilibrium model would require the estimation of a core model for the nonagricultural sector, or preferably two nonagricultural sectors, the organized and the nonorganized ones. The task cannot be achieved on the basis of existing data within the time span of this

project. However, we intend to use the general equilibrium results derived by Binswanger to guide us in determining the areas where the neglect of general equilibrium implications could seriously distort the result. We will then make adjustments of the partial equilibrium results accordingly, for example, introducing a stronger shift in the demand curve for agricultural products when simulating policies which will clearly increase non-agricultural incomes and thus shift the demand for food.

In order to link personal incomes with the market solutions in terms of prices and the quantities of output and factors of production two additional items of data are required. First, asset holding data or the shares of family income by source (of income) must be known for the groups whose income changes are modeled. For example, the changes in wage rates or land rents derived from the model must be weighed by the shares of income coming from these two sources to arrive at the effect of a policy change on family income. The Farm Management Studies and the ICRISAT Village Level studies (see appendix D) contain the necessary data for the rural sector. Different asset holding groups will be modeled separately, but we do not propose to integrate each group's income changes into Gini ratios or other aggregate measures of income distribution. Second, nominal income changes must be deflated by price indices to arrive at real income changes. This can be done if the fraction of income spent on agricultural commodities is known. Such estimates--by income and asset holding groups--have been published in several rounds of the Indian National Sample Surveys, in the diet monitoring studies of the National Institute of Nutrition and are also available for the ICRISAT village level studies. The models will therefore be capable of studying the effects of several exogenous shocks and policies on real family incomes of different asset holding classes of the population.

6b. Phase II Estimating the Core Components of the Models

The core component of the model is a system of factor demand and output supply equations for each of the regions analyzed. These equations are connected with standard production function theory via the relatively new theory of duality between production functions, profit function, cost functions and factor demand and output supply functions (McFadden, 1966; Lau, 1969; Diewert, 1971, 1973; and Binswanger 1975). These links and the details of the econometric specification are discussed in appendix B.

Starting the model from factor demand and output supply functions has several advantages over production functions. It allows the use of more complex production structures than is generally possible with production functions.[1] Econometrically the functions can be specified such that no simultaneous equation bias arises, with prices of variable outputs and factors of production and quantities of fixed factors as dependent variables. With appropriate data and somewhat elaborated procedures they allow the estimation of demand and supply parameters as well as rates and biases of technical change.

Factor demand and output supply parameters will be estimated from the individual farm data of the series of Indian Farm Management Studies. This allows us to treat output and variable input prices as exogenous. We have Farm Management Study reports from 70 studies in 24 Districts at different points in time. Appendix C details these studies. The reports provide data for small aggregates of individual farm data. A typical sample of 150 farms is aggregated by farm size group and producing zone into approximately

[1] Empirical applications of production functions have not yet frequently proceeded beyond very restrictive Cobb-Douglas or CES functions.

15 groups. We have individual farm observations for 20 of the 70 studies. In addition, similar data collected by ICRISAT under the guidance of Binswanger (Binswanger 1976b) will also be utilized.

The advantages of the Farm Management Data lies in their high degree of reliability. They have been collected over three year periods by experienced resident investigators. A second advantage is their completeness which allows the estimation of labor demand functions, broken down into family and hired labor as well as into male and female labor. The disadvantage of the studies is the shortness of the series. Also the micro data are not as well suited to estimate fertilizer demand elasticities as the longer term macro data.

For these reasons output supply and factor demand functions will also be fitted to time series data for approximately 20 years from around 250 districts in India. This data set has been assembled for North India by Evenson and for South India by ICRISAT under the guidance of Binswanger.

We will rely primarily on the parameter estimates from the micro data but complement them with parameter estimates from the macro data where we feel the former are weak.

The macro data will also be used to estimate rates and biases of technical change. The estimation of the rate of technical change will initially be done with standard residual techniques, using the econometric results from the farm level studies to construct factor shares. Second, each supply and factor demand function fitted with the aggregate data will contain a time trend whose coefficient estimates the factoral rate of technical change with respect to the particular factor.

The econometrics methods required for this estimation are not standard but the principal investigators have previously worked with these methods. The combination of time series and cross section data in the district data will be handled by computational methods developed for ICRISAT by D. T. Wallace and packaged programs are available for the restricted generalized least square procedures required to deal with the full system of equations to be specified at the farm level.

6c. Phase III. Elasticities and Projections of Output Demand and Input Supply.

The estimates of the non-core components of the model depicted in figure 1 will be taken largely from existing literature and concurrent studies and from projections of past trends, by the Indian Planning Commission, etc.

The impact of policies on output demand and input supply functions can be of four kinds: direct market interventions such as purchases and sales arising out of buffer stock operations or public works; subsidies or taxes on inputs and outputs; tariffs or export subsidies on inputs and outputs; and finally direct controls of imports and exports. The international trade literature demonstrates that quantitative controls can be expressed as tariff equivalents (or taxes and subsidies) and vice-versa, enabling these policies to be analytically translated into functional shifts in our model.

Table 1 summarizes the main sources to be used for the elasticities, trends and projections. India has a large empirically based economic and planning literature from which we will be able to draw. The literature is especially strong in the area of income elasticities of consumer demand and

Table 1: Sources of Other Elasticities, Trends and Projections

Functions	Estimate of	Sources	Data Used	Remarks
1. Output Demand	Income Elasticities	Sarma, 1976	NCAER[2] Income Surveys	National Coverage
		Singh & Nagar, 1973	NSS	National Coverage
		Singh, 1973	NSS	National Coverage
		Jain & Tandulkar, 1973	NSS	National Coverage
		Ienger, 1967	NSS	National Coverage
	Price Elasticities[1]	NCAER, 1970	Aggregate Time Series	National Coverage
		ICRISAT, concurrent	NSS	National Coverage
		Lluch et. al., 1977	Sample Surveys	International comparisons
	Population	Cassen & Dyson, 1976	Census	Surveys older projections and presents new ones
		Planning Commission Projections		
	Income	Planning Commission Projections		
2. Labor Supply	Supply Elasticity	Rosenzweig, 1977 and concurrent	NCAER income and savings survey	National Coverage
		Bardhan, 1976 and concurrent	NSS rural employment survey	West Bengal
		ICRISAT, concurrent	Village level studies	Maharashtra, Andhra Pradesh
		Bardhan, Kaplana, 1977		
	Migration Responses	Bardhan, concurrent?	NSS	
		New Estimates	Census, NSS, District level data sets	
	Labor Force Growth	Planning Commission Projections		
		Interregional and intersectoral migration	Census trends and Planning Commission Projections	
	Employment policies	Planning Commission Projections		
3. Power	Supply Elasticity	Policy dependent simulation variable		
	Trends	Subrahmanyam & Ryan, 1975		
		Binswanger, 1978		
		Planning Commission Projections		
4. Fertilizer	Supply Elasticity	Policy dependent simulation variable		
	Trends	Fertilizer Association of India. District level data sets		
		Planning Commission Projections		
5. Land & Irrigation	Land Supply Elasticities	Close to zero		
	Trends in area and irrigation	District level data set		
		Planning Commission Projections		

[1] The underlined items will receive special attention in the project.

[2] NCAER = National Council of Applied Economic Research, NSS = National Sample Survey Organization, ICRISAT = International Crops Research Institute for the Semi-Arid Tropics, Planning Commission Projections = Projections underlying the sixt five year plan to be published in January 1978 and the annual revisions thereof afterwards.

is improving rapidly in the area of labor supply elasticities. Also the data on past trends of population, labor force, income, migration, etc., are good. In addition, the five year plans of the Planning Commission (which will henceforth be revised annually on a rolling plan basis) provide detailed projections on many crucial variables which will be used as a starting point for the policy simulations. The sixth plan—to be published in January 1978—will be a substantial departure from previous policies with much more emphasis on rural employment, irrigation investment and small scale sector growth. The "Planning Commission Projections" mentioned in table 1 will be those underlying the sixth plan.

The two areas which will present some problems and may require additional work are the price elasticities of output demand and the migration responses of labor to interregional and intersectoral wage differentials.

Price elasticities of output demand are more difficult to find than income elasticities because they have often to be estimated on the basis of time series data. NCAER (1970) has estimated aggregate output demand elasticities on the basis of aggregate data. For individual commodities, ICRISAT has initiated a collaborative project with the National Sample Survey (NSS) to exploit their national consumer demand surveys for different periods. Results (which will be accessible because Binswanger is an advisor on the project) will be available within 12 to 15 months. Finally, in order to gain a better understanding how income and price elasticities vary across wealth classes, the substantial international comparative work by Lluch et. al. (1977) will be used which extends earlier work by Houthakker and Goreux. We may nevertheless do some additional estimation of price elasticities

for commodity groups using state or national aggregate data which are easily accessible.

Research has recently been completed on labor supply elasticities by Rosenzweig, 1977 (NCAER survey data with national coverage) and Bardhan, 1976 (NSS data, West Bengal and Uttar Pradesh). James G. Ryan at ICRISAT is currently using Village Level Studies data to estimate labor supply elasticities for Andrah Pradesh and Maharashtra. The existing studies indicate that resident labor supply is very inelastic to wage changes both for males and females and for landless laborers and small farmers. Labor supply adjustments to policies or technical changes must therefore come primarily from migration and substantial interregional migration from lagging areas to the prosperous green revolution districts has indeed taken place.

For the regional analysis, therefore, the knowledge of the labor supply response to wage rate differentials between regions becomes crucial. Unfortunately little prior work exists for India and we will have to develop new estimates.[1] For intersectoral migration Mundlak has recently estimated migration responses with international cross section data, but we will have to apply his estimation procedures to Indian data sets.[2]

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[1] It appears that Professor Bardhan is also working on this problem and that we may be able to use his results as well, or check our results against his.

[2] Data to measure migration responses to wage rate differentials do exist. The district level data set contains complete agricultural wage rate series for the past 20 years. Census data (available on a district basis in New Delhi) give the number of immigrants per district since the last census and allow the estimation of net migration rates as well. Immigrants are classified geographically into intradistrict, intrastate and interstate migrants, allowing a gross breakdown by distance of migration.

6d. Phase IV. Policy Analysis

A clear understanding of the distributional implication of macro policy options is important both for national governments as well as for outside donors such as USAID who have to integrate their projects and programs into the overall policy frame of the receiving country. Furthermore, outside donors may have an interest in framing projects or programs which will benefit groups or regions which national governments cannot or will not reach without outside donors. The results of this model should enable USAID program officials to plan and assess the distributional impact of their supplementary efforts in a more rigorous and definite way.

For the Indian study the policy analyses will be tied closely to current and important policy options and redirections. The Janata government, since its arrival to power has made increases in employment the cornerstone of its economic policies. The planning commission is building the employment objective into the coming five year plan in the following ways: (Personal communication from Prof. Raj Krishna, member of the planning commission for employment. The plan documents will be available in early 1978.)

1) A massive stepup of irrigation investment from around 2 Mill. ha to 3-1/2 Mill. ha per year. This will affect rural employment and wage rates by first employing people in the construction of new irrigation systems and improvement of existing irrigation systems. Second, the additional land resources so created will permanently increase agricultural labor demand.

2) Massive emphasis on rural public works, partly in connection with the irrigation investment but also for other infrastructural investments, erosion control and afforestation. While a national employment guarantee scheme (as operated currently in Maharashtra) has not yet been proposed, such a policy is actively being considered.

3) A redirection of public industrial sector investment towards agricultural inputs such as fertilizer and electricity.

4) Careful attention to choice of technique in agriculture. The importation or domestic production of harvest combines has been banned and credits from official sources for tractors have been totally stopped.

5) More careful attention on (a) choice of technique and (b) output mix in the industrial sector to ensure the use of more labor intensive techniques and the production of more labor intensive commodities. This is being done by more active support of small scale industries which are labor intensive, by basing subsidies to new industries on their employment or output, rather than subsidizing the purchase of capital equipment and by a liberalization of licensing and import controls to make it easier for small firms to compete for crucial inputs. If successful, these policies would lead to withdrawal of labor out of the rural sector.

With the proposed model it will be possible to simulate the rural income distribution impact of these proposed policies, either singly or in various combinations. Irrigation investment targets imply a labor absorption in these projects which can be estimated and translated into a shift of the labor demand curve whose impact on rural wage rates can be estimated. The newly irrigated land implies similar labor absorption on a more permanent basis. Its effect on wage rates, rental income and output can be

estimated in the model and translated into income distribution impacts.

Plans for rural works always give estimates of the number of laborers to be employed and can thus be handled in the same way. The emphasis on the provision of agricultural inputs such as fertilizer shift the fertilizer supply and its effect on output and output prices can be traced. The discouragement of mechanical inputs such as tractors and combines shifts the power supply curve upwards. Its impact on labor demand is traceable via the core of the model and therefore it becomes possible to estimate the wage rate effects. The nonagricultural employment goals imply shifts in the labor supply for agriculture which can also be estimated, at least in an approximate way.

Some of the policies will also have a specific regional focus such as irrigation for previously unirrigated areas. We want to explore the regional income distribution impact of concentrating irrigation investment and rural works in the lagging regions.

The simulations of these projected policies is important: These sets of policies have long been advocated by economists concerned with employment and they correspond in many ways to the investment choices made in China after the Great Leap Forward failed. The crucial question is whether in the Indian economy these policies--if successfully implemented--will be sufficient to raise labor income of the poorest groups to satisfy their basic needs. If this is not the case the only hope would lie in more radical income or asset distribution policies.

In addition to these simulations with immediate policy concern we also want to explore the income distribution of policy changes whose impact is delayed in a longer run:

a) Alternative technological change patterns: First a historical counterfactual analysis will be done over the green revolution, assuming that the rates of technical change of the ten years preceding the green revolution had persisted. This counterfactual analysis should significantly increase our ability to interpret the actual observed distributional consequences. In particular we expect a regressive impact of the absence of the green revolution, induced by the more rapid rises in food prices which would have occurred in the absence of the green revolution. Looking forward we will project the distributional impact of current rates of technical change and of alternative research policies. We will consider a policy of continuance of current investment levels, a policy of investing more heavily in lagging regions and a policy of aggressive expansion of the research system to produce higher rates of technical change in all regions.

b) Alternative labor force and population growth scenarios: Simulations in this case extend beyond the 10-15 year horizon for other policies. For the next 15 years labor force growth rates are locked in because the new entrants are already born except for women freed by a decline in fertility. Current trends (UN median estimates) and optimistic and pessimistic projections will be used which correspond to successful and unsuccessful family planning efforts. In addition, a counterfactual analysis of the green revolution will focus on what would have happened if at the same time labor force growth and population growth had occurred at lower than actual rates.

6e. The Satellite Projects: Philippines and Bangladesh

Appendix D discusses in some detail the two satellite projects to be supported as part of this project. These projects are treated as satellite projects rather than as an integral part of the main project for the following reasons.

1) Each satellite project will produce a doctoral dissertation and the primary responsibility for design and concept must accordingly rest with the doctoral student.

Jaime Quizon, a Ph.D. candidate at the University of the Philippines will be conducting the Philippine satellite study.

Salahuddin Ahmad, a Ph.D. candidate at Yale will be conducting the Bangladesh satellite study.

The researchers on this project will be advising these students. (Vitae are included in Appendix F).

2) This project will provide only partial support to the subprojects. Each candidate has stipend support from other sources. The Agricultural Development Council is providing stipend support to Mr. Jaime Quizon who

will be at Yale for a period of 12 to 18 months completing his dissertation. Mr. Ahmad will be supported for the remainder of his graduate program. This project will provide data processing assistance and support for data assembly. The satellite projects will provide a basis for comparative analysis and this will be undertaken as part of this project.

7. Contribution to Institution Building

Both researchers have been associated with institutions in developing countries chiefly in India and the Philippines. Mr. Binswanger is currently associated with ICRISAT in India and the Agricultural Development Council. Mr. Evenson has been associated with the University of the Philippines at Los Banos (indirectly with IRRI), The Agricultural Development Council and the Indian Agricultural Research Institute.

This project, through Binswanger's current association, through the satellite projects and through consultants, will indirectly support these institutions. We will be participating in seminars and workshops discussing the project. It is expected that we will be maintaining close contact with investigators in the Poor Rural Households project.

8. Plans to Facilitate Utilization of Research Findings

Research and results will be documented in writing through reports as follows:

a) Working papers will be prepared periodically and distributed through the Yale University Economic Growth Center Paper Series. This series is distributed to all international development agencies and centers and to a substantial list of LDC institutions. Copies will be provided to TA/AGR for other distribution.

b) It is expected that three or four research papers will be published. Direct journal reprints and the ADC reprint series will be utilized to assure distribution of these research papers.

c) The researchers will participate as appropriate in the network meetings organized under the Poor Rural Households Project.

d) The final models will be made available to other researchers and policy analysts interested in using them. Yale will develop a documented bank of all data associated with the project to be made available to other researchers.

e) A research monograph based on the project is planned. The results of the study will be discussed in a Seminar to be conducted as part of this study.

Researcher Competence and Resources

The two principal investigators, along with the principal investigators of the Poor Rural Households project, represent a substantial part of the high-level national research competence in these particular research areas. Each is well trained and has spent most of his professional career as an economic analysts in this and closely related areas. From the enclosed vitae, it can be seen that each has already produced an imposing list of publications dealing with several phases of agricultural development.

The Economic Growth Center at Yale University would be an excellent setting for work of this sort. For serious research workers, it is blessed with a fine library on economic development, good computer and other research support, and stimulating colleagues who are interested in economic development. These colleagues include economists, other social scientists, and quantitative analysts. Not least in importance in judging the excellence of the particular Yale environment is the presence of large numbers of high-quality graduate students in economic development, both from the LDC's and the developed countries.

Included here are Curriculum Vitae for Professors Binswanger and Evenson and also Salahuddin Ahmad and J.B. Quizon, respectively Bangladesh and Philippine, graduate students who may be available to work on the research.

10. Overall Cost Estimates

The proposed budget is summarized in Table 2. The time periods are presented in terms of USAID's fiscal year. A separate budget for the two satellite projects is presented. The following points should be noted:

I. One-quarter of Evenson's academic year 1978-79 is covered, plus two months in the summers of 1978 and 1979. Research assistance covers one full-time assistant, plus programming assistance. One secretary's salary is covered. Increases have been figured at 8% for budgetary purposes.

II. Fringe benefit rates are 21.5% for academic year salaries and 16.5% for all other wages and salaries.

III. Overhead is figured at the HEW accepted rate of 76.5% of all wages and salaries (including the salary listed in Section X, the Satellite Program).

IV. A subcontract will be written with the Agricultural Development Council to cover the services of Hans P. Binswanger for the period 4/1/78 through 9/30/78 and a later period 5/1/79 through 7/31/79. The present estimated cost of this amount of time is $27,625; the subcontract would be written to include the actual rate of salary paid to Binswanger and the actual time served on the project, with the total payment to ADC kept to the approximate range of $27,500.

V. Computer rental from the Yale Computer Center--rates attached.

VI. Supplies and telephone toll calls: xerox, postage, and miscellaneous items are included.

VII. The two researchers will each travel to India for a stay of one to two months during the contract. U.S. travel includes professional meetings and data collection in Washington, D. C. Foreign consultants will be brought to the United States for periods of one to two months.

A conference in India for Indian researchers will be held to share the results of the work; travel within India and accommodations for the conference will be covered.

VIII. Consultants will be paid for data collection and analysis in India. A workshop in the United States will be organized during academic 1978-79 to invite U.S.-based scholars to a forum on the project.

IX. Publications: Several discussion papers will be printed and disseminated during the two-year project, and a monograph will be published following the completion of the work. Since editing and printing of this monograph will take some months and the billing for publication costs may be delayed, a request for an extension may be made to meet publication costs in the year following the expiration of the contract.

X. Satellite Program: The graduate stipend and tuition support for a fourth-year graduate student are covered. Costs of computer rental and supplies for both this graduate student and an additional graduate associate from the University of the Philippines and also included. Travel costs are included to cover one trip to the Philippines or Bangladesh for each of these students, with per diem costs for a one- or two month stay.

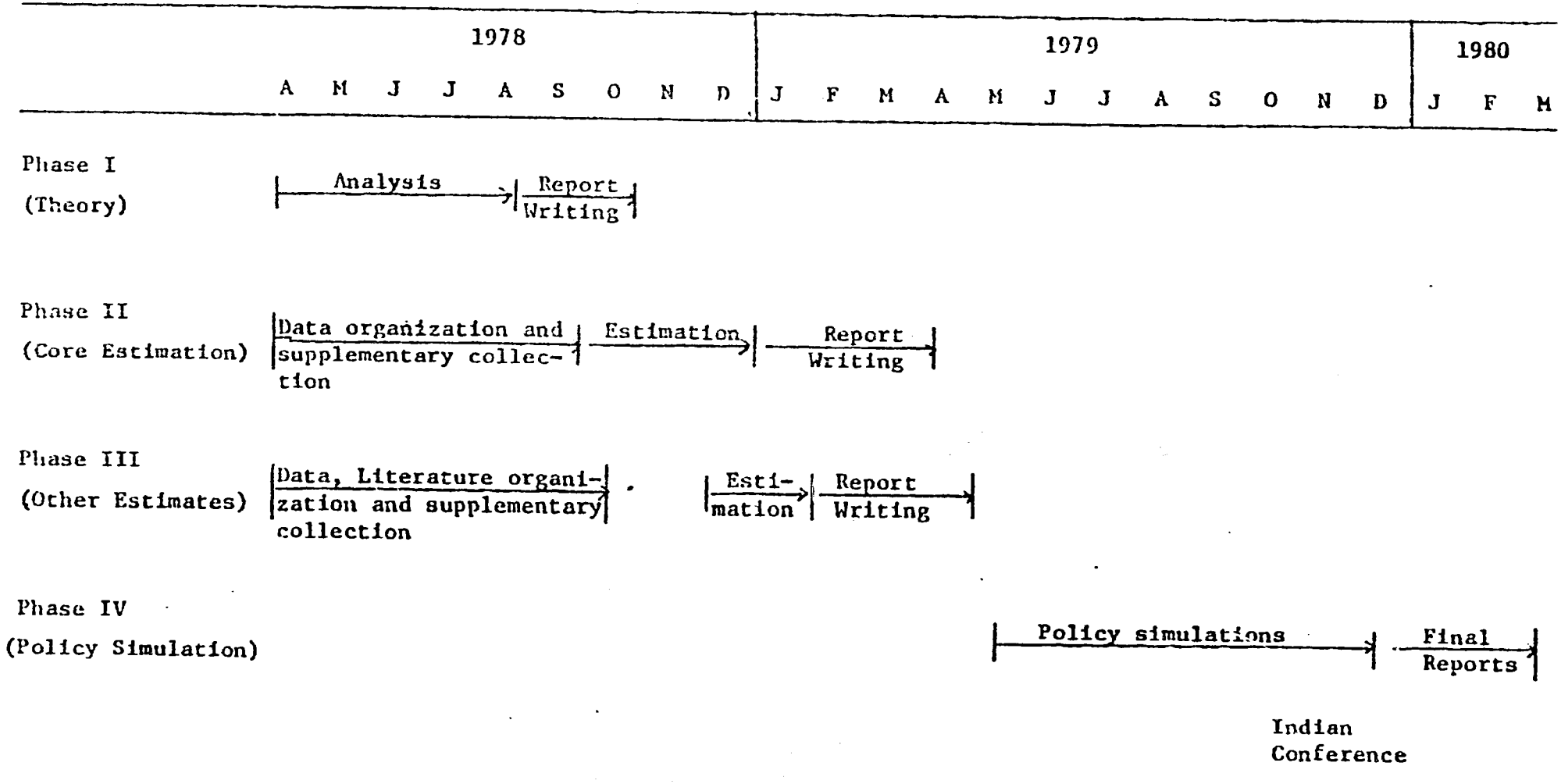
11. Work Plan

In effect, this project is for a period of two years. Accordingly sections 6 and 10 cover salient details. We will note, however, that the project has four main phases which are closely related to the objectives of the project and which are summarized in Figure 2.

A. Model building and extension

B. Estimation of the model core

Figure 2 - Sequence of Activities



C. Output demand and input supply elasticities

D. Policy simulations

Data organization is contained under B and C and involve the updating of the Indian secondary data set. This should be completed by September to October, 1978. A trip to India will be required to obtain recent unpublished data.

Proposed Budget

Technology, Policy and Rural Incomes

Robert E. Evenson, Principal Investigator
in collaboration with Hans P. Binswanger

		4/1/78-9/30/78	10/1/78-9/30/79	10/1/79-3/31/80	Totals
I.	Wages & Salaries--Yale				
	Evenson, academic year	$ 1,960	$ 5,870		$ 7,830
	Evenson, summers	6,960	7,515		14,475
	Research assistance	3,800	13,000	$ 7,500	24,300
	Secretarial	3,800	9,550	5,000	18,350
	Total Wage & Salaries	16,520	35,935	12,500	64,955
II.	Fringe Benefits	2,820	6,225	2,065	11,110
III.	Overhead, 76.5% W & S	12,640	27,490	9,560	49,690
IV.	Binswanger--ADC Subcontract	18,200	9,425		27,625
V.	Computer Rental	4,000	7,000	6,000	17,000
VI.	Supplies, phone	2,000	2,000	1,000	5,000
VII.	Travel				
	a) P.I.'s - U.S.	1,000	1,000		2,000
	Foreign	3,000	3,000		6,000
	b) Consultants - to U.S.	3,000	2,000		5,000
	Conference, India			4,000	4,000
	Total Travel				17,000
VIII.	Consultant's fees				
	a) India	4,000	3,000		7,000
	b) Workshop, U.S.		2,000		2,000
	Total Consultant's				9,000
IX.	Publications			8,000	8,000
X.	Satellite Program				
	Graduate Salary	1,000	3,000		4,000
	Overhead, 76.5%	765	2,295		3,060
	Tuition (4th yr) + health fee	200	1,680		1,880
	Computer	1,000	3,000		4,000
	Supplies	200	800		1,000
	Travel	2,500	3,000		5,500
	Total Satellite Program				19,440
	GRAND TOTALS	$72,845	$112,850	$43,125	$228,820

Proposing Office General Appraisal

DS/AGR/ESP considers this project to be highly significant in the efforts of DSB to develop a more adequate information base for acting effectively on the Congressional mandate to AID. Obviously, it would be delayed under restricted funding. If it is postponed, the information which is the primary purpose of this research project will not be developed by any other means. The research project could be done in parts, but what is proposed here is the minimum analysis required to develop information that could be used as direct inputs into decision making processes. The useful information would require completion of the analytical components and their synthesis.

D/C

The Agricultural Development Council, Inc.

1290 Avenue of the Americas, New York, N. Y. 10019

Established by John D. Rockefeller 3rd

Tel: 212-765-3500 • Cable: Agridevel New York

January 23, 1978

Professor Robert E. Evenson
Economic Growth Center
Yale University
Box 1987, Yale Station
New Haven, Conn. 06520

Dear Professor Evenson:

Following up on our phone conversation, I would like to spell out the costs of services by Hans Binswanger, Associate of the Agricultural Development Council now on study leave at the Economic Growth Center, Yale University, for work on the project "Technology, Policy and Rural Incomes," which is being proposed to the Agency for International Development.

April 1 - September 30, 1978: 6 months salary at $28,000 per year	$ 14,000
May 1 - July 31, 1979: 3 months salary at $29,000 per year	7,250
	$ 21,250
Fringe Benefits at 30%	6,375
	$ 27,625

The above salary figures estimate a possible increase of $1,000 per year in 1979. Billing will cover actual salary figures paid during this period, and actual time worked on the project.

Sincerely,

THE AGRICULTURAL DEVELOPMENT COUNCIL, INC.

A. Russell Stevenson
Secretary-Treasurer

APPENDIX A.

The One Commodity--Two Factor--One Region Model for Distributional Policy Analysis

The distributional model presented here was initially developed by Evenson and Finis Welch. It has been further refined by Evenson (1976) who extended it to take into account the problems of technology access restricted to certain regions of the country. These versions of the model were based on a production function. Binswanger then reformulated the model in terms of cost or profit functions which makes it consistent with estimation techniques proposed in Appendix B and allows a straightforward extension of the model to more than two factors or more than one sector. The two-factor version of the model will be presented here in its cost function version. This model will serve as a basis for all extensions discussed in section 6a.

The predominant approach for analyzing biased technical change has been to restrict it to factor-augmenting technical change. Here, however, we start from a cost function dual to a linear homogeneous production process with technical change of an arbitrary nature.

$$C = Y\,U = Y\,U(W, R, t)$$

where C = total cost, Y = output level, U = unit cost,

W, R = wage rate and capital rental rate, respectively.

t = technology index or time.

Shephard's lemma gives the factor demand curves per unit of output.

$$\frac{\partial U}{\partial W} = \ell = g^1 (W, R, t) \qquad (1)$$

$$\frac{\partial U}{\partial R} = k = g^2 (W, R, t) \qquad (2)$$

where $\ell = \frac{L}{Y}$ = labor input per unit of output

$k = \frac{K}{Y}$ = capital input per unit of output.

Differentiate totally as follows

$$dL = d(Y\ell) = dY + Y\frac{d\ell}{\partial W} + Y\frac{d\ell}{\partial R}\,dR + Y\frac{d\ell}{\partial t}\,dt \qquad (3)$$

and transform into logarithmic changes or time rates of change (i.e. $X^* = \frac{\partial \log X}{\partial t}$) we find for labor and capital

$$L' = Y' + \eta_{LW}W' + \eta_{LR}R' - A'_L$$
$$K' = Y' + \eta_{KW}W' + \eta_{KR}R' - A'_K \qquad (4)$$

where $A'_L = \frac{1}{\ell}\frac{\partial \ell}{\partial t}\,dt$

$A'_K = \frac{1}{k}\frac{\partial k}{\partial t}\,dt$

Factoral rates of technical change or shifts in the factor demand curves caused by technical change

The factoral rates of technical change are the negative shifts of the labor and capital demand curves respectively. They are defined negatively so that technical advance corresponds to positive A'_L and A'_K.

Since unit costs $U = \ell W + kR$ and since the rate of technical change T' is equal to the negative rate of unit cost reduction $= U'$, it is easily shown that

$$T' = -U'\,|_{W,\,R} = S_L A'_L + S_K A'_K \qquad (5)$$

where s_L = share of labor and s_K = share of capital in total costs. This shows that the rate of technical change is the share-weighted sum of the factoral rates of technical change. The bias of technical change is defined as

$$Q\,|_{W,\,R} = \frac{d(L/K)}{dt}\,\frac{1}{(L/K)} = A'_L - A'_K \gtreqless 0 \quad \begin{matrix}\text{Labor saving}\\ \text{neutral}\\ \text{Capital saving}\end{matrix}$$

Here the bias is simply the difference in the factoral rates of technical change or the difference in the shifts of the factor demand curves caused by the technical change.[1] Factoral rates of technical change can be estimated empirically by using the frameworks of Appendix B. Two estimation procedures are possible and both circumvent McFadden's impossibility theorems.[2] First, if factor demand elasticities are unknown and if factoral rates of technical change are constant (or can be approximated by constant rates) then estimating factor demand curves which incorporate technology shifter variables will estimate factoral rates properly.

Second, if factoral rates of technical change are not constant then the factor demand elasticities have to be estimated in <u>independent</u>

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[1]This is one version of Hicks-biased technical change. For its relation to other definitions in terms of marginal products see Binswanger and Ruttan, 1978 Appendix to Chapter 2.

[2]The impossibility theorems simply assert that one cannot estimate biases unless one is willing (1) to choose a functional form for the cost function and (2) to either assume that biases are constant or to estimate the cost function (factor demand) parameters in independent samples and estimate the biases residually, which correspond to the first and the second estimation procedures respectively. For an example of both these methods see Binswanger, 1974.

cross-sections of firms or other producing units. The labor rates of internical change for each time period can then be computed residually as follows:

$$A_L' = Y' - L' + \eta_{LL}W' + \eta_{LK}R'$$

and similarly for all other factoral rates of technical change.[3]

Both of these approaches to measuring the factoral rates of technical change require the specification of a functional form for the cost function and the factor demand curve. Diewert's Generalized Leontief cost function is particularly convenient for estimating factoral rates of technical change.

All models which follow will be in terms of elasticities only and not in terms of parameters of the Generalized Leontief function. Transforming back to this particular econometric parameterization is quite straightforward. It should, however, be noted that factoral rates of technical change, which are simply shifts in factor demand curves, are consistent with any kind of functional form one might choose. The Generalized Leontief function is just a particularly convenient one among many.

The Evenson-Welch model can be written as a six equation model in cost function form. Instead of Evenson's marginal product relationships, the first two equations are now the dynamic labor demand and capital

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[3]See Binswanger (1974a) for an example of such an approach with factor augmenting technical change and translog cost function. Note that the form finally estimated in that paper is consistent with factor augmentation as well as with more general forms of biased technical change.

demand curves (4). The third equation is the commodity price change equation which states that the rate of commodity price change must be equal to the share-weighted sum of factor price changes, less the rate of technical change.

$$P' = U' = s_L W' + s_K R' - T' \tag{8}$$
$$= s_L W' + s_K R' - s_L A_L' - s_K A_K'$$

Finally we have the output demand and the two factor supply equations which can be written in dynamic form as

$$Y' = \alpha P' + D^* \tag{9}$$

$$L' = \varepsilon_L W' + L^* \tag{10}$$

$$K' = \varepsilon_K R' + K^* \tag{11}$$

where α is the demand elasticity for final output, ε_L and ε_K are the supply elasticities of labor and capital respectively, and D*, L* and K* are final demand and input supply shifters.

Equation (9), (10) and (11) can be used to eliminate Y', L' and K' from equations (4) and (8). One can then invert the remaining three equations.

With a few further manipulations one can get Evenson's expression for the decomposition of the absolute wage rate changes.

$$W' = \frac{1}{\Delta}\left[(\sigma + \varepsilon_K)\ (\alpha + 1)T' + s_K(\varepsilon_K - \alpha)\ (A_L' - A_K')\right.$$
$$- (\varepsilon_K + \sigma + s_L\alpha)d^* + (\varepsilon_K + s_L\sigma - s_K\alpha)L^* \tag{12}$$
$$\left. + s_K\ (\sigma + \alpha)K^*\right]$$

where $\Delta = \alpha(\sigma + s_L \varepsilon_K + s_K \varepsilon_L) - \sigma(s_L \varepsilon_L + s_L \varepsilon_K) - \varepsilon_L \varepsilon_K < 0$ because α is less that zero while all other parameters and shares are positive.

Note that this expression is independent of the supply elasticity of labor. However, what happens to labor income is not independent of its own supply elasticity. If M_L is equal to the wage rate times employment in the sector, then $M_L = WL$. Therefore, $M_L' = W' + L'$. Since $L' = \varepsilon_L W' + L^*$ the change in labor income in the absence of labor supply shifts is

$$M_L' = (1 + \varepsilon_L)W' \tag{13}$$

Expression (13) simply means that the change in labor income is a multiple of the change in the wage rate, the multiple being the larger, the larger the elasticity of supply of labor and the shift in the labor supply curve. In situation where labor gains the gains will be larger, the larger the supply elasticity of labor. Conversely, any losses will also be larger, the larger is ε_L.

The change in relative factor prices due to technical change alone can be evaluated from the following expression:

$$W' - R' = \frac{1}{\Delta}\{|(\varepsilon_K - \varepsilon_L)T' + (\varepsilon_K - \alpha)A_L' - (\varepsilon_L - \alpha)A_K'\} \tag{14}$$

The equilibrium price of a factor in this model is affected as follows according to equation (12) and (14):

1. The sign of the pure effect or neutral technical change on the demand for and the equilibrium price of each factor depends on whether aggregate demand is inelastic or not. If aggregate demand is inelastic the impact of technical change is to reduce the demand for each factor.

2. The effect of a positive shift in aggregate demand is to increase the demand for both factors.

3. A positive shift in the supply function of labor (capital) will lower the equilibruim price of labor (capital).

4. A positive shift in the supply function of capital (through a World Bank subsidy program for example) will affect the labor market according to whether the elasticity of substitution (σ) exceeds the aggregate demand elasticity (α) or not. If $\sigma > |\alpha|$ the impact will be to reduce the demand for labor.

5. For any set of feasible parameter values, labor-saving technical change always tends to reduce the wage rate in terms of goods of the other sector (and employment) when compared with an equal neutral rate of technical change.

6. The relative position of labor as against capital when both gain or both lose absolutely from technical change depends on the elasticity of supply of the two factors. In situations of absolute gain for both factors, the factor in relatively inelastic supply will gain relative to the factor in elastic supply. Conversely, in situations of absolute loss due to technical change (inelastic demand for output) the inelastic factor will be the larger loser.

7. A large elasticity of substitution between factors acts as a buffer between them by reducing discrepancies in their relative price movements (Because the absolute value of the determinant Δ in (14) rises as σ rises).

These are the comparative static effects of single change in exogeneous variables. However, the biggest advantage of the equation (12) or (14) is that they allow the simultaneous consideration of change in all exogeneous variables, rates of technical change as well as shifts in output demand due to population or income growth and a concurrent shift in labor or capital supply.

The model can be estimated for changes in the land rental rate R' and in the output price P' (relative to the price of nonagricultural commodities.) These price changes can then be related to nominal income changes via the income group specific shares of income coming from labor

and land V_{iW} and V_{iR} (where i stands for the i'th income group and M_i stands for the nominal income of group i).

$$M_i' = V_{iW}W' + V_{iR}R' \tag{15}$$

Finally we can deflate the nominal income change M_i' to a real income change m_i' by using an income group specific price deflator

$$q_i' = E_i P' \tag{16}$$

where E_i is the share of expenditure of income class i on food. Equation 16 says that the consumer price index for food of income class i changes by the price change of food multiplied by the share of expenditures which income class i spends on food and when nonagricultural commodities are taken as the numeriare. The change in real income of group i therefore is

$$m_i' = \frac{M_i'}{q_i'} = \frac{V_{iW}W' + V_{iR}R'}{E_i P_i'} \tag{17}$$

Equations 4, 5, 6, 15, 16, 17 have straightforward extensions to many factors and many commodities and many regions. Analytical results may no longer be possible in any case but numerical solutions are always possible if parameter estimates exist.

Appendix B. Output Supply and Factor Demand Curves: Duality and Econometric Procedures

The core model will be estimated in a set of simultaneous output supply and factor demand curves of the following form

$$Q_1^* = f_1 (P, Z) \qquad (1)$$

where Q_1^* is the output quantity and $Q_2, \ldots, Q_n$ are the (negative) optimal quantities of variable inputs. P is a vector of outputs (i = 1) and input (i = 2, ..., n) prices and Z is a vector of fixed inputs such as land, environmental characteristics such as climatic or soils variables and of research and education variables, i.e. a vector of all those quantities which affect production and input demands but are not under the short run control of the farmer.

The system 1 is related to standard production function via the theory of duality between production, profit (or cost function) and output supply and factor demand functions (For relatively straight forward reviews see Binswanger 1975. The basic Shephard lemma in the case of Cost Function is stated in Appendix 1). Lau and Jorgenson (1974) have shown that under very general conditions there exists a one to one relationship between the system of supply and demand equations and the production function which allows one to choose functional forms for the output supply function and the factor demand curves which obey certain regularities and be sure that the implied production function is monotonic in inputs and strictly concave even though one may not know its functional form. Thus functional forms may be directly chosen for the equation system 1. Furthermore, the output supply and factor demand functions are econometrically properly specified.

They do not contain endogenous variables on the right hand side. Finally the theory of profit function suggests constraints on the parameters of the supply and factor demand curves which are useful in econometric estimation (See for example Binswanger, 1974).

The functional forms which can be chosen correspond to second order approximation of the profit function, i.e. they enable us to model production processes which we are far more complicated than those implied in Cobb-Douglas or CES Functions. The three best functional forms are the Translog, Diewerts generalized Leontief and the Quadratic. (See Diewert 1974 or Binswanger 1975). The supply and factor demand equations corresponding to the generalized Leontief are as follows:

$$Q_i^* = a_{ii} + \sum_j a_{ij} P_j^{1/2} P_i^{1/2} + \sum_k b_{ik} Z_k \qquad (2)$$

The estimated equations provide a <u>complete set of estimates of input demand and output supply</u> elasticities which are simple transforms of the b coefficients (Diewert, 1971). Economies of scale can be estimated if the vector of Z variables includes farm size F as follows

$$e = \sum_i b_{iF} P_i$$

If $e > 0$, there are economies of scale, if $e < 0$, there are diseconomies. And this measure can be adjusted for climate, research, irrigation, etc.

In addition the impact of any of the Z variables on profits can be estimated as follows: Profits π^* can be written as

(where inputs are negative Q_i^*)

Since $\partial Q_i^*/\partial z_k = b_{ik}$, the impact of exchange in z_k on profits is

$$d\pi^*/dz_k = \sum_i p_i b_{ik}$$

If one of the exogenous variables, for example, is research or education, this allows a direct estimation of the factor productivity effect of research or education. If one of the z variables is time, then the rate of technical change can be estimated similarly. Finally note that the b_{ik} variables are shifters of input demand curves and output supply curves. Comparison of them among factor demand curves allows the estimation of biases of technical change, provided time was included as a z variable.

The full system (2) will be estimated with Farm Management Studies and ICRISAT data. An incomplete system (excluding the labor and power demand equation but including fertilizer demand) will be estimated with the district level data set.

APPENDIX C

Basic India Data

Both micro data, i.e., individual farm data and aggregate data will be utilized for estimation of factor demand and supply parameters. The principal micro data sets to be employed are the following:

a) Indian Farm Management Studies:

Andhra Pradesh	West Godavari	57/58, 59/59, 59/60
Andhra Pradesh	Cuddapah	67/68, 68/69, 69/70
Assam	Nowgang	68/69, 69/70
Bombay (Maharashtra)	Ahmednagar	55/56, 56/57
Bombay	Ahmednagar	67/68
Bihar	Monghyr	57/58, 58/59, 59/60
Bihar	Sahabad	60/61, 61/62, 62/63
Gujerat	Surat & Bulsar	66/67*, 67/68*, 68/69
Kerala	Alleppey & Quilon (Ernakulam)	62/63, 63/64, 64/65
Madras (Tamil Nadu)	Coimbatore	54/55*, 55/56*, 56/57* and 70/71, 71/72, 72/73
Madras	Thanjavur	67/68*, 68/69*, 69/70
Madhya Pradesh		55/56, 56/57, and 62/63, 63/64, 64/65
Orissa	Sambalpur	57/58, 58/59, 59/60
Orissa	Cuttack	67/68, 68/69, 69/70
Punjab		54/55*, 55/56*, 56/57* and 61/62, 62/63, 63/64,
Punjab	Ferozepur	67/68*, 68/69*, 69/70*
Rajasthan	Pali	62/63, 63/64, 64/65
West Bengal		54/44, 55/56, 56/57
Mysore (Karnataka)	Bangalore	60/61, 61/62
Uttar Pradesh		54/55*, 55/56*, 56/57*
Uttar Pradesh	Deoria	66/67, 67/68, 68/69
Uttar Pradesh	Muzaffarnagar	66/67*, 67/68*, 68/69*

We have individual farm data for the 20 studies marked with an asterisk. For the remaining studies data are available in an aggregated form.

Reports from each of these studies have been published and are available to the principal investigators (it is possible that several more will be available in the near future). The typical report provides full data from 150 farms aggregated into from five to eight farm size groups and from two to four zones or regions within the District. The West Godavari (Andhra Pradesh) report, for example, provides data for eight farm size groups for two regions for each year. The three West Godavari reports for 57/58, 58/59 and 59/60 then provide 48 "observations" (8 x 2 x 3). Ten sample villages were first selected representing two zones in the district. Then a stratified (by farm size) sample of 110 farms was drawn (the number in most studies is 150). Averages for the farms in each size group in each zone are then reported for detailed production data.

The data reported are quite thorough and well suited to the study. Data include:

Land holdings, cropping pattern tenancy and fragmentation
Farm assets
Farm household data (education, etc.)
Family labor employment
Hired labor - wages
Bullock labor - family and hired (wages)
Fertilizer and other costs (inc. tractors)
Maintenance data for livestock
Output and price data.

Some of the reports have crop price data. In general, a common format was followed in data collection and reporting although it is likely that a small

number of the studies may turn out to be poorly suited to this study. All of the above reports are available in India. We have personal copies of most of them. The individual farm data were made available as part of the earlier Economic Growth Center Project with the approval of the Economic and Statistical Advisor of the Ministry of Agriculture of the Government of India.

The ICRISAT data are collected under the supervision of Hans Binswanger and N. S. Jodha and James G. Ryan, (ICRISAT Village Studies: Sampling procedures data coverage and resource endowments of the study areas" ICRISAT Socio-Economic Program, Occasional Paper 16, June 1977) Data are from six villages in three different agro-climatic zones. The farm management component is congruent with the Farm Management Studies and were collected by resident investigators.

The aggregate data set consists of two partially overlapping district level data sets.

A. The Indian district level data collected for previous studies by Evenson is summarized below. Note that some of the input quantity series are based on interpolation between censuses. Our methodology can incorporate some interpolation in that we can estimate the basic parameters from census years (or averages of years centering on census years). This cuts down the number of observations but does not prevent us from pursuing the study. The generated productivity series will have some elements of interpolation but this is not too serious for most purposes. We are working on procedures to estimate inter-censal labor force data, however.

Notes on Calculations of Total Factor Productivity for 140 Districts

1. The output index is calculated from
   a) Government of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, *Estimates of Area and Production of Principal Crops in India* (1970) (Detailed Tables) 1954–55 to 1964–65.

   b) State *Statistical Abstracts* and *Crop and Season Reports* for later years.

2. The input quantity indexes used in this calculation were:
   a) *Land*: An annual index of net harvested acreage from the same sources as the output data.
   b) *Fertilizer*: Data from a World Bank Study. W. B. Donde and D. B. Brown, *Effective Demand for Fertilizer in India*. N. P. and K. treated as separate inputs.
   c) *Pump Irrigation*: Data from livestock census; 1951, 1956, 1961. For 1966, 1967, 1968, from *Economic and Social Indicators of India*, USAID, 1972.
   d) *Tractors*: Data on number of agricultural tractors interpolated between Census of Livestock, 1951, 1956, 1961 and 1966. After 1966 for later years from estimate given by MMA Baig, Manager, *Market Research, Escorts Limited* (correspondence to Rakesh Mohan, 10th July, 1972).
   e) *Implements*: Wooden plows, Iron plows, cane crushers, Ghanis and carts from *Indian Livestock Census*, 1951, 1956, 1961, 1966. Linear interpolation between census and extrapolation after 1966.
   f) *Bullock labor*: Male cattle used for work and male buffalo used for work, from *Indian Livestock Census* 1951, 1956, 1961, 1966. Linear interpolation between census and extrapolation of 1961–1966 trend to 1971. An adjustment for days worked per year was made from *Farm Management Survey Data*.
   g) *Human labor*: Data on number of male cultivators and male agricultural laborers from *Fact Book on Manpower*, 1970. Institute of Applied Manpower Research, New Delhi and *Provisional Population Totals*, Paper 1 of 197 supp., *Census of India* – 1971. Data on females, from the same sources. 1971 female data were not taken from 1971 census counts because of inconsistent definitions between 1961–71. Female growth rates between 1961 and 1971 were assumed to be the same as the actual growth rates in the male labor force. The number of days worked per year by male and female cultivators and laborers, *from Fact Book on Manpower* (N.S.S. data) were used to correct numbers of laborers into numbers of days worked separate growth rate between censuses for males and females were computed.

3. Input share data were computed using the following prices:
   a) *Land*: Rental values of irrigated and unirrigated land were computed from *Punjab Farm Accounts* annually for 1956 to 1970. This series was adjusted by comparison with cash rental data from several *Farm Management Studies* (summarized in C. H. Rao, *Agricultural Production Functions*, Asia, Pub. Aug. 1965, for early years) and taken from reports for several districts in later years. Andhra Pradesh (1961–62), Mysore (1960). Other data from 1959–60. Rural credit Survey data were also used. On the basis of these sources, a determination was made to use the Punjab-Haryana

rental rates for irrigated and unirrigated land for the Northern states, Punjab-Haryana and U.P. These were our best estimates of the comparative prices based on the farm management study data. Irrigated land (excluding tubewells) was on the farm management study data. Irrigated land was treated as a separate input and the difference in the rental rates for irrigated or unirrigated land was assumed to reflect the public sector as well as private sector investment in canal irrigation.

b) *Fertilizer*: Prices for nitrogen, phosphate, and potash from *Fertilizier Statistics*, Fertilizer Association of India.

c) *Pumpsets*: Farm mangement data from the Punjab used to compute depreciation maintenance plus operating costs per tubewell. Irrigated acreage in the land series did not include this irrigation.

d) *Tractors*: Prices from *Agricultural Prices in India* and from *Escorts Limited.*

e) *Implements*: Prices from Tara Shukla, *Capital Formation in Indian Agriculture*, Vora and Co., Bombay, 1965, up-dated through wholesale price index.

f) *Bullocks*: Prices obtained from *Punjab Farm Account* data and from *Farm Management Survey* data. Depreciation maintenance and fodder included in the overall price, since much livestock feed is not captured in the output data.

g) *Labor*: Wage rates from *Agricultural Wage Rates in India*, (1971 data provided by the Ministry of Agriculture) were averaged over districts, months, and tasks. Males and females were given separate wages, and cultivators were given the same average wage as the field laborers.

4. The annual input index growth rates were weighted by 1960–61 factor share from 1963 to 1961–62, by 1965 shares from 1962–63 to 1967–68 and by 1970 shares for the remaining years. These weighted aggregate input index changes were incremented to form the input index.

B. ICRISAT, under the guidance of Binswanger has collected a similar data set for the complete set of districts of the State of Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh and Madhya Pradesh. The two data sets will be combined.

The ICRISAT data sets cover the years 1950 to 1973/74. Some series in the Evenson data will have to be updated to the same period.

APPENDIX D.

The Satellite Studies: The Philippines and Bangladesh

The satellite studies are distinguished from the main study because they will be dissertation studies and as such their character will be somewhat distinct from the main study. The doctoral students, Jaime Quizon and Salahuddin Ahmad (see vitae in Appendix E) have initially committed themselves to dissertation which will allow comparisons with the Indian study.

Each of the satellite studies will have a structure similar to that set forth in this proposal. Data availability is also similar in that both secondary data and micro-level data will be utilized in the satellite studies.

The Philippine secondary data are similar to the Indian data in most respects. A study of productivity change in Philippine Agriculture for nine N.E.D.A. regions for the 1948-1975 period has been completed. Myrna Antonio a student at the University of New England, Armidale, N. S. W. is currently completing a Master's thesis analyzing productivity change utilizing these data. Major sources are:

I. Aggregate Production

Crops and Livestock

1. Crop, Livestock and Natural Resources Statistics, 1973. Bureau of Agricultural Economics. Department of Agriculture and Natural Resources. Republic of the Philippines.
2. Livestock

Crop, Livestock and Natural Resources Statistics Annual.

a. Livestock and Poultry on Farms (As of January 1, 1973)

b. Statistical Tables

3. Philippine Statistics 1969 Yearbook

4. Journal of Philippine Statistics

5. Philippine Agricultural Statistics, Division of Ag. Econ., Dept. of Agriculture and Natural Resources

6. Prices

1. Monthly Average Prices of Rice and Corn, 1972.

(Monthly compilation of wholesale and retail prices for rice and corn in Calenday Year 1972)

Source: AMNEWSS (Agricultural Marketing News Service) Daily Market Price Report

2. Philippine Agricultural Situation (Journal published quarterly)

3. Central Bank Annual Reports

4. Central Bank Statistical Bulletins.

5. Journal of Philippine Statistics

a) Vol. XX, No. 2, 1969

1) Food price indices and percent change for the Philippines, 1967 and 1966.

6. Philippine Agricultural Statistics

7. Economic Census of the Philippines

7. Land Series

a. Annual Reports. Land Authority

1. Land Surveys
2. Land Distribution
3. Land Administration

b. Annual Reports: National Food and Agriculture Council

c. Economic Census of the Philippines. Bureau of Census and Statistics

d. Philippine Agricultural Statistics

e. Philippine Agricultural Situation

f. Philippine Economic Journal

g. Philippine Economy Bulletin

h. Philippine Statistics 1969 Yearbook.

Two Micro-data set in the Philippines will be utilized:

1. The Laguna Study Data

The Laguna Study (conducted under the direction of Robert Evenson) produced three sets of data, two of which will be utilized in this study. One of the data sets represents a "resurvey" of farms surveyed initially in 1963. The University of the Philippines Farm and Home Development Office (FHDO) surveyed some 500 households in 1963 and again in 1968. The 1968 data were quite carefully collected and covered two rice seasons. Juanita Baskinas of the FHDO staff resurveyed 400 of these same farms again in 1973 in a Masters degree study of farm tenancy. Erriquetta Torres resurveyed 150 of these farms in 1975 as part of her Doctoral dissertation at the University of the Philippines - Los Banos. The Laguna Study team resurveyed the Baskinas sample in 1977 collecting data for two more seasons as well as a wide range of related data.

Thus the FHDO-Baskinas sample to be employed in this study has data for 300 plus rice farms for 1968, 1973 and 1977 (two seasons each year). In addition, data for 150 of these farms are available for 1975. All basic output, input and relevant price data were taken by season. The

data include measures of schooling, extension contracts, nutritional status, technology use, and tenancy. Additional data on barrio level factors were also collected (social services, organizations, prices, transportation and utilities).

The Laguna Study also undertook a separate survey of 600 households including roughly 250 farms in Laguna province in 1975. Data for two crop seasons were obtained. Data for a third rice crop in 1976 was later obtained and these households were also resurveyed in 1977. Thus a sample with data for 5 crop seasons has been obtained. This sample has additional data on home production and time allocation.

II. The IRRI Studies

IRRI has several sets of panel data which have been utilized by C. Ranade in the USAID Poor Rural Households project. One set from Central Luzon includes data for several years from a sample of farms and will be well suited to the approach of this project. Ranade has investigated some related questions with these data but has not attempted to estimate a number of the parameters of interest in this project.

The Bangladesh study will encompass a longer historical period and will undertake a study of the erstwhile Bengal State concerning a pre-independence period 1926-1940 and a past-independence-partition period 1955-1973. Both West Bengal and Bangladesh (East Bengal) will be covered in the study.

Mr. Ahmad has concentrated his major work to date on the pre-independence data set and has documented numerous sources. Bangladesh secondary data

set and has documented numerous sources. Bangladesh secondary data are generally similar to Indian sources. Mr. Ahmad has been associated with the Bangladesh Institute of Development Economics and will have access to both its secondary and primary data on Bangladesh. He plans to spend two to three months in Bangladesh assembling data.

APPENDIX E

Curriculum Vitae

VITA

January 1, 1978

I. PERSONAL

Name: Robert E. Evenson Born:

Marital Status: Married, three children

Citizenship: United States

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II. EDUCATION

Undergraduate: Mankato (Minnesota) State College--attended 1959 and 1960

University of Minnesota--awarded Bachelor of Agricultural Business Administration degree in 1961 (with Highest Distinction)

Graduate: University of Minnesota--awarded Master of Science Degree in 1964

University of Chicago--awarded Ph.D. Degree, 1968

III. PROFESSIONAL EXPERIENCE

1966-1969: Assistant Professor of Agricultural Economics and Economics, University of Minnesota

1968-1969: Visiting Assistant Professor of Economics, Southern Methodist University

1969-1974 Associate Professor of Economics, Yale University

1969 (Summer): Visiting Lecturer in Economics, University of Tucuman (Argentina)

1970 (Summer)
1972 (Summer) Visiting Lecturer in Economics, Indian Agricultural Research Institute (New Delhi, India)

1971-1972 Visiting Associate Professor, Department of Economics, University of Chicago

1974-1977:	Associate, The Agricultural Development Council Visiting Professor of Agricultural Economics, University of the Philippines at Los Banos
1977:	Visiting Fellow, Development Studies Center, Australian National University
	Professor of Economics, Yale University

PUBLICATIONS:

"The Contribution of Agricultural Research to Production", Journal of Farm Economics, Vol. 49, No. 5, December, 1967.

"Technical Change and Agricultural Trade: Three Examples-Sugarcane, Bananas and Rice", (with V. W. Ruttan and J. P. Houck) in Vernon, R., (ed.), The Technology Factor in Interational Trade, Columbia University Press, 1970.

"Economic Aspects of the Organization of Agricultural Research", in Fishel, W. (ed.), Resource Allocation in Agricultural Research, University of Minnesota Press, 1971.

"Economic Factors in Research and Extension Investment Policy", in FAO ECA Monthly Bulletin, 1972.

"Production Quota Systems with Production Uncertainty", International Journal of Agrarian Affairs, 1972.

"Technology Generation in Agriculture in Development Theory, Lloyd Reynolds (ed.), Yale University Press, 1975.

"Research and Productivity in Wheat and Maize" (with Yoav Kislev), Journal of Political Economy, June 1974.

"Investment in Agricultural Research and Extension: An International Survey" (with Yoav Kislev) Economic Development and Cultural Change, 1975.

"Agricultural Trade and Shifting Comparative Advantage" in Trade and Agricultural Development, ed. G. W. Tolley, Ballinger, 1973.

"Research, Extension and Schooling in Agricultural Development", 1973-74 Yearbook of Education, London, 1974.

"International Diffusion of Agrarian Technology", Journal of Economic History, June 1974.

"The Indian Agricultural Research System", (with D. Jha and R. Mohan), Economic and Political Weekly, Bombay, 1973.

"The Indian Agricultural Research System and Its Contribution to Agricultural Production", (with D. Jha), Indian Journal of Agricultural Economics, 1974.

"The Intensive Agricultural Districts Program in India: A New Evaluation", (with Rakesh Mohan) Journal of Development Studies, 1976.

"Cycles in Research Productivity and International Diffusion Patterns in Sugarcane, Wheat and Rice in Resource Allocation and Productivity in National and International Agricultural Research (Thomas Arndt, Dana Dalrymple and V. W. Ruttan editors) University of Minnesota Press, 1977.

"Comparative Evidence on Returns to Investment in National and International Research Institutions" in Thomas Arndt, Dana Dalrymple and V. W. Ruttan (Eds.) op. cit. University of Minnesota Press, 1977.

"Consequences of the Green Revolution", Proceedings VI Pacific Trade Congress, Mexican City, July 1974.

"The Green Revolution in Recent Development Experience, American Journal of Agric. Economics, July 1974.

"International Transmission of Technology in the Production of Sugarcane", Journal of Development Studies, 1976.

"Technology Transfer and Research Resource Allocation" (with Hans P. Binswanger) in H. P. Binswanger and Ruttan, V. W. Induced Innovation and Economic Development, Johns Hopkins Press, 1976.

"Science and The World Food Problem" Connecticut Agricultural Experiment Station Bulletin 758, 1975.

"On the New House Old Economics", Journal of Agricultural Economics and and Development Vol. VI, Jan. 1976.

"Research and Factor Productivity in Agriculture: An Inter-Country Study" (with Y. Kislev) Supplement to International Journal of Agrarian Affairs, 1976.

"Farm Income and Its Taxation: Evidence of Gross Inequities" (with F. Welch). To be published in a volume based on a "Conference on Full Employment" Madison, Wis. 1975.

"A Stochastic Model of Applied Research", reprinted from the Journal of Political Economy 1976, Vol. 84, No. 2, (with Y. Kislev).

"Productivity Measurement in the Developing Economies: The Indian Case" Proceedings Conference on Productivity Measurement, Ulm. Germany, 1974.

"Social Returns to Rice Research in the Philippines: Domestic Benefits and Foreign Spillover" (with Piedad Flores and Yujiro Hayami) Economic Development and Cultural Change (forthcoming).

"Risk and Uncertainty as Factors in Crop Improvement Research (with R. Hardt, J. O'Toole, W. R. Coffman and H. Kaufmann) to published in a volume on Risk and Uncertainty in Development based on a Conference in Mexico, 1976.

"Fertility, Schooling and the Economic Contribution of Children in Rural India" with M. Rosenzweig, Econometrica, Vol. 45, No. 5 (July, 1977).

"Social Return to Rice Research (with Piedad Flores) in Economic Consequences of New Rice Technology in Asia, Y. Hayami (ed.) IRRI, 1977.

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"The Contribution of Agricultural Research to Agricultural Production", Ph.D. Dissertation, University of Chicago, 1968.

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"Labor in the Indian Agricultural Sector" (A Report to A.I.D.), October, 1972.

"Productivity Change in U. S. Agriculture" (with D. Landau), Sept. 1973.

"Agricultural Research and Extension in Asia: A Survey", prepared as a report to the Second Asian Agricultural Survey Team, September 1976.

"Agricultural Research and Extension in Asia: A Survey with Special Reference to Nepal", paper presented at a Seminar on "Research Productivity and Mechanization in Nepalese Agriculture" jointly sponsored by Centre for Economic Development and Administration and Agricultural Projects Services Centre, Oct. 26-28, 1976.

"Economic, Demographic, Health and Nutritional Factors in Rural Household Behavior" (with Cecilia Florencio) prepared for the CAMS-ODA Seminar Labor Supply, 1976.

"Economic Implications of Food Aid Programs: The Perspective of Recent Advances in Economic Theory of the Households"

"Gains and Losses from Agricultural Technology", paper presented at the 1975 Annual Meeting of Philippine Economic Society November 15, 1975 at the Central Bank Building, Manila.

"Research, Farm Scale and Agricultural Production" (with Finis Welch)

"Scale Economies, Elasticities of Substitution and Productivity Change in the Indian Manufacturing Sector" (with M. A. Qomen).

"Technology Access and Factor Markets in Agriculture" paper presented at the Workshop on Technology and Factor Markets, ADC Singapore, August 9-10, 1976.

BOOKS:

Agricultural Research and Productivity (with Y. Kislev) Yale University Press, New Haven, Conn. 1975.

Research, Information and Agricultural Productivity (with F. Welch) in draft.

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RESUME

HANS P. BINSWANGER

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Marital Status: Married, with one daughter (6 yrs.)

Nationality: Switzerland

Birthdate:

Education:

University of Paris, France	1964	Certificate of Political Sciences
Eidgenoessische Technische Hochschule, Zurich, Switzerland	1969	Master in Agricultural Production (Ingenieur Agronom)
North Carolina State University	1972	Ph.D. in Economics Minor in Statistics and Econometrics

Publications: List of publications Attached.

Present Position: Associate, Agricultural Development Council, Inc. stationed at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India.

Experience:

Research Associate, Economic Development Center, University of Minnesota, St. Paul, Minnesota.

1970-1972 Research Assistant, Department of Economics, North Carolina State University, Raleigh.

1968-69 Eidgenoessische Technische Hochschule. Research in optimal organization of farms and organization of a statistical survey of forecast potato yields.

Working Languages: English, German, French Speaking knowledge: Hindi, Italian

Organization Membership and awards: Phi Kappa Phi, Omicron Delta Epsilon, Special Scholarship by Swiss Board of Schools (Schweizerischer Schulrat) for the purpose of studying economics at an American University.

PUBLICATIONS OF DR. HANS P. BINSWANGER

Books and Journal Articles:

1) Hans P. Binswanger, "A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution", *American Journal of Agricultural Economics*, Vol.56, No.2, May 1974: 377-386.

2) Hans P. Binswanger, "Borrowing of Technology, Adaptive Research and Research on Home Technology", *Pakistan Economic and Social Review*, Vol.12, No.2, Summer 1974 : 144-156.

3) Hans P. Binswanger, "The Measurement of Technical Change Biases With Many Factors of Production", *American Economic Review*, Vol.64, No.6, December 1974 : 964-976.

4) Hans P. Binswanger, "A Microeconomic Approach to Induced Innovation", *Economic Journal*, Vol.84, No.336, December 1974 : 940-958.

5) Mitoshi Yamaguchi and Hans P. Binswanger, "The Role of Sectoral Technical Change in Development : Japan, 1880-1965", *American Journal of Agricultural Economics*, Vol.57, No.2, May 1975 : 269-278.

6) Ronald C. Duncan and Hans P. Binswanger, "Energy Sources : Substitution and Biases in Australia", *Australian Economic Papers*, December, 1976 : 289-301.

7) Hans P. Binswanger, "Measuring the Impact of Economic Factors on the Direction of Technical Change" in Thomas M. Arndt, Dana Dalrymple and Vernon W. Ruttan, eds., *Resource Allocation and Productivity in National and International Agricultural Research*, University of Minnesota Press, Minneapolis, 1977.

8) Hans P. Binswanger and Vernon W. Ruttan, "*Induced Innovation : Technology, Institutions and Development*", Johns Hopkins University Press, Baltimore, Maryland, 1977.

Conference and Position Papers:

1) Hans P. Binswanger, *The Measurement of Biased Efficiency Gains in U.S. and Japanese Agriculture to Test the Induced Innovation Hypothesis*, Doctoral Dissertation, North Carolina State University, 1973.

2) Hans P. Binswanger, *Technology Transfer and Research in Agriculture*, Paper prepared for National Academy of Science/Nacational Academy of Engineering Panel on Appropriate Technologies for Developing Economies, August 1974.

3) Hans P. Binswanger, *The Use of Duality Between Production, Profit and Cost Functions in Applied Econometric Research : A Didactic Note*, ICRISAT, Economics Department, *Occasional Paper No.10*, May 1975.

4) Hans P. Binswanger, "*Distributional Consequences of Neutral versus Nonneutral Technical Changes : Partial versus General Equilibrium Analysis*", A.D.C. Workshop on Technology and Factor Markets, Singapore, August 8-10, 1976.

5) Hans P. Binswanger, *The International Agricultural Research System and Nepal*, Seminar on Research, Productivity and Mechanization in Nepalese Agriculture, October 26-28, 1976, Center for Economic Development and Administration, Tribhuvan University, Kathmandu, Nepal.

6) Hans P. Binswanger, B.A. Krantz and S.M. Virmani, *The Role of the International Crops Research Institute for the Semi-Arid Tropics in Farming Systems Research*, ICRISAT, August 1976.

7) Hans P. Binswanger and S.V.R. Shetty, *Economic Aspects of Weed Control in the Semi-Arid Tropical Areas of India*, ICRISAT, Economics Department, *Occasional Paper 13*, March 1977.

8) Hans P. Binswanger, James G. Ryan, N.S. Jodha and Matthias von Oppen, *Approach and Priorities for the Village Level Studies*, Economics Program, *Occasional Paper 15*, June 1977.

9) Hans P. Binswanger, *Risk and Uncertainty in Agricultural Development : Notes on an A.D.C. Seminar*, ICRISAT, Economics Program, *Occasional Paper* 17, July 1977. (to be published in the Conference Volume).

10) Vernon W. Ruttan, Hans P. Binswanger and Yujiro Hayami, *Induced Technical Change in Agriculture*, Paper presented at the 5th World Congress of Economists, August 29-September 3, 1977, Tokyo, Japan.

11) Hans P. Binswanger and James G. Ryan, *Efficiency and Equity Issues in Ex Ante Allocation of Research Resources*, Economics Program ICRISAT, Hyderabad, India.

12) Hans P. Binswanger, *The Economics of Tractors in the Indian Subcontinent : An Analytical Review*, Economics Program, ICRISAT, Hyderabad, India.

13) Hans P. Binswanger, *Risk Attitudes of Rural Households in Semi-Arid Tropical India*, Economics Program, ICRISAT, Hyderabad, India.

CURRICULUM VITA

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BORN:

ACADEMIC BACKGROUND

M. A. (Econ.)	Yale 1977
Presently continuing with Ph.D.	Yale
M.S. (Econ.)	Stirling 1975, Scotland, U.K.
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B. A. (Honors) Economics	Panjab 1970
Intermediate Science	Dacca 1967
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CURRICULUM VITA

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BORN:

ACADEMIC BACKGROUND:

University of the Philippines (School of Economics)
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—M.A. (Economics) 1975

Ateneo de Manila University
—B.S. in Management Engineering (1973)

Paco Catholic School (Manila)
—High School (1968)

Member, Philippine Economic Society

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Technology, Policy and Rural Incomes
ADDENDUM:

Summary of RAC Recommendations - March 30-31, 1978

Regional Development Impacts of Agricultural Change (New) - Yale University. Duration of project, 2 years; estimated cost, $230,000
*Heady, Anderson, Montgomery, Swanson, Thorbecke

Recommendation: That the proposal be approved as submitted with the requirement that the investigators engage the participation of Indian colleagues so that they gain experience with the model and its operation and are in a position to take possession of it and continue its use in the evaluation of Indian Government and other exogenous policies after the project is complete.

Note: RAC noted the improvements in the project as compared to the original proposal that was submitted to the Committee at its May 1977 meeting. The model to be constructed will be used to simulate the effects of new public policies and other major economic influences at the regional and national levels in India. RAC considered it important that local researchers gain sufficient experience in the use of this model to continue using it after the project is concluded.

*RAC review subcommittee; chairman underscored