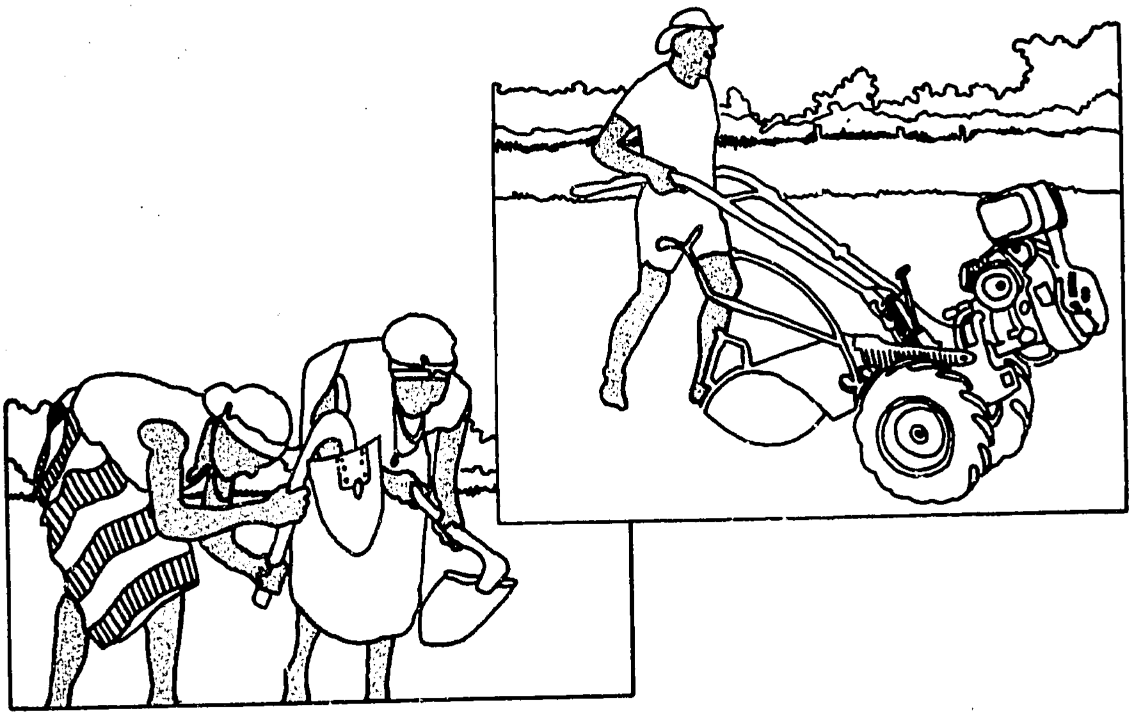
PN-AAP-132

TECHNOLOGICAL CHANGE AND RURAL DEVELOPMENT



MAY 3-4, 1982
JOHN M. CLAYTON HALL
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

UNIVERSITY OF DELAWARE
1833-1983
150 YEARS OF PROGRESS

PNAAP 432

TECHNOLOGICAL CHANGE AND RURAL DEVELOPMENT

IN DEVELOPING COUNTRIES

Selected Papers from the University of Delaware

Title XII Conference

May 3-4, 1982

Edited By

G. Joachim Elterich and Peter Weil

with the assistance of Harry Brautigam

TITLE XII PUBLICATION NO. 5

TITLE XII OFFICE
Agricultural Hall, University of Delaware, Newark, Delaware 19711

ACKNOWLEDGEMENTS

A conference on so complex a subject and the editing of so large a number of papers from the many disciplines represented at the conference are large undertakings, the success of which are only possible through the active involvement of many people.

The editors want to express their appreciation to the Program Committee members who contributed so much of their thought, time, and effort in the organizing and implementing of the conference. The members were:

Dr. Byong Ahn, Visiting Professor, Department of Political Science

Ms. Jean Anthony, Office Coordinator, Title XII Office

Dr. Sally Bould, Associate Professor, Sociology

Dr. William Boyer, Professor, Political Science

Dr. Harry Brautigam, Assistant Professor, Agriculture & Food Economics

Dr. Luciano Corazza, Director, International Fisheries/ Aquaculture

Dr. Charles Curtis, Special Assistant to the President and Provost, Coordinator, Title XII Office

Dr. Mir Islam, Associate Professor, Food Science and Human Nutrition

Dr. Vivian Klaff, Associate Professor, Sociology

Dr. Victor Martuza, Associate Professor, Educational Studies

Mr. Joseph Rykiel, Energy Information Specialist II, Energy Conversion

Dr. Norman B. Schwartz, Professor, Anthropology

Dr. John Stapleford, Director, Bureau of Economic and Business Research, Urban Affairs & Public Policy

The editors are greatly indebted to the following for serving as outside reviewers. Their comments, in combination with the active discussions and commentary by authors and the international audience at the conference and with the professional judgement of the editors, were included in the many editorial decisions concerning the following papers in this volume.

Dr. Melbourne R. Carriker, College of Marine Studies for the Anderson and Luna papers

Dr. Vytautas Klemas, College of Marine Studies for the Withington paper

Dr. John Kmetz, Business Administration for the Ashworth paper

Dr. John Stapleford, Urban Affairs, and two anonymous reviewers for the Elterich and Brautigam paper.

Finally, we would also like to thank Dr. Charles Curtis, Coordinator of the Title XII Office, for providing administrative support and arranging for publication of this volume. Financial support was provided by the University of Delaware Title XII Strengthening Grant. Special thanks go to Laura D. Sowers for conference logistics and Marilyn A. C. Brown for typing and proofreading the [illegible]al versions.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

PREFACE viii

PART A: THEORIES, POLICIES AND LEVELS IN DEVELOPMENT

1. APPROPRIATE TECHNOLOGY, FOOD PRODUCTION, AND RURAL DEVELOPMENT: THE RURAL SECTOR FROM A FOOD POLICY PERSPECTIVE

   C. Peter Timmer 1

2. A SURVEY OF DEVELOPMENT THEORIES

   James H. Weaver and Marguerite Berger 47

TECHNOLOGICAL CHANGE BEARING UPON ECONOMIC AND INFRASTRUCTURAL ISSUES, FOOD AND RESOURCE AVAILABILITY

3. POLICY OPTIONS FOR RURAL DEVELOPMENT

   G. Joachim Elterich and Harry E. Brautigam 85

4. FARMING SYSTEMS RESEARCH AND TECHNICAL CHANGE

   Richard D. Robbins 109

5. WHEN YOUNG MEN LEAVE AND THE OLD RETURN: DEVELOPMENT POLICY IN AN AREA OF INTENSE OUTMIGRATION, THE UPPER SENEGAL RIVER VALLEY

   Lucie Gallistel Colvin 129

6. REMOTE SENSING TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES

   C. F. Withington 163

7. BIOMASS ENERGY TECHNOLOGIES IN RURAL DEVELOPMENT

Romir Chatterjee, John Lee and Vinod Mubayi 177

8. ROLE OF TECHNOLOGY IN REDUCING POST-HARVEST FOOD LOSSES

Mir N. Islam 203

PART B: ADMINISTRATION IN TECHNOLOGY TRANSFER

9. TECHNOLOGY, INSTITUTIONAL DEVELOPMENT AND SOCIAL CHANGE

Nyle C. Brady 225

10. INTERNATIONAL RESEARCH AND TECHNOLOGICAL CHANGE IN AGRICULTURE IN DEVELOPING COUNTRIES

Donald L. Plucknett and Nigel J. H. Smith 241

11. PRIVATE ENTERPRISE AND TECHNOLOGY TRANSFER

Roger D. Moeller 259

NATIONAL AND LOCAL INSTITUTIONS FURTHERING RURAL DEVELOPMENT VIA TECHNOLOGICAL CHANGE

12. INTERMEDIATE INSTITUTIONS AND RURAL DEVELOPMENT

Kenneth W. Eckhardt and Norman B. Schwartz 281

13. TECHNICAL CHANGE AND RURAL DEVELOPMENT: A DEMOGRAPHIC PERSPECTIVE

Wayne Schutjer, C. Shannon Stokes and Warren C. Robinson . . 317

14. RELATIONSHIP OF POPULATION POLICY TO TECHNOLOGICAL CHANGE IN DEVELOPING COUNTRIES

Vivian Z. Klaff 351

15. RURAL DEVELOPMENT AND LEADERSHIP PATTERNS IN SOUTH KOREA

Byong Man Ahn and William W. Boyer 389

16. DUALISM IN LESS DEVELOPED COUNTRIES

Luciano E. Barraza 409

PART C: TECHNOLOGICAL TRANSFER AND THE RURAL HOUSEHOLD

17. IMPLICATIONS OF TECHNOLOGICAL CHANGE FOR HOUSEHOLD LEVEL AND RURAL DEVELOPMENT

June Nash 429

IMPLICATIONS OF TECHNOLOGICAL CHANGE AT HOUSEHOLD LEVEL AND ON RURAL DEVELOPMENT

18. FARMING SYSTEMS RESEARCH AND SMALL FARMER TECHNOLOGY

J. W. Beausoleil 477

19. BARRIERS TO ADOPTION OF NEW TECHNOLOGIES AT THE FARM LEVEL

Peter B. R. Hazell 495

20. IMPACT OF FISHERIES IN RURAL DEVELOPMENT

Julio Luna 515

21. FISHERIES MANAGEMENT AND RURAL DEVELOPMENT

Lee G. Anderson 527

22. FROM LABORATORY TO LABORER: NOTES ON THE SUCCESSFUL DELIVERY OF NEW TECHNOLOGIES IN THE DEVELOPING WORLD

John H. Ashworth 537

PREFACE

The selected papers included in the volume are the revised and expanded product of the Conference on "Technological Change and Rural Development in Developing Countries" held at the University of Delaware in May, 1982. The papers were prepared to meet the following goals of the conference:

1) review the state of the art of technology transfer in rural development including technologies, management, and research methodologies

2) to explore aspects of the social, economic and political effects of technological change at the "grass roots" through the national levels

The attainment of such goals was seen as requiring the participation of experienced researchers and policy-makers from the broad spectrum of disciplines and institutional settings actively involved in meeting the challanges of technology transfer. Thus the authors include researchers, policy makers, and administrators from eight universities, nine international institutions, and seventeen disciplines. Three basic categories, each encompasing elements of both conference goals, were identified and discussed in broad integrative papers concerning Technological Change and Rural Development were prepared.

In the first category entitled THEORIES, POLICIES AND LEVELS IN DEVELOPMENT papers were prepared by:

1) Peter Timmer, Economics, Harvard
2) James Weaver, Political Economics, American University

In the second category ADMINISTRATION IN TECHNOLOGY TRANSFER addresses were delivered by:

1) Neil Brady, Senior Assistant Administrator for Science and Technology, USAID
2) Donald L. Plucknett, Scientific Advisor, International Group of Agricultural Research, World Bank
3) Roger Moeller, Engineer, USAID

June Nash, Anthropologist, CUNY, treated the theme TECHNOLOGICAL TRANSFER AND THE RURAL HOUSEHOLD.

The other authors prepared papers on more particularistic aspects of each of these three basic categories. They are as follows:

1) GROUP A. TECHNOLOGICAL CHANGE BEARING UPON ECONOMIC AND INFRASTRUCTURAL ISSUES, FOOD AND RESOURCE AVAILABILITY

   a. Joachim Elterich and Harry Brautigam
      Agricultural Economics, University of Delaware
   b. Richard Robbins, Agricultural Economist, USAID
   c. Lucie Colvin, History, University of Maryland

d. Charles Withington, Geologist, United Nations
e. Romir Chatterjee, Economist, U.N. Network of International Training Centers
f. Mir Islam, Food Science, University of Delaware

2) GROUP B. NATIONAL AND LOCAL INSTITUTIONS FURTHERING RURAL DEVELOPMENT VIA TECHNOLOGICAL CHANGE

a. Norman Schwartz, Anthropology, University of Delaware and Kenneth W. Eckhardt, Sociology, University of Delaware
b. Wayne Schutjer and Shannon Stokes Agricultural Economics and Rural Sociology, Pennsylvania State University
c. Vivian Klaff, Sociology, University of Delaware
d. Byong Ahn, Hankuk University, Korea, and William Boyer, Political Science, University of Delaware
e. Luciano Barraza, Economist, Interamerican Development Bank

3) GROUP C. IMPLICATIONS OF TECHNOLOGICAL CHANGE AT HOUSEHOLD LEVEL AND ON RURAL DEVELOPMENT

a. Joseph Beausoeil, Economist, USAID
b. Peter Hazell, Economist, International Food Policy Research Institute
c. Julio Luna, Social Scientist, Interamerican Development Bank
d. Lee Anderson, Marine Studies, University of Delaware
e. John Ashworth, Group Manager, International Development Group Solar Energy Research Institute, Golden, Co.

The papers have been revised in the light of the active discussions and commentary by authors and international audience at the conference.

The proceedings as a whole are intended to provide the reader with an understanding of the major contemporary trends and challanges in technology transfer with the ultimate goal of increasing the interdisciplinary approach of those challanges in the 1980s.

J. Elterich
P. Weil

Newark, June, 1983

APPROPRIATE TECHNOLOGY, FOOD PRODUCTION, AND RURAL DEVELOPMENT:

THE RURAL SECTOR FROM A FOOD POLICY PERSPECTIVE

APPROPRIATE TECHNOLOGY, FOOD PRODUCTION, AND RURAL DEVELOPMENT: THE RURAL SECTOR FROM A FOOD POLICY PERSPECTIVE

C. Peter Timmer
John D. Black Professor of
Agriculture and Business
Harvard Business School

This paper represents an attempted synthesis of several themes of the author's work over the past few years. The macro-micro perspective on appropriate technology is most clearly seen in "Public Policy for Improving Technology Choice," from which parts of this paper draw heavily. The integrated food policy perspective is worked out in Food Policy Analysis, written for the World Bank with Professors Walter P. Falcon and Scott R. Pearson. Neither the Bank nor my collaborators bear any responsibility for the views expressed here.

INTRODUCTION

At least two major lessons have been learned about economic development in the past thirty years. First, W. Arthur Lewis' stricture from 1954 really does hold: "...industrial and agrarian revolutions always go together, and ...economies in which agriculture is stagnant do not show industrial development" (p. 433). Food supply problems might be solved by importing cheap food or through food aid. But if food is not cheap or if international markets are highly unstable and threaten the stability of domestic policy, a country's own agriculture must meet growing food demand. More importantly, because the large majority of poor people live in rural areas, the elimination of poverty and hunger cannot succeed without successful rural development.

The second lesson of development experience is precisely the mirror image of the first. Rural development and raised productivity in agriculture cannot succeed except in the context of a successful overall development strategy. The macroeconomic forces that emanate from the general development strategy are too powerful for "development from below" to succeed unless "development from above" is proceeding apace. Sustained macro development is not possible without rural development. Sustained rural development is not possible without macro development.

The essential link between rural development and overall economic development is technology choice and the efficiency of resource allocation, especially in agricultural production. Markets and prices provide the connections and signals that make the link effective. This essay is designed to illuminate the macro to micro link from a food policy perspective, which integrates the broad set of objectives which a society has for its food sector with the technical, economic, and political constraints which condition the range of choice available for actual policy implementation.

A food policy perspective is different from an agricultural development perspective in three ways: it has a broader set of objectives, it has a macroeconomic focus, and it worries specifically about who consumes the food at the end of the food production-marketing-consumption chain. Each country specifies its own food policy objectives, but they usually can be recast into particular weights on one of the following general goals: efficient growth in the rural sector; productive employment creation and more equal distribution of earned income; reduction of hunger and malnutrition; and improved food security for both households and the country.

The macroeconomic focus of food policy also distinguishes it from most rural development perspectives. A society's macroeconomic policy encompasses its budgetary, fiscal, and monetary policies as well as its macro price policies. Both components of macro policy are important for the rural sector. The traditional macro policies determine budget allocations for rural programs, the level and incidence of rural taxation, and the seriousness of inflation. Policy makers frequently try to cope with inflationary pressures by keeping food prices low.

The less traditional role of macro policy is through efforts to set or control a society's basic macro prices -- interest rates, wage rates, foreign exchange rates, and the rural-urban terms of trade. These prices for capital, labor, foreign currency, and food (usually the most important component of the rural-urban terms of trade) strongly influence the broad choice of technology in a country and, in particular, the choice of technology in the countryside where a wide range of choices is typically available. When efficient choices are made relative to the scarcity of basic factors of production, economic growth can be rapid and employment creation can be widespread in both rural and urban areas.

At the same time, however, setting the macro prices to reflect factor scarcity to induce efficient technology choice carries severe income distribution consequences, including serious short-run food consumption consequences among poor people who are squeezed between very low wages, which reflect international opportunity costs. An important political economy dilemma that is widespread in the third world results between the short-run welfare of the poor and the long-run economic growth which is essential if the poor are to escape from poverty.

The focus on food consumption consequences of efficient macroeconomic policy is a further distinguishing feature of the food policy analytical perspective. Poverty and hunger are intimately related. In many countries they are the same thing. Rural development from a food policy persepective means a strategy for alleviating rural poverty through rapid growth in economic output and the creation of productive new jobs, while focusing on the short-run food intake of the poor who are squeezed by the economic policies that make the growth and jobs possible.

The concern for short-run food intake problems of the poor has both urban and rural dimensions. Because of the different types of delivery systems available, however, targeted food consumption programs in urban areas are easier to design and implement than programs to increase the access of the rural poor to targeted food schemes. In both the short run and the long run, rural poverty and hunger might have to be dealt with through more remunerative employment for the rural landless and near-landless.

A narrow focus on rural development will not create these jobs. Rural people live in a matrix of linkages that connect their economic opportunities to what is happening more broadly in the international economy, in the macro economy, and in other parts of the rural economy. Just as a narrow "industrialization means modernization" approach has failed to transport poor societies to riches and power, so has a narrow rural development strategy failed to generate the momentum in the rural economy that is necessary to alleviate poverty in the countryside.

APPROPRIATE TECHNOLOGY IN A MACRO-MICRO CONTEXT

In the past decade a rising discontent over the rate of growth of economic output and the extent to which the poor, especially the rural poor, have shared in its income generation has forced to the surface the questions asked by the appropriate technology movement: which technologies, to produce what, for whom, at what environmental cost? These are the questions of analytical economics, but many questions of technology choice are important precisely because of what must be left out of the current economic models of choice.

It is important to understand this dilemma, even if it is not possible to resolve it. If the economists who control planning agencies do not realize that standard economic decision-making models (such as cost-benefit analysis) may give socially incorrect answers when applied mechanistically to technology choice problems, then there is little hope for finding and implementing correct answers. Similarly, if concerns for the goals of appropriate technology are irrelevant. Choice will be determined by the personal commitments and feelings of a semi-religious utopian movement. Policy makers concerned about technological change and rural development must find ground between these two polar extremes.

All societies have arrangements for deciding what products the economy will produce (choice of product), how the products will be produced (choice of technique, or the means of production), and how the products will be distributed (choice of income distribution mechanisms, or the more of production). Choosing the technique of production -- the machine or industrial process -- provides an answer to only one of the three basic economic questions societies must answer in their overall choice of technology. Preserving this distinction of terms is useful as "choice of technique" thus refers to the choice along an isoquant that identifies a particular type of machine or factory with specified factor coefficients. The term "choice of technology" can be reserved for the broader set of issues society faces, including choice of product and distribution mechanisms. Choice of technology refers here to the basic economic choices all societies must face.

This distinction is designed to keep the term "appropraite technology" from being delegated to narrow technical answers to the broad development problems actually faced by third world societies. The solution to rural poverty is no more likely to be found in bullock-drawn steel plows and solar vegetable dryers than it is in 14-foot combines and concrete bulk grain silos. Each of the "techniques" is appropriate in some settings, and a methodology that related the characteristics of the setting to the characteristics of the techniques in such a way that the appropriate choice emerges is essential. Such choice of technique methodology is available, but it addresses only the relationship between technique and setting, not the nature of an appropriate setting itself. More important are the public policy issues for appropriate technology choice in the broader sense of an appropriate economic environment.

Public Policy and Technology Choice

Appropriate technology choice offers a country improved employment prospects with higher productivity for the urban and rural poor while long-run environmental resources are maintained. The four basic macro prices are the primary variables of economic policy that influence the choice of appropriate technology, but the impact of macro prices on technology choice is through complex mechanisms in even the simplest economies.

The major complexity arises because no government is able to set any of these macro prices willynilly. The national and international economies that provide the policy environment strongly condition the wage rate, for example, that can be chosen and set by national fiat and yet be widely applicable as the prevailing wage rate throughout the economy. The same is true of interest rates, exchange rates, and food prices. These macro prices are meant to reflect to the economy and to international trading partners the relative scarcities of these goods and factors. Governments have only limited powers to abolish arbitrarily the relative scarcities dictated by the "real" economy. To a large extent, the levels and relative values of the macro prices will be dictated by the economy and not to the economy by domestic policy makers.

What then is the role of policy? In short, it is to change gradually the environment in which choice of technology decisions are made in both the public and private sectors. The factors must be combined to do this: a sensitive understanding of the macro price equilibrium likely to be produced by the real economy in the absence of a particular intervention; an understanding of the ability of government activity to alter the real economy directly, for example, by funding projects which raise the demand for labor or increase the supply of food or foreign exchange; and an understanding of the limited, but still positive, ability to nudge the macro prices in a desired direction either directly (by fiat, as in announcing a new interest rate) or indirectly (by banning the export of food and hence lowering its domestic price and shifting the urban-rural terms of trade in favor of cities). The range of choice for economic policy depends on how these three factors relate to each other, but all countries have significant potential to alter the environment in which choice of technology decisions are made.

A serious asymmetry, however, exists in this potential. Improving the environment in the sense that more appropriate techniques and technology are chosen is a delicate task involving changes that are freqently unpopular, while dismantling an environment conducive to appropriate economic choices is remarkably easy and popular in the short run. Hence high interest rates which discourage capital intensity, low real wages which encourage labor absorption, high foreign exchange costs which discourage imports of consumer luxuries and encourage the export of labor-intensive products, and high food prices which pump real purchasing power into rural areas encompass a package of economic policies that is patently unpopular in most countries.

If such policies become suddenly necessary as austerity measures to bring actual policies clo[illegible] to what the real conditions of the economy can actually support, the short-run welfare implications can be exceedingly severe. Such phrasing sounds neutral and carries a tone of "but it's good for them." In fact, "severe short-run welfare implications" in poor countries usually means a rapid rise in infant mortality rates due to acute malnutrition, subclinical hunger which affects worker and student productivity, and excess short-run scarcity profits to the owners of capital and foreign exchange and to speculators who hold large food inventories.

Facing this dilemma over the "right" macro prices and the resulting short-run welfare costs is the heart of modern political economics. Three important considerations must be incorporated in any resolution of the dilemma: the need for a subsistence floor through targeted food subsidies; the need to exploit dynamic economic and political feedback linkages; and the need to disaggregate welfare problems by economic function and income class.

Providing a minimum subsistence floor, one that is unconnected to the marginal productivity of labor as reflected in market wages for unskilled labor, separates sheer survival from economic policy. Keesing has pointed out that prices based on real scarcities, especially capital and labor prices, contribute to highly skewed income distributions in labor-surplus, capital-poor countries. Some mechanism for protecting the consumption of the very poor in these environments will be needed if the macro price environment is to be used to foster appropriate technology choices. Ideal mechanisms might be asset redistribution or fiscal policy capable of redistributing incomes to the poor, but other less ideal mechanisms, such as ration shops, food stamps, or other targeted food subsidies, may be more feasible.

The second consideration is the extent to which feedback linkages reinforce both "right" and "wrong" policy choices with respect to macro prices. In essence, the policy environment is unstable between a macro price set that fosters appropriate technology choices and a policy set that does the opposite. Hence any movement from an existing intermediate point will tend to result in cumulative pressures in the same direction. A somewhat overvalued foreign exchange rate which is even further overvalued as a deliberate act of policy will set in motion forces that tend to make even greater overvaluation necessary.

Some of these forces are economic. The effective protection afforded by an overvalued exchange rate to domestic industry using imported inputs tends to make the industry less efficient with little incentive for cost control. When domestic production costs rise faster than international costs, foreign competition again becomes a threat, and further protection in the form of tariffs or revaluation is needed. But many of the forces are social and political. Protected domestic industry develops a patron-client relationship with the government policy makers who provide the protection. The workers in the protected industry enjoy the high wages made possible by the protection and lobby (in the streets if necessary) for its maintenance and extension.

The dynamics in the opposite direction are not nearly so strong nor as well documented empirically because of the limited number of success stories. Taiwan, South Korea, and Hong Kong hardly provide the basis for generalization. But the dynamics do seem to exist. The rigors of scarcity values for macro prices induce an efficiency and flexibility in production and trade which seem to energize labor-absorbing investment. More important for most countries, such policies seem able to tap the latent dynamism in rural sectors which have frequently suffered from decades of discrimination and neglect. A dynamic rural sector is an essential factor in the equitable and rapid economic transformation of a poor society. The role of appropriate macro prices in generating such rural dynamism is still a subject of some controversy. But Schultz's recent book on distortions of agricultural incentives shows that most agricultural development specialists are now squarely in the price incentive camp regarless of the short-run welfare consequences. Peterson's empirical estimates show very high long-run supply elasticities and correspondingly large social costs to undervaluing agricultural output.

The third important consideration in the analysis of the political economy of macro prices and welfare costs is the importance of disaggregation to understand the welfare problem and any financially plausible government interventions. The evolution of this perspective is outlined in two of my own papers (Timmer, 1980, 1981). Its empirical foundation is the recognition of differential food consumption consequences by incomes class when food prices change. By working out both the analytical mechanisms and the empirical parameters of this effect, policy analysts can generate options for intervention, possibly commodity-specific rather than income class-specific, which are not apparent when aggregate supply and demand parameters are used to describe and analyze the issues.

At first glance it would seem that the issues of appropriate technology choice could be resolved if public enterprises made all the choices directly on the basis of social cost-benefit analysis. The early appeal of planning models that emulated the extensive involvement of the Soviet state in production and distribution was based at least partly on this apparent simplicity. If the private sector is myopic, backward, risk averse and unable to encompass the public welfare dimensions of investment decisions, then the state could do it directly without having to worry about implementing a complex set of macro policies which might possibly produce the desired result but which might not have the "guarantee" of direct state initiative.

Sadly, the actual experience in most third world countries with state-run enterprises and with detailed planning of investment by central planning agencies is quite the contrary of the logic above. Capital and labor are not the only two factors of production required in the fields or in the factory, but planning agencies seem to have only these two factors within their capacity to allocate. The managerial and administrative talent needed to coordinate the production and distribution activities is an extremely scarce resource in these economies. Most planning exercises, however, assume such talent is irrelevant or a free good.

Further, the information required for a planning agency to allocate investment resources rationally is not costless, and the analytical expertise required to arrive at the right answers has a high international opportunity cost. Many of the most talented economists from the third world work for the IMF and the World Bank, which place a premium on employing a reasonable geographical balance of economists able to use the most sophisticated tools of analysis. The simple logic that suggests public enterprises will automatically select more appropriate projects and the means of implementing them than will private enterprise is faulty. The potentially positive role for public enterprise in improving technology choice is an empirical issue. It is necessary to look within such public entities to see how decisions are actually made.

Two aspects of performance need to be evaluated: the influence of the process by which bureaucratic planning decisions are made; and the scope for exercise of personal utility functions on the part of bureaucrats and planners. An earlier article on choice of technique in Indonesia (Timmer, 1975) explained the bias toward capital-intensive projects. National plans are typically assembled from sectoral plans which are independently constructed.

If sectoral planners do not receive firm guidelines on capital available to the sector, sectoral planners almost always pick a capital-intensive strategy designed to maximize sectoral output but which will ultimately not be consistent with full employment in their sectors when smaller capital allocations are actually received. Providing these guidelines is usually impossible at an early stage when preliminary sectoral plans are being assembled.

If a range of investment strategies is forwarded to the central planning agency, the problem can be avoided, for the agency can then allocate a national capital budget among sectors by choosing projects and techniques that result in full employment of both capital and labor resources. Without such a range of strategies, however, the sectoral offices tend to pick strategies that maximize gross output for their sectors and remain committed to those strategies even in the face of a reduced capital appropriation. The result is an inevitable anti-employment bias in favor of capital intensity.

Such a bias is all the more inevitable if sectoral planners never looked at a range of possible projects and techniques in the first place. Public officials do not feel the competitive pressures which would doom an undertaking in the private sector that was too lavish in its use of imported capital or with quality standards inappropriate to the market. Where such competition does threaten a government undertaking, the natural tendency is to protect it by forbidding the activity to private enterprise. Gene Ellis relates a characteristic example where private well-drillers in Ethiopia were willing to contract for services at half the cost of government well-drilling. The government's response was to forbid peasants in the rural development project to use the private drillers. Banning the competition does nothing to eliminate the excessive social costs or the social impact of the inappropriate techniques being used.

In addition to the simple failure to feel the competitive pressures that push projects toward appropriate characteristics, a combination of other factors causes many public sector officials actually to prefer more capital-intensive and less appropriate projects. The sources of the bias occur in three main areas: managerial expediency, corruption, and aid-donor biases. Such bias on the part of public sector officials can have a very serious impact on the welfare of the urban and rural poor who carry the brunt of the burden of inappropriate technologies because of their exclusion from access to higher productivity means of production. The sources of this bias can be readily identified.

A few large projects are much easier for a public official to design, construct, administer, regulate, and control than many small-scale projects which are usually influenced by the local environment in which they are sited. Few government planners have even a sketchy notion of the variation in local environments, and they tend to prefer a project sufficiently large to create its own environment (or for which it is worth creating a special environment). It is true that labor-intensive projects can also be very large scale, but the organization and administration of such projects draw on extremely scarce bureaucratic resources in most third world countries (possibly excepting China). Foreign consulting and construction companies obviously have little desire or capacity to manage large-scale labor-intensive projects. Such projects require coordination and maintenance of very large numbers of very low paid and unskilled workers, and for foreigners to function in such a role is highly suggestive of imperialism.

Second, corruption among civil servants in positions to grant licenses, loans, import clearances, and so on is found to varying degrees in most bureaucracies. However, the greater the disparity between the civil servant's salary and the monopoly income to be made with his chop on the important piece of paper, the worse the corruption seems to be. In such a situation pressures build to retain the economic hurdles and, importantly, to seek those projects and investments capable of generating the most lucrative side payments. Large capital-intensive projects with a substantial import component can most easily pay these substantial barriers to economic entry.

Third, aid financing from bilateral and multilateral agencies has had a serious biasing effect on choice of technology because of donor insistence on adequate financial controls -- partly because of the corruption issues just discussed -- which are impossible to implement when funds are channeled to many very small enterpreneurs. The tendency instead has been to focus funds on large-scale projects, frequently operated as a public enterprise. The scale of the projects alone is usually inappropriate for effective participation of the urban and rural poor. More to the point is that the techniques employed in constructing the projects and in designing them are usually too capital and foreign exchange-intensive.

Since officials in domestic planning agencies must formulate, evaluate, approve, and frequently manage or administer these projects, they have little time or inclination to seek out more appropriate projects for domestic funding. Indeed, any economies of scale in planning are generated by replicating projects initially funded by foreign donors. Naturally, using these projects as models replicates the foreign-induced tendencies toward inappropriate projects into domestic projects as well, thus magnifying the initial foreign distortion.

It is not at all clear that there are mechanisms available for correcting the biases in planning agencies at either the process or personal level. Application of existing project evaluation methodologies would certainly be a major step in the right direction, at least assuring appropriate techniques in government projects (even though the broader technology choice questions involving product choice and distribution mechanisms would not be adequately treated). Stewart has shown, however, that these methodologies are not used very frequently even by the high-powered analysts in international agencies who understand them. Third world planning agencies seldom use them. Consequently, the social benefit-cost methodologies can be seen to have a subtle biasing effect themselves since it makes sense to apply them in their full rigor only to projects large enough to justify the analytical expense. The same is not true, however, of the analytical effort expended to understanding the impact of macro price policy on choice of technology because setting appropriate levels for those prices has an effect throughout an economy.

Improved performance from public enterprises in the context of the "right" macro prices would lead a country toward more appropriate technologies. But how far? When a national economy is being pushed toward a new general equilibrium by a set of macro prices, are the interaction effects and linkages synergistic and supporting in this effort? If so, are they adequate or will specific additional steps be required to reach the desired objectives?

No economy is well enough understood to answer these questions. Indeed, since all economies are in a state of dynamic evolution, they may not sit still long enough for adequate study. The interactive simultaneity of even simple economies is extremely complex both analytically and in the real world. One of the cardinal principles of the appropriate technology movement is that "simple is better." The point of this discussion is to argue that "complex is real."

FOOD PRODUCTION AND RURAL DEVELOPMENT

Food production is a means to an end. A confusion over means and ends is almost certainly one of the major reasons why agricultural development strategies have had remarkably little impact on hunger even when they were successful in raising farm output. Food production and food consumption are very different biological, social, and economic activities. Even in low-income societies, they are connected only through a complicated set of linkages, linkages which are quite tenuous for the very poorest citizens. In order to place food production in this context of connections, four questions must be addressed.

First, what are the objectives for the sector per se, as opposed to the need for food to meet food consumption requirements? Answering this question involves understanding why the agricultural sector is different from steel or transportation and what the social and analytical issues are that flow from these important differences.

Second, how do farmers make decisions? Only in the context of a decision-making framework that incorporates the full range of factors influencing farm households is it possible to address the behavior and performance of the food sector as a whole. Most farm households are characterized by joint consumption-production decisions, but not in a tightly-defined subsistence setting. Farm households make their consumption-production decisions in the context of farm input prices, cash and food crop output prices, the prices of consumer goods from the market, and the opportunity cost of their various members' time either in outside labor markets, on farm production (including household work), and demand for leisure. The full context of household decision-making is essential to understanding how food production will change when external circumstances change.

Third, what government interventions are available to change household decision-making and thereby the performance of the food producing sector? Understanding how interventions will affect decision-making is more important for agriculture than for any other sector, for the government has very few interventions available that can directly alter domestic food production. State-run farms and public exhortations to farmers to step up output still must deal with the reality of millions of day-to-day decisions in planting, tending, and bringing in the crops. An old saying holds that governments do not grow food; only farmers grow food. But governments can import food, subsidize fertilizer, make agricultural research a priority, or "purchase" food surpluses at gunpoint. For better or worse, the farmer's fate is tied to government policy, but the government's fate, or at least the success of its food production plans, hinges on the willingness of farmers to go along.

What are the elements of a successful agricultural development strategy? Of the wide variety of possible government interventions, what combination can be used to reinforce the achievement of sectoral goals while simultaneously serving the broader set of food policy objectives? This question raises a somewhat different set of issues than the traditional output-oriented agri-cultural development literature, for food policy is concerned with the inter-sectoral and consumption consequences of a production strategy as well as the impact on yields. The consumption perspective encompasses many of the broader concerns of rural development, but placing the strategy question squarely in a macro policy context distinguishes the food policy approach from both the agricultural development and the rural development literature.

Why Agriculture is Different

Farmers are remarkably diverse people, ranging from near-subsistense peasants in India or Guatemala to corporate businessmen in California or Sao Paolo. Nevertheless, private agriculture is a markedly homogeneous industry in the kinds of decisions that must be made day in and day out and in the kinds of uncertainties that condition those decisions. The corporate soybean farm in Sao Paolo or the rice farm in California has more in common with the wheat-growing peasant operation in the Punjab than with U.S. Steel or Volkswagen of Brazil.

In a substantial part of the world, agricultural decisions are made within a collective environment -- from North Korea through China to Vietnam and in Eastern Europe and the Soviet Union. Perhaps half the world's farm households are part of collectivized or communal agriculture, and yet these households, like their private counterparts, must still make many decisions that are not made by higher authorities. Much of their daily work is done at their own initiative, and the incentives they face to perform this work in a timely and careful fashion strongly influence the quality and quantity of agricultural output. In both private and collective agricultures the decision-making environment is conditioned by the nature of incentives to work. Identifying the factors that influence the size and composition of agricultural output is impossible without an understanding of this decision-making environment of the farm household.

Growing food is a decision-intensive undertaking. What crops to plant, what inputs to use, when to plow, to seed, to cultivate, to irrigate, to harvest, how much to keep for home consumption, how much to sell and how much to store for later sale -- these are the farming decisions that occupy the daily routine of most agricultural producers. What is truly unique about agricultural is that literally millions of individuals and households are making these decisions themselves or in consultation with relatively small numbers of neighbors, friends, or partners. In Brazil, India, Indonesia, Nigeria, and even China, changing agricultural production decisons to increase food output is an entirely different process than changing decisions about how much steel or cement to produce. In each of those countries -- indeed in most countries -- a dozen or so individuals could take direct action which would lead to a ten percent increase in steel output in a year or so. Their decisions would be decisive.

Nowhere can a similar small group of individuals decide to raise food production by ten percent. To be sure, a small group of planners, or the president and the cabinet, can decide they <u>want</u> food production to rise by ten percent. They can tell the food logistics agency, the ministry of agriculture, the newspapers, and agriculture extension agents that they want food production to rise by ten percent. But they cannot increase food production ten percent by themselves. They must also convince the millions of farmers in their country to want to increase food production by ten percent, <u>and make it in their self-interest to do so</u>.

Here is the true importance of the vast number of agricultural decision-makers. There are simply too many to reach directly either with information and pleas for cooperation or with police power. Farmers must see the benefits of higher yields for themselves because there are too many opportunities to let high yields slip beneath the hoe or in a late fertilizer application, even under the watchful eyes of a guardian. Farming is a subtle combination of skilled craft and brute force. The brute force alone will not achieve high yields.

The logical result of this decision-making perspective on agriculture is that farmers' decisions are likely to be altered only when they perceive the incentives to be favorable to the change. A heated and frequently sterile debate has been waged over the nature of the incentives needed to induce change in farmers -- the elements range from pretty ribbons to raising political consciousness, from basic literacy to the availability of consumer goods for purchase in rural markets. The debate is nearly dead now, for the answer is largely in. Most farmers respond to opportunities to improve their economic and material well-being. Not all farmers respond this way, and not all farmers respond to the same degree. The evidence, however, is now overwhelming that farmers make economic calculations in considering their agricultural decisions. When the economic environment changes, their calculations change in directions predicted by appropriate economic models of producer behavior.

Household Decision-Making

Truly subsistence households produce their own consumption needs and do not need the market for either buying or selling. To such households price signals are not only irrelevant, they are unseen. Few such households remain in today's world, not because farm families no longer consume produce from their own fields but because most farm families now buy and sell inputs and output in rural markets. They are aware of and react to market prices in making a wide variety of household decisions. Most farm households still retain some or most of their farm production for home consumption, and this role of home consumption is a further distinguishing feature of the agricultural sector. Few steelworkers or even textile workers take their products home for household use.

The simultaneous need to make interconnected production and consumption decisions within a single household obviously complicates life for the farm household, for the value of additional time spent in food preparation or tending the children must be balanced against the productivity of an additional hour weeding the rice, driving the ducks, or tending the home garden. Where it exists, the opportunity to spend some of that time working for cash on a neighbor's farm or in a rural wage-labor market places a lower bound on value of household-farm time, and the value of leisure ultimately places a limit on the willingness to work, especially at low-productivity tasks. However, for households with inadequate land to grow surplus crops for sale and with limited outside employment opportunities, the marginal value of leisure time may be low indeed, and possibly near zero. Even tiny increments to output can be valuable for very poor households.

The importance of joint household-farm decision-making also raises complex questions for analysts in search of ways to organize date and research issues into managerable and comprehensible frameworks for analysis. These complex questions have recently become the focus of a revived interest in models of household economics. At one level, the "new household economics" provides a powerful perspective on joint decision-making about food production food consumption, investment in human capital, and even fertility and other demographic decisions. By showing how all these decisions are related to each other and to the economic environment surrounding the household, the household economics models provide a conceptual understanding of the complicated lives that rural people live.

At the level of full empirical specification, however, the household economics models have so far not been able to provide more than a hint of the quantitative significance of the internal decision-making relationships. This shortcoming is partly because data on actual time allocations within households are difficult to obtain with precision, especially without biasing the time allocations themselves. More importantly, judging the real opportunity cost of time is both conceptually and empirically difficult because the true value lies in the subconscious of the decision-maker. Knowing whether the possibility of entering the wage market really influences the mother's allocation of time to raising children or the time of family members spent in the fields and gardens is critical to implementing household economics models, but simultaneously it may not be knowable. This is particularly troubling for policy analysts as the importance and role of household labor in agricultural production is a major issue in understanding how farm households respond to economic incentives and what their costs of production are when responding. Less formal and somewhat *ad hoc* procedures for understanding this role may be the best that is possible.

The Sources and Dynamics of Technical Change

Technical change is the source of most productivity growth in the long run, as continued investment in capital that embodies traditional technology very quickly faces low marginal returns. Technical change in agriculture shares many of the characteristics of technical change in other sectors, especially the tendency for individual inventors to be unable to capture the economic rents from their inventions. Consequently, the private sector seldom has socially-optimal incentives to invest in research and development that lead to technical change.

Agriculture faces this same divergence in an especially acute way. In addition, technical change in agriculture tends to have characteristic factor biases, depending on whether it is a mechanical or biological innovation. Because the innovations are usually embodied in new inputs that must be purchased from the market, access to new technology on the part of small farmers with limited capital or credit availability is constrained. For a variety of reasons, including credit constraints, large farmers tend to adopt new technology before small farmers. All of these issues -- public responsibility, factor bias, and the farm size distribution of adoptees -- are related to each other and to the ultimate welfare impact of new agricultural technology.

Most farmers are inveterate experimenters and tinkerers, always on the lookout for a slightly better way of doing things, whether it is a different seed spacing or a modified shape to the plow. As late as the 1920s most of the agricultural innovations in Europe and the United States arose on the farm and were gradually diffused by word of mouth and by agricultural colleges. Such on-farm innovation continues, but the scientific revolution in agriculture has made the discovery of technical innovations much more knowledge- and capital-intensive. Very few farmers even in the United States have the resources to carry out significant agricultural research programs, and most such research is now conducted by publicly-funded agricultural research centers and by a handful of large agribusiness concerns, primarily involved in developing hybrid seed technology, chemical technology (herbicides and pesticides), and agricultural machinery. The small-scale and limited financial resources of most farms means little important agricultural research is conducted by farmers.

Unless the new agricultural technology can be restricted for sale by its inventor or approved licensees, the economic returns to innovation are small from the private inventor's perspective but may well be very large from a social perspective. Apart from the sheer scale required to do modern agricultural research, the inability of private research companies to capture the full return to their invention means that public agencies should play a major role in funding and in carrying out agricultural research.

Diffusion of new technology is also a matter of policy concern, especially because not all farm households have equal access either to the knowledge to use new technology or to the agricultural and financial resources needed to make it productive on their own farms. This public role can be overemphasized, as the evidence suggests that truly profitable innovations spread quickly no matter what the government does. However, the location-specific nature of much new agricultural technology, especially seed technology, means that large areas of a country may be bypassed by the diffusion process unless government research and extension workers are actively engaged in the on-farm testing and evaluation of new technology. The surprisingly small potential for borrowing an agricultural innovation from another country or region for direct use reflects the site-specific characteristics of much agricultural technology. Adapting a general agricultural technology to a specific seed strain or technique that fits individual farming environments is also an important responsibility of local research and extension stations.

Most technical change in agriculture involves improvements in the biological processes by which plants and animals grow and yield output useful to man or in the mechanical functions that are necessary for the biological processes to carry on more efficiently than in a natural setting. Primitive agriculture uses natural biological materials and processes in combination with human labor and management to bring in a food crop or livestock product. Modern agriculture uses scientific knowledge to reshape the biological materials so that each plant and animal is more productive, and it increasingly substitutes machines for human labor. Biological-chemical innovations, such as hybrid seeds, fertilizers, and pesticides, all tend to be yield-increasing and thus save on land. Mechanical technology can also have a yield effect when it permits heavy soils to be cultivated or water to be pumped to dry lands, but most mechanical technology is designed to make agricultural work less physically burdensome and to save on the amount of labor needed to produce a unit of output. It is labor-saving.

Hayami and Ruttan have shown that biological-chemical innovations have tended to be discovered and introduced in land-scarce, labor-rich societies, such as Japan and Western Europe, whereas mechanical innovations were developed and used in land-rich, labor-scarce societies, such as the United States, Canada, and Australia. Such "induced innovation" suggests that each society develops an agricultural technology appropriate to its resource endowments and agricultural needs. Whether such society-specific innovation will continue to yield appropraite results in the context of a much more interdependent international agricultural system is a prime question for the rest of the century.

Because most new agricultural technology is embodied in a physical input -- a bag of fertilizer, a new seed, a tractor, or an irrigation pump -- it can be effective in a farmer's field only if a purchase (or rental arrangement) is made. Several consequences flow from this simple fact. For small farmers to participate in the benefits of technical change, not only must it be workable on their small farms (combines, for instance, usually are not) but they must also be able to purchase the input that carries the new technology. Where a new seed-fertilizer package has a 200 percent rate of return, even borrowing from a village moneylender at 10 percent per month may be profitable. But for the full benefits of modern technology to reach small farmers, a credit program accessible to the farm household with only half a hectare or less may be essential.

Equally important, if new technology is embodied in inputs, then a marketing and distribution system will be essential for farmers actually to be able to purchase the inputs. Many traditional agricultural societies have a long history of small-scale marketing of surplus output to urban regions in exchange for consumer items, such as cloth, kerosene, or pots and pans, needed by farm households. There is no similar experience with large-scale movements of inputs, such as fertilizer or modern seeds, to those same dispersed farm households. The embodied nature of agricultural technology means that farmers cannot just be told about it. The marketing system must also deliver the inputs when needed.

A further characteristic of embodied agricultural technology is that complementary fixed ital investment are often required to achieve the maximum benefits from the innovation. Usually this investment takes the form of better water control, land-leveling, and drainage. Sometimes much better control of seed bed preparation, which may require tractors with modern implements, or more sensitive and faster harvesting techniques to avoid shattering and other harvesting losses, which may require combines or threshers, is also needed. Shorter-maturity cereal varieties often mature while the rainy season is still under way, and solar drying is difficult or impossible. In such cases mechanical dryers and added storage capacity are essential.

Food Production as a Rural Development Issue

As each of the questions about food production is addressed from a rural development and food policy perspective, a series of issues emerge that begin to reveal the complicated linkages connecting food production to the rest of the economy. Some of these issues, such as the concern for rural poverty, input availability, and resource utilization, are more or less sectoral in nature. Others arise because of important macro implications that flow from rural decision-making, for example, the degree of food crop self-sufficiency and the balance of production between food and cash crops. The linkages among the sectoral and macro issues are also important. Rural-urban linkages at a personal level, where individuals respond to income opportunities by migration, provide much of the dynamics of employment and wage rate formation with all their ramifications on income distribution. The most complex linkages create a mutual relationship between efficient allocation of resources in rural areas and overall economic growth, a relationship which permeates the entire discussion of food policy.

The extent and causes of rural poverty are tied directly to the performance of the agricultural sector and to the efficiency of its connections to the rest of the economy. Rural poverty is partly a function of the decision-making environment of rural households -- the set of economic incentives they face to grow crops and to find outside jobs -- and partly a function of the distribution of assets and human skills with which to operate within that environment. The options available for reducing rural poverty will be significantly conditioned by the set of factors which are most pressing.

The circumstances under which farm households have access to land for growing crops has many ramifications beyond the obvious insecurity and commonly weak bargaining position faced by tenants and renters. Land ownership provides an asset base from which credit can be obtained for inputs or investments in farm capital. It provides greater incentives to save from household income. The conditions of tenure frequently condition the willingness of landlords to invest in land improvements and tenants to use yield-raising inputs at socially efficient levels. Land tenure relations also indicate who are the powerful and who are the weak in rural societies. The changed attitudes that result from attempts at land reform are often the most important aspects of the effort.

Traditional agriculture can subsist in a closed ecological system where crop rotations, fallowing, and manuring permit stable but low yields over extended periods. Modern agriculture and the capability to grow enough food for an expanding population require a much more open and interdependent farming system which relies heavily on the availability of inputs from the industrial sector to raise yields and sustain them year after year. Agriculture is a seasonal and geographically dispersed industry. Delivering the necessary inputs precisely when and where needed is a complicated logistical undertaking that most third world governments have neglected or, in some cases, have actually impeded.

For farmers to adopt new technology, not only must the modern inputs be physically available, but farmers must be able to afford to use the inputs. Credit programs designed to improve the access of farmers, and especially small farmers, to modern inputs are an essential component of the input programs themselves. In addition, some inputs are lumpy and cannot be used efficiently on even average-sized farms in many parts of the world. Large-scale tubewells and tractors might contribute significantly to higher productivity even on small farms if institutional arrangements can be found to separate the service flows that such inputs can provide from the ownership of the assets themselves. Where the entrepreneurship exists and the economic environment permits, rental arrangements and tractor-hire services frequently emerge spontaneously.

Farmers use resources in agricultural production from a private profitability perspective even though some of the resources-use decisions have important spillover effects on their neighbors or society as a whole. One important concern is the use of irrigation water in such a way that salinization becomes a problem or the underground water table is lowered. Soil erosion and the silting of rivers and irrigation facilities is another. If farming techniques that are privately profitable lead to soil runoff that causes serious social costs, government policy must search for interventions that maintain the long-run viability of both the cropland and the irrigation systems. The matter is frequently made more difficult because of the severe poverty of the worst offenders, the poor households who push up hillsides to cultivate marginal soils for their own subsistence or who strip vegetation from the catchment areas of irrigation systems in search of firewood or fodder for sale.

Rural development strategies usually have an implicit goal of achieving near self-sufficiency in food production, and certainly one of the most important roles of government is to ensure that the society's food supply is not subject to the whims of weather, international markets, or political blackmail. Providing for food security is an important food policy objective, but it is not the same thing as self-sufficiency. As a political slogan, however, and even as a lever to pry loose budgetary allocations to increase agricultural productivity, self-sufficiency is a potent concept. Channeling a political drive for food crop self-sufficiency into a series of programs that enhance both food security and the efficiency of food crop production is the ideal response. Avoiding catastrophic and high-cost investments in grossly inappropriate food production schemes is often the best that can be achieved.

Income generation and employment are important objectives of rural development, but controversy has arisen over the role of cash and export crops. The argument that producing food should be the first priority until hunger is eliminated, after which diversification into cash crops can be permitted, has an emotional appeal when strawberries are being exported while landless peasants starve. The appropriate balance of crops, between cash crops and food crops and between cereals and legumes, has several dimensions in addition to the apparently simple question of whether all farm households are producing their own food first.

Several important crops are needed as industrial inputs, and the potential of increased cotton or jute output to create more and higher-paying jobs in the industrial sector is a major factor in the social profitability of growing them. Farmers whose incomes are increased by growing cotton may be much worse off if forced to grow corn, and the greater home production of food may not nearly offset the worsened poverty. At the same time, pushing tenants off the land on which they raised food for their families in order to grow export crops with mechanized farming techniques may contribute to significant rural hunger. The important connection, however, is not the nature of the crop being grown but the size of the income stream from growing the crop and the recipients of that income. Labor-intensive cultivation of tomatoes for export may improve rural welfare; mechanized growing of wheat may harm it.

Creating productive jobs in the rural sector is an important concern of rural development, but even when a development strategy seems to be succeeding, rural to urban migration is to be expected. Rural workers with low-paying and back-breaking jobs look enviously at industrial workers tending machines indoors out of the rain and mud or dust and heat. Urban life usually looks attractive and exerts a significant pull on rural youth despite the real probability of ending up in the squalor of an urban slum. The harshness of rural life pushes the mobile population out in search of the chance for a better life. Rural to urban migration is a major phenomenon of the development process. This migration is a major factor influencing the formation of rural and urban wages. Because poor people depend so heavily on wage income to provide their livelihoods, understanding both the push and pull aspects of migration is important to understanding how poor people earn their incomes and how policy can intervene to raise their standard of living, including the quanity and quality of their food intake.

Rapid growth in any sector tends to induce dynamism in other sectors as well. The stronger the linkages among sectors, the faster and more efficiently is the growth process transmitted. Agriculture's links to other sectors have already been noted. The importance of its sheer size means that as a generator of growth to be transmitted to the urban sector, the rural sector has the potential to play a leading role in the elimination of poverty. In the context of rapid and efficient growth agriculture can provide surplus labor, savings, foreign exchange, and household demand for urban products. In the context of stagnation and urban exploitation of rural productivity, the growth process in both sectors can be brought to a halt. Subtle and dynamic linkages connect economic performance in rural and urban areas. Either good or bad policy at each end is eventually transmitted to the other.

ELEMENTS OF A STRATEGY FOR THE RURAL SECTOR

Production Strategies

Understanding how farm production systems work is essential to formulating a strategy for development of the rural sector, but such a strategy must include a number of issues beyond agricultural output. Consumption, marketing, and trade policies will affect, and in turn be affected by, production strategies. Knowing what tradeoffs exist at the farm level and at the sectoral output level provides the necessary insight to place production issues in their important but proper perspective.

Four major lessons come out of a farm household decision-making perspective which are likely to influence most production strategies, especially when they are incorporated into a broader and consistent food strategy.

These lessons include the desirability of broad-based programs for small farm households, the necessity to use policy to foster appropriate price incentives for increasing agricultural output and to generate rapid increases in rural incomes, the importance of technical change for raising productivity and keeping food prices to consumers within reasonable limits, and the efficiency to be achieved by using international markets both as a source of gains from trade and as a measure of opportunity costs in policy deliberations when short-run trade is ruled out for other reasons.

Countries that have emphasized broad-based programs for small farmers have been more successful in achieving both their production and consumption goals. Bimodal rural systems with a few large, modern farms and many small farms have sometimes achieved agricultural growth, but most have left or even exacerbated widespread poverty in the countryside. This poverty is the major constraint on solving the problems of hunger and on using new technology to increase agricultural productivity in the long run. Nor have state farming operations had widespread success in helping solve a country's agricultural problems. Bringing more decisions under direct state control has been almost a sure route to agricultural stagnation in nearly all third world countries.

In most instances, farming systems with a large number of relatively small-scale farms have more effectively generated rural income and achieved a more equitable income distribution. Given the decentralized nature of agriculture, the impact of prices, both received and paid by farmers, is a crucial element in attempts to create a dynamic rural society. Even in the short run, price responsiveness can be important quantitatively. For the longer run, a continuation of "cheap food" policies pursued by many less-developed countries is likely to have severe negative production effects. With an appropriate set of price incentives, a country can benefit from a decentralized system of management, where many individual farm households respond to changed economic conditions. Since farmers reap the rewards of good management, income incentives are important in all agricultural systems, both market-oriented and centrally-planned.

The profitability of food production is related to technology as well as to prices. Outward shifts in the sypply curve arising from technical change are more important to increasing agricultural productivity than movements along it. Increasing productivity is a primary mechanism for sustaining longer-run profitability in agriculture without having to resort to higher food prices for consumers. For farmers to adopt new technology in response to price incentives, the improved technology must actually be available and appropriate to the environment. Governments play an important role in developing new irrigation systems, fostering research to develop improved locally-adapted seed varieties, and investing in rural infrastructure and marketing to facilitate the flow of productive inputs and output. In the absence of such technical improvements in farming systems constrained by traditional technology, government policies can have only a limited effect in raising agricultural productivity.

Interaction with international markets provides a standard of efficiency for both domestic industry and agriculture. For poor societies, such efficiency is critical to the mobilization of domestic resources to cope with poverty and hunger. Attempts by countries to become completely autarkic and to insulate themselves from international prices have often led to severe price distortions and disincentives within agriculture, resulting in a stagnant rural economy. For every country that followed international price signals too closely and experienced roller coaster instability, there must be ten countries which have not read the signals closely enough and are saddled with inefficient and stagnant rural sectors. Both types of countries are likely to face significant problems of hunger in rural and urban areas, and both need to seek the middle ground defined by a broader food policy perspective.

This broader food policy perspective includes reading long-run international market trends and using the signals to measure the efficiency of domestic price policy initiatives. It also includes careful attention to the domestic food marketing sector, which is the primary carrier of both price signals and food commodities from producers to consumers. For many commodities price formation itself takes place in domestic markets, and these prices influence farmers, consumers, and the options available to policy makers as they try to alter decisions made by both. Policy for farmers must fit within this broader marketing and macro context. At the same time, however, farm productivity fundamentally conditions the range of options available to policy makers across the spectrum of food policy objectives, including the reduction of hunger.

Strategies for Appropriate Technology and Rural Development

The record of most rural development programs, even those ostensibly conducted within an appropriate technology framework, has not been encouraging. Example of failures abound, of grossly inappropriate technology for human needs, with grim consequences. The few success stories are not well understood functionally and seem of dubious transferability. The reasons for failure are deeply rooted in the political economic fabric of most societies. The reasons for success seem vague and fragile. This widespread difference between the success stories and failures creates the asymmetry in the disequilibrium path between appropriate and inappropriate technology choices which make policy analysis in this area so subtle, policy changes so fraught with real political risks arising from genuine welfare issues. The almost inevitable tendency is to back away from the issues and the analysis altogether and to seek an alternative intervention point. Start with the people. Start at the village. Work from below in a classical revolutionary strategy and eventually build enough local momentum that the pressures blow the lid off the top. No complicated analysis is necessary, just the will to begin with "right process."

There is much appeal in such a strategy as a personal commitment to the welfare of the wrentched of the earth. Indeed, duplicated widely over many countries and regions, a strategy of personal involvement at the village level will be an important component of any country's ultimate success in finding a technological path that leads to higher productivity and better lives for all its people without destroying the natural environmental resources on which it is based.

It is the essence of the technology choice problem, however, that such local strategies are doomed to failure in the face of a hostile macro environment. In the jargon of the movement, a "bottom up" strategy is just as likely to fail in the face of a nonsupportive "top" environment as a "top down" strategy is likely to fail in the face of a nonsupporting local environment. Again there is an asymmetry in this apparently inverse relationship.

Appropriate macro price policies and public enterprise investments can have an important energizing effect on the local environment, but no vice versa. To do so, however, two questions must be addressed. What are the appropriate policies? Are the macro decision-makers willing to have an energizing effect on the local environment? Many national leaders see local initiative, decentralization, and development from below as causing the center to lose political control over the periphery. Whether this is a good or bad thing is very important but irrelevant to the point at hand, which is that the concern from the perspective of the center over control of the periphery is both real and legitimate. In the absence of political revolution from below, from the periphery, ways of energizing rural areas with policies from the center that do not imply lost control will be critical for any significant movement toward strategies of appropriate technology.

This paper has been directed to the first issue. What does it mean to "get the macro prices right"? Only analysis can say, analysis with a sensitivity to the welfare objectives of appropriate technology in the context of the society in question. It is terribly important that this point not be misunderstood. It does not say that better analysis of government projects will lead to appropriate technology (although it will help) or that better analysis of the economy will permit planners and managers of public projects and enterprises to take the economy to the promised land. The analysis called for is to determine the range of choice the government has with respect to its macro prices and to demonstrate the influence of prices on the other primary decision-making arenas in the economy and in turn, the influence of these areas on the macro prices themselves.

Such analysis is not the exclusive province of any one discipline. An obvious but unstated thesis running throughout this paper is that economics as an analytical body of thought has spent little time with these issues although the tools and perspective of economics make it the natural organizing discipline for the coordinating effort required.

The plea for analysis should also not be misread as a plea for the construction of formal interactive planning models of sectoral or national economies which permit quantitative answers to questions about macro price variation. Such models are interesting analytical exercises, but none captures any of the essential linkages between micro, micro-macro, and macro levels that have made the structural equations of such models unstable in the face of significant changes in the policy environment. What is called for is sensitive research into the important micro relationships, a reasonably simple macro model of the economy in terms of national income accounting aggregates, such as Lance Taylor has constructed for food and nutrition policy issues, and an acquired sense of how the pieces fit together to make the system work. The process probably cannot be quantitatively systematic for a long while. Efforts to make it so will almost certainly lead to inappropriate results.

It is not premature to guess at the general dimensions of a macro price set conducive to promoting appropriate techniques directly and to energizing the urban and rural poor into a dynamic process of direct participation and involvement which lead to more appropriate technologies in the broad sense. The basic economic realities of poor societies place fairly narrow limits on these dimensions, limits which if exceeded have demonstrable welfare costs for the poor. Scarcity values define these limits, and scarcity values are set by opportunity costs. At the same time, it is important not to take a narrow, short-run, or mechanical view of opportunity costs. The first tends to leave out environmental costs, the second is unduly influenced by temporary fluctuations in highly leveraged international markets, and the third implies that some formula will provide the answers. As a first order of magnitude, macro prices should be set to reflect these properly defined opportunity costs.

All macro prices carry with their allocative properties drawn from scarcity values some important distributional properties drawn from their role as direct or indirect factor payments. In the short run the owners of capital benefit from scarcity prices for capital, the owners of land benefit from high food prices, and laborer's incomes are determined by their wages (even in the short run, the income distribution consequences of changing foreign exchange prices can be very complicated). In the long run all factors ought to benefit if the right macro price environment does energize rapid and broadly participative economic development and a nonregressive fiscal policy is pursued.

The policy dilemma, however, is the short-run tradeoff between allocative and distributional goals for significant parts of society. Although some price environments are so bad that both allocative and distributional goals are served by change, such a happy relationship is not likely to persist forever. Eventually hard choices must be faced. At this point the potential for sensitive and appropriate program design is needed to protect the poor from the full brunt of the distributional consequences of an allocatively efficient macro price set. The alternative, a program structure designed to attenuate the allocative effects of a macro price set designed primarily for distributional goals seems not to work because of the inability of public enterprises and regulators to gather and process information in a sufficiently rapid and sensitive fashion to avoid strangling the dynamics of both public and private economic decison-making.

Implications for Thinking About Rural Development

There is no simple way to separate the technology choice issue into discrete compartments, some dealing with micro issues and others with macro issues, some dealing with urban issues and others dealing with rural issues, and some dealing with public issues and other dealing with private issues. The traditional analytical framework of economics which has private decision-makers in micro units (households and firms) react to an economic environment set by public decision-makers at a macro level does not provide an analytical perspective for dealing with the spectrum of decision-makers who make technology choices.

Neither does it cope with the two-way network of linkages between rural and urban sectors and between micro and macro levels which cause the outcome at one level to affect the environment and outcome at other levels, which then feed back to influence the original decision-maker and the desirability of the decision. No decision-making model exists that can accurately represent the objectives, environment, and rules of choice which ultimately determine a society's technology. Intuition, experience, and sophisiticated analytical perspective within a cohesive framework for integrating the various pieces of the system are all that can be offered now to guide policy makers.

If the process of "getting prices right" is not to have disastrous short-run welfare consequences for the urban and rural poor in many third world countries, a new emphasis on targeted food subsidies will be essential. The right macro prices are essential on allocative grounds. Alleviating the distributional consequences is essential on social, political, and human grounds. The probelm is finding the right mix of private and public decision-making and finding ways to rely on price signals rather than on regulation and control to reach appropriate technological choices. In essence, development policy must concentrate on efficient and equitable growth while development projects and programs must pick up the short-run welfare burden. For most countries this approach involves a 180-degree shift in orientation.

Much of the rural development literature is caught in this policy-project contradiction, partly because the categorization of policies and strategies into bottom up or top down misses the essence of the problem. Neither strategy can work in the absence of an appropriate setting at the other end. Complex and strong linkages exist between micro and macro levels and between urban and rural sectors. No single arena of choice can serve as the exclusive or even dominant target of analysis aimed at improving technology choice and rural welfare. A food policy perspective attempts to incorporate the entire range by focusing on the food system from producer to consumer, wherever they may be located and whatever the source of influence on their decisions.

All of the policy choices that lead toward a more productive rural sector through more appropriate choice of technology are likely to be politically unpopular. Simultaneous design and implementation of programs to alleviate the worst of the impact on the poor will help somewhat, but surprisingly little when it is recognized that the poor have little political influence in most countries. Broadening the programs to include enough of the urban masses to ensure political support also substantially magnifies the fiscal drag and the disincentive effects which are minimized when only the destitute are included. At this point economic analysis can be a powerful ally of wise policies by describing the long-run costs and benefits of various strategies in an accurate way. However, the economic analyst can also be hopelessly irrelevant by pointing out the efficiency of neutral fiscal transfers to alleviate the short-run human suffering made necessary by the long-run development strategies. Such advice encourages the formation of bad policies by default because politicians know such ideal solutions are impossible to implement. Designing short-run bridges across the fundamental problems is the real solution and the role of the policy analyst.

REFERENCES

Gene Ellis, On Development from Below: Service the People or Let the People Serve Themselves, mimeo, University of Denver, 1979.

Yujiro Hayami and Vernon Ruttan, Agricultural Development: An International Perspective, Johns Hopkins University Press, 1971.

Donald D. Keesing, "Causes and Implications of Growing Inequality in Incomes within Developing Countries," (Memorandum No. 127, Research Center in Economic Growth), Stanford University, February, 1972.

W. Arthur Lewis, "Development with Unlimited Supplies of Labor," Manchester School, May, 1954. Reprinted in A. N. Agarwala and S. P. Singh, eds., The Economics of Underdevelopment, Oxford University Press, 1963.

Willis Peterson, "International Farm Prices and the Social Cost of Cheap Food Policies," American Journal of Agricultural Economics, February, 1979, pp. 12-21.

Theodore W. Schultz, Distortion of Agricultural Incentives, Indiana University Press, 1978.

Frances Stewart, "Social Cost-Benefit Analysis in Practice: Some Reflections in the Light of Case Studies Using Little-Mirrlees Techniques," World Development, February, 1978.

Lance Taylor, "Price Policy and the Food People Consume," MIT International Nutrition Policy and Planning Program, 1978.

C. Peter Timmer, "Food Prices and Food Policy Analysis in LDC's," Food Policy, August, 1980.

______________, "Is There 'Curvature' in the Slutsky Matrix?" Review of Economics and Statistics, Vol. LXII, No. 3, August, 1981, pp. 395-402.

______________, "Choice of Technique in Indonesia," in Timmer, et al., Choice of Technology in Developing Countries: Some Cautionary Tales, Harvard Center for International Affairs Monograph No. 37, 1975.

A SURVEY OF DEVELOPMENT THEORIES

ABSTRACT

In examining the evolution of development theories and the policy prescriptions associated with them, it is helpful to distinguish between two paradigms -- the mainstream/orthodox and the political economy/ alternative paradigms. Although the mainstream approach is dominant in the development literature, the political economy approach has many committed adherants, especially in the third world, and is extremely important for understanding non-capitalist development strategies. Within the former there have been definite phases in the development of theory and policy -- from the laissez faire emphasis on international trade to the call for planned state investment for industrial development and the use of trade barriers for import substitution. Recently, a new modification of the orthodox approach has been put forward, the basic needs strategy. It focuses on meeting the needs of the poorest people in the LDCs directly as a means to promote growth with equity.

For the political economy paradigm as a whole, the goal of development is the satisfaction of basic human physical and social needs. But political economists generally reject the capitalist model of development, focusing on alternative institutions and strategies. Within the political economy paradigm the most important debate of the post-war period has taken place between dependency theorists, who blame underdevelopment on imperialist exploitation of the LDCs by the advanced countries, and their Marxist critics, who find the causes of underdevelopment in the internal structure of the LDCs.

There are certain lessons we have learned from the development experience of the past 30 years, and certain points of agreement have emerged among proponents of conflicting theories and policies. Development economists are less optomistic than they once were. They realize they don't thoroughly understand the process of development and can't make predictions of success or failure. There are no simple formulas for development; many complex factors contribute to the process. But development theorists and policy-makers seem to be in agreement on a few points, including: the need to transform the agricultural sector in the LDCs, the need to focus on human resource development and meeting basic needs, and the important role the market can play in development.

A SURVEY OF DEVELOPMENT THEORIES

James H. Weaver
American University

and

Marguerite Berger
American University

INTRODUCTION

Concern with economic development is certainly no new phenomenon. In The Wealth of Nations, a book which celebrated its bicentennial along with that of the United States, Adam Smith made it clear that his leading theme was to be "economic development".[1] That theme has continued to concern theorists during most of the 200 years since. Therefore, in attempting to survey the theories and strategies of economic development, we have a difficult and perhaps lengthy task ahead of us. But we will try to be as brief as possible.[2]

From the outset we should note that it is useful to distinguish between two broad views, or paradigms, of development. These are the mainstream paradigm, or approach -- also referred to variously as the conventional, traditional, orthodox, or neoclassical approach -- and the political economy, or radical, or alternative paradigm. Although the mainstream approach is dominant in the development literature, the political economy approach has many committed adherents, especially in the Third World, and is extremely important for understanding non-capitalist development strategies.

We will discuss the mainstream paradigm and its theoretical underpinnings first. Next we will outline the major policy proposals associated with that paradigm: the laissez-faire, planning, and growth with equity strategies. Then we will take a look at the political economy paradigm, focusing on the debate that surrounds dependency theory. And finally, we will offer some concluding remarks on the lessons of the past thirty to forty years for development theory and policy.

THE TRADITIONAL PARADIGM

Traditional economists assume that people are economically rational, that is, they know what is in their own interest and act so as to maximize their individual welfare. Welfare, or well-being, comes from maximum consumption of individually marketable goods and services with as little effort and use of resources as possible. Simply put, "more is better." Therefore, the goal of development is to maximize the growth of output people want in the most efficient manner possible -- given the resources and technology available.

In neoclassical economics a crucial determinant of output is the way that inputs, or factors of production, are combined. Therefore, looking back on the history of mainstream development economics, it is helpful to trace the evolution of thinking on the role of the three basic factors of production: labor, capital, and land.

A. Labor

When Adam Smith looked at the question of economic development 200 years ago in The Wealth of Nations, he found that labor was the key input. He argued that output is a function of the quantity and quality of the labor force. In addition, he put particular emphasis on the way labor is organized through his famous example of the pin factory. He noted that in the factory, one person cut the wire, another put the head on, another stuck them in the paper, and so on. He found that the plant produced about 4,800 pins per worker per day. But he argued that if each worker made the entire pin himself, i.e., cut the wire, put the head on, stuck it in the paper, etc., he could make only twenty pins per day. So Smith concluded that the key to increasing output was specialization and division of labor. With specialized labor, each person doing one small part of the task, far greater output is attainable.[3]

In the early 1800s David Ricardo further elaborated on the benefits of the division of labor, focusing on its international manifestation, with his famous principle of comparative advantage.[4] Arguing against the corn laws, which restricted grain imports into England, Ricardo put forth a model that showed how international specialization and trade could result in greater total output and thus encourage growth.

Post-war thinking on the appropriate role of international trade has gone through four basic stages: first, an outward-looking strategy emphasizing exports of primary goods from the Third World; then import substitution; followed by an inward-looking strategy focused on primary products; and, finally, an export promotion model oriented toward manufactured products.

<u>1</u>

One of the major colonial legacies left to the Third World was specialization of production in primary agricultural and mineral products for export, with substantial reliance on foreign investment. In the immediate post WWII period, that sort of outward-looking development, based largely on the ideology and policy of laissez-faire, was regarded as the most suitable for the LDCs. Foreign investment and increasing the division of labor through international trade were seen as engines of growth for the LDCs. Comparative advantage ensured that developing countries exported raw materials and agricultural products. The foreign exchange they earned would supposedly allow them to import the capital goods they needed to develop domestic industry.

2

However, in the late 1950s and '60s dissenting opinions were heard, perhaps the most widely known being those originating in the UN Economic Commission on Latin America. Raul Prebisch was the first to criticize systematically the outward-looking, primary goods focused development strategy.[5] He argued that the developing countries experienced deteriorating terms of trade for their products over time and therefore constantly found themselves in the position of having to pay for manufactured imports with greater and greater quantities of primary exports.

Around the same time, Hans Singer argued that the LDCs should decrease their dependence on foreign investment, which he thought served to benefit disproportionately the advanced countries to which profits were repatriated.[6] These arguments bear close relation to those voiced by the dependency theorists whom we will discuss in connection with the Political Economy paradigm.

The solution to the problem identified by writers such as Prebisch and Singer was an inward-looking strategy oriented toward secondary products, i.e., manufactures, a process of import substitution industrialization.

Import substitution required that restrictions be placed on trade in the form of protective tariffs and other barriers that would allow infant manufacturing industries to develop in the LDCs.

Usually the policy of import substitution took the form of local manufacture of products that were previously imported for consumption of the well-to-do in the Third World. Because of the great inequalities in income distribution, the primary source of market demand for products other than necessities was limited to this rich minority. Therefore profit-seeking firms found it most lucrative to produce for that market. One result of this pattern of consumption and production was a steady drain of foreign exchange earnings. Factories, spare parts, intermediate inputs, and sometimes even the raw materials had to be imported to produce modern consumer goods for the rich. In addition, in order to make capital imports cheaper, many less developed countries tried to maintain overvalued currencies. This had the effect of discouraging exports.

The import substitution phase often brought little transformation of the economies of the periphery. No technological breakthrough took place in the way most work was done. In most countries the lives of the majority of the people were not much improved, if at all, as the result of the import substitution phase of development.

3

In response to import substitution's heavy emphasis on manufactures and the food shortages of the early 1970s, inward-looking, primary commodity-oriented models became popular. These focused not only on the necessity of directing more labor toward the production of agricultural products (especially foodstuffs) for domestic consumption, but also on improving the quality of that labor. In the work of such authors as Bruce Johnston and Peter Kilby, the emphasis was placed on rural and agricultural development.[7] Self-sufficiency in food production was made an important goal, and the role of foreign trade in development was downplayed.

4

Although the previous approaches have by no means disappeared, the strategy of the 1970s and '80s has been export promotion, an outward-looking scheme focusing on secondary (manufactured) products.[8] Despite the fact that the Third World countries as a whole still depend on primary products for over three-fourths of their total exports, the export profiles of many LDCs have shifted markedly over the past 10-20 years. This is partly due to government policies there, and also to the changing orientation of foreign investment. Many development economists today see this trend as one which Third World countries ought to foster actively. Export promotion, especially of light manufactures, relies on the LDCs most abundant input for labor-intensive production. At the same time, it provides needed foreign exchange and can be carried out without recourse to such severe protectionist measures as those required by import substitution. Countries such as Taiwan, Korea, and Hong Kong, which have become virtual export platforms for light, labor-intensive manufactures, are seen as the model for this scheme.

However, with the current world-wide economic crisis worsening and protectionism on the rise, the prospects for export-led growth in the LDCs do not seem very promising at the moment.[9]

B. Capital

The second major factor of production is capital. Generally, for production to take place, labor must work with capital goods (tools, machines, factories, etc.), as well as raw materials. The Industrial Revolution was essentially a revolution in the source of energy for production. Production no longer relied solely on animate energy provided by people, horses and oxen, but began to rely much more heavily on inanimate energy, i.e., water power, steam, coal, petroleum, and now nuclear energy. But in order to contribute to output or be transformed into useful work, this energy must be applied to machinery. Thus capital formation has come to occupy a central place in orthodox theory.

To the traditional economist, physical capital consists of man-made goods that are produced, but rather than being consumed immediately, are used to produce other goods. In order to produce capital goods on a larger scale, there must be factories, so industrialization becomes the key. Traditional economists will often go so far as to argue that development equals industrialization, that the two processes are synonymous. Such a claim is based on the observation that the rich countries in the world are industrialized countries.

An emphasis on physical capital has characterized the work of a larger number of post-war development economists. In different forms it is the basic focus of Arthur Lewis, Paul Rosenstein-Rodan, Ragnar Nurkse, Harvey Leibenstein, Gustav Ranis, John Fei, and many others.[10] They all emphasize the key role of capital in production and argue that the problem of development is to build capital. Development involves using increased quantities of capital per worker, so that the society can become more productive, and increase output. Raising productivity relaxes the ever-present constraint of scarcity.

1. Capital-intensive Industrialization

In the 1950s and '60s development efforts focused on capital-intensive technology transfer for industrial development. Ragnar Nurkse and Paul Rosenstein-Rodan argued that public investment should be aimed at acheiving balanced growth throughout the economy.[11] If government undertakes investment in a number of industries at the same time, the growth of these industries will provide demand for each other. One entrepreneur won't build a shoe factory because the small market demand means he won't make a profit. But if the government plans investment so that at the same time the country builds a shoe factory, a transistor radio factory, and a bicycle factory, there will be enough demand created so that the firms' workers and owners can buy each other's products. This program will allow an attack on the vicious circle of underdevelopment.

In the late fifties Albert Herschman called for a strategy of unbalanced growth, emphasizing that government should plan investments in those industries having the most linkages, or connections, to other industries.[12] For instance, a shirt factory will provide demand for cotton cloth, and this will create a demand for raw cotton, etc. These are "backward" linkages. On the other side, the shirt factory will create a need for retail outlets to sell shirts, a forward linkage. If government can encourage investment in those industries with the most linkages, investment rates will be accelerated and development will follow.

However, any of these efforts demand large amounts of financial capital for the needed investments in physical capital. Funds can be generated by injecting capital from outside in the form of foreign aid or private foreign investment. In addition to foreign sources, capital can come from within. In a work that won him the Nobel Prize, W. Arthur Lewis showed how underdeveloped countries could draw on various agricultural surpluses to get the resources necessary for investment.[13]

Lewis argued that if surplus agricultural labor is moved to the factories, the people who are left behind can produce the same amount since the transferred labor is essentially redundant in agriculture. In the factories, however, it is more productive. In addition, in the factories workers are paid a subsistence wage, or a little bit above subsistence. But they will be able to produce output worth more than the subsistence wage. The surplus is kept by the capitalists as profit. When profits are reinvested, more capital is created, which leads to more growth, and so the process of development is stimulated. As development proceeds, the capitalist will invest and employ more workers, and income will increase. It is assumed that in the process of growth, income will eventually trickle down to all segments of society. This is a "grow now, trickle later approach".

2. Labor-intensive Industrialization

During the period dominated by the approach to development which focused on capital intensive industrialization, per capita incomes in the LDCs rose very rapidly. Overall growth rates were much higher than those estimated for England during the Industrial Revolution -- many less developed countries doubled that rate during the 1950s and '60s, and some even tripled it. But there were a number of other economic trends which were much less positive. In the areas of unemployment, income distribution and absolute poverty the experience of growth apparently benefited the poor little, and there are some indications that their situatio eteriorated over the period.

As a result, it has been recognized that simple concentration on growth and capital-intensive industry is not enough. Alternative strategies for investment have been proposed which would direct funds to labor-intensive industry and encourage the use of so-called intermediate, or "appropriate," technology. Employment generation has become a concern in itself. It is no longer assumed that growth will automatically provide employment for the growing populations of the less developed countries.

There has been widespread criticism of overvalued exchange rates in the LDCs, which created a bias toward more capital-intensive production by making imported capital goods cheaper for LDC producers. This aggravated the problems of unemployment and underdevelopment. Therefore, the LDCs are being urged to "get prices right" and allow the market to decide the rate of exchange for their currencies.

And finally, the human capital approach to employment has been applied to the underdeveloped countries. It is argued that LDCs should spend more on human resource development, in order to provide an adequate labor force to support labor-intensive industrial development.

C. Land

Ever since the emergence of economics as a discipline, land has been given great importance as a factor of production. In fact, the Physiocrats believed that only agricultural labor was productive and referred to classes other than agricultural producers as sterile.[14]

1

Treating land as a scarce factor of production, David Ricardo developed a model of diminishing returns in agriculture that was a precursor to modern marginalist analysis.[15] Ricardo argued that as population grew capitalist farmers would be forced to produce on less and less productive lands, thus enabling the owners of the more fertile properties to charge higher and higher rents. He believed that eventually those high rents would act as a barrier to further accumulation, and economic growth would reach a plateau. Ricardo used his model to justify the role of the capitalist against that of the landlord. He foresaw that capitalist development required the repeal of laws (like the corn laws) that benefitted the landlords and hurt the capitalist class. Even today in Third World countries development of the agricultural sector is often held back by constraints imposed by the landlord class, which receives a large share of the surplus and often uses it unproductively.

2

Until recently it was thought that agriculture had a less important role to play in economic development than industry. A. K. Sen, for example, argued that since agriculture was subject to diminishing returns (as Ricardo had shown), then development strategies should concentrate on encouraging the growth of industry.[16] For Sen, agriculture was a residual sector. However, lack of development in the agricultural sector proved to be a serious bottleneck for many developing countries.

Since World War II the strategies for development of the agricultural sector have been of four basic types. The first and earliest concentrated on expanding agricultural output through intensive and extensive cultivation. This transformation scheme called for the use of capital-intensive technology on large land holdings.

The second approach, sometimes referred to as the focal point approach, introduces agricultural improvements through those local farmers who appear to be predisposed to accept them. Extension services work with the more progressive farmers and teach them how to use new techniques which will then "trickle down," or be generalized, when their effectiveness has been demonstrated.

During the 1960s agricultural development was organized with the use of new seeds, fertilizers, herbicides and irrigation -- the Green Revolution began. The results were a dramatic success; agricultural output in the LDCs doubled during the period 1950-1975. But many economists argue that if there is agricultural development only, as in the Green Revolution, the rich will reap the benefits, for they can take advantage of the new technology and can afford the new seeds and tertilizer. This simply widens the gap between the rich and the poor.

The failure of the Green Revolution to bring about equitable development has given rise to the agricultural strategy advocated by Johnston and Kilby, known as the transformation strategy.[17] It calls for the structural transformation of the entire society with agriculture leading the way. This is a reversal of the traditional emphasis on industry as the leading sector. The transformationists are balanced growth advocates -- calling for balance between industry and agriculture.

At present, productivity is very low in the agricultural sector of most LDCs. Several reasons have been given for this:

1. Peasants are satisfied with their way of life and do not want to give up their independence [18].
2. The LDC's lack productive technology and a method to extend it to farmers [19].
3. The problem is lack of security on the part of the peasants and units of production that are not efficient, e.g. latifundia or mini-fundia. The necessary pre-requisite is land reform [20]
4. Failure to offer fair prices for agricultural products provides farmers with little incentive to produce more
5. New technology is too expensive and too risky, and farmers are risk-averse
6. Farmers lack various inputs, such as credit, seed, transportation, fertilizer, water, tools, etc
7. Markets are either inaccessible or otherwise inadequate and there is little to buy in rural areas, so there is nothing to spend extra money on

All of the above missing factors must be provided for successful transformation, depending on the particular country and its most important problems. Special emphasis is placed on new and significantly more productive technology of a biological kind -- seeds, fertilizer, etc.

There are many benefits to be derived from the transformation of the agricultural sector. It will cheapen the costs of food and fibers and thus allow industrial wages to be low and keep profits up. It will generate goods which can be exported in order to earn foreign exchange for necessary imports of energy, raw materials, capital goods, fertilizer, etc. Agricultural transformation is required to soak up the excess workers in the rural sector, stem the tide of migrants to cities, meet the basic needs of the poor quickly, bring about more equitable income distribution, and develop job skills among the rural population that can be used in industry. Another result is an increase in the size of the market for domestically produced industrial goods, particularly labor-intensive goods. And finally, it leads to a dispersed development of many small towns and cities rather than concentrating development in the capital city. For all these reasons agricultural transformation is the key to a development policy aimed at achieving both economic growth and equity.

DEVELOPMENT STRATEGIES

A. Laissez-Faire

The development strategy advocated by Adam Smith, one of the oldest development strategies, is also one of the newest. At the time of Adam Smith, and through his influence, the economic policy of government was clearly specified: hands off; laissez-faire. Ronald Reagan echoed these sentiments at Cancun, Mexico when he called on the LDCs to rely on the "magic of the marketplace," encourage the private sector, and minimize government interference in their economies in order to stimulate growth and development.

As we saw earlier, capital is considered the key factor of production by the mainstream economists. It is argued that in order to build capital, a society has to save; it has to forego consumption today and invest in steel mills, power plants, textile mills, etc. According to orthodox theory, these necessary savings in poor countries should be provided by the local capitalists. The capitalists will save, reinvest, and produce more capital; this will lead to further industrialization, and to further transformation of energy into output.

Until the late 1950s and '60s the conventional wisdom held that in order to encourage capitalists to invest, Third World governments had only to provide a suitable business climate. That meant that the government should be responsible for national defense, maintaining law and order (protecting private property in particular) and providing a stable monetary and credit system. If government does just these things and leaves businessmen/entrepreneurs alone, the institutions emphasized by Adam Smith will work. In particular, the government should avoid taxing entrepreneurs too heavily, for their savings might be discouraged. The entrepreneurs will bring resources together in order to make profits, and development will take place as they reinvest their profits and output expands. According to the mainstream economists, England developed in this way, as did the United States. This is the orthodox parable, the lesson which should be learned by the underdeveloped countries.

B. Planning

The post-war period raised a challenge to this view. If development occurs in this fashion, why haven't the underdeveloped countries developed? This question stimulated a search for a strategy to overcome the obstacles of missing factors, low level equilibrium, and low growth rates. By the mid 1950s, some development theorists began to have doubts. They began to wonder if everything was going to turn out right just by letting time pass. Many became pessimistic and lost confidence in laissez-faire, since it had obviously not worked.

Economists pointed to the low level equilibrium of underdevelopment, instances of market failure in the LDCs (due to external economies that could not be captured by private enterpreneurs), and the lack of social overhead capital in order to argue for the necessity of government intervention. To overcome these problems, which were seen as the reason for the failure of laissez-faire development, a new strategy was suggested: planned capitalism. If the market won't do it alone, the government must solve the problem.

The planning strategy was concerned almost exclusively with industrial development. From the beginning it was linked to import substitution policy. However, little attention was paid to the pattern of income distribution that was fostered by rapid industrial development. Rather than worrying initially about income distribution in a poor country where the only thing to distribute is poverty, the strategy was to plan and grow first. It was argued that the society could redistribute later if it didn't happen naturally.

C. Growth with Equity

Despite all of its success in raising rates of growth of GNP, the planning strategy of economic development has come under criticism for its failures: continued unemployment, growth in income inequality within and across nations, increases in absolute poverty, etc. Concern with these problems has stimulated a new modification of orthodoxy, the growth with equity approach.

The genesis of the new approach is a reexamination of mainstream views carried out by writers who had previously been strong exponents of planning. Beginning in the late 1960s with the work of James Grant at the Overseas Development Council, Ted Owens at the U.S. Agency for

International Development, the House Committee on International Relations, etc., a catalogue of failures of the accepted approach was begun; and in the period since then we have seen a variety of other failings cited.

One common theme runs through the noted failures of the planning approach, and this is that the distribution of benefits in the process of development have such as to benefit the poor little, if at all. Such a result offends any sense o justice, since it is the poor who face most directly the problem of basic survival. As might be expected, however, the traditional approach has not been abandoned, but a series of alternative strategies have recently been developed to attack its failures. It should be noted that these new strategies are emerging amidst continued criticism both from within and without.

All of the growth with equity approaches have certain aspects in common. All spring from a conviction that the traditional reliance on growth of GNP will not benefit the poor in today's less developed countries, or won't benefit them quickly enough. Proponents are convinced that the LDCs can improve standards of living and equity without social revolution, and they cite Taiwan, Korea, Hong Kong, Israel, Japan, Singapore, Ivory Coast, Costa Rica, and Sri Lanka as examples of countries where this has happened.

Another common factor is their implicit assumption that most people in the poor countries, including the peasants, will respond to economic opportuniti and market incentives. And finally, these theorists all give considerable emphasis to social and political variables in achieving growth and equity. They argue that one of the crucial limitations of past approaches was their narrow focus on simple economic factors -- land, labor and capital -- to the exclusion of political, social and cultural factors.

Writers such as Jim Grant, Paul Streeten, and Mahbub Ul Haq have called for a direct attack on rural poverty that would immediately improve the quality of life in the LDCs by meeting basic human needs directly.[21] Irma Adelman proposed increased investment in human resource development. Recently such an approach has again been given serious attention; the 1980 World Development Report of the World Bank stresses the importance of human resource development in the LDCs and indicated that expenditures on basic needs and so-called "social" development can have long-term productive effects, not just immediate consumption impacts.[22] Such findings go against the grain of a thirty-year legacy in development theory that directed governments to put money into industrial investment and minimize the amount of money intended for recurrent expenditures, like education.

Advocates of growth with equity strategies generally favor a labor-intensive industrialization policy. They contend that capital-intensive technology created little employment, and then only for a local elite. Income from production went to capital owners and thereby exacerbated the unequal income distribution in those countries. E. F. Schumacher and his Intermediate Technology group proposed that concerted efforts be made to develop intermediate or appropriate technologies which could be incorporated in the development efforts of all countries.[23] Schumacher's case is a very strong one in favor of a technology which improves labor productivity, uses local resources, minimizes the use of non-renewable resources, and produces goods intended for local markets. It is in essence small-scale, self-help development.

The International Labor Organization (ILO) also designed an employment generation scheme based on encouragement of production in the informal sector of LDC economies.[24] The informal sector is largely composed of petty traders, retailers, artisans, etc., that actually have substantial entrepreneurail ability but lack capital.

Along the same lines, Hollis Chenery has argued that public investment should be oriented away from large-scale, centralized projects toward projects that directly benefit the poor, such as education, credit access and public facilities.[25] Although this "trickle up" approach may further equity at the expense of growth in the short run, Chenery believes it will expand employment opportunities and in the long run the increased productivity and income it gives the poor will help raise the incomes of all members of the society.

Land reform is also cited as a necessary pre-condition for equitable growth -- although it is an interim strategy.[26] Ultimately, many people will move to cities and large farms will absorb small farms. Along with agricultural transformation, labor-intensive industry must develop also. Otherwise, there would be inadequate demand for the increased agricultural production. Also, agricultural transformation depends on inputs which can be supplied by labor-intensive domestic industry. It is a symbiotic process, and a long-term process. Taiwan and Korea are often cited as countries which achieved such structural transformation. Both have had rapid growth accompanied by a remarkable degree of income equality.

There is evidence that shows small farms to be more efficient in the use of land and inputs than large farms. In addition, ownership of land determines income distribution, and income distribution determines the pattern of demand.

Small farmers demand labor-intensive goods. Thus, land reform leads to a more labor-intensive industrialization. Since small farms use more labor than large farms, they help to absorb the growth in the labor force that cannot be handled by industry, particularly in early stages of development. And finally, political stability is enhanced by widespread land ownership, relatively equal income distribution, and meeting the basic needs of the masses of people. Therefore, the growth with equity strategy has focused a great deal of attention on agricultural and rural development strategies.[27]

THE POLITICAL ECONOMY PARADIGM

The second general paradigm in post-war development theory we will call the political economy, or alternately radical or non-conventional paradigm. This approach begins with Marx and includes Marxists such as Lenin, Mao, Paul Baran and Samir Amin.[28] It also includes the dependency school of writers such as Andre Gunder Frank and the Latin Americans, Celso Furtado, Osvaldo Sunkel, and Teotonio Dos Santos.[29] Finally, in this category, we also place the liberationists such as Ivan Illich, Denis Goulet, and Paolo Freire whom we only mention here for lack of space.[30]

Even though we may not like it here in the U.S., it is a fact that Marxism is the most pervasive political, ideological, and philosophical element of the post-war period. Almost all revolutionary movements of the 20th Century have been in some way related to Marxism. It has even sneaked its way into development literature. Within the political economy paradigm the most important debate of the post-war period has taken place between Dependency Theorists (whether Marxist or not) and their Marxist critics, such as Bill Warren.[31] Indeed, this debate has prompted Dudley Seers to assert that there is a certain congruence between Marxist and neoclassical development strategies![32] We do not agree with this characterization, however, and that is why we continue to categorize the development literature in terms of mainstream and political economy paradigms.

A. Dependency Theory vs. Marxist Critics

An important component of the political economy approach is its focus on the historical experience of the underdeveloped countries, and in particular on the analysis of their relationship with the developed capitalist countries in the context of imperialism. The dependency theorists, or dependentistas as they are also called, argue that imperialism prevented successful capitalist development in the LDCs created dependence and underdevelopment, and that the international capitalist system continues to block development of the underdeveloped countries today.

Dependency theorists agree that development in Brazil, for example, is much like it was in Europe, in certain respects. In both, income inequality increased with growth; in both, unemployment increased; in both, capitalists controlled the social surplus; and in both cases there was no income redistribution during the initial process of industrialization.

But dependency theorists argue that there are crucial differences which mean that capitalist development will not ultimately succeed today and that the difficulties of those countries which are following the traditional approach are not surprising. In the developing countries of today new goods are imported, rather than being produced domestically; the technology is also foreign, and its capital-labor ratio is inappropriate; production units in the poor countries are monopolies or olgopolies, not competitive firms as in England, and this leads to slower growth and more concentration; unemployment today is much greater than it was in the European case because of the population explosion; most of today's developed countries were never colonies, and so were able to take advantage of the international economy rather than being victimized by it; and finally, in the eighteenth and nineteenth centuries the developed countries didn't have a socialist alternative, while the underdeveloped countries of today do.

The dependentistas, especially those of the Monthly Review School (such as Andre Gunder Frank, Paul Baran, Harry Magdoff and Samir Amin), argue that the LDC's remain backward because a large portion of their surplus product is siphoned off by foreign capital, rather than being reinvested as it would be in the absence of foreign control over industry. The work of these writers highlights the fact that the LDCs are dependent on foreign capital for technology, management, markets for exports, financing, etc. This dependence guarantees that the surplus produced in the LDCs will flow to the developed countries in the form of license payments, royalties, repatriated profits, interest, and terms of trade that are unfavorable to the LDCs leaving them perpetually impoverished.

The Marxist critics of dependency theory, however, hold that imperialism was a progressive force in the underdeveloped countries because it broke down traditional societies and began the process of capitalist development. The Marxist critique of dependency theory has several major aspects. First, dependency theory is attacked on empirical grounds. It is argued that some Third World countries are developing and becoming industrialized.

These Marxists view dependency theory as superficial and circular. They say that dependency theory presupposes what it seeks to explain. The Dependentistas simply start with developed and underdeveloped countries and then argue that the presence of the former has made, and still makes it impossible for the latter to develop.

The non-dependency Marxists argue that some underdeveloped countries are experiencing successful capitalists development today and those that aren't are blocked by domestic factors, rather than by the international economy. Writers such as Bill Warren, John Weeks and Elizabeth Dore, and Geoffrey Kay argue that the causes of underdevelopment are internal -- they are related to the stagnant nature of the social structure in the LDCs, especially in the rural sector.[33] This argument implies that in order for capitalist development to proceed in the LDCs, those countries will have to pay the same social cost most developed capitalist countries have paid. They will have to experience a violent, wrenching social transformation of their agricultural sectors.

B. Policy Issues

For the political economy paradigm as a whole, the basic goal of development is defined as the provision for basic needs and the satisfaction of social needs. Since the institutional structures and technology in the underdeveloped countries hamper the attainment of that goal, they must be changed. There is a wide variety of approaches to such institutional change, ranging from electoral politics (the overthrow of Allende has virtually discredited this approach) to violent revolution. In addition, there are a variety of forms the resultant society might take: a highly decentralized socialist confederation, a grouping of worker managed firms and enterprises, or a democratic state socialism. The exact form must emerge from the experience and desires of given populations.

Most political economists reject the institutions which the traditional paradigm posits, seeing in them the result of a process of underdevelopment and a mechanism which blocks liberation. Many argue that capitalist development in underdeveloped countries is problematical today, that LDCs cannot follow the paths the United States or the United Kingdom followed, and that new institutions are needed instead. Thus, political economists generally reject the capitalist model of development. They would focus their attention on alternative institutions and strategies. Alternatives which impress many political economists are the socialist models being developed in China, Cuba, Vietnam, Tanzania, Mozambique, and Nicaragua.

Most political economy strategies call for a diminished role for markets in allocation of resources, determination of production levels, and distribution. Central planning is needed to allocate the factors of production, i.e., to allocate the land, labor, and capital, and to direct the social surplus into productive investments which meet people's basic needs. This is not the planning in a semi-capitalist economy which many consider basically a front for ruling class desires. Rather, it is planning which will generate the basic material goods to satisfy society's needs. China, for example, has combined central planning for the overall operation of the economy with decentralized and self-reliant activity in many areas.[34]

CONCLUSIONS

In preparation for this paper, we reviewed the development literature that was published during the period 1975-1982. We were struck by how empty, how trivial, how insignificant the literature seemed. There was nothing to begin to rival the essays by Lewis, Nurkse, Hirschman, Prebisch, or Baran of thirty years ago. In fact, the most notable essays of this recent period were by two authors of the earlier period, Lewis and Hirschman, and these articles reflected a growing sense of pessimism about development theory and development policy.

In an essay based on his Nobel Prize speech, Arthur Lewis argued that the world economy is slowing down, following the unprecedented growth of the period from 1950 to 1973.[35] The implications for the less developed countries are ominous, in Lewis's view. He believes that the long-term slowdown in the growth of world trade will lead to a severe decline in growth of output in the less developed countries and this probably cannot be compensated for by trade with other LDCs. So, the outlook for continued LDC growth is grim indeed.

The other essay, a piece by Albert Hirschman, entitled, "The Rise and Decline of Development Economics", is, if possible, even more pessimistic.[36] Hirschman exposes the naiveté of the 1950s and 1960s -- the shared optimism that the Marshall Plan experience in Europe could be repeated in the LDCs All that was needed was a large enough injection of foreign capital (both public and private) and national planning to rationalize LDC economies. It was a positive-sum-game -- DCs and LDCs would both benefit, and all classes in the LDCs would benefit from development. Laissez-faire economists disagreed with these solutions but were equally optimistic that market forces and international trade could be unleashed to bring about rapid transformation of the LDCs economies.

The Marxist vision was also one of progress. In the preface to the first German edition of Capital, Marx wrote, "the country that is more developed industrially only shows, to the less developed, the image of its own future".[37]

Even dependency theorists, such as Andre Gunder Frank, who called for socialist revolution in the Third World as the only means to development, have been disappointed.

That early optimism -- that naive optimism is gone. We have seen the Khmer Rouge, quoting Marx and mouthing socialist rhetoric, exterminate millions of their fellow human beings. We have learned that totalitarianism and fascism are just as likely to succeed capitalism as is socialism. The decline of the British economy has challenged the dependency theorists' argument that the center constantly expands at the expense of the periphery, and we now search for a development theory that explains both the rise and decline of countries. So the radicals are no longer quite so optimistic. Development is not a uni-linear, unidirectional process.

The laissez-faire economists have seen their theory most successfully applied by a bloody dictatorship in Chile which came to power by overthrowing the constitution, killing the elected president, denying basic civil rights to thousands of people, and causing great human suffering. And the countries planners point to with pride, such as Korea and Taiwan, are the same countries Amnesty International accuses of being flagrant violators of human rights. Those early success stories, Pakistan and Iran, turned into economic, political, and social disasters before the planners' very eyes. Of course, this recounting leaves out the atrocities of events in such trouble spots as Uganda, the Central African Empire, Lebanon, Argentina, and El Salvador.

Today, the world economy teeters on the brink of another Great Depression. All the ingredients are there, but one. A financial panic may be all that is needed to turn this decade-long stagflation into another world-wide depression like the one in the 1930s.

At the same time, nuclear war seems more likely than ever. The world has become a global arsenal -- bristling with missles and bombers. The U.S. and the U.S.S.R. both have need of Middle East oil and are now in a conflict situation in which their fundamental national security is at stake for the first time -- unlike the conflicts in Berlin, Cuba, or Vietnam. The issue is there, the weapons are poised, and we wait for the spark.

The ecological crisis and the world population explosion add to our feelings of imminent doom. Paraphrasing Woody Allen, Mankind is at a crossroads. One road leads to despair and utter hopelessness. The other road leads to total destruction. May we have the wisdom to make the right choice.[38]

A. Lessons of the Post-War Period

Thus, development economists are more pessimistic and more humble than they were 30 years ago. We now realize that we do not really understand the process of development. We do not have one overall theory that explains why some countries develop while others do not. In 1955, no one would have predicted that Korea would be a great economic success story twenty-five years later, and no one would have predicted that the Iranian economy would be in shambles today. We simply cannot predict when or where development is going to take place.

The OPEC experience has taught us that transfers of foreign resources do not necessarily bring about development, nor do they necessarily benefit the poor. Many of the oil exporting countries are following the examples of Spain and Portugal in the 16th century. The Iberian countries were the original looters and plunderers of the Third World, and they brought home great quantities of gold and silver. But they are now the least developed capitalist countries in Europe. They achieved great wealth and by virtue of this wealth, they were impoverished. So, although we need a new international economic order (NIEO) -- because the present one is not working in the interest of the poor and working people in either the developed or less developed countries -- a transfer of resources to LDCs through NIEO would not necessarily lead to development or improvements in living standards for the poor.

We have also learned that the expansion of trade is neither a necessary nor sufficient stimulus to economic development, as the 16th century lessons of Spain and Portugal should have taught us long ago. Expansion of the market can stimulate development if the necessary institutions for capitalist development are already in place. Capitalist development requires a labor force that is divorced from the means of subsistence and must sell its ability to work in the labor market and buy its necessities in the commodity market, and a class of capitalists that owns and controls the means of production. Trade expansion can rigidify feudal and other pre-capitalist relations of production, as it seems to have done in parts of Latin America.

It seems that the international capitalist system requires a hegemonic power -- one country to make the rules and enforce them. When Britain lost that capacity after WWI, the world was thrown into a crisis that produced the Great Depression. The U.S. has now lost the capacity to run the international capitalist system and we are in the midst of a new period of crisis and decline. However, we cannot be entirely sure of the direction of causation here. Perhaps it was the crises themselves that brought on the decline of the UK and the US, or the two events may have occurred concurrently, re-enforcing each other. In any event, the result in both cases was a dramatic reversal of the rapid growth process previously underway.

We have recently observed the crucial importance of religion. Iran, Pakistan, Brazil, Poland, and El Salvador are all striking examples of the power of religion to shape political and economic struggles. Yet no economic development text with which we are familiar deals with the role of religion in development beyond a cursory mention of Weber's thesis on the relationship between Protestantism and the rise of capitalism in Europe.

The fact that we ignored religion was symptomatic of the hegemoney of economists and economic ideas in shaping the thinking about developing in the postwar period. All political and social values were subordinated to the value of economic efficiency and economic growth. The LDCs were set out like wind-up toys to march through the stages of development, if they only saved and invested in the approved manner.[39]

B. Agreement on Development

Looking at the recent work in the field, it is possible to say that development economists have arrived at four main points of agreement over the last 30 years of successes and failures. First, the need to transform the agricultural sector as a pre-condition for successful development is almost universally accepted. However, there is still appalling ignorance about how to transform the agricultural sector. So despite a world-wide glut of industrial output, the LDCs and international aid agencies continue to concentrate on building industry. It would seem that agricultural transformation is beyond us. Oddly enough both political economists and more tradition economists now agree on the fundamental importance of the agricultural sector. The old capital intensive, industrial-based development strategy has been considerably modified by both camps. There is a widely recognized need for structural transformation that includes both industry and agriculture.

Second, there seems to be widespread agreement amongst most developmentalists on the need for directing development programs toward meeting the basic needs of the poorest in the LDCs. Conservatives and revolutionaries alike can agree that it is difficult to provide an able workforce when people are undernourished and suffering from disease.

A third major point of agreement centers on the importance of markets and the need to use them along with development planning. The conservative's dream is, of course, to turn <u>everything</u> over to the market, but even those mainstream development economists who had relied heavily on the planning strategy are now realizing that, in numerous cases, markets can handle allocation and distribution more efficiently than governments. A recent World Bank study by Eliott Berg highlighted the many failures of development schemes in Africa that resulted from government attempts to control all economic variables without the use of markets.[40]

And now, even socialist economists are advising LDCs to rely more on markets, to speed their development by using a sort of NEP (New Economic Program) model. China, Vietnam, and even Cuba are reversing former policies and relying more on markets. Countries like Nicaragua, which has a socialist leadership, are committed to encouraging private investment and are nationalizing only a limited part of their economies.

Fourth, along similar lines, Marxists, and even some political economists we would label <u>dependentistas</u>, are beginning to take a more "pragmatic" stance with respect to the role of multinational corporation in fostering industrial growth in the LDCs. They argue that the LDCs can bargain with MNCs in order to improve the terms of foreign investment and can benefit by it. Of course, this has always been the position of most orthodox economists. And Marxists like Bill Warren have argued all along that the MNCs are the primary force for the development of capitalist social relations in the LDCs. Where socialist revolutions have taken place recently, it is now common to hear leftists call for nationalization only of the "commanding heights" of the economy and to encourage private investment by both domestic and foreign capital.

Whether these new points of agreement among development economists will prove useful to the LDCs remains to be seen. We can only hope that the lessons of the past thirty years will be assimilated. Maybe then the people of the world, confronted by that choice between despair and total destruction, will have the wisdom to make the right choice.

NOTES

1. Adam Smith, An Inquiry into the Nature and Causes of the Wealth of Nations (New York: Modern Library, 1937).

2. Much of this paper is based on a larger study by James Weaver and Kenneth Jameson, Economic Development: Competing Paradigms (Washington, D.C.: University Press of America, 1981).

3. Smith, p. 4-5.

4. David Ricardo, On the Principles of Political Economy and Taxation, ed. Piero Sraffa (Cambridge: Cambridge University Press, 1951), chpt. VII, "On Foreign Trade," p. 128-149.

5. Raul Prebish, "International Trade and Payments in an Era of Coexistence: Commercial Policy in the Underdeveloped Countries," American Economic Review, 49:2 (May, 1959), p. 251-273.

6. H.W. Singer, The Strategy of International Development (London: MacMillan, 1975).

7. B. Johnston and Peter Kilby, Agriculture and Structural Transformation (New York: Oxford, 1975).

8. Bela Balassa, "Structural Change in Trade in Manufactured Goods Between Industrial and Developing Countries," World Bank Working Paper No. 396 (Washington, D.C.: World Bank, June, 1980, p. 22; Bela Balassa, "Exports and Economic Growth: Further Evidence," Journal of Development Economics, Vol. 5, No. 2 (June, 1978), p. 181-189; and World Bank, World Development Report 1979 (Washington, D.C.: World Bank, 1979), p. 68 especially.

9. William R. Cline, "Can the East Asian Model of Development be Generalized?" World Development, vol. 10, no. 2 (1982), p. 81-90.

10. Lewis, W.A. "Economic Development with Unlimited Supplies of Labor," The Manchester School (May, 1954), pp. 139-191; Leibenstein, H., "Allocative Efficiency versus X-efficiency," American Economic Review, (June, 1966), pp. 392-415; Nurkse, R., Problems of Capital Formation in Underdeveloped Countries (Oxford 1967); Ranis, G., and Fei, J., The Development of the Labor Surplus Economy (New Haven: Yale, 1962); Rosenstein-Rodan, P., "Problems of Industrialization of Eastern and South-Eastern Europe," Economic Journal (June-September, 1943), pp. 202-211.

11. See Nurkse and Rosenstein-Rodan.

12. Albert O. Hirschman, The Strategy of Economic Development (New Haven: Yale University Press, 1958) and -----,"A Generalized Linkage Approach to Development, with Special Reference to Staples," Economic Development and Cultural Change, 1977, p. 67-98.

13. See Lewis.

14. For a brief background discussion on Francois Quesnay and others of the Physiocrats, see Leo Rogin, The Meaning and Validity of Economic Theory (New York: Harper and Ros, 1957), p. 14-50.

15. Ricardo, p. 67-84, 289-320.

16. A. K. Sen.

17. Johnston and Kilby.

18. Goran Hyden, Beyond Ujamaa in Tanzania: Underdevelopment and an Uncaptured Peasantry (Berkeley: University of California Press, 1980).

19. Schultz.

20. Dorner.

21. James Grant, "A Fresh Approach to Meeting Basic Human Needs of the World's Poorest Billion: Implications of the Chinese and Other Success Models," American Political Science Assn. (1976); M. Haq, The Poverty Curtain (New York: Columbia University Press (1976); Paul Stretten, "A Basic Needs Approach to Economic Development," in K. Jameson and C. Wilber, eds., Directions in Economic Development (Notre Dame and London: University of Notre Dame Press, 1979).

22. World Bank, World Development Report, 1980 (Washington, D.C.: World Bank, 1980).

23. E. F. Schumacher, Small is Beautiful (New York: Harper and Row, 1973), expecially Part III, chpt. 2, "Social and Economic Problems calling for the Development of Intermediate Technology," p. 171-191.

24. United Nations, International Labor Office (ILO), Towards Full Employment: A Programme for Columbia (Geneva: ILO, 1973); ----,Matching Employment Opportunities and Expectations: A Program of Action for Ceylon (Geneva: ILO, 1974); -----,Employment, Incomes, and Equality: A Strategy for Increasing Productive Employment in Keyna (Geneva: ILO, 1977).

25. Hollis Chenery, et. al., Redistribution with Growth (Oxford: Oxford University Press, 1974).

26. Irma Adelman, "Growth, Income Distribution and Equity Oriented Development strategies," World Development, vol. 3, no. 2-3 (Feb. - March 1975).

27. See Johnston and Kilby.

28. There are extensive historical tracts on the development of capitalism in England in Karl Marx, Capital, Vol I (New York: International Publishers, 1967). See also V.I. Lenin, The Development of Capitalism in Russia (Moscow: Progress Publishers, 1956); Rosa Luxemburg, The Accumulation of Capital -- An Anti-Critique (New York: Monthly Review Press, 1972); Maurice Dobb, Studies in the Development of Capitalism. More recent contributions to development theory within the Political Economy paradigm include the radical dependency theorists: Paul Baran, The Political Economy of Growth (New York: Monthly Review Press, 1957); Samir Amin, Accumulation on a World Scale (New York: Monthly Review Press, 1974); and Andre Gundre Frank, Capitalism and Underdevelopment in Latin America (New York: Monthly Review Press, 1967).

29. Celso Furtado, "The Concept of External Dependence in the Study of Underdevelopment," in Charles K. Wilber, et., The Political Economy of Development and Underdevelopment (NY: Random House, 1973), p. 118-123; ----- Economic Development of Latin America (London: Cambridge University Press, 1976); Osvaldo Sunkel, "Transnational Capitalism and National Disintegration in Latin America," Social and Economic Studies (U. of West Indies), Vol. 22, no. 1 (March, 1973); Teotonio dos Santos, "The Structure of Dependence," American Economic Review, 60 (May, 1970), p. 231-236; and Fernando H. Cardoso and Enzo Faletto, Dependency and Development in Latin America, M. M. Urquidi, tras. (Berkeley: University of California Press, 1979).

30. Ivan Illich, "Outwitting the 'Developed' Countries," in C. Wilber, ed, The Political Economy of Development and Underdevelopment, 2nd ed. (NY: Random House, 1979); Dennis Goulet, "Development or Liberation in Wilber (1973); Paolo Friere, Pedagogy of the Oppressed (New York: Herder and Herder, 1971).

31. Bill Warren, "Imperialism and Capitalist Industrialization," New Left Review 81 (Sept./Oct., 1973), 3-44 and Bill Warren, Imperialism: Pioneer of Capitalism (London: New Left Books, 1980).

32. Dudley Seers, "The Congruence of Marxism and Other Neoclassical Doctrines," in A. Hirschman, et. al., Toward a New Strategy for Development: A Rothko Chapel Colloquim, (NY: Pergamon Press, 1979).

33. See the works by Bill Warren already cited and Bill Warren, "The Post-War Experience of the Third World," in Hirschman, et. al. (1979); John Weeks and Elizabeth Dore, "International Exchange and the Causes of Backwardness," Latin American Perspectives, vol. 6, no. 2 (Spring, 1979); Geoffrey Kay, Development and Underdevelopment, (NY: Macmillan, 1975).

34. See for example, John Gurley, "Rural Development in China 1949-72 and the Lessons to Be Learned from It," World Development, vol. 3, no. 7-8, (July-August, 1975) p. 455-471.

35. W. A. Lewis, "The Slowing Down of the Engin of Growth," American Economic Review, 70:4 (Sept., 1980), p. 555-564.

36. A. O. Hirschman, "The Rise and Decline of Development Economics," in Essay in Trespassing (Cambridge: Cambridge University Press, 1981).

37. Karl Marx, Capital, Vol. I (New York: International Publishers, 1967), p. 8-9.

38. Woody Allen, Side Effects (NY: Ballentive Books, 1979), p. 79.

39. W. W. Rostow, The Stages of Economic Growth (Cambridge: Cambridge University Press, 1960).

40. World Bank, Accelerated Development in Sub-Sahara Africa: An Agenda for Action (Washington: World Bank, 1981).

POLICY OPTIONS FOR RURAL DEVELOPMENT

ABSTRACT

Rural Development policies stressing technological change are often sources of conflict. The objective of this paper is to review a number of such policies.

In spite of past efforts and progress, the agricultural sectors of less developed countries continue to present challenges which, to be met, will require new ideas, the revision of old ones and above all, the concerted efforts of national and international agencies and disciplines. Among the reasons for unfulfilled expectations are unrealistic goals, and conflicting policies and objectives. Such conflicts have been identified at the sector level, at the national level, and over time.

To set an appropriate stage for policy review, it is assumed that development objectives can be ranked at the national level, and that they are compatible with priorities of individual decision makers at the farm level. Policy options for rural development are then discussed under technological change, and institutional and infrastructural support.

Such important issues as the divisibility of technology and the factors affecting technology adoption are reviewed. Caution is suggested regarding attempts to substitute governmental institutions for market mechanisms, or stifle private initiative with unwieldy bureacracy. Subsequently, policy problems are attacked at the sector level (for example, land reform) and at the national level (for example, fiscal and monetary policies) Finally, before presenting a research strategy for rural development, social and economic infrastructure issues are incorporated, implicitly acknowledging the need for an integrated approach to development.

POLICY OPTIONS FOR RURAL DEVELOPMENT

G. Joachim Elterich and Harry E. Brautigam
Department of Agricultural and Food Economics
University of Delaware, Newark, Delaware

INTRODUCTION

The less developed countries are facing increasing challenges and barriers to their efforts at development. To traditional constraints must now be added those derived from variables and uncertainties appearing during the last decade or so, noncyclical in nature. Increased energy costs, unstable international commodity prices and increased cost of capital are only some of the external factors partly responsible for aggravating the problems of developing countries (DC). Internally, many poorer countries continue to be subject to structural problems and vexing policy inadequacies particularly affecting agriculture, but touching other sectors as well. Emperical studies have concluded that "the agricultural sector in developing countries is often heavily taxed, consequently production is discouraged while consumption is subsidized ..."[1]

Recent World Bank data show that the GNP average annual growth rate for all developing nations decreased from 3.5 to 2.7 percent between 1960-70 and 1970-79.[2] The annual rate of growth of the value of agricultural output

---

[1]Ernest Lutz and Pasquale L. Scandizzo. "Price Distortions in Developing Countries: A Bias Against Agriculture," The World Bank.

[2]"Accelerated Development of Sub-Saharan Africa: An Agenda for Action." The World Bank, p. 3.

(constant 1970 dollars) in poorer countries decreased from 2.5 to 2.0 percent, and in more advanced, less developed countries from 3.6 to 3.0 percent. Moreover, it is significant that agriculture's share of the GDP in poorer DC declined from 51 percent in 1960 to 34 percent in 1979, while the agricultural labor force only declined from 76 percent to 71 percent during the same period.[3]

These few figures indicate the magnitude of the problem, particularly when we remember that over 2.3 billion people now populate the poorer DC, and that over 70 percent depend directly and indirectly on agriculture for their livelihood (World Bank, Table 20).

Development would be self-defeating if separated from its ultimate beneficiaries. Therefore, present conditions and challenges warrant revising DC internal policies, strategies and probably new approaches to development, in order to improve the lot of rural people and foster economic growth. The choice of a development strategy is critical. Policy makers should be aware that in certain circumstances greater economic and social advantages could result from a rural-led employment-oriented strategy (Mellor, pp. 269-294) than from an urban capital-oriented one. Most countries seem to have opted for the latter over the last two decades.

This paper will review problems of agricultural policy in DC, stress technological progress, institutional, infrastructural and demographic settings, and finally explore avenues of research. In attempting to present some policy options and their implications for rural development, generalizations have been made that might not apply in specific circumstances. However, the objective was not to survey all policy options and implications, but to review those that impact an agricultural technical change.

---

[3]The World Bank 1981 Development Indicators, Tables 2, 3, and 19.

POLICY BASIS

Before surveying policy options and instruments, several basic questions must be addressed by policy makers.

It is generally accepted that agricultural transformation benefits society in several ways. Technological change makes relatively cheap food possible and allows industrial wages to remain low. Profits from increased exports help pay for imports. More rural residents are employed, not just in farming but also in emerging prosperous small industries. This, it is hoped, retards migration to urban centers, and improves income distribution and size of domestic markets. However, to accomplish orderly agricultural transformation, some or all of the policies discussed should be in place.

Experiences from the field (in this case Subsaharan Africa, although many other examples can be cited) indicate that governmental policies are usually urban and industry biased.[4] This generally results in low food prices and few incentives for producers and traders of agricultural staples; in unstable markets partially due to a deficient infrastructure and institutions; in a shortage of administrative, extension, teaching and research capacities; and in a lack of coordination among institutions, agencies and the private and public sectors. Because of bias or lack of clear agricultural policies, it is not unusual for private and public sector agencies to distrust each other, and for conflict to exist even within public sector institutions.

There are obvious advantages when each political unit can establish objectives and rank priorities, regardless of whether the economy is market oriented or centrally planned. While options are different under capitalistic

---

[4]Elterich and Daves (1978), Daves and Elterich (1978), Elterich and Nicolson (1978).

and socialistic regimes, trade-off decisions--among sectors, time periods, population segments or regions--still must be made. In societies with skewed resource ownership, redistribution might be desirable. However, under immediate pressures of solving equity consideration, short run and long run policies often clash. This should be avoided.

Disparities among sectors, regions and population segments, as well as structural problems, can only be ameliorated in the long run and require the concerted effort of <u>disciplines</u> (social and hard sciences) and <u>institutions</u>. Convincing evidence suggests that integrated efforts are seldom made to achieve a set of stated objectives among disciplines, institutions and donors. Technological changes may necessitate institutional changes and vice versa, but may not always occur in the right form or place at the right time. Agricultural policy for DC should recognize farms as decision-making units, in which production-consumption-investment (savings), family size and labor allocation (on and off the farm) are closely interrelated (cif. Beausoleil Robbins, this volume). Therefore, an interdisciplinary approach to the househol farm operation is warranted. Policy makers should also recognize that they intend to benefit, not homogenous, but highly heterogenous production units. The specific characteristics of these units must be known, and policies formulated to achieve positive results.

Similarly, it is worth remembering that effective policies require individual decision makers to perceive national objectives as compatible with their own. Experience has shown that discrepancies or incompatible objectives lead to unfulfilled goals, waste and frustration. Equally important is the need to identify the technique and level of technology necessary to achieve an objective. Within different technological levels, more capital- or labor-intensive techniques may be appropriate and available. Thus, an objective of increasing rural employment would be best met by labor-intensive rather than capital-intensive means.

Policy Options

What follows is intended to show that the rate of technological change in agriculture can be affected by a broad range of policies. Macro-economic policies can impact positively or negatively, as can more specific policies, such as those involving credit or pricing. The issue, therefore, is that policy makers must be more aware of existing interrelationships among policies. In some instances, whether policies are contradictory or complementary can be determined only in-situ, thus the responsibility of researchers.

Technological Change

Technological change and evolving farming systems must fit agroclimatic as well as socioeconomic conditions. This implies that research in these fields should be coordinated and integrated before any widespread diffusion efforts are made. Recommended techniques will more likely be effective if the new technology indeed uses relatively abundant resources and saves relatively scarce ones. Land-augmenting technologies (hybrids, water control, fertilization and chemicals) can require labor, even when combined with selective mechanization (Yudelman, et al., pp. 90-100). Complete or large-scale mechanization is inappropriate for economies with a surplus of labor and a shortage of capital, because it depresses employment and consumes capital. (Yudelman, et at., pp. 79, 89). Therefore, adoption should not be perceived as an all or nothing proposition. Instead, cumulative, sequential progress should be facilitated so that poorer small-holders will be convinced of the benefits of a change-over. Required production factors should only be imported if their use is justified. But, agriculturalists must consider the divisibility of new technology and the action of inputs which may or may not be required for success. Politicians should be sensitive to the potentially conflicting outcomes of technologies applied to differing economic, social, institutional and cultural environs.

A growing number of agricultural economists believe that the adoption of new technologies is often largely tied to the institutional framework within which farmers operate. New technologies developed for large farms should be adapted so that they are within the reach of small subsistence farmers. To pacify groups presently better off, while assisting the disadvantaged, may require compromises.

Latin American studies have shown that in the adoption process, it is important to minimize risks to farmers. This can be accomplished with policies stabilizing output and input prices as well as assuring accessibility to active markets (credit, seeds, fertilizer, products), especially for the target population. How farmers feel about cropping patterns, prices, yields and incomes resulting from new technologies must be understood, since yield variations are usually overestimated. Farmers' perceptions are often biased, and how they make decisions is often inadequately understood, particularly in view of the objective which the farm-household unit holds (Arcia, Johnson and Sanders, No. 5). Farmers and scientists have different perceptions of yields and prices. Methods need to be developed to understand the sociological factors involved and reconcile the discrepancies.

Early adopters (pioneers) benefit most and are often in a better position to sustain a potential setback. However, often successful adoption is made first by the larger landholders. This leads to increased product supplies in the markets, resulting in lower prices for smallholders or late adopters, thereby aggravating their situation even more. In such instances, special attention to smallholder adoption is justified, especially when increased employment is a goal. Cooperative buying-selling of goods and services by smallholders would enable them to compete with large producers.

Emperical studies have shown that farm size alone is not always a factor in adopting certain types of technological improvements. In some countries adoption has been found to be even higher among smaller farms than larger ones when high-yielding varieties are involved. However, farm size is usually positively related to wealth or negatively to land quality and access to markets. This is believed to account for variations in technology adoption. Owners of land are more likely to adopt HYV than tenants; however, this could be due to the lack of credit available to tenant farmers (Schutjer, et. al., p. 16).

Institutions

Since DC governments usually have tight budgets and perhaps even tighter constraints on their scientific, administrative and educational resources, it is important to avoid duplication of effort.

It would seem prudent for governments to concentrate on supporting the "invisible hand," assist working institutions, and avoid taking over every marketing function with an unwieldy bureaucracy (Schwartz and Eckhart, this volume). Policy should be formulated to deal with excesses or give temporary support to the disadvantaged. Under no circumstances should policy stifle private initiative and interfere with efficient resource allocation; rather it should support them. The guiding principle for optimizing returns in the long run for society should be allocation by opportunity costs for factors, products and expenditures. There is little disagreement that some state planning should be directed at correcting disequilibria and constraints, but operational planning and implementation should be largely decentralized, tailored to local needs, and elicit grass-roots commitment.

Judicious trade-offs are required to achieve what is desirable as well as economically and politically feasible. Hence, the potential effects of policy changes, so-called "impact analyses," should be researched when alternatives are considered, as part of a comprehensive analysis of the impacts on the total system.

While institutional changes designed to deal with the objective function and constraint set are possible, they may be economically or politically infeasible. For example, consider land reform. An alternative approach concentrating on institutional mechanisms to affect product prices (floor or marketing board) and the perception of yield levels (extension and demonstration plots) may accomplish the same thing with less government expenditure and "ill will." Thus, policies to stabilize prices and create predictable markets (government purchases, sales and storage) will go a long way toward giving farmers the incentive to adopt income and yield increasing technologies for the commodities in question.

Research is needed to determine the economic, political or sociological implications when consumers pay the market price for food, and when taxes subsidize domestic producers so their incomes become competitive and high enough to keep them producing. Finally, monetary and fiscal policies that affect agriculture and technological change cannot be neglected. Monetary (including capital markets) and fiscal policies (taxation and subsidies) directly and indirectly affect availability and prices of agricultural products and inputs.

Also vital are policies linking domestic and international economics, especially import and export levies and the rate of exchange. Export levies generally hurt producers and benefit the government, which uses the proceeds to further the interests of another sector, not necessarily benefiting those who suffer under the levy. Such relationships and consequences should be researched in a manner which is case-specific, but may draw on similar studies elsewhere. Import levies may benefit a domestic producer if the products imported compete with his, but may hurt him if fixed (ceiling) prices are in effect, when the goods are factors of production and squeeze the domestic producer's return. Floor prices may not have the same effect. Another policy approach, taken by a number of countries at different times, may promote substitution of domestic products for imports, instead of export subsidies.

Exchange rates and money market rates can be free or distorted. If fixed too high, they reduce export potential and/or flood domestic markets with cheap imports, which may ruin domestic producers. If exchange rates are set too low, the country and its producers are robbed of foreign exchange earnings, making it unprofitable for importers to obtain needed goods not produced domestically.

In recent years, flexible exchange rates and the growing integration of international capital markets have again brought comparative advantage predominately into play.

Monetary policies affect agriculture and the flow of resources, including labor. A tight-fisted central bank tends to increase the value of domestic currency to the detriment of exports, while the opposite holds for a central bank with few constraining policies. Therefore, the trading sectors bear the initial adjustments to changes in monetary policies. Thus, floating exchange rates tend to destabilize foreign demand in the short run, while making trade a more important issue to the agricultural sector. In the long run, predictions are difficult since, aside from governmental policies, relative prices and quantities matter greatly.

It is increasingly evident that, for some countries, the cost of energy deters development. Thus, there is a need to generate or adopt suitable technologies (water, sun, geothermal or biogas) as opposed to importing energy, to save scarce foreign exchange. The trade-offs need to be studied.

Infrastructure

When a dualistic farming sector is present—one commercial, the other subsistence (partially market oriented) and dependent, depending on off-farm employment--small rural industries, infrastructural projects and cottage industries may be subsidized initially to keep more of the population productive and in rural areas. This may also require measures to help poor rural farmers rent or buy land (via initially subsidized credit), grainful off-farm employment, or organize co-ops (buying, selling, irrigation) in order to offset large farm advantages at least partially. Selective mechanization can keep farm labor employed. Institutional and other barriers to technological advances should be broken down and risks minimized through improved performance in the factor and product markets.

Agrarian reforms - mainly of institutions - should be a continuing dynamic process not limited to land reform,which may help achieve equity by sacrificing some efficiency. If the land tenure system and political reality make outright land distribution to the landless or poor infeasible, perhaps studies should be initiated to document costs and benefits, and whether subsidizing the poor and taxing the rich would accomplish the same objective of a more equal land distribution. Other alternatives to land expropriation are selective price policies, and imposing ownership ceilings and strict regulation of tenancy, with longer term leasing encouraged, thus protecting tenants to a greater extent. In any event, communication, transportation, and water control networks, as well as chemicals, fertilizers, seed (HYV), credit and appropriate technologies including mechanization, should be available through stronger delivery institutions.

Orderly, open and stable markets and structural improvements help solve developmental problems, but market stability is one of the most important issues in developed as well as in developing nations. A national price policy for staples is needed in conjunction with production incentives. Efficient public institutions should complement, but not replace the private sector. Technologies and farming systems need to be perfected, and the diffusion process integrated with functioning market facilities for inputs and outputs. Several options are available:

(1) Widely disseminated, speedy and regular market information, acquisition and distribution create transparency in markets. This option requires forecasting of yields and harvested areas, and may be facilitated by aerial or remote sensing technology.

(2) Price floors (or ceilings) or guarantees, to be announced before planting time, and private and public sector sharing in buying/selling and storing of grains.

(3) Contracts, preferably consummated between private parties, but sanctioned by courts.

(4) Vertical integration.

(5) Insurance schemes.

(6) Effective storage, which may be most essential for stable prices, can be strategically placed in production and consumption centers to minimize post-harvest losses.

To protect farmers and consumers alike, governmental storage functions or income insurance schemes should be examined for their distributional impact. Such measures can help remove some of the perceived risk and uncertainty when small farmers adopt new technology.

Social Infrastructure

Health care and educational policies should go hand in hand with economic policy, since they have a positive impact on productivity. Schultz has long advocated investing in human capital to forge progress. Obviously, that can take many different forms: educating children and/or adults, maintaining an effective extension service, giving free demonstrations (plots) at crucial locations where farmers congregate (e.g. at regional market locations). Another form may be disseminating information by radio (perhaps even TV). However, even in education, trade-offs between unemployment and output exist. In the Philippines, agricultural extension expenditures increased the demand for variable farm inputs, especially labor, but also for fertilizer and equipment, while their effect on output appears to have been insignificant (Quizon, pp. 13ff).

Generally, agricultural research and development expenditures tend to increase output due to increased fertilizer and equipment demand, while possibly decreasing labor demand. Analysis has established that additional agricultural research expenditures increase profits at the farm level. This, in turn, implies that combinations of state budget allocations for research, extension and water projects can simultaneously restructure current demand for agricultural factors and increase supply. Resources in R and D and extension, while they have increased, are still insufficient in many DC, and large returns from expenditures can be expected, especially in the intermediate run.

Demography

Demographic changes must also be considered in the dynamics of rural development. An urban bias in developmental programs usually contributes to rural-urban migration, with associated problems in metropolitan areas (unemployment, congestion, lack of shelter and sanitation, perhaps even lack of food). Policies need to be devised and their impact studied to counteract the "Landflucht". A very negative byproduct of migration is that the productivity of the small farms suffers, not only because there are fewer workers but also because of potentially reduced access to extension, advanced technology, and credit. This not only leads to less money available on the farm for other purchases, but also to less food available for rural and urban consumption, hence lowering nutritional and health standards (see Nash, this volume). It is very important to quantify these direct and indirect side effects of migration.

PROGRAM STRATEGY

A three-stage procedure is suggested. The first stage should attempt to form a clear picture of resources and restrictions, and collect and evaluate relevant studies concerning data bases in an area. One way to achieve this goal is to start with a comprehensive resource inventory and evaluate the country's options given its objectives and hirarchies. Obviously this is very expensive and time consuming. A less expensive approach could focus on sector models with feedback from the remainder of the economy, or simulations based on secondary data, using to the fullest extent possible, knowledge gained from other detailed studies. Synthesized models can facilitate wise decision making before costlier research projects are attempted. A system simulation is very flexible with respect to completeness, methods (econometric systems of equations, LP or input-output etc.) and rigor. Additions can be made in building block fashion over time. Another approach is to list regions to be developed and undertake a comprehensive study of each. (See AID's Country Development Strategy Statements.) In many cases, without an input-output social-cultural farming system study, and/or similar survey of the target population, researchers will not fully understand the interactions and the bottlenecks. This assumes that farmers possess skills that can be exploited to increase productivity and household income.

In the second stage, actual costs and benefits of various policy options are researched according to the special circumstances of the area. Target groups and variables are clearly specified, policy instruments identified, and the likely relationships among the behavioral and normative sphere studied. Direct and indirect distributional aspects of factor returns need to be analyzed. The models developed should be flexible enough to incorporate additional variables or policy options as their importance is revealed. While general equilibrium models are desirable, often data and other limitations (time and funds) will not allow or justify their use. Under these circumstances, partial analysis will provide sufficient information to make intelligent choices among options.

Policy models should deliver realistic and plausible results and believable (to users) predictions about alternative outcomes. The results and their implications should be readily understood by nonscientists. Results of similar studies can serve as first approximations or preselection of policy alternatives. Short and long run private and social costs, benefits, and noneconomic impacts should be known for alternatives considered. At this stage, a dialogue between decision makers and researchers should commence.

During the third stage, researchers and politicians (including representatives of the target group) should finalize the actions to be taken and work together on effective implementation. This should be followed by periodic evaluation of progress, so that feedback may improve the direction and desired impact of the program. Periodic monitoring will ensure that development is coupled with equity, and that the dynamic process continues.

The following additional aspects of research should be considered:

(1) Physical research (yield) needs to be augmented by a review of economic aspects at the outset, detailing price distributions resulting from new technologies.

(2) Biological and physical management of the environment is still in its infancy. Decertification, deforestation and erosion, with their far reaching consequences, are important factors.

In summary, it is not only important to assess the potential micro-level socioeconomic impact of technological changes, but also to include dynamic factors and feedback when considering the macroeconomic frame viz. markets. within and outside the agricultural sector. In the final analysis, likely welfare effects need to be studied a priori of technological change or application of (institutional) policy investments.

SUMMARY AND CONCLUSIONS

Increased attention should be given to agriculture in developing countries as a way to reduce the gap between rich and poor nations.

In attempting to accelerate rural development, there should be a greater awareness of conflicts arising between objectives and policies, as a first step toward minimizing social costs. There is ample evidence of conflicts at th national level, between national and sectoral or regional objectives, and even between national and individual objectives. Conflicts have also existed between temporal objectives and the means of achieving them. The aim of this review has been to underline areas believed to require additional research, in order to optimize resource use and minimize policy conflicts.

The farm unit should be considered a producing and consuming unit enmeshed in a socioeconomic, cultural and physical environment. Appropriate technologies must take into account the resource base, specifically the labor and capital available.

Institutional and governmental units should be considered dynamic (not fixed) elements in the development process, and clearly gauge the short-vs. long run trade-offs as well as the private vs. social benefits of policy ex ante. Fiscal and monetary instruments, as well as import-export policies shape the social and economic infrastructure, and affect the stability cf markets appreciably.

Technical change and industrialization of rural areas interact intimately, not only with the measure base and environment, but also with the demographic dynamics of those regions. It is suggested to pursue policy research and strategies, allowing different levels of scope and methodology in order to be efficient and effective in generating optimal policies for (rural) development.

BIBLIOGRAPHY

African Strategy Review. "Accelerated Development in Sub-Saharan Africa, The World Food Bank, Washington, D.C., 1981.

Ahmed, Raisuddin. Agricultural Price Policies Under Complex Socioeconomic and Natural Constraints: The Case of Bangladesh, IFPRI Research Report 27, October, 1981.

Arcia, Gustavo, S. R. Johnson and John N. Sanders, Jr. "Policy Analysis Implications From the Bean Technology Experiments and Small Farm Decision Modelling," Report No. 6, January, 1981. Small Research Grant AID/DS/AER/ESP.

________________. "New Technology, Institutional Change, Farm Decision Processes, Supply Response, Welfare Gains and the Adoption Problems," Report No. 7, January, 1981.

Banco, Mundial. "Informe Sobre el Desanollo Mundial 1981." Banco Mundial, Washington, D.C., Agosto de 1981.

Barkley, Paul W. "Some Non-Farm Effects of Changes in Agricultural Technology," Washington Agricultural Research Center, Washington State University.

Colman, David and Frederick Nicson. Economics of Change in Less Developed Countries, Halsted Press Book, New York, 1978.

Cooper, Charles, (Consultant). Development Policy Staff, "Policy Interventions for Technological Innovation in Developing Countries," World Bank Staff Working Paper No. 441, December, 1980.

Davenport, Charles Michael D. Boehlje and David B. H. Martin. "The Effects of Tax Policy in American Agriculture," USDA, Report Number 480, Washington, D.C., February, 1982.

Daves, T. and J. Elterich. "Several Aspects of Marketing and On-Farm Storage of Cereals in Niger--Survey Results and Recommendations," Niamey, April, 1978.

Dregne, Harold E. "Impact of Land Degradation on Future World Food Production USDA, ERS-677, Washington, D.C., March, 1982.

Elterich, J. and T. Daves. "Methods for Improving Cereals Production Forecasts in Upper Volta," Ouagadougou, May, 1978.

Elterich, C. Joachim and Walter H. Nicholson. "Grain Marketing Proposal for Mauritania," Nouakchott, June, 1978.

Enochian, Robert V. "Solar- and Wind-Powered Irrigation Systems," USDA, Report No. 462, Washington, D.C., February, 1982.

Falcon, Walter P. "Reflections on the Presidential Commission on World Hunger," American Journal of Agricultural Economics, Vol. 63, No. 5, December, 1981.

Feder, Gershon, Richard Just and David Silberman (Consultants). "Adoption of Agricultural Innovations in Developing Countries: A Survey, "World Bank Staff Working Paper No. 444, February, 1981.

Federal Reserve Bank of Kansas City (Symposium). Modeling Agriculture For Policy Analysis in the 1980's. Kansas City, September 24-25, 1981.

Foster, Phillips. "Agricultural Policies and Rural Malnutrition," Occasional Paper Series in Economics and Sector Planning, No. 7, USAID, February, 1978.

Gonzales, Leonardo A. "The State of Agricultural Economics and Sector Policy Formulation in the Philippines," Journal of Agricultural Economics and Development. Vol. 9, No. 2, July, 1979.

Green, Albert A. "Planning and Information: The Need and the Potential for Rural Development." Occasional Paper in Economics and Sector Planning No. 1, USDA/TA, V, 1975.

Honadle, George, Elliott R. Morss, Jerry Van Sant and David D. Gow. "Integrated Rural Development: Marking It Work?" AID Project 936-5300, July, 1980.

Inter-American Institute of Agricultural Sciences. "Conceptual Framework of the Agricultural Planning Process in Latin America and the Caribbean: A Comprehensive View of the Policy Analysis and Decision-making Process in the Agricultural Sector," Proplan Document -1, 1978.

International Agricultural Development Service, "Agricultural Development Indicators--Statistical Comparisons of 139 Developing Countries," 1981.

Laorma, J. S. "Growth and Equity: Policies and Implementations in Indian Agriculture," IFPRI Research Report 28, November, 1981.

Lasley, Floyd A. "Food Prices and Rising Energy Costs," USDA, ERS-674, Washington, D.C., February, 1982.

Lele, Uma and John M. Mellor. "Technological Change, Distributive Bias and Labor Transfer in a Two Sector Economy," Oxford Economic Papers, Vol. 33, No. 3, November, 1981.

McIntire, John. "Food Security in the Sahel: Variable Import Levy, Grain Reserves and Foreign Exchange Assistance," IFPRI Research Report 26, September, 1981.

Mehra, Shakuntla, "Instability in Indian Agriculture in the Context of the New Technology," IFPRI Research Report 25, July, 1981.

Mellor, John W. The New Economics of Growth, A Strategy for India and the Developing World, 1976.

Merrill, William C. "The Impact of Agricultural Mechanization on Employment and Food Production," Occasional Paper Series in Economics and Sector Planning, No. 1, USAID, September, 1975.

Oram, Peter A. and Vishva Bindlish. "Resource Allocations to National Agricultural Research: Trends in the 1970's," Review of Third World Systems, November, 1981.

Quizon, Jaime B. "Factor Input Demand and Output Supply Elasticities in Philippine Agriculture," June, 1981, From Yale research project with AID/DS/AG/ESP. Technology, Policy and Rural Incomes.

Rasmussen, Wayne D. and Jane M. Porter. "Strategies for Dealing With World Hunger: Post-World War II Policies," American Journal of Agricultural Economics, Vol. 63, No. 5, December, 1981.

Rossmiller, George E. (ed.) Agricultural Sector Planning - A General System Simulation Approach, Agricultural Sector Analysis and Simulation Projects, Department of Agricultural Economics, Michigan State University, Lansing, 1978.

Sarma, J. S. "Growth and Equity: Policies and Implementation in Indian Agriculture," IFPRI Research Report 28, November, 1981.

Schutjer, Wayne A. and Marlin G. Van Der Veen. "Economic Constraints on Agricultural Technology Adoption," Occasional Papers Series in Economics and Sector Planning, No. 5, USAID, March, 1977.

Scobie, Grant M. "Government Policy and Food Imports: The Case of Wheat in Egypt," IFPRI Research Report 29, December, 1981.

Selowsky, Marcelo. "Reflections on the Presidential Commission on World Hunger: Discussion," American Journal of Agricultural Economics, Vol. 63, No. 5, December, 1981.

Srinivasan, T. N. "Reflections on the Presidential Commission on World Hunger: Discussion," American Journal of Agricultural Economics, Vol. 63, No. 5, December, 1981.

Western Regional Research Project W-149 Seminar at San Francisco, California, January 25 and 26, 1979. "Risk Management in Agriculture: Behavioral, Managerial and Policy Issues," Department of Agricultural Economics at University of Illinois, July, 1979, AE-4478.

Wharton, Clifton R., Jr. "Risk, Uncertainty and the Subsistance Farmer: Technological Innovation and Resistance to Change in the Context of Survival," Joint Session AEA and Association for Comp. Economics, Chicago, December 28, 1968.

____________________, (ed.) Subsistance Agriculture and Economic Development, Aldine, Chicago, 1965.

Yudelman, Montague, Gavan Butler, Ranadev Banerji. "Technological Change in Agriculture and Employment in Developing Countries," Development Center Studies Employment Series No. 4, Organization for Economic Co-operation and Development, Paris, 1971.

FARMING SYSTEMS RESEARCH AND TECHNICAL CHANGE

Previous Page Blank

ABSTRACT

FSR is a multidisciplinary approach to research that involves a holistic understanding of the farm, the family unit, the relationship between crops and livestock, ,. well as community values and norms. FSR has four stages: (a) diagnostic, (b) technology, (c) farmer field testing, and (d) evaluation and dissemination.

During the diagnostic stage, the researchers attempt to learn the farmer, his existing system and to identify problems. The design stage includes the identification and/or development of technology suitable for the farmer. In the farmer testing stage, on site testing of the technology occurs under farmer's actual conditions. The evaluation and dissemination stage determines how successful the technology will be by focusing on its adoption by the target population.

FSR offers several advantages including (1) savings on time and funds by focusing on all the factors that affect adoption, (2) continuous feedback to make the technology more appropriate, (3) testing under "real world" conditions, (4) focusing on problems of concern to the target population, and (5) identify policies that affect adoption rates.

FARMING SYSTEMS RESEARCH AND TECHNICAL CHANGE

Richard D. Robbins
Professor of Agricultural Economics
and Rural Sociology
North Carolina A&T State University

INTRODUCTION

Food production in many of the developing countries has not kept pace with the growth in population. In fact, in many countries, per capita food crop production has fallen in recent years. Food crop production has grown in volume in most countries, but population has grown faster (Table 1). Many reasons have been advanced for the relatively poor performance of the agricultural sector. These include, (a) failure of farmers to adopt appropriate technology, (b) drought and natural disasters especially in East Africa and the Sahel, (c) institutional weakness in credit, education, research and extension, (d) disruptions because of civil disorder and war, (e) unfavorable shifts in the terms of international trade, (f) policies and incentives that work against food producers (see Elterich and Brautigam, this volume) and (g) failure to consider the unique needs of the limited resource farmers.

In an attempt to increase food production, more attention is now being given to small farmers as a potential source of increased production. Many small farmers remain reluctant to adopt technology, and others have limited access to purchased inputs. It has become apparent for many development experts that better understanding of small farm practices, problems, and constraints is essential to improving productivity. For these reasons, and others, farming systems research and development have evolved as a means of reaching the small farmer.

The primary purpose of this article is to review the stages of farming systems research and present advantage over "traditional" research approaches. In addition, examples will be given where farming systems research could have been applied, or where it was applied.

Table 1 World Indicies of Food Production by Region and selected Countries

	1980		1975		1970		1965	
	Actual	Per·Capita	Actual	Per·Capita	Actual	Per·Capita	Actual	Per·Capita
South America	143	110	120	105	102	102	85	97
Costa Rica	136	106	136	120				
Panama	122	92	116	101				
Peru	99	99	114	97				
Bolivia	128	73	128	113				
East Asia	141	113	123	110	101	101	84	94
South Asia	120	97	113	101	102	102	80	90
Mid East-West Asia	144	110	125	109	100	100	86	98
Bangladesh	129	99	114	100				
India	120	97	113	102				
Indonesia	144	116	120	107				
Thailand	162	127	136	118				
Africa	113	85	108	94	99	99	87	100
Tanzania	141	109	135	116				
Zambia	112	86	140	119				
Nigeria	115	85	108	92				
Senegal	82	64	137	119				
Angolia	81	66	94	87				
Cameroons	117	95	102	92				

Source: Word Indices of Agricultural and Food Production USDA, ERS, Statistical Bulletin No. 669

DEFINING FARMING SYSTEMS RESEARCH

There appears to be a great deal of difficulty in precisely defining Farming Systems Research (FSR). To some, FSR means looking at the existing cropping patterns and their systems, hence cropping systems research (1, 5, 7). Others tend to look at one crop and how it fits into the system; some include livestock, others ignore them (6, 7). For many, FSR excludes non-farm activities. Despite the difficulties in defining farming systems research, there appears to be some agreement on certain components. FSR is an approach to research that involves an understanding of the entire or whole farm system, the resource base, and its interacting elements. All factors that affect the production and consumption of the farmer and his household enters into the process. For the purpose of this paper, FSR is defined in its broadest sense, the holistic approach to understanding the decision-making process of the farm unit, the relationship between crops, the role of livestock, as well as non-farmer activities, and including societal customs as norms. As a result, FSR demands a multidisciplinary approach.

The research teams are composed of several disciplines from the agricultural and social sciences. Usually a team is composed of an agronomist, an extensionist, a social scientist, and one or two other technical experts, dependent upon the specific needs of the research objective.

FSR involves full farmer participation throughout the research process. When FSR includes testing new technology, the farmer participates in the design and testing of the technology. He assists by giving feedback to the researcher, feedback on the constraints he faces and the suitability of the proposed technology. The researcher attempts to fully understand the basis on which the farmer makes his decisions, how the decisions fit into the household objectives.

Some have stated that farming systems research is not new, that it is farm management work that was in vogue in the United States several decades ago (7). But there are differences in the farm management studies and FSR. First, farm management did not attempt to alter the system, but, given the resources of the farmer, to get maximum profit from various enterprises. There were few attempts to develop technology to overcome problems faced by the farmer. Farm management has focused on selection of the most profitable combination of enterprises (farm) given existing technology. FSR seeks to bring innovations into the farm system - innovations that are appropriate to the farmer as well as accessible.

As a result of farmer participation, new phrases have originated to describe the research process. FSR has been described as "bottom-up" or "downstream" research. "Bottom-up" refers to farmer participation in identifying technologies appropriate to himself or similar farmers. "Downstream" refers to adoption of agricultural technologies to improve target group production in a specific location for the short run (7). Research that is discipline-oriented is said to be topdown, i.e., the researcher working in isolation develops new technology and disseminates it for adoption. He decides if his research will assist in solving farm problems. Hopefully conventional research results will be picked by extension specialist who will try to get it adopted by the farmer. As can be seen, this procedure is different from what FSR does.

FSR STAGES

FSR has four distinct stages. The first stage is the diagnostic stage or survey stage. The second stage is the technology design stage. Farmer field testing occurs in the third stage. Finally, in the fourth stage, the evaluation and dissemination of technology takes place.

1. Diagnostic and Survey Stage

During the diagnostic and survey stage, the researcher attempts to learn as much as possible about the farmer and his system, and to identify problems faced by the farmer. Ideally, the FSR team obtains data from secondary sources and makes a brief survey of the research site. Secondary data can be used to make preliminary analysis of the socio-economic conditions within the region, and make preliminary decisions of what is needed in the region. However, secondary data are often inadequate. Thus, rapid surveys need to be done to supplement secondary sources. These studies are fairly short and often informal. The idea is to identify needs without spending years pouring over large quantities of date that may be obsolete before it is analyzed.[1] Secondary data, the diagnostic survey, and other data obtained over the first year of the FSR program can serve as a baseline against which some evaluation can be made later.

---

[1]In practice, the survey stage may go beyond the short-term period. However, preliminary results need to be presented early in the research cycle. Longer term analysis can assist in making adjustments and modifications throughout the cycle, and provide a more accurate baseline for evaluation.

2. Design Stage

During the design stage, it is expected that those technologies that are suitable for a particular site should be considered. There are two approaches to making this determination. One FSR groups advocates identifying those constraints that are found in the diagnostic stage and developing technology to overcome these constraints (7, 8). Other groups advocate identifying technolocy that is transferable from other communities and research stations and, then using them in the on-farm testing stage (7, 8). In any case, the technology must be compatible with all of the needs of the farmer, including the community norms, beliefs, cultural values as well as with the agronomic relationships that exist on the farm and the consumption relationships that exist in the household. Both approaches require on-farm testing of the selected or created technology.

3. Testing Stage

During the on-farm field test, several approaches to management of the research are used. They are either farmer managed or researcher managed or a combination of farmer-researcher managed tests. The researcher-managed tests assures the researcher that all of the cultural practices and inputs follow recommendations that are wanted. He can suggest when to plant, weed, and harvest; how much fertilizer, insecticides, etc., to use. At the same time, the researcher can better evaluate the applicability of his technology to actual farmer's conditions. One danger, however, is that the experiment can be controlled too much by the researcher, that it merely becomes research on the farmer's field. In an attempt to get the best possible results, the needs of the farmer may be overlooked by the researcher (4, 8, 9).

The farmer-managed tests gives the researcher the opportunity to see the farmers' reaction to the new technology. The FSR team serves as an advisor, furnish the test items (seed, fertilizer, etc.), and observes the result. Although explanations are made on cultural procedures, the farmers run the experiment independently. The advantage of this approach is that deviations and adjustments can be made. In this case, test results are more likely to duplicate results that would have been obtained had the technology been disseminated. Some scientists frown on these results because they are not controlled experimentation (3, 8, 9).

The combined researcher-farmer-managed trials are useful for testing technology under a range of conditions. The trials are often limited to a single factor (8). Researchers are able to obtain impact of various factors (e.g. labor) on the technology, and what adjustment could be made. The three types of trials may be viewed as a continum. Early in the research, the trials may be researcher-managed, then more farmer participation is sought, until finally the farmer alone manages the tests.

4. Evaluation and Dissemination Stage

The last stage is sometimes separated into evaluation and extension rather than treating them jointly. Indeed, attempts to evaluate and adjust technology occurs throughout the research process. However, continual adjustment is more appropriately a part of feedback and monitoring in the testing stage. Indeed ICTA feels FSR generated technology is not successful unless and until it is adopted on a large scale by the target farmers (5). Thus, evaluation has to center on the rate of adoption of technology, i.e., how successful the technology will be, how well it meets the needs of the farmers, and thus is adopted. The evaluation is tied to all steps in the research process and is constantly repeated. From data collection and analysis along with information from constantly monitoring the research, a baseline against which comparisons of improvements in the system can be established. Generally, most FSR research does not use the entire farm to carry out the experiment. Only a portion is set aside. This portion can become an evaluation plot as well as demonstration plot for dissemination. The farmer uses the new technology in the test plot, and yield is compared to the rest of his land. The farmer immediately knows the difference in yields and can recommend to neighboring farmers the practices.

The dissemination of technology can occur through the farmer as well as the extension service. The farmer test sites, if successful, could provide a demonstration for all farmers in the region. Other farmers may observe the one in the test to determine whether or not to adopt the technology. Thus the selection of the participating farmer could be important to the dissemination of the technology. He should be a leader, an innovator, and one that has the respect of the community. If he is successful, others will follow.

Following Hildebrand's (5) recommendation that the final evaluation should be based on the acceptability of the technology, dissemination is extremely important. Although little has been said about extension up to now, that should not be taken to mean that extension should enter only at this point. With the traditional experiment station research, extension would be responsible for dissemination only. FSR is believed to have an advantage here in that the extension service has been involved as an integral part throughout the project. Extension workers should have a knowledge of the FSR process and be actively involved in site selection, supervision of tests, and provide feedback to the researcher. The traditionally extensionist's role of a disseminator of information, will continue in FSR. The agent can organize field days for other farmers to see the test results. He can assist in developing packages to "market" the new technology to other farmers in the region. By the agents knowledge and understanding the farmers, their limitations, values, community norms, they can prepare a package suitable to a particular community. In other words, the extension agent's role is supportive during the early activities (5) takes on major responsibilities during multilocational testing and pilot production, and is widespread during diffusion. The importance of extension is highlighted by realizing that research's ultimate payoff is broad farmer acceptance of the new technologies it produces (8).

There are two approaches to using extension in FSR: (1) building extension as a part of the FSR program; (2) using the existing extension service. In both approaches, extension agents must be trained as part of the preparation for introducing FSR. Regardless of approach, extension plays a vital role in disseminating the FSR technology to the target population.

FSR AND TRADITIONAL RESEARCH

The primary purposes of FSR are to increase the productivity of small farmers and to develop new technologies that are acceptable to the farmer family and compatible with the farmer's system given his constraints and resources. FSR can complement traditional research in the development and testing of such technology. It is not designed to replace the traditional experiment station research. There is still a great need to develop new crop varieties, to improve livestock breeds, to perfect fertilizer and insecticides, and to develop appropriate machinery for the agricultural sector. What the FSR process can do is to transfer these ideas to the farmers prior to completion of the station research. Thus feedback can begin early, and the station researcher may know whether it is an acceptable technology, and is suitable for the environment for which it is designed.

The FSR approach may be viewed as "applied research" while traditional experiment station research may be viewed as "basic research". While there are no definite differences, this distinction may generally hold. The development of new varieties and improved varieties can be better controlled in the research stations rather than on farmer fields where, e.g., cross-fertilization can occur. The selection of strains, development of hybrids, and cross breeding of varieties to other species require close control of fertilization. The development of traits and characteristics that the plant breeder is looking for may not be readily controlled in the farmer fields. The experiment station, therefore, plays and will continue to play an important role in the development of technology. Breeding crops and livestock eventually involves a narrowing of the genetic base as improvements are made and genetic factors are isolated. Thus the experiment station researcher will continue in their efforts to improve yields, increase disease resistance, and to reduce pests. Further, as technology is transferred from other parts of the world, initial testing could be done at the experiment station before dissemination for farmer testing.

Some practitioners advocate joint efforts of research programs (4). The basic developmental work could be carried out in the developed countries (U.S., Western Europe, etc.) or the international research centers. The applied research could be conducted by the LDC research organizations. This dual effort is said to be cost efficient since national programs can develop site specific models of the technology developed elsewhere. This procedure presumes that the technology needs of the country specific programs are being developed in alternative locations.

ADVANTAGES OF FARMING SYSTEMS RESEARCH

The advantages of FSR are several (1). First, it can avoid the wasted expenditure of several years of time and effort at the experiment station and can increase the probability of successful adoption and results before involving farmers. An example of this can be seen from a Nigerian experiment (6). In the northern region, cotton is planted after food crops. An improved cotton package was developed at Ahmadu Bello University. However, it required earlier planting in sole stands, fertilizer and six applications of insecticides each with 225 liters of water per hectare. The returns from the improved cotton package were considerably higher. However, the labor inputs were also higher. Further, because of earlier planting dates of the improved cotton, a conflict resulted, farmers were forced to make the choice, planting cotton or planting food crops. Since most small farmers are subsistence farmers, they choose to plant food crops, rejecting the improved cotton package. The labor requirement for transporting water, plus the conflicting labor demands between cotton and food crops lead to the failure to adopt the new technology.

In another example from the Central Zone of Tanzania, largely a semi-arid zone, averaging less than 500 mm of water per year where although maize is grown, millets and sorghums are widespread.[2] A new millet variety with potential to increase yields substantially was developed at the Kilosa Research Station. After some early successes with adoption, the number of farmers using the new variety declined significantly. Further investigation found that the new variety had poor storage qualities. It was much more susceptible to pest damage during storage than traditional varieties. Nearly all of the crop was lost during storage, and shortages of food occurred before the new planting season.

In both examples, a FSR approach may have identified problems that could have been overcome prior to the general release of the improved variety. Years spent in developing the variety were lost and additional time had to be spent developing varieties that were compatible with the farmers' needs.

Experiment station research is conducted under ideal conditions. In many cases, the station is located on the most fertile soil, with adequate fertilizers, chemicals and other supplies. These ideal conditions often do not approach the realities that exist in the farmer fields. Predictions and estimates of yields are based upon station results, and farmers are disappointed at much lower actual yields. Farmer-testing until realistic conditions are likely, give better estimates of potential benefits to farmer while at the same time demonstrating farmer capability to handle the technology.

---

[2]This example was based on personal discussion of the millet project with researchers at the Kilosa Station.

Another advantage of farmer testing is the continuous feedback enabling the practitioners to modify the research design as needed. They can bring in new techniques as needed instead of waiting until later. An example here comes from the CIMMYT program (2). Researchers in one country observed that farmers regularly strip the lower leaves from the maize stalk for breeding animals. They recommended against the practice because they found that leaf stripping tended to lower yields significantly. They were also working on new varieties of maize with shorter stalks and fewer leaves. However, with the new variety, leaf stripping leads to significantly lower yields in the station tests. Conducting experiments using farmers' timing and method of leaf-stripping, they found little effect on yields indigenous of varieties. Realizing the value of leaves for use on livestock feed, and the potential yield-loss of stripping, researchers now knew how much the improved varieties must increase yield before farmers adopt the varieties that have limited tolerance of stripping. Clearly, better understanding of the farmers' technique and of how the maize plant fits into the entire farm system assisted in developing a variety more suitable to adoption.

Another advantage of FSR is that the research can focus on problems that are important to the farmer and not just on problems that satisfy the researcher's intellectual curiosity. A good relationship can be established with the farmer that will help in future research and testing. If a farmer feels that he is being helped and that problems affecting him are being studied, he may be more willing to cooperate in the research process.

A final advantage of FSR is to identify possible policies that affect the adoption of new technology. If prices are not sufficiently high to pay for the new technology and yield some profits, the farmer may not adopt the technology, regardless of how appropriate (see Elterich and Brautigam, this volume). Other limitations faced by the farmer can also be determined, e.g., does the infrastructure exist to support the new technology? Are these problems in distribution of inputs? The actual field-testing of technology can help identify problems that the farmer in a given location will face as dissemination occurs.

FSR AND INFRASTRUCTURE

A brief comment is needed about infrastructure in the LDCs. One of the characteristics of the farming system approach is to fully understand all constraints facing the farmer and to develop appropriate technology designed to overcome those constraints. It is very easy to overlook an important part of the system - namely marketing. Normally, the problems of infrastructure's impact are considered to be less severe in FSR approach than in traditional research. The reason is that FSR accounts for these constraints in the development of the technology. The chief reason for adoption of technology is to improve productivity and to increase yields. Most small farmers are subsistence farmers, consuming as much as 80 percent or more of what they produce. If the new technology is successful, and yields do increase substantially, much of the surplus may not reach the market, for distribution to the cities and to areas where deficits occur. Furthermore, the lack of roads, trucks, and gasoline needed to distribute inputs during planting season may lead to low technology adoption rates. The FSR practitioner must consider infrastructure for both provisions and the handling of surplus production. There is a need for storage, for assembly points, and for trucking of goods to market. Even though the basic concept of FSR is to improve the productivity and level of living for small farmers, much of the efforts may go for naught if in fact inputs are not provided and/or production is increased, and the surplus cannot get to market. The FSR practitioner cannot work in isolation from other sectors. At the time the FSR practitioner is working to improve yields, some attempt to improve infrastructure will have to be made.

CONCLUSIONS

Farming systems research has an important role to play in the development and diffusion of appropriate technology. It seeks to fully understand the farmer's system and community values, and to plan technology appropriate to that system. It is not a panacea; it should not work totally in isolation of experiment stations and of other development activities in the community. FSR, however, is an approach to reach the small farmer who may be outside the traditional system and was reluctant to adopt technology in the past. A better understanding of the small farmer, the farmer's problems, the farmer's constraints will lead to the development of appropriate technology.

Many questions still have to answered. Among them are:

(1) Is FSR workable in all LDC's? Are there some that do not have a base on which to build a FSR system?

(2) How expensive is FSR? FSR is site-specific. It requires a multidisciplinary team working with small farmers. What are the relative costs and benefits of using the FSR approach?

(3) How should FSR be organized? Should it be made up of existing institutions or stand on its own? What should be the links between FSR and other agricultural development programs?

(4) Are FSR results transferable? Can the lessons and approaches learned in one country be of benefit to another country?

REFERENCES

(1) Bradford, Stillman. "Appropriate Methodology for Appropriate Technology." Paper Presented at the American Society of Agronomy Meeting, Chicago, December, 1978.

(2) CIMMYT. "Planning Technologies Appropriate to Farmers: Concepts and Procedures," Economic Program, Mexico, 1980.

(3) Collinson, M.P. "The Exploratory Survey: Content, Methods and Detailed Guidelines to Discussion with Farmers," CIMMYT Farming Systems Newsletter, Nairobi, Kenya, June, 1981.

(4) Goldman, Richard H. "The Role of On-Farm Testing and Evaluation in Agricultural Research and Policy Management." Paper Presented at Ford Foundation Agricultural Staff Workshop, Yogyakarta, Indonesia, November, 1979.

(5) Hildebrand, Peter E. "A Multidisciplinary Methodology for Generating New Technology for Small, Traditional Farmers," ICTA, Guatemala, July, 1976.

(6) Norman, David. "The Farming Systems Approach: Relevancy for the Small Farmers," MSU Rural Development Series Paper No. 5, Department of Agricultural Economics, Michigan State University, East Lansing 1980.

(7) Rohrback, David. "Issues in Developing and Implementing on Farming Systems Research Program," USDA, Office of International Cooperation and Development, USGPO, Washington, D.C., September, 1981.

(8) Shaner, W.W., Philip, P.F. and Schmehl, W.R. "Farming Systems Research and Development," Vol. 1 and 2, Consortium for International Development, Tucson, August, 1981.

(9) Whyte, William F. "Participatory Approaches to Agricultural Research and Development: A State of the Art Paper," Rural Development Committee, Center for International Studies, Cornell University, 1981.

WHEN THE YOUNG MEN LEAVE AND THE OLD RETURN:
DEVELOPMENT POLICY IN AN AREA OF INTENSE OUTMIGRATION,
THE UPPER SENEGAL RIVER VALLEY

ABSTRACT

This paper explores the impact of intense male outmigration from the Senegal River Basin on attempts to develop the economy of the river valley. It traces the depth and persistance of outmigration despite efforts to control or reverse it by both sending countries (Senegal, Mali, and Mauritania) and the main receiving country, France. Prospects for reversing the flow through development of the homeland are poor, although over $1 billion in investments is scheduled for dams and irrigation. In spite of the problems created for families, communities, and development planners by absences, the balance sheet on outmigration has a positive side. Returned migrants are contributing initiative, capital, and organizational skills to irrigation and related new economic activities. The presence of migrants from the basin in distant national capitals also creates social and political ties to national governments, giving impetus to development plans for their home territory.

<u>WHEN THE YOUNG MEN LEAVE AND THE OLD RETURN:</u>

<u>DEVELOPMENT POLICY IN AN AREA OF INTENSE OUTMIGRATION,</u>

<u>THE UPPER SENEGAL RIVER VALLEY</u>

Lucie Gallistel Colvin
University of Maryland

Can the economic development of the Senegal River Basin, long a neglected border area of Senegal, Mauritania and Mali, reverse its high rates of out-migration? Can economic development even take place once this pattern is established, and a majority of the most dynamic members of the community are absent? These are familiar questions in developing countries, where <u>most</u> rural areas experience outmigration,* and development policies and projects typically list as one of their goals a reduction of the rural exodus. The Soninke area of the upper Senegal is an extreme case in a number of ways -- the distance and time involved in emigration, the scale of the opportunity gap between homeland and destination, cultural contrast between Soninke and French society, and perhaps most interestingly, the magnitude of the Senegal River Basin development effort recently focused on the homeland.

Among the Soninke of the upper Senegal River Valley a man proves himself by making his way to France in his early twenties and working until he has saved enough to take a wife, on average seven years for a first stint. After a year or two of married life and starting a family, he returns to France, now into a cycle of work and home visits likely to last most of his working

---

*<u>Outmigration</u> and inmigration are used here for departures and arrivals in general, including citizens moving from one department to another within one country, as well as international migrants. <u>Immigration</u> and <u>emigration</u> refer specifically to those moving beyond natural boundaries.

years. Those who never make it to France linger in Dakar or Nouakchott, Nouadhibou or Bamako, working at whatever petty trade or service they can find, ashamed to return home empty handed. Tukulor men from neighboring villages also leave to look for jobs, but France is an option for only a small proportion, the majority preferring to "try their luck"* nearer by in Dakar or the secondary cities of the region.

Because the Senegal River Basin is an extreme case, the answers this area is beginning to suggest as to the relationship between outmigration and development are appearing earlier and more clearly than in many other areas of Africa. They suggest a negative answer to the hope of reversing the rural exodus through rural development in the next few decades. Yet a positive one to the possibility of economic change and growth in the homeland, drawing on the positive aspects of migrant experiences and coping with the problems of continued outmigration.

In looking at the prospects for development in an area of outmigration, this paper will also suggest a new approach to planning and evaluation in such areas. Less reliance will be put on statistical volume of outmigration as an index of either development potential or project success, and more attention suggested to the historical phases of the migration process and the dynamics of communities that have institutionalized migration in different ways. Mature streams of outmigration, those that have continued for more than one generation, show new patterns of adaptation, mitigating the most severe problems experienced in the first phase by both migrants and the home community. The choices made and patterns emerging at that point become

*Trying one's luck is the universal colloquial phrase for the migration experience. It connotes both the hesitancy with which a young man leaves his family and village for a harsher reality, and an almost Odyssean sense of quest for one's personal destiny.

crucial to the prospects for development in the homeland. For instance remittances, the money typically sent home by the first generation may dwindle as later migrants spend more on themselves and bring families to join them. Or money may continue to be repatriated, and be oriented less toward prestigious consumption and more towards productive investments. The few migrants who return may look on their situation as retirement or unemployment, and encourage a disdain for manual labor in their home community. Or they may start new projects at home, introducing the work discipline learned punching a time card and technological and organizational sophistication gained abroad. In the long term, another important factor is the extent to which political energies are expended in distant centers (either work-place or national capital) as opposed to focusing on development of the homeland.

Migrant labor has been one of the outstanding characteristics of the transition to capitalist economies, beginning with the British enclosures movement and in the 20th century extending increasingly to a movement from underdeveloped countries to developed. Studies of the process of migration and of the consequences for the areas of in and outmigration have therefore a long history. The analysis of causes of outmigration typically focus on "push" factors, the economic stagnation or decline of the area of origin, and "pull" factors, the higher incomes, more jobs, and better amenities in poles of attraction (urban areas, cash crop zones and developed countries). Labor migration always reflects unequal geographic patterns of development. In Africa there is a more specific pattern in which capital cities have been the major poles of attraction, and these are in turn surrounded by cash crop zones which also attract migrants and develop a fairly dense population.

The outlying areas have become a neglected hinterland, and zone of outmigration. This pattern within nations also extends beyond national boundaries. There are actually four major poles of attraction in West Africa today in descending order of importance: Ivory Coast, Nigeria, Senegal and Sierra Leone. Land-locked nations (Upper Volta, Mali and Niger) and those in economic disarray (Ghana, Guinea) have become substantial net exporters of manpower.

In a recent collaborative study the author and a team of Senegalese scholars traced the historic and geographic evolution of this pattern in the Senegal and Gambia River basin areas.[1] This allows us to see the outmigration of the Soninke as a pattern of exodus from border areas in general. Young men from all ethnic groups in the Senegal River Valley migrate out of the area.[2] The Soninke are unique only in that they typically go to France, where they constitute 7 of every 10 African immigrants and their Tukulor neighbors are another 1/10th.[3] The majority of Tukulor, Wolof, and Moor emigrants from the Basin make their way to Dakar, or one of the smaller cities of the region.[4]

Discussion of the consequences of migration have focused on the problems it causes for individuals, families, and both sending and receiving communities. Despite negative political and social reactions to immigrants, the economic consequences of migration are generally assessed as positive for the area of inmigration. It benefits from cheap stable (not unionized) labor, willing to work at jobs disdained by local citizens, and having fewer dependents. Even the extent to which migrants compete with local workers for jobs has been seriously challenged by economic analysis.[5]

In contrast, economic analysis of the impact of outmigration on sending areas is universally gloomy. Jonathan Power after surveying the recent labor migration to Europe and the United States concludes that areas of outmigration have bleak economic prospects over the long term, and cites the Irish experience as an example.[6] He notes that even though sending countries and communities often encourage migrants in anticipation of the money they will return, the remittances are rarely spent on productive investments and even that they contribute little to balance of payments deficits since they are spent largely on imported consumer goods.

Looking more specifically at West Africa, Jacques Bugnicourt reaches similarly negative conclusions as to the impact on zones of outmigration.[7] He notes that sending areas tend to lose their most dynamic workers and in some cases more than half of their active-aged (15-64) male population. Remittances, he writes, tend to accelerate the penetration of the monetary economy, facilitate the collection of taxes, promote the consumption of imported goods, encourage the monetization of human relationships including wage labor, and inflate the local prices of bride wealth, housing and land. He claims that the apparent increase in economic activity that remittances stimulate translates too often into an increase in commerce, which is largely in foreign hands, and into non-productive savings. He explores the psychological impact of migrants stories and behavior upon their return, remarking a dissociation between work and income and the impression in the local community that luck is more significant for success. Bugnicourt argues that the work experience overseas rarely transfers usefully back to the home area. Many emigrants work in factories (of which there are none in the Upper Senegal River Basin), or as cooks, which is a woman's role at home. Even for those few who work in agriculture, the French agricultural experiences are ill-adapted to local conditions. He observes overall a severe loss of social dynamism, and frequently the emergence of regionalist political consciousness or even separatism arising out of migration related frustrations.

Such a picture would not bode well for the multi-million dollar Senegal River Basin development scheme currently being launched by the Governments of Senegal, Mauritania and Mali and a consortium of international donors. Indeed a decade ago when Soninke and Tukulor societies fit this portrait to the last detail, the appropriateness and feasibility of investment on a large scale in irrigated agricultural development would have been questionable. But in the last five years irrigation projects have been launched in over three hundred villages in the Middle Valley (Dagana/Rosso to Matam/Kaedi) and Upper River (Bakel/Gourayes-Kayes-Bafoulabe). This paper looks at the role of returned migrants and migration-related capital in bringing about the technological and organizational changes this development entails, as well as the problems associated with continuing outmigration.

Outmigration in the Senegal River Basin began dramatically with the colonial conquest, these wars lasted in the river basin from 1855 through 1890, and pitted the Islamic holy warrior al-Hajj Umar Tall against the French intruders. Until that time the river basin had been a zone of inmigration for centuries. People were attracted to it by the variety of resources and opportunities it offered in comparison to the dry surrounding plains: water supply, two cropping seasons, fish, flood recession pasture lands, game, and an avenue for long distance trade.

The Tukulor are believed to be among the earliest inhabitants of the river basin, having moved in from the north as the Sahara desert expanded and built the empire of Tekrur which flourished in the ninth through eleventh centuries. The Soninke were also among the peoples attracted to the River Basin. They moved down as colonists from their famous empire of Wagadu to the northwest (better known as Ghana) as part of a trade diaspora in the 10th through 13th centuries when the empire was at its peak. They continued to trade and colonize trade routes all over the Senegal and Gambia river basin areas in subsequent centuries, even after their empire had been eclipsed by the more powerful Mali and Songhai. Both they and their Tukulor neighbors became pilots and crewmen in the flotilla of French trading boats which mounted the river to the Bakel area every year during the flood season (August - November).

The colonial conquest set off two types of outmigration one immediate and massive and the other slower and long term. The first wave were Tukulor soldiers recruited into the army of al-Hajj Umar from the 1850s on. While statistical estimates are difficult if not impossible, contemporary accounts suggest that the emigration to join al-Hajj Umar affected more than half the adult male population of Futa Toro (the Tukulor homeland), and was devastating in its consequences both for those who left and for those left behind.

In the last years of the colonial conquest, from 1885-87 the Soninke experienced their own Islamic revolution, under the leadership of al-Hajj Mamadu Lamin Drame, a former disciple of al-Hajj Umar. Overthrowing both Tukulor overlordship and French domination, Mamadu Lamin led the Soninke in their moment of glory in 1885 and 1886. But the following year he was forced to retreat to the Gambia and killed.

Once colonial administrations were installed the long slow process of individual outmigration began. The Senegal River was suddenly a border instead of the main trade route, and Bordeaux commercial firms drove Soninke and Tukulor merchants out of their traditional roles. The Upper River basin was divided among three separate French administrative territories: the

Protectorate of Senegal, the military territory of Mauritania, and the French Soudan (now Mali). And the administrations resolved to force people into the cash economy as rapidly as possible, through the imposition of a cash head tax. This obliged every family to either grow a cash crop (in Senegal peanuts), sell some major capital item (cattle or jewelry), earn cash trading in the dry season, or work for the Europeans. To do any of these except sell family capital one had to leave the river basin. Forced labor also started some on the path to migrant labor. River villages had to provide porters, boatmen, haulers, and construction workers for public works and the railroad.

Colonial rule also transformed the patterns of labor and occupational distribution in Senegambian societies, particularly in the centralized and highly stratified Tukulor and Soninke societies. The top and bottom were most immediately and radically affected. The ruling elite were eliminated by the conquest itself, as most of their jobs ceased to exist and they were destituted, or, at best, made junior administrators in a colonial hierarchy. Village labor organization was further disrupted by the 1905 announcement of the end of slavery. Over half the population of the river basin was of slave status. Soninke and Tukulor families responded to outlawing of slavery by transforming the system into a sharecropping arrangement. But many former slaves left in order to make their freedom real. Often they went to work as seasonal client farmers (nawetanes) in the peanut growing zone, located along the Dakar-Saint Louis and Dakar-Bamako rail lines. Frequently they found the sons of nobles working alongside, sent to earn the family's tax payment.

The railroad was the seal of doom in the Senegal river basin. It became the central trade route, and traders abandoned the river. The port of Dakar supplanted the port of Saint Louis. Cash cropping (peanuts and cotton) had flourished here in the nineteenth century, but the upper river basin was now too distant from the developing markets of the Dakar area to compete with areas along the rail line.

A small but historically important number of Soninke and Tukulor make the transition from Senegal river boatmen to service in the French navy in World War I and II and in the French merchant Marines. After participating in the liberation of France in 1945 a few settled and found work in the post-war economy, mainly around Marseilles. As the economy began to recover in the 1950s the demand for migrant labor grew rapidly. The majority of the migrant workers in France were North African and Portuguese, followed numerically by Spanish, Italians, Yugoslavs and Turks.

Black Africans were a tiny minority until the Algerian War (1952-58). Employers and North African migrants developed tensions, and a recruitment of Soninke began in the mid-1950s. Village level data from three recent studies agree in dating the latest upsurge in emigration to this recruitment campaign of 1957 to 1963.[8] The first wave of migrants were in their twenties and thirties, a few in their forties. As the pattern of migration became established in the 1960s and 1970s the median age of first departure has moved to 20 years; now about 90% of the first departures take place in the 15-24 age group.[9]

Tukulor outmigration from the river valley began to accelerate at exactly the same time. However, whereas more than 80% of Soninke have France as their destination, the Tukulor preference has been for Dakar and the peanut basin. Today more than 1 in 3 Tukulor live in Dakar and more than 2 out of 3 live somewhere outside of the river basin homeland.[10]

Outmigration affects a similar proportion of Soninke, with an overall average of 30% of active age males absent at any given time, over 80% emigrating at one point during their lifetime, and more than half of the 15-25 year olds absent at present.[11] Geographer Andre Lericollais developed maps showing: 1) substantial variation in absentee rates from different villages of the Soninke area; and 2) the distribution of emigration to France along the river valley and its concentration among the Soninke. (see fn. 2)

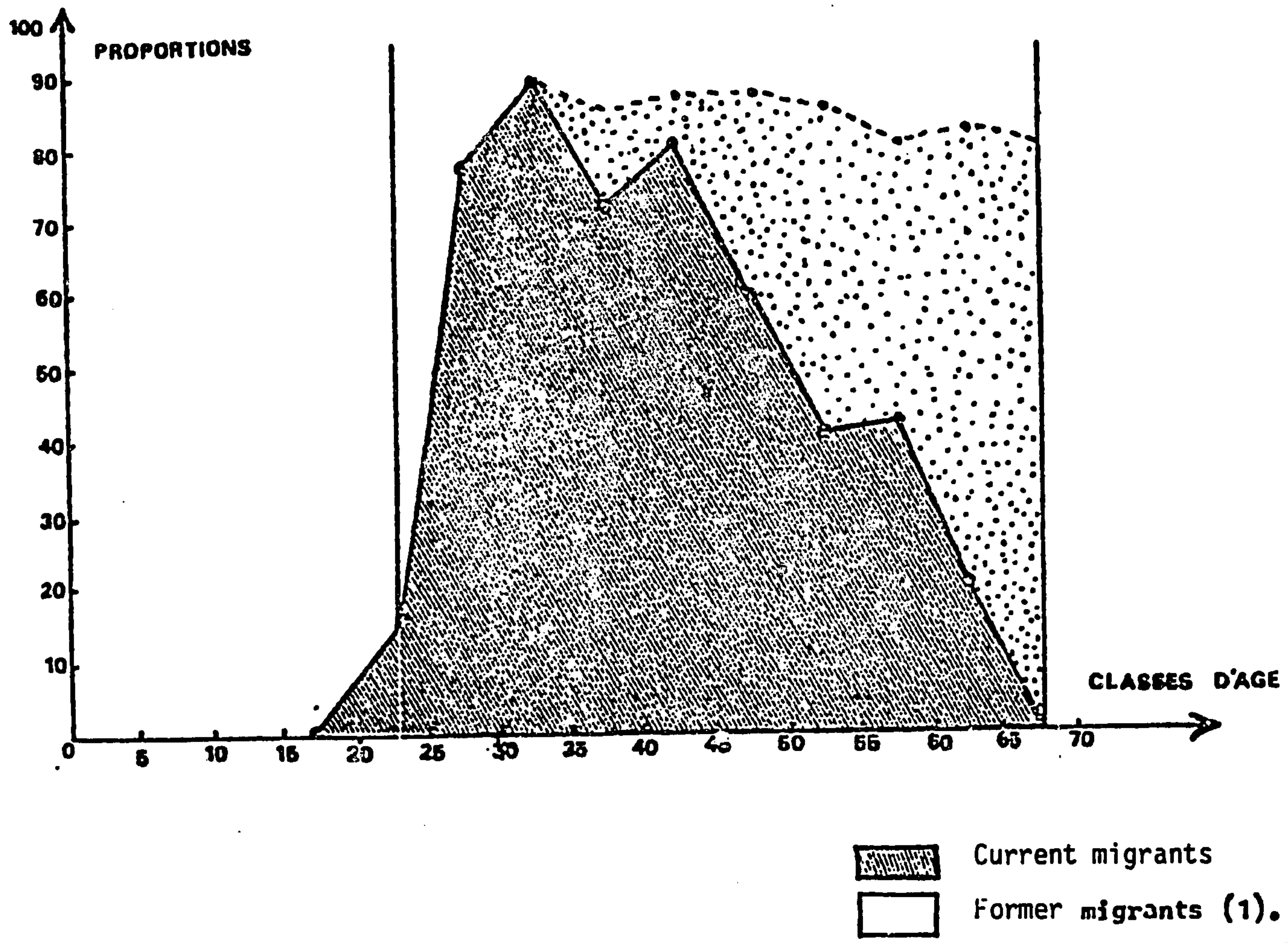
Another substantial difference between the two types of migrations is in marital arrangements. While the vast majority of the emigrants to both France and other areas of Senegal are married (80% of the total and virtually all men over the age of 30), only 5% of the Soninke bring their wives to live with them in France, while the majority of Tukulor outmigrants eventually send for their wives and children.[12] Thus the Tukulor children grow up in Dakar or elsewhere, while the Soninke children stay home until they are old enough to leave on their own. Part of the reason for this is that the government of France has subjected African emigration to increasingly tight legal control and made it difficult for wives to join their husbands. An additional reason is the determination to save, which is hard to do with a family in France.

Statistics from all Soninke areas studied show that the increasing legal obstacles to immigration in France have not slowed outmigration. The number of departures has continued to accelerate. Those who are arrested as illegal emigrants and sent back to Dakar merely await their next opportunity to return. And some are finding new destinations in Libya, the Middle East, or other African countries. Moreover, the stop and search policy of the Giscardian regime provoked embarrassed outcry at home (and Senegalese reprisal against expatriates in Senegal). The Socialists recently announced that identity checks would stop.

The typical pattern for emigration historically is to begin as seasonal departure, change to a temporary emigration for a period of a few years, and gradually become long term or definitive. There are important variations in this between the Tukulor and the Soninke based primarily on the difference in destination. Only a small proportion of Soninke are retired, married, or otherwise definitively established in France, whereas the majority of Tukulor outemigrants tend gradually to resettle. Figure 1 showing proportions of former migrants and of current migrants by age group, prepared by Weigel and reproduced here, shows that Soninke men are tending to stay away until retirement age (at age 55-60 40% of the total male cohort [half of those that ever emigrated] are still overseas, and 20% of those aged 60-65 are still absent.) The Figure also shows a substantial proporation of returned migrants among the resident population. It is these migrants who as agents of change interest us in this paper.

The wave of outmigration in the late 1950s coincides exactly with a major socio-economic study of the river basin.[13] The portrait that it paints of the river valley allows us to understand the conditions in which outmigration swelled. Independence was approaching, and people wanted their economic position to improve. Yet the river valley was still far from the zones in which cash circulated regularly. The money that went into the river valley was like an ink drop surrounded by wide areas with no market economy. Remittances went into construction of housing and mosques, the purchase of jewelry, and the building of a herd of cattle. There was no point in investing it in agriculture, since there were inadequate men to work the land and no facilities for marketing any surplus that might be produced. On the contrary, part of the money was generally used to purchase food, or hire labor to grow it, for the family left behind.

Figure 1. Proportions of Migrants and Returned Migrants by Age Group.



(1) Migrants who have returned for good.

Source: Wiegel, p. 42.

During that time, and in fact until the late 1970s the valley was almost inaccessible. Camel caravans were the main overland contact except during four months in the late dry season when trucks and jeeps could take the tracks running along either bank of the river. Piroques from Saint Louis could reach Bakel and Kayes during the flood, but the annual arrival of trading fleets had stopped in the 1920s when the railroad was completed. During the rest of the year canoes could circulate only short distances. What consumer goods were in evidence generally had been purchased in Dakar or even France, and opportunities for local purchases were minimal. The diet was limited to millet, sorgum, niebe beans, beref, okra, corn, peanuts, milk, fish, very rarely meat, wild leaves and local fruit. Gasoline was available only at deports so far apart that trips had to be planned around them, and repairs were difficult or impossible, so that vehicles occasionally had to be abandoned.

The drought of 1968-73 struck at a time when frustration over this situation was running high among emigrants, who had watched governments' investments during the first decade of independence go largely into their respective capital city areas. The difficulty that all three national governments experienced in delivering relief food supplies to the Upper River became an embarrassment and a source of reproach. Both locals and emigrants protested energetically. In the space of five years half of the large livestock in the area died, the rainfed fields and pastures along the river bank turned to desert in the middle valley (but not the Upper River), a large proportion of the flood plain lands became useless because the flood was so meager, families rationed themselves to one meal or less per day, and starving refugees flocked to the towns. Pastoralists began staying out of the River Valley, since their flood plain pastures had disappeared.

The rainfall and ecology of the river valley have not returned to normal since the drought, but people have made substantial progress in adopting new strategies. Irrigation is the key element in the change.

Irrigation had already been tried in the Senegal river basin, mainly in the Delta from the 1950s on, and had not been notably successful. It had been introduced by outside firms, either private or state sponsored, on large projects constructed and tilled by machinery. Farmers on these schemes became little more than integers in the production process. The land had been appropriated without compensation to the owners, and many of those to whom it was distributed were recruited from outside the area. Farmers were presented with a complete package of inputs and a marketing monopoly at fixed prices. They had no say in the decision making processes. They came to see themselves as subsistence farmers, and yields were low. The great majority of farmers soon became chronically indebted to the state development corporations (SAED* in Senegal and SONADER* in Mauritania).

At the height of the drought two pilot perimeters were started in villages near Matam using a totally different approach. Villages, with former emigrants in the lead, organized their own cooperatives and by hand did the canals and levelling necessary for small irrigated plots near the village. With the guidance of the French technicians and the initial capital input necessary for the first pump provided by the French, they were still able to keep control of essential decisions, including where and how and when to build, what crops to plant, and how to organize the marketing. Their first season was in 1972 just as the drought reached its worst, and news of their success

*Société pour l'Aménagement et l'Exploitation des terres du Delta (SAED); Société National du Dévelopment Rural (SONADER). Mali's equivalent, the Operation de la vallée du Sénégal, Terekolé - Magui (OVSTM), was not organized until 1980.

spread instantly up and down the river. In 1973 a few new villages in the area initiated projects and by 1974 and 1975 the phenomenon was spreading rapidly through the river valley.

The initiative in almost every case came from outmigrants. Sometimes they organized a cooperative while still overseas. More often returned migrants enlisted fellow villagers. They realized that they had the necessary capital for some of the components of projects in their own savings. They also had access to farm equipment sales outlets, and technical assistance agencies of which their country cousins had never heard. They knew how to work in disciplined teams, to time their work and emphasize efficiency and productivity. And migration had been going on for so long by the time irrigation caught on, that most village chiefs were themselves returned migrants. While the migrant experiences had not eliminated the prerogatives of birth, it has paved the way for more egalitarian approaches at home through familiarity with proletarian ideological tenets in Europe.

Cooperatives and villages all along the river bank have similar rules of organization. There is an initial membership fee as well as an obligation to provide work on the initial construction of canals, fencing or dikes, and the levelling of fields. Those who are not able to work must provide someone to work for them or an equivalent in cash (750-1000 CFA or 200 UM, about $3.00 per day). Later arrivals who ask to join after the initial work is finished can come in only by taking over the plot of a family member who cedes it, or by paying the equivalent of both the membership fee and the work obligation in cash.

As many plots in the project are laid out as there are members of the cooperative, they are distributed by lottery. In some places the owning families who have provided the land are given first choice of plots, larger plots or some other special consideration, but in general this is quite limited. While farmers from landowning families usually lead the cooperatives, the membership comes disproportionately from the land-poor families of caste and slave origin.

Initially plots have been quite small, 8-25 ares (8-25/100 of a hectare). This allows all interested families to participate, and recognizes the capital and work intensive nature of irrigated farming. These plots are large enough to provide drought security to the families involved, who can earn extra cash in the dry season if their rainy season food crops are good, or switch to food crops on irrigated plots if their rainy season harvest was poor. The small size of the plots also reflects the fact that irrigated farming is but one small ingredient in the total economic strategies of river basin farmers, particularly of land owning families. It tends to be a larger part in the economic strategy of land poor families, and in a number of areas groups of hard working farmers of low social status have asked to expand to new and larger fields.

About 20% of the farmers in the river basin currently participate in irrigation in some form. They produce whatever crops allow them an appropriate mixture of food security and cash income. In the Middle Valley they generally plant rice in the rainy season followed by tomatoes, corn, and mixed crops in the dry season. In the Upper River area corn is generally grown in the rainy season, if any irrigation is done at that time (in years of good rainfall rain-fed agriculture is more cost effective in this zone), and corn and fresh vegetables in the dry season.

All along the river valley there are experiment stations testing out improved varieties of fruits, wheat and other grain crops, legumes, and forage crops. But none of these is yet being extensively cultivated. In the delta sugar cane is grown commercially by a French-Lebanese corporation called the Compagnie sucrière sénégalaise, a subsidary of the MIMRAN conglomerate.

Migrants and returned migrants are involved in irrigation cooperatives all along the river valley, but those cooperatives run exclusively by and for migrants (e.g. Sobokou, Samankidi, Danfagabougou, Bafoulabe) have some unique aspects. It is a phenomenon only of migrants to France, hence, predominantly Soninke and in the Upper River. These cooperatives are more tightly disciplined and have higher initial capital input and cash flow. The cooperative at Danfagabougou for example was not able to admit any local residents because villagers were unable to come up with the initial membership fee at the scale set by the migrants. The cooperative at Sobokou set a fine for 5 minutes' lateness on days of cooperative work obligation at 750 francs, the same rate as was charged for a full days absence in most other cooperatives. In other villages 5 minutes lateness would not even be noticed.

Exclusively migrant cooperatives also tend to have a slightly higher level of mechanization, investing for example in small motorized tractors as soon as the pump maintenance and depreciation fund has been established. They also tend to be among the few that are able to stay free from debt. They tend to prefer to get their technical assistance directly from expatriate advisors rather than through state development corporations. The leaders of such cooperatives have explained their versions to government agencies in terms of a desire to maintain control over the development process themselves and to stay free from indebtedness.

In the rush to respond to the drought, there has been conflict over roles between natives of the area, governments, and the international donor community. The crisis served as a catalyst for the decision of the governments in 1972 to form the three-nation Senegal River Basin Development Organization Organisation pour la mise en valeur de la vallee du Senegal (OMVS), committed to build dams to provide year round water flow and control flooding. The coincidence of the drought and the rapid growth of petrodollars in the mid 1970s allowed the project (which had been mooted for more than 20 years), to move rapidly into the committed funding and planning stage. As of March, 1982 there are full funding commitments for a high dam at Manantali providing flood control, year round flow and hydro-electric power as well as a 1½ meter high salt-intrusion dam at Diama in the Delta 40 kilometers from the mouth of the river. The estimated $764 million in construction and related costs have been pledged by Arab and Western donors shown in Table 1. Another $383 million has been committed for downstream development, as shown in Table 2.

On the domestic front the governments expanded the mandates of their respective regional development agencies to the entire river valley, and at the same time reorganized the agencies internally. The extension of SAED and SONADER into the Middle and Upper valleys received a largely negative reaction from villagers and private voluntary organizations already working at small village irrigation projects in the area. As government agents arrived to explain that they were coming to provide training and assistance, they were greeted by village leaders who asserted that their approach was too authoritarian. Residents claimed that the fixed package of inputs and marketing offered by SAED and SONADER simply resulted in taking all control of projects out of villagers hands and leaving them in chronic debt. Furthermore many village leaders criticized SAED for trying to make villagers grow rice when in fact the staple in their own diet was millet. The clash was most extreme at Khoungani, near Bakel, where the cooperative refused to have anything to do with SAED in the spring of 1975, and accused it of coopting the technicians

Table 1. O M V S

Diama and Manantali Dams
Current Status of financial commitments
by donors

		$ (000)
Saudi Arabia		150,000
Kuwait		100,000
Abu Dhabi		40,000
Irak		40,000
Islamic Development Bank		20,000
Federal Republic of Germany		89,333
France (Caisse Centrale de Coopération Economique	46,786	69,972
France (Fonds d'Aide et de Coopération	23,186	
Italy		35,000
European Development Fund		92,700
African Development Bank	33,400	61,480
African Development Fund	28,080	
Canada (25,106 Can. $)		21,158
United Nations Development Programme		10,000
Iran		4,000
TOTAL		763,643

Source: U.S. Agency for International Development, River Basin Development Office, Dakar, Senegal, March 1983.

Table 2.

SENEGAL RIVER BASIN			DOWNSTREAM DEVELOPMENT INVESTMENTS (CY 79 - 82 Levels of Commitment)
COUNTRY	DONOR	AMOUNT ($000)	ACTIVITY
Senegal	IBRD Consortium	51,000	Irrigation IV Project, Delta Region, Large Perimeters, Institutional Development
"	Caisse Centrale	40,000	Irrigation Delta and Middle Basin, Agriculture Credit
"	FED	10,700	Small Perimeters in Delta and Middle Valley
"	Netherlands	6,400	Small Perimeters, Delta and Middle Valley
"	FAC	4,800	SAED Institutional Development, Small Perimeters Middle Valley
"	Japan	4,600	Fisheries Development; Large Delta Perimeters
"	China (PRC)	4,000	Large Perimeter, Middle Valley
"	Kuwait	3,100	Large and small Perimeters Delta Region, SAED Institutional Dev.
"	African Dev. Bank	2,500	Small Perimeters Middle Valley
"	UNDP/FAO	2,000	Agriculture Research on Mechanization
"	Italy	1,500	Land Use Planning Upper Basin
"	20 Other Donors	14,000	Small Perimeters, Food Protection and Storage, Co-Op Development
SUB-TOTAL		144,600	
Mali	Canada	25,000	Integrated Rural Development
"	IBRD	19,600	Primary Health Care and Rural Literacy
"	FAC	5,600	Agriculture Research and Livestock
"	Germany	3,200	Reforestation and Land Use Planning
"	African Dev. Bank	2,000	Rural Water Supply
"	Kuwait	500	Feasibility Studies of Medium Perimeters
"	UNDP/FAO	200	Seed Farm at Ag Research Station
"	PVOs	300	Small Agricultural Projects
SUB-TOTAL		55,200	
MAURITANIA	IBRD	49,000	Small and Large Perimeters, Middle and Upper Valley, Sonader Inst. Dev.
"	Germany	38,000	Delta Perimeters, Ag Training Center, Roads
"	Saudi Arabia	22,800	Delta Large Perimeters, Health, Sonader Institutional Development
"	FED	17,000	Small and Large Mid/Upper Valley Perimeters, Roads
"	FAC	12,500	Small Perimeters Flood Recession Ag, Ag Research, Middle Valley
"	IFAD	16,000	Large Perimeters, Middle Valley
"	Libya	10,000	Large Perimeters Middle Valley
"	Islamic Dev. Bank	6,000	" " " "
"	United Arab Emirates	6,400	" " " "
"	African Dev. Bank	5,500	Large Perimeters and Grain Storage, Middle Valley
"	Netherlands	3,000	Small Perimeters, Middle Valley
"	Caisse Centrale	1,300	Recession Agriculture and Livestock
"	China	N.A.	Primary Health Care
"	Italy	2,000	Irrigation Feasibility Studies, Middle Valley
"	WFP	N.A.	Food and Perimeter Construction, Middle Valley
"	UNDP/FAO	N/A.	Agricultural Training and Research
SUB-TOTAL		183,500	
GRAND-TOTAL		[illegible]3,300	

Source: U.S. Agency for International Development, River Basin Development Office, Dakar, Senegal, January 1983.

that the village had already recruited, forcing them to work for SAED instead of the villagers.[14] In the standoff which ensued, the villagers formed a confederation of villages generally referred to as the Soninke Federation enlisting more than half of the villages in the Bakel zone. A similar confederation of predominantly Tukulor villages, called the Tukulor Federation, has since also been organized. The government has refused to recognize either, which deprives them of legal identity and bars them from signing contracts. While officials have been very circumspect in stating their reasons, they have let it be known that they suspect ethnic particularism in the motivations of the founders. For their part the Federations disclaim all political character and note that their memberships are open to all ethnic groups and devoted exclusively to economic development. In this situation the private voluntary organizations originally financing the projects, CIDR, OXFAM, and War on Want, gradually withdrew from the Bakel area one by one, and USAID began providing technical assistance and financing in the region through a contract with SAED.

Having won the battle, SAED conceded most of the villagers' points in subsequent negotiations. It agreed that the village perimeters could organize according to a collective work mode if they chose, rather than in cooperatives along the SAED model, that they could grow crops of their choice, and market them locally. Villagers on both banks are in theory prohibited from selling their cereal crops across national boundaries, but in fact most of the produce seems to be finding its way into the Kayes region of Mali at present. Until 1981, farmers in Bakel were not allowed to transport their produce across Departmental boundaries for sale, which cut them off from their closest domestic market at Tambacounda. The USAID-funded technical assistant at Bakel for the last five years has operated quite independently of SAED. He is, however, an expert in rice cultivation and has been criticized by the Soninke federation leadership for focusing exclusively on rice at the Bakel project. He has defended his focus, noting that the Bakel project has been financially feasible for participants, and that this year they are opening a new larger project. He notes that now that the government has raised the farm-gate price of rice from 41 francs CFA per kilo to 55 francs CFA per kilo many small village perimeters have begun to take an interest in rice production.

Another government initiative, the paving of roads, along the river bank and improvement of the railroad, has received an uncritical welcome from all concerned. Most villages are still cut off periodically during the rainy season when their access roads flood, but the new road on the Senegalese side had greatly facilitated the repair of pumps and supply of fuel that used to cause frequent crop casualities. Without a road infrastructure, marketing of anything but imperishable cereals was handicapped. Since vegetable and fruit crops are by far the most profitable dry season irrigated produce for farmers, an improved transportation system is essential. The governments of Mali and Mauritania unfortunately are still far from being able to envisage mobilizing the funds necessary for paved roads on their sides of the Upper River area. Both are counting on the year-round navigability hoped for from the Manantali dam to stimulate river traffic. Mali also anticipates substantial upgrading of the Dakar-Bamako railroad in connection with the construction of the Manantali dam. If, as some observers expect, the railroad proved inadequate for the construction firms building the dam and the latter decide to upgrade the road access to the damsite, these road links will go a long way to eliminating the historic isolation of the region.

The already improved transportation network facilitates the functioning of the independent non-governmental initiatives in the area, whether they be village cooperatives, private voluntary organizations, or local merchants. Migrants and return migrants have already within the last few years put substantial investments into transportation enterprises, both river barges, which are rented out, and transport vehicles.

Earlier the question was raised as to the effect of continued outmigration on labor supply for irrigated perimeters. Irrigated farming takes substantially more intense labor than traditional rain-fed or flood-recession crops, as well as stretching labor far into the dry season when people traditionally travelled, traded, and earned cash from craft and construction. Yet we have noted that the rate of departure of young men has accelerated rather than diminished during the period in which irrigation has caught on. Not surprisingly in these circumstances, a close look at the labor situation on the existing perimeters shows that a significant portion of it is provided by other than family members. The rule is in effect in all three countries the recipients of plots should farm them directly. Nevertheless, new forms of client and wage labor seem to be expanding on the irrigation schemes. For example, at the USAID sponsored scheme in Bakel, it was found that some 30% of the plots were being farmed by someone other than the person mentioned.[15] At the Gorgol scheme in Kaedi, Mauritania, it was found that 41% of the registered plot holders were salaried workers, officials, or merchants. Twelve were marabouts (Muslim religious leaders), and only 45% were primarily agriculturalists. The marabouts send their young disciples to work in the field; sometimes they are supervised sometimes not. Salaried workers and other monied groups may work their own fields some of the time, but will supplement with wage labor and other family members help in peak seasons. Even among the 45% who were primarily agriculturalists traditional labor obligations were drawn upon. A similar pattern emerged for women's groupments where the vast majority of the women members used paid labor in addition to their own.

Who are the paid laborers? There has been no systematic study, but questioning of those working in the fields and employing people indicates that most are referred to as nawetan, and originate generally in Mali or Mauritania, not far from the area in which they are working. Some are from villages set back from the river which have no possibility of developing irrigation, some are haratin from Mauritania seeking to escape the traditional 50% sharecropping system, some are herders destituted by the drought, and some are local school children.

There are also cases of multiple plots assigned to single families. These include not only former landowners, who are thus compensated for the loss of their land, but also large and unusually enterprising families of low origin who acquire more land because of their greater interest in farming. In most villages migrants away in France or in African cities are allowed to be allocated a plot provided they send a regular cash contribution to the cooperative. This allows their families to survive and ensures the migrants of holdings once they return.

Many who are participating or sponsoring the irrigated development of the Senegal River valley wish to believe that this development will slow or stop outmigration from the area. The assumption seems to be that reversing a pattern of neglect will reverse its consequences. Now that it is not being neglected and capital is being invested in it, people will stop leaving. At the risk of being simplistic one could reduce this to an invalid logical syllogism. P (neglect) implies Q (outmigration) therefore not P implies not Q. The reasons that this logic will not hold in the case of the upper Senegal river basin are multiple. Most important from the migrants' point of view is that wage scales in France are so far above incomes in Senegal. The average migrant income in France in a 1972 study was estimated at 870 French Francs per month, of which 40% was repatriated to Senegal, for a total savings of 200,000 Francs CFA (1972 U.S. $816) per year.[16] A 1978 study found earnings ranging from 100,000 to 180,000 CFA per month of which 20-43% was saved and repatriated. Of the repatriated sum, only 44% was sent back during the migrant absence, by either postal mandate or personal correspondence, and 56% was brought back by the migrant himself.[17] The average wage corresponded to 132,500 CFA per month and the average savings to 36% of that or the equivalent of 576,000 CFA (1978 U.S. $2,900). The typical jobs held included manual laborer (35%), semi-skilled worker (57%) and sailor in the merchant marine (35%). One third of them were working in the Marseilles area, another 1/3 in the Paris region, 1/6 in the Lille area and another 1/6 at Grenoble.

In contrast, net earnings from irrigation currently range from negative (cost of fuel, seed, fertilizer and pump amortization exceed income) to ca. 200,000 CFA for the entire season (1982 U.S. $670). When one factors in on the positive side the education and maturity that a man gains by migrating, as well as on the negative side the hardship that he and the family left behind endure, the balance stills comes out in favor of emigration for most men and their families. The educational opportunities, improved health care, rural electrification and other amenities that may over the long term come into the area as a result of the OMVS developments, as well as improved incomes due to better efficiency of farmers and development agencies will certainly reduce the disparities. However, for the foreseeable future it cannot close the gap.

Yet one cannot properly speak of the labor shortage in the river basin, despite the sparse population and high rate of outmigration. The area under irrigation and total production could expand many times using the existing labor force more efficiently. But problems of organization, reliability and indebtedness have to be resolved as the perimeters expand gradually. The current projects enlist only part of the energies of part of the villagers. As projects are gradually improving their rate of return and their reliability, that proportion can be expected to grow.

Another constraint on expansion is that a legal framework allowing secure tenure of irrigated land has yet to be developed. Land rights are currently vested in the cooperatives in the villages of the Middle and Upper Valley, and in SAED in the Senegalese Delta. SONADER's title is less clear. It controls 1/3 to 1/2 of the land in the large perimeters it has developed, but the legal tenure to that land is still being challenged and has not been decided by the government. The general rule in both large and small perimeters is that plots cannot be transferred except within families, and that abandoned plots revert to the cooperative with no compensation to the person who levelled and/or otherwise developed the land. So long as villagers are not allowed to develop an economic interest in the land, there is little incentive for investing all of one's time and energies in irrigation. Canal maintenance and soil conservation measures tend to be neglected. While these other constraints continue to mandate gradual rather than sudden expansion, one cannot speak of an absolute labor shortage. The population is growing at a rate of about 3% in recent decades, corresponding to a doubling every 21 years. The combination of growth and local mobility allows considerable flexibility in the local labor situation.

The age structure of the returned migrant population in Figure 1, shows that the highest proportion of them are relatively old. The proportion of returned migrants begins to be significant only in the 45-50 age group and increases sharply only in the 60-65 age group. Men of this age in traditional society tend to do more organizing and supervising and less direct manual labor. The migration experience also predisposes men to managerial roles, for returned migrants are among the wealthiest residents of the villages due to their overseas earnings. Certainly one cannot say that the arduous working and living conditions that they endure in France prepare them for a role of leisure at home. On the contrary, many are willing to come back and work more intensely than those who never left. Nevertheless the continuing departure of young men and return of old men and the available supply of nawetan from still more disadvantaged areas and families suggest that patron client labor will be an ongoing feature of irrigated development.

In conclusion, it appears that outmigration has been institutionalized in the Upper Senegal River Basin in a way that allows it to be a positive factor in the spread of new technologies and the economic growth of the home communities. It gives the migrants a receptivity to technological change, and the capital and purchasing knowledge necessary to make it effective. Although only a small number of Soninke return before they are in the older age groups, at that time in their 40s and 50s they have acquired managerial and organizational abilitie that are very useful in the adaptation of new technologies in the home community. They have a political and economic sophistication that allows them to negotiate much more vigorously with development agencies over the terms under which development will take place, and ultimately gives them a larger role in the process. Returned migrants predominate among leadership of the new cooperatives that are being formed, and even in the roles of village chief. Enough of them have worked in mechanical jobs also to have brought a new mechanical maintenance capability into the area that was not present a decade ago. The Soninke experience in France as a marginal and temporary proletariat also tends to introduce more egalitarian ideology into the region, and prepare the way for reception of land-poor farmers of caste and slave origin into the irrigation developments.

Some of the same factors are at work in the Tukulor areas of the Middle and Upper Valley. Migrants have taken the initiative in forming cooperatives and mobilizing capital assistance for their home villages. However, from Dakar they are not able to generate as much capital as from Paris or Marseilles, nor are they as likely to return to participate in the project personally. Their home communities are more directly dependent upon SAED and SONADER assistance. The tendency for Tukulor outmigration to become definitive and for remittances to dwindle as family members go along makes outmigration a greater constraint at present for those communities than for the Soninke. Over the long term, however, they have the advantage that the Tukulor communities in Dakar and Nouakchott have become major forces in national politics and culture. Thus the two ethnic groups have institutionalized outmigration at similar rates, but with very different results. One maximizes the prospects of immediate capital accumulation in France and local development at home, while the other is tending toward long term urbanization in the capitals, participation in national politics, and less dynamic development in the original homeland.

REFERENCES CITED

[1]Lucie G. Colvin, Cheikh Ba, Boubacar Barry, Jacques Faye, Alice Hamer, Moussa Soumah, and Fatou Sow, The Uprooted of the Western Sahel: Migrants' Quest for Cash in the Senegambia (New York: Praeger, 1981). The present paper is an outgrowth of that study, based on additional research and field work in the Senegal River Basin in 1981 and 1982.

[2]André Léricollais has mapped the pattern of outmigration from the entire Senegalese and Mauritanian portion of the valley, village by village. See "Peuplement et migrations dans la vallee du Senegal," Cahiers de l'Office de la Recherche Scientifique et Technique Outre-Mer [Cah. ORSTOM], ser. Sci. Hum., 12, 2 (1975), 123-136 and maps at end.

[3]Adrian Adams, Le Long voyage des gens du Fleuve (Paris: Maspéro, 1977), p. 13. Concerning Soninke emigration see also Jean Yves Weigel, "Mode de migration et système de production soninke," (Unpub. thesis, IIIe cycle, Paris I, 1979); Francois Kane et André Léricollais, "L'émigration en pays Soninke," Cah. ORSTOM, ser. Sci. Hum., 12, 2 (1975), 177-188; A. Dubresson, "Les travailleurs Soninke et Toucouleurs dans l'ouest parisien," in the same, pp. 189-208; Elizabeth Dussauze-Ingrand, "L'émigration sarakollaise du Guidimaka vers la France," in Samir Amin, Modern Migrations in West Africa (New York: Oxford University Press, 1974).

[4]Concerning Tukulor migration see Abdoulaye Bara Diop, Société toucouleur et migration (Dakar: Institut Fundamental d'Afrique Noire, 1965); André Léricollais and M. Vèrniere, "L'émigration toucouleur: du Fleuve Senegal à Dakar," Cahiers de l'Office de la Recherche Scientifique et Technique Outre-Mer [Cah. ORSTOM], ser. Sci. Hum., 12, 2 (1975), 161-176; and Yaya Wane, Les Toucouleur du Fonta Tooro (Dakar: IFAN 1969).

[5]See e.g. Albano Cordeiro, citing Anicet le Pors, who found the repatriation of 150,000 migrant workers in France would free only 1,300 additional jobs for French citizens. Le role économique des travailleurs immigrés et leurs revendications (Conférence-débat de la quinzaine des migrants, 4 Mai 1979), published by the Office municipal des migrants de Creteil, 1979, p. 75.

[6]Migrant Workers in Western Europe and the United States (New York; Pergamon Press, 1979), Ch. 7.

[7]"La Migration: contribue-t-elle au développement des zone 'rétardees'?" in Amin, Modern Migrations, pp. 191-214.

[8]Adams, pp. 73-76; Weigel, pp. 26; and Dusauze-Ingrand, op. cit.

[9]Weigel, p. 43.

[10]Léricollais and Vernière, p. 161 et passim.

[11]Kane and Léricollais, p. 177; Weigel, pp. 38-49; Adams, pp. 74-91; Dusauze-Ingrand, op. cit.

[12]Weigel, p. 40, Government of Senegal, Bureau Nationale du Recensement, "Recensement nationale de la population du Sénégal, Avril 1976."

[13]Mission Socio-economique de la vallee du Senegal (MISOES). Published as la moyenne vallée du Sénégal (Paris: Presses universitaires de France, n.d. [ca. 1962]).

[14]Compare versions of Adrian Adams, op. cit., and Robert Aprin (one of the technicians involved), "Politique et aménagement hydro-agricole de la vallée du Sénégal: Résistance paysanne chez les Soninke." (Unpub. thesis, IIIe cycle, 1981).

[15]Interview Richard Miller, AID/OMVS Social scientist, Dakar, July 28, 1981.

[16]Kane and Léricollais, p. 184.

[17]Weigel, p. 153-155.

REMOTE SENSING TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES

Previous Page Blank

ABSTRACT

In order to be most effective, technology transfer must contribute positively toward the development of a country. Contributions must include training and possible institution building, for the end objective should be to enable developing countries to develop on their own and increase their gross national product using their own trained personnel.

One example of successful technology transfer that meets these criteria is in remote sensing. Interpretation of Landsat and meteorological satellite imagery is a useful tool to help resource managers learn where and how extensive their resources are. The United Nations and many of the developed countries have supported the establishment of remote sensing training centres around the world, where resource managers can learn to interpret satellite imagery and aircraft photographs to help manage their natural resources. In addition to these centres, both the U.N. and the USAID have sponsored projects using remote sensing. Some of these projects are described in this paper, along with other projects which are still in the proposal stage.

REMOTE SENSING TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES*

C.F. Withington
Natural Resources and Energy
Division, TCD
United Nations
New York

In India there is a discussion going on now about installing automatic coal loading facilities for the railroad. This would be considered a noble idea until it is remembered that thousands of women, who now load coal, would be jobless. Thus technological change that relieves back-breaking labour is not good if it doesn't create new jobs.

It is important to recognize that development must be undertaken by the people themselves. Therefore, all technology transfer should begin with training. The training should be geared to the capabilities and needs of the people.

Most of the policy-makers in developing countries recognize the need for new technologies for their countries, for during the past several years, the world economy has deteriorated due to the recent rise in oil prices and the following general world-wide recession. These financial crises have led policy-makers to look for methods of increasing their gross national product (GNP) through increasing their agricultural and forestry output and developing their petroleum and mineral resources. Unfortunately, in many cases, the decision-maker finds it difficult to begin collecting data, because, although the

*The views expressed in this article are written in the author's personal capacity and do not necessarily reflect those of the United Nations.

resource data may be available, they have not been collected or displayed in a manner that can be used. In other cases, base maps at a usable scale are lacking, and thus the resource manager has no means of analyzing his data. Finally, many resource managers and decision-makers have no detailed information on the extent and location of their resources and do not know where to begin acquiring such data.

In this situation, many are turning to remote sensing techniques. Remote sensing is, broadly, the identification of natural resources from satellite imagery and aerial photography. The current emphasis on remote sensing started in 1972 with the launch of ERTS 1 (Earth Resources Technology Satellite which is now called Landsat). The first satellite lasted 5 years and was followed by 2 more. A fourth was launched in July, 1982. In addition, the French will launch SPOT, an Earth Resource Satellite in 1984.

The first three remarkable Landsat satellites each have the ability to take images of almost the entire world (the polar areas excepted) every 18 days at approximately the same time of day for each area. The images are taken in four bands of the electromagnetic spectrum; one each in the green and red parts of the visible and 2 in the near infrared, just above the visible. When these black and white images are combined photographically through the proper filters, false colour composite pictures are produced. Interpretation of these images makes an excellent tool for helping countries locate, gather and display information on resources. Techniques have been developed, for instance, whereby Landsat imagery may be inexpensively mosaicked to make geographically correct up-to-date maps of a country at scales as large as 1:250,000. Through photogeology and other photo-interpretation techniques, along with correlation of existing data, reasonable planimetric maps, base maps of mineral resources, water resources, forest and range conditions and extent, and types of agriculture can be produced.

Although most decision-makers in developing countries are aware of remote sensing, they are not in a position to capitalize on its benefits. In order to help the governments on the uses of remote sensing, therefore, a "Critical world-wide nucleus" of natural resource specialists is being trained in remote sensing techniques. The basic training can be done in one of the several regional training centres that have been established around the world. Further training can be carried on in their home country in remote sensing centres established on a national level.

It is important that resource managers are trained in the analysis of their own natural resources. If the task were done for them by experts from the developed world, the reports would probably end up on a shelf. In addition, few countries like outsiders analyzing their resource data without the policy-makers knowing what has been found.

The great advantage of the Landsat imagery is that it is available to anyone who wishes it. The United Nations early recognized the advantage of the satellite imagery to the developing countries, and of the need to train the resource managers in the interpretation of the imagery. As a consequence, the U.N. along with many developed countries has supported training centres around the world. Some of these centres are regional; the one in Upper Volta which is supported in part by the Economic Commission for Africa, France, Canada, U.S.A., and the West African governments, is designed to train resource managers for the West African countries. In Kenya a similar centre has been established with U.S., U.N. and African support to train East Africans. A third regional centre is being established through the auspices of the Economic and Social Commission for Asia and the Pacific (ESCAP) in Thialand to train south-east Asians. Numerous national centres have also been set up, with UNDP's support. The newest one is in China. In some cases, the governments established the centres themselves, such as the one in Equador.

In addition to the remote sensing centres there have been numerous projects undertaken by various organizations in which remote sensing has played an important part. The following are some examples.

1. A river blindness eradication project in West Africa was designed to use remote sensing to locate the breeding grounds of the fly that causes the disease. The project resulted in showing conditions where river blindness thrives, and in developing techniques to eradicate the fly that causes it. By clearing up large areas of river blindness the governments are able to provide areas where those displaced by the Sahelian drought could settle safely (Tippetts, et al.).

2. The area frame sampling project is designed to help developing countries determine their crop yields using remote sensing techniques (Wigton). The project is being carried out by the U.S. Department of Agriculture under AID auspices, in 14 different countries in Africa, Asia and Latin America, and is proving a most useful tool in helping countries determine their crop yield almost as soon as the harvest comes in. To do this an area is chosen

of perhaps 100 sq km, and the crops measured throughout the growing season. Satellite imagery is used to compare the reflectance of the known crops with the unexamined areas, using the theory that if wheat, for instance, has a given reflectance, then everything that reflects like wheat must be wheat. Acreages of areas of wheat can then be calculated and when the harvest is begun in the test area, yields per acre are known and can then be projected for the entire country.

3. The U.N.'s Food and Agriculture Organization (FAO) in Rome has a locust control project. This project is using both Landsat and meterological satellite data to try to discover meteorological conditions that cause locusts to "bloom". It takes a combination of rainfall and vegetation to bring about hatching of locusts. At the present time the only way to anticipate the proper conditions is to drive around the deserts looking for possible areas where outbreaks might occur; this technique is not effective and a waste of valuable energy resources. With the locust control project, the locust control teams can be sent directly to suspected areas where extermination can be undertaken. The interpretation is based on observing the rain shadows from meteorological satellites, and observing vegetation on Landsat. These techniques are nearly operational (Hielkema).

4. FAO also has a project to anticipate drought conditions in the Sahel, using meteorological satellite data. Wheather patterns are traced across the Sahel and amounts of rain are estimated. These data are correlated with the rain gauge information at the FAO. With this technique, it is hoped that any future drought can be anticipated in time to get the necessary food supplies to the needy.

5. Natural resources studies using satellite information have been carried on in a number of countries. Satellite data is being used to determine the extent of these resources. In Syria, for instance, a natural resource atlas will be produced by the Syrian Remote Sensing Centre. The Syrians feel they are so far behind in learning where their natural resources are and how best to develop them, that they are counting on remote sensing to bring them up to date. Already they have a good start on their soils mapping, and will soon start on geology, water resources, and agriculture monitoring. Senegal and Mali have resource studies underway for soils and ground water supplies. In Mauritania, considerable work has been done on trying to understand the advancing desert, and develop ways of dune stabilization. Remote sensing played a role in these studies.

For the future, a number of projects are being proposed to the various developing countries. Water resources development is important since it is vital that countries have a knowledge of their water resources. Water-borne diseases, for instance, are by far the major killers of children. It is a U.N. goal to develop safe ground water sources to help prevent these diseases. Water is also important for agriculture, and satellite data can be used to determine areas where ground water might be found, based on analysis of geology and structure that can be interpreted. These data indica areas where drilling might have the best chance of finding water.

Monitoring coastal zone processes is one of the areas in which remote sensing has not been tried to any great extent as yet, and one which gives promise of contributing greatly to the understanding of changes that take place along the coast, especially in areas where rivers are to be dammed. It is wise to try to anticipate what changes will take place in an estuary if the supply of fresh water is cut off. For example, if it had been recognized what changes would occur in the Nile Delta with the completion of the high dam at Aswan, it might have created more concern. The cutting off of the annual fresh water influx with all the nutrients that were carried into the eastern Mediterranean Sea has all but wiped out the fishing industry almost overnight. In addition the sea is gnawing at the coastal areas of the delta, eroding it, and salt water is intruding up the Nile, causing a loss of irrigation water in the delta area. All this must be balanced with the benefits that the dam has brought, of course, but if the disadvantages had been recognized some compromise in dam construction might have been made. Therefore, satellite is an excellent tool to find out what conditions existed before a dam is built, and to monitor the changes that take place after the dam is completed. Several new areas should be examined for this now since in at least three area dams on river basins are being developed which could extensively alter the estuaries and coastal areas of the Gambia and Senegal Rivers in West Africa and Mahaweli River in Sri Lanka.

In mineral exploration, remote sensing can make an important contribution. As an example, the type of project in which remote sensing can play a major role, might be for the exploration of gold in Upper Volta.

Upper Volta is underlain by metamorphic and igneous rocks that contain minerals in concentrations that could have economic value if they were closer to markets. Unfortunately, Upper Volta, being land-locked, is placed at a disadvantage as far as developing the known deposits of manganese, marble and aluminum, all high bulk, low cost minerals that cannot compete in the world market. Upper Volta, however, has the potential for deposits of other minerals of high value, low bulk, which could compete, such as gold and diamonds. The problem with these mineral deposits, however, is that they have not only to be outlined but developed, their development will undoubtedly be done initially by foreign capital managed by the Upper Volta Government to ensure that the best return accrues to it.

Upper Volta is an area of few roads and few maps of a scale that can be useful in prospecting. This has hindered mineral development. With the growth of remote sensing techniques, a tool if available that can speed up the exploration process. In exploring for gold, a study of Landsat images by Jan Kutina prepared for the U.N. several years ago, showed that there was a definite relation between the gold-bearing rocks and the linear features that could be identified on Landsat imagery.

The Voltaic geologists would be trained at the Remote Sensing Centre in Ouagadougou to interpret the satellite imagery and determing places where gold might quite likely be found, and to prospect in those areas. In addition, the local farmers might be trained to look for certain types of rocks which they could bring to the geologists in return for a small sum of money. (Involving the locals is an excellent way to get an area prospected. This method was used successfully in the United States in prospecting for uranium in the 1950s.) When deposits are found, foreign capital can be attracted to help develop the deposits.

As with mineral exploration, remote sensing techniques can be used in prospecting for areas where petroleum might be found. One area that came to my attention is about 30 miles up the Gambia River from Banjul. Landsat imagery shows that the course of a small river, the Minimum Bolson may be caused by an uplift that may indicate the presence of petroleum (see Fig. 1). The course of this river flows eastward, then southward before it joins the Gambia River. The Gambia itself seems also to have been affected by this uplift. It is known that the area of the Landsat image is underlain by sedimentary rocks, and that petroleum has been found offshore.

In this paper I have tried briefly to show how remote sensing can help solve problems in many diverse fields. Remote Sensing is, of course, not the panacea to solve all the problems of the developing countries, but it is one of the better tools that can contribute toward the management of natural resources by their own personnel through a method that can be easily and inexpensively transferred from developed countries.

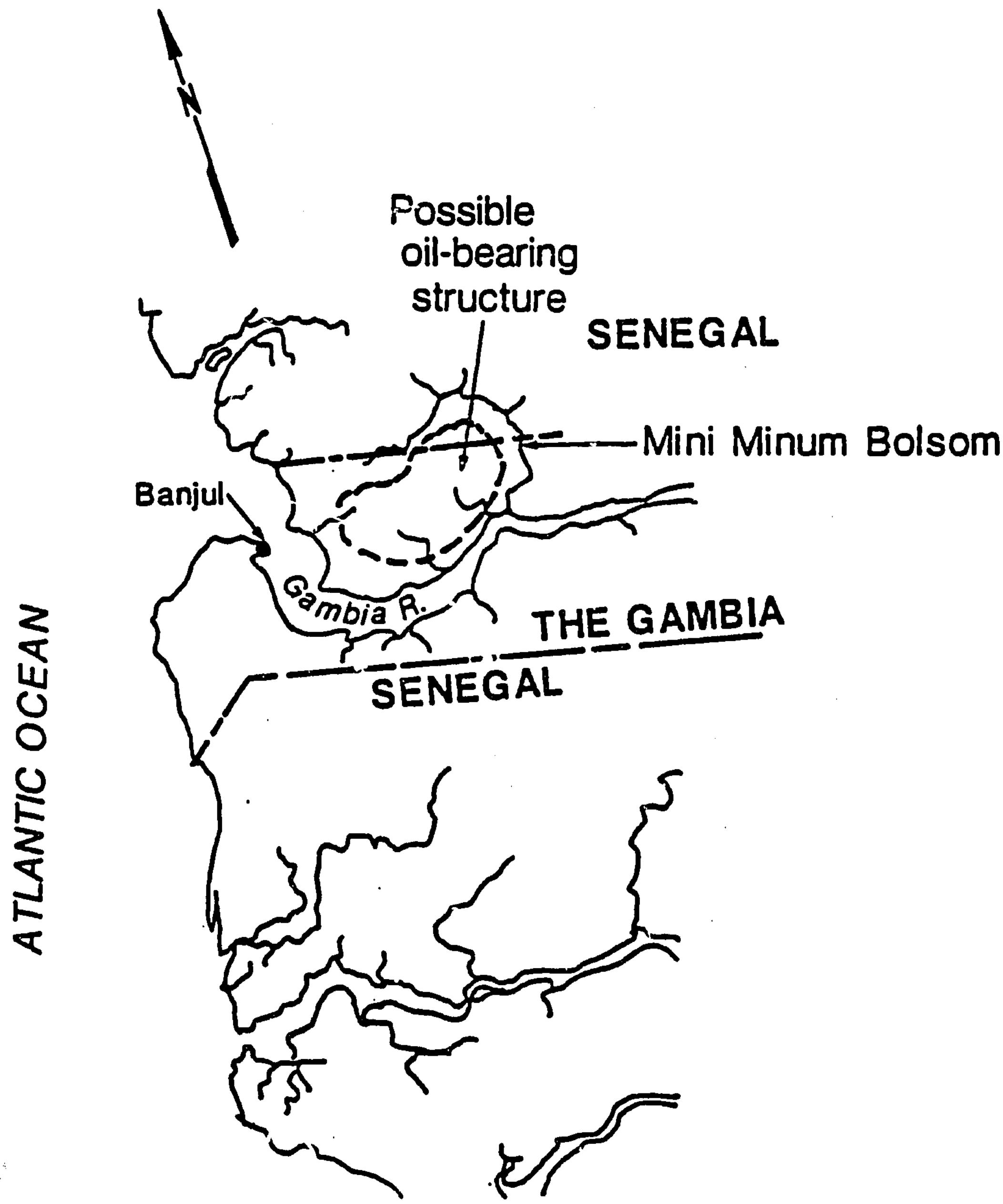
BIBLIOGRAPHY

Hielkema, J.U., 1981, Desert Locust Habitat monitoring with satellite remote sensing; International Institute for Aerial Survey and Earth Sciences (ITC) jour. v. 1981-4, p. 387-417, Enschede, the Netherlands.

Kutina, Jan, 1974, On the relationship between mineralization and deep tectonics in Upper Volta, West Africa; New York, United Nations unpublished report in two parts, with prognosis map accompanying Part I.

Tippetts-Abbett-McCarthy-Stratton. 1980. Landsat Related Study for Regional Planning of Onchocerciasis-Free Areas. Volume I: Regional Study, Volume II: Sub-area study prepared for African Development Bank/USAID. New York, New York.

Wigton, William, 1981, Area Sampling Frames for Agriculture in Developing Countries: U.S. Department of Agriculture Statistical Reporting Service, prepared for AID, in partial fulfillment of contract for the Bureau of Science and Technology. 45 p.



Part of The Gambia and adjacent Senegal, showing extent of possible oil-bearing structure. (Base after Remote Sensing Institute, 1980, Compte-Rendus du Seminaire de Teledetection, p. 486, Brookings, South Dakota. Landsat image 1213 10580)

BIOMASS.ENERGY TECHNOLOGIES IN RURAL DEVELOPMENT

Previous Page Blank

ABSTRACT

Firewood, crcp residues and animal waste are among the most important sources of energy in the rural areas of the developing nations, being used primarily as fuels for cooking. While energy requirements are likely to grow in response to population growth, to raise productivity and to improve standards of living, reliance on these sources of energy will probably continue for the foreseeable future. This paper examines the potential of selected biomass energy technologies to substitute for traditional forms of biomass energy use over the next two decades. Anaerobic digestion, and pyrolytic conversion of biomass to produce higher grade liquid, solid and gaseous fuels are examined. These fuels can be used more efficiently than traditional forms, and can substitute for future requirements of petroleum fuels.

The current supply of biomass resources and patterns of end-use consumption in sic illustrative countries are projected to the year 2,000 to examine the potential of biomass technologies in meeting rural energy needs. With one exception, the findings suggest a very significant role for biomass technologies in the selected countries. These technologies may be capable of supplying all anticipated rural energy needs under certain assumed conditions. This potential can be realized, however, only if a number of critical barriers to the diffusion of these technologies are overcome through policies to encourage their spread.

BIOMASS ENERGY TECHNOLOGIES IN RURAL DEVELOPMENT*

Romir Chatterjee
United Nations Development Programme

and

John Lee
Brookhaven National Laboratory

and

Vinod Mubayi
Brookhaven National Laboratory

INTRODUCTION

Firewood, dried crop residues and animal dung are the most extensively used rural fuels in most countries of the developing world. These biomass fuels provide energy for the principal energy-using activities in rural areas, of which domestic energy needs for cooking are dominant.

Much of the energy presently used in the rural areas is for essential human needs through the direct combustion of fuels at characteristically low efficiencies, or, through metabolic energy inputs to provide mechanical power for agricultural production. The current use of biomass fuels generally takes place outside the market-place (hence the term "noncommercial fuels" has gained usage), and often, occurs in the context of multiple uses for the resources in question. Crop residues, for example, are applied to both energy and non-energy uses, being used as fuel, fertilizer, building materials and animal feed. Similarly, dung is both a fuel and a fertilizer.

---

*The empirical information in this paper is drawn from earlier work by the author, reported in V. Mubayi, J. Lee, and R. Chatterjee, "The Potential of Biomass Conversion in Meeting the Energy Needs of the Rural Populations of Developing Countries - An Overview," American Chemical Society Symposium Series, No. 130, Washington, D.C., 1980.

Historically, modernization in the world's rural areas has been accompanied by an aggregate increase in energy requirements and also by changes in the pattern of fuels consumed. A shift from biomass fuels to petroleum products to provide energy for a variety of on-farm and off-farm uses has been the traditional energy 'transition' accompanying the development process in the rural areas. Nowhere has this transition been more dramatic than in the rural areas of the United States. An almost exclusive dependence on wood, providing, one hundred years ago, ninety per cent of all rural energy needs, has been replaced almost entirely by a reliance on fossil fuels. While the developing world today relies, as the United States once did, on biomass fuels in many regions there are signs of a similar transition under way. Kerosene is widely used as an illuminant, and as a fuel for cooking. Diesel oil and gasoline are important fuels for irrigation pumps, farm equipment and transportation. The indirect use of petroleum in the form of naptha for fertilizer production has also become widespread. However, the world oil situation now makes the "petroleum route" to development an increasingly difficult one for many developing countries.

While it is widely accepted that modernization and development will continue to mean that energy use will expand in both aggregate and per capita terms in most developing countries to raise agricultural productivity, to provide off-farm employment and to provide essential amenities to improve the quality of life (for lighting, potable water and sanitation), it is also recognized that the reliance on biomass sources of energy will continue, at least over the next twenty years. In this context, two concerns emerge in evaluating the future pattern of consumption and supply of fuels and energy in the rural areas of the developing world. The first of these concerns is to assess the over-all adequacy of biomass resources in relation to the likely evolution of fuel requirements. The second concern focusses on identifying potential conversion technologies to transform biomass resources into fuels that can meet the expected pattern of end-use demands, and that can also be used more efficiently. The efficient use of biomass resources is particularly relevant in countries where deforestation, soil erosion and associated ecological impacts are clearly in evidence, and are associated, at least in part, with the growth of fuelwood demands among rural populations. (Nepal and the Sahel are some of the more dramatic recent examples of such regions.)

This paper presents a preliminary assessment of the potential contribution of biomass conversion technologies to future rural energy needs in six selected countries: India, Indonesia, Peru, Sudan, Tanzania, and Thailand.[(1)] While the choice of countries for analysis was dictated in part by considerations of available data, they also present a useful range of variation in resource availability and consumption patterns. Taken as a group, they typify the rural energy situation in a large number of developing countries in South, and South-east Asia, Africa, and South America. Our overview assesses the potential availability of biomass resources in each of the selected countries, and presents estimates of the current pattern of end-use rural energy demand. Current consumption is projected to the year 2,000, based upon our estimates of future subsistence needs (e.g. energy for cooking), and of future energy needs associated with increasing productivity and improved living standards. The potential application of selected biomass conversion technologies is then assessed in the context of these possible future requirements.

The technologies selected for analysis are: anaerobic digestion of wet biomass to produce methane, and the pyrolysis of dry biomass to produce charcoal, liquid fuels, and low-Btu gases. Preliminary estimates are made of the amounts of fuels that could be produced in each of the six countries, using a combination of these technologies. It is our finding that biomass conversion technologies, providing a variety of fuels which can be efficiently used, will be essential to meeting future subsistence and developmental energy needs in these countries.

In five of the six countries (the exception being India), the use of these technologies can fully meet both subsistence and developmental energy needs of their rural populations. The successful implementation of these technologies, however, will rest on a much fuller analysis of institutional, economic and social barriers to their widespread dissemination in each country.

CURRENT SOURCES OF BIOMASS SUPPLY

The principal sources of biomass used for energy purposes are wood, (gathered from forests, orchards and farms), agricultural crop residues and animal wastes. Human wastes can also be potentially considered as an energy resource for biomass conversion technologies such as anaerobic digestion if appropriate sanitation systems and collection practices are employed (as, for example, in many Chinese villages). We exclude from our purview organic matter which could be potentially grown in "energy plantations" in agriculture, silviculture, or aquaculture. This is not to suggest that such plantations are not potentially important sources of biomass energy in developing countries. However, an evaluation of their contribution would require an analysis of alternative land-use patterns which are specific to each country and falls outside the scope of our assessment.

Table I provides estimates of the biomass produced annually in each of the six countries. However, this biomass is not all available for energy conversion. There are numerous uncertainties involved in attempting to estimate the amounts of biomass that could be used as an energy source such as the fraction of wood, crop residues, and animal wastes that can be collected and the alternative non-energy uses that exist for the amounts that are currently collected. Crop residues, for example, are commonly utilized for animal feed and sometimes as building materials; animal dung is utilized as a fertilizer, and so forth. We have nevertheless, attempted to obtain preliminary estimates of the biomass available for energy conversion in the six countries based in part on existing data, and in part on the use of reasonable assumptions. Such crude estimates are adequate for the purposes of an overall assessment of the impact of biomass conversion technology on rural energy needs, and are reasonable approximations of the amounts of biomass that could be made available for energy conversion. Assuming an average energy content of 14 billion joules/dry ton for crop residues, 15 billion joules/dry ton for animal wastes and 16 billion joules/dry ton for fuelwood, the total potential for energy from biomass can then be calculated based on these estimates (Table II).

In order to assess the significance of these estimated energy potentials, we have compiled the best available data on the current rural biomass consumption for energy in the six countries (Table III). It appears that for Sudan the biomass energy potential, estimated at 650 x 10^{15} joules, is about ten times its current biomass consumption. For Peru, the potential is estimated at 1341 x 10^{15} joules, which is enough to supply all its rural biomass energy

TABLE I

Estimated Potential Sources of Biomass in Rural Areas
(per annum)

Source	Peru 10^6 Ton	Peru 10^{15} Joules	Thailand 10^6 Ton	Thailand 10^{15} Joules	Indonesia 10^6 Ton	Indonesia 10^{15} Joules	India 10^6 Ton	India 10^{15} Joules	Sudan 10^6 Ton	Sudan 10^{15} Joules	Tanzania 10^6 Ton	Tanzania 10^{15} Joules
Human Waste[a]	0.2	3.0	1.0	15.0	3.2	48.0	14.3	214.5	0.5	7.3	0.4	6.0
Animal Manure[b]	6.9	103.5	12.8	192.0	10.0	150.0	198.0	2970.0	24.0	360.0	20.6	309.0
Crop Residues[c]	6.0	84.0	37.0	520.0	52.0	728.0	160.0	2240.0	9.3	130.0	2.1	29.4
Fuelwood[d]	510.0	8160.0	198.0	3168.0	720.0	11520.0	300.0	4800.0	132.0	2112.0	152.0	2432.0
Total	523.1	8350.5	248.8	3895.0	785.2	12446.0	672.3	10224.5	165.2	2609.3	175.1	2776.4

[a] Based on UN statistics (1,2) and 33 Kg (dry weight) of waste production per person per year.
[b] Based on livestock population (1) and manure production rate of major livestocks (3,4).
[c] Based on production of major crops production (1) and their respective residue coefficients (5,6).
[d] Based on actual forestry area (9-11) and per unit area increment of wood by type of forest (12).

TABLE II

Estimated Availability of Biomass for Energy Conversion in Rural Areas
(per annum)

Source	Peru 10^6 Ton	Peru 10^{15} Joules	Thailand 10^6 Ton	Thailand 10^{15} Joules	Indonesia 10^6 Ton	Indonesia 10^{15} Joules	India 10^6 Ton	India 10^{15} Joules	Sudan 10^6 Ton	Sudan 10^{15} Joules	Tanzania 10^6 Ton	Tanzania 10^{15} Joules
Human Waste[a]	0.1	1.5	0.5	7.5	1.6	24.0	7.2	107.3	0.3	4.4	0.2	3.0
Animal Manure[b]	5.2	77.6	9.6	144.0	7.5	112.5	148.5	2227.5	18.0	270.0	15.5	231.8
Crop Residues[c]	2.7	38.0	16.7	234.0	23.4	328.0	24.0	560.0	4.2	58.5	1.0	13.2
Fuelwood[d]	76.5	1224.0	29.7	475.0	108.0	1728.0	119.0	1900.0	19.8	316.8	22.8	365.0
Total	84.5	1341.1	56.5	860.5	140.5	2192.5	298.7	4794.8	42.3	649.7	39.5	613.0

[a] Assuming 50% collectibility.
[b] Assuming 75% overall collectibility.
[c] Assuming 50% overall collectibility. It is further assumed that 50% of the collected crop residues is used for animal feed in India, 10% in Tanzania (5) and the remaining countries.
[d] Assuming 15% use of the estimated total annual increment of wood (the percentage may be an overestimate for Peru and Indonesia due to the location of forest resources). For India, the availability has been assumed to equal current consumption.

TABLE III

Estimated Consumption of Biomass as an Energy Source in Rural Areas
(10^{15} Joules)

Source	Peru[a]	Thailand[b]	Indonesia[c]	India[d]	Sudan[e]	Tanzania[f]
Human Waste	--	--	--	--	--	--
Animal Manure	25.0	--	--	860.0	--	--
Crop Residue	8.7	54.4	200.0	472.0	2.6	--
Fuelwood	138.0	440.0	800.0	1900.0	60.0	320.0

Sources:
[a] U.S. Dept. of Energy (6).
[b] U.S. Agency for International Development (13), assuming all crop residues are consumed in rural area.
[c] Mubayi et. al. (14).
[d] Mubayi et. al. (15).
[e] Abuyazid (11).
[f] Per capita consumption of fuelwood in rural area from Revelle (16). Estimated 1975 rural population from UN (2).

needs 7.5 times. The potential for other countries is about twice the rural consumption for Indonesia, Thailand, and Tanzania, and 1.5 times for India. To fully utilize this potential, however, requires an understanding of a disaggregated pattern of rural energy needs and the biomass conversion technologies that can transform this potential into usable fuels.

RURAL ENERGY SUPPLY-DEMAND PATTERN

Table IV shows the estimated energy use by type and end use for the six countries studied. It appears that the energy share of cooking and heating, which is primarily from wood, ranges from a high of 98.5% (Tanzania) to a low of 86.4% (India). Lighting (mainly supplied by kerosene) accounts for about 3% or less of the total rural energy consumption. Although direct fuel use in agriculture (irrigation, soil preparation and harvesting) is proportionately small (from 0.3% in Tanzania to 9.7% in Sudan), the total energy requirements of this sector are in general much greater if energy embodied in metabolic forms, such as human and animal power were to be included. Energy use in rural transport, which depends on draft animal power, would be a particularly large component, under these circumstances. In order to assess the potential increase of fuel demand due to mechanization of agriculture and transportation, we have estimated the amount of useful work contributed by draft animals in the six LDCs based on the number and intensity of utilization of these animals in each of these countries (5,11,16). The estimates show that total animal energy demand varies widely, from a negligible amount in Tanzania to about 94 x 10^{15} joules in India. Cottage industries which include activities such as brick-making, pottery and metal works mainly use energy to provide process heat and their energy share appears generally small except in India (9.3%).

TABLE IV (cont.)

Indonesia (1972)

	FUELWOOD	CROP RESIDUES	ANIMAL WASTES	COMMERCIAL FUEL	SUBTOTAL	% OF TOTAL
RESIDENTIAL						
Cooking/Heating	800.0	200.0	--	--	1000.0	96.4
Lighting	--	--	--	30.0	30.0	2.8
AGRICULTURE	--	--	--	4.0	4.0	0.4
Irrigation						
Soil Preparation,etc.						
COTTAGE INDUSTRY	--	--	--	1.6	1.6	0.2
TRANSPORTATION	--	--	--	1.7	1.7	0.2
TOTAL	800.0	200.0	--	37.3	1035.7	100.0

Estimated Animal work in agriculture and transportation: 67 x 10^{15} Joules
Source: (14).

Sudan (1974)

	FUELWOOD	CROP RESIDUES	ANIMAL WASTES	COMMERCIAL FUEL	SUBTOTAL	% OF TOTAL
RESIDENTIAL						
Cooking/Heating	250.0	2.4	--	--	252.4	96.0
Lighting	--	--	--	3.0	3.0	1.1
AGRICULTURE						
Irrigation	--	--	--	3.0	3.0	1.1
Soil Preparation,etc.	--	--	--	4.0	4.0	1.5
COTTAGE INDUSTRY	--	--	--	0.2	0.2	0.1
TRANSPORTATION	--	--	--	0.4	0.4	0.2
TOTAL	250.0	2.4	--	9.6	263.0	100.0

Estimated Animal work in agriculture and transportation: 1.0 x 10^{15} Joules.
Sources: (10) and (18).

TABLE IV (cont.)

Tanzania (1977)

	FUELWOOD	CROP RESIDUES	ANIMAL WASTES	COMMERCIAL FUEL	SUBTOTAL	% OF TOTAL
RESIDENTIAL*						
Cooking/Heating	320.0	—	—	—	320.0	98.5
Lighting	—	—	—	4.0	4.0	1.2
AGRICULTURE	—	—	—	1.0	1.0	0.3
Irrigation						
Soil Preparation, etc.						
COTTAGE INDUSTRY	—	—	—	—	—	—
TRANSPORTATION	—	—	—	—	—	—
TOTAL	320.0	—	—	5.0	325.0	100.0

Estimated Animal work in agriculture and transportation: Negligible
Sources: (15) and (20).

India (1972)

	FUELWOOD	CROP RESIDUES	ANIMAL WASTES	COMMERCIAL FUEL	SUBTOTAL	% OF TOTAL
RESIDENTIAL						
Cooking/Heating	1700.0	460.0	760.0	50.0	292.0	86.4
Lighting	—	—	—	74.0	74.0	2.2
AGRICULTURE						
Irrigation	—	—	—	55.0	55.0	1.6
Soil Preparation, etc.	—	—	—	13.0	13.0	0.4
COTTAGE INDUSTRY	200.0	12.0	100.0	4.0	316.0	9.3
TRANSPORTATION	—	—	—	2.0	2.0	0.1
TOTAL	1900.0	472.0	860.0	198.0	3380.0	100.0

Estimated Animal work in agriculture an transportation: 94 x 10^{15} Joules
Source: (15).

TABLE IV

Peru (1977)

	FUELWOOD	CROP RESIDUES	ANIMAL WASTES	COMMERCIAL FUEL	SUBTOTAL	% OF TOTAL
RESIDENTIAL						
Cooking/Heating	138.0	--	24.0	6.3	168.3	90.8
Lighting	--	--	--	5.6	5.6	3.0
AGRICULTURE	--	--	--	9.5	9.5	5.7
Irrigation						
Soil Preparation,etc.						
COTTAGE INDUSTRY	--	--	--	1.0	1.0	0.5
TRANSPORTATION	--	--	--	1.0	1.0	0.5
TOTAL	138.0	--	24.0	23.4	185.4	100.0

Estimated Animal work in agriculture and transportation: 7×10^{15} Joules
Source: (6).

Thailand (1978)

	FUELWOOD	CROP RESIDUES	ANIMAL WASTES	COMMERCIAL FUEL	SUBTOTAL	% OF TOTAL
RESIDENTIAL						
Cooking/Heating	440.0	6.7	--	--	446.7	86.5
Lighting	--	--	--	13.4	13.4	2.6
AGRICULTURE	--	--	--	46.5	46.5	9.0
Irrigation						
Soil Preparation,etc.						
COTTAGE INDUSTRY	--	6.3	--	1.7	8.0	1.5
TRANSPORTATION	--	--	--	1.7	1.7	0.4
TOTAL	440.0	13.0	--	63.3	516.3	100.0

Estimated Animal work in agriculture and transportation: 8×10^{15} Joules
Sources: (1) and (19).

TECHNOLOGY OVERVIEW

Biomass conversion technologies can be classified into three main types: Anaerobic digestion, pyrolysis and alcohol fermentation. In anaerobic digestion, organic materials are broken down by microorganisms in the absence of oxygen to produce methane. Although this process has been used in urban waste disposal for many decades, its utilization for producing energy at the village or individual household levels is still relatively new. China and India are two countries where the technology has, perhaps, been most extensively implemented in rural areas (4,21,22). Animal wastes are the most widely used input materials in the digestors currently operating although crop residues or a mixture of crop residues and animal wastes can also be utilized. One great advantage of anaerobic digestion is that the left-over slurry after the digestion process generally preserves the nutrient values of the input feed and can be used as a good organic fertilizer.

Pyrolysis is an irreversible thermochemical change in which, biomass materials are heated in an oxygen-free, or low-oxygen atmosphere, decomposing into less complex organic compounds to produce a mixture of charcoal; pyrolytical and low-Btu gas. These fuels can be used with higher energy efficiency than the direct combustion of biomass materials. Although pyrolytic conversion of wood into charcoal by means of simple earth-covered kilns has been widely used for many centuries in the rural areas of many LDCs, the process is very inefficient and does not permit the recovery of the liquid and gaseous energy by-products. However, a number of promising pyrolytic processes have been developed to produce charcoal and other high grade fuels:

(a) continuous low-temperature pyrolysis of wood and crop residues with various retort designs (22), (b) small scale gasification of wood and crop residues (24,25), (c) medium to large scale distillation of wood to produce methanol (25,26).

Alcohol fermentation is a microbiological process to produce ethanol from a variety of sugar containing materials. Various cellulosic forms of biomass which can be converted to glucose sugar through enzymatic or acid hydrolysis are also being tested as substrates in this process in many on-going research projects (27). Because of geographical, economical and other constraints on producing the fermentable sugar needed in this process on a large scale, Brazil is the only country, at present, which has developed a substantial program to produce ethanol for energy use.

Table V lists eight processes that appear as the most likely candidates for processing organic materials into fuels. It should be noted that the table is intended for descriptive purposes only and not for comparison of these processes. In addition, the determination of the maintenance requirements was highly qualitative and the energy costs of each process were not necessarily derived on the same basis or definitions. In the assessment that follows, we have excluded alcohol fermentation because in its present status of development, it requires grown organic materials such as sugarcane as substrates. In planning a future biomass conversion development strategy, however, the selection of technologies for a country is much more complicated and the following criteria should be taken into consideration: (a) sustainability of substrate (b) maintenance and technology requirements (c) capital costs (d) adaptability to a variety of different environments (e) ability to supply the existing and projected patterns of end use needs (f) acceptability in the cultural and social structure.

Table V

Biomass Conversion Technologies

Energy Product	Substrate	Process	Status of Technology	Maintenance Requirement	Sustainability of Substrate	Estimated Energy Cost ($\$/10^9 J$)
Methane	Crop residues Animal wastes	Anaerobic digestion	Well developed	Low	High	2-4[a]
Charcoal	Wood	Carbonization by kilns	Well developed	Low	Country dependent	2-6[b]
Charcoal, pyrolytic oil	Wood Crop residues	Pyrolysis	Available	High	High	1-3[c]
Methanol	Wood	Pyrolysis/ distillation	Development stage	High	Country dependent	8-10[d]
Ethanol	Sugarcane	Batch fermentation	Available	High	Country dependent	18-20[e]
Ethanol	Crop residues	Batch fermentation	Research stage	Medium	High	30-50[f]
SNG	Wood	Gasification	Development stage	High	Country dependent	6-8[g]

[a] Based on a 75 m^3/day community size plant Does not include collection cost of wastes (28).
[b] Lower limit based on retail price of charcoal (1977) in Thailand (29) and upper limit based on retail price of charcoal (1977) in Ghana (23).
[c] Lower limit based on production cost of a pyrolytic converter with one ton/day capacity (7). Upper limit based on production cost of a designed converter with six ton/day capacity in Ghana (23).
[d] Based on the economic feasibility of a plant of 100,000 gallon/day capacity at a feedstock cost of $19/ton dry wood (13).
[e] Calculated selling price based on a feedstock cost of $13.6/ton in Brazil (30).
[f] Based on the economic feasibility of a plant of 75,800 gallon/day capacity at a feedstock cost of $15/ton dry wood (13).
[g] Based on the economic feasibility of a plant of 6.4 x 10^6 SCF/day capacity at a feedstock cost of $19/ton dry wood (13).

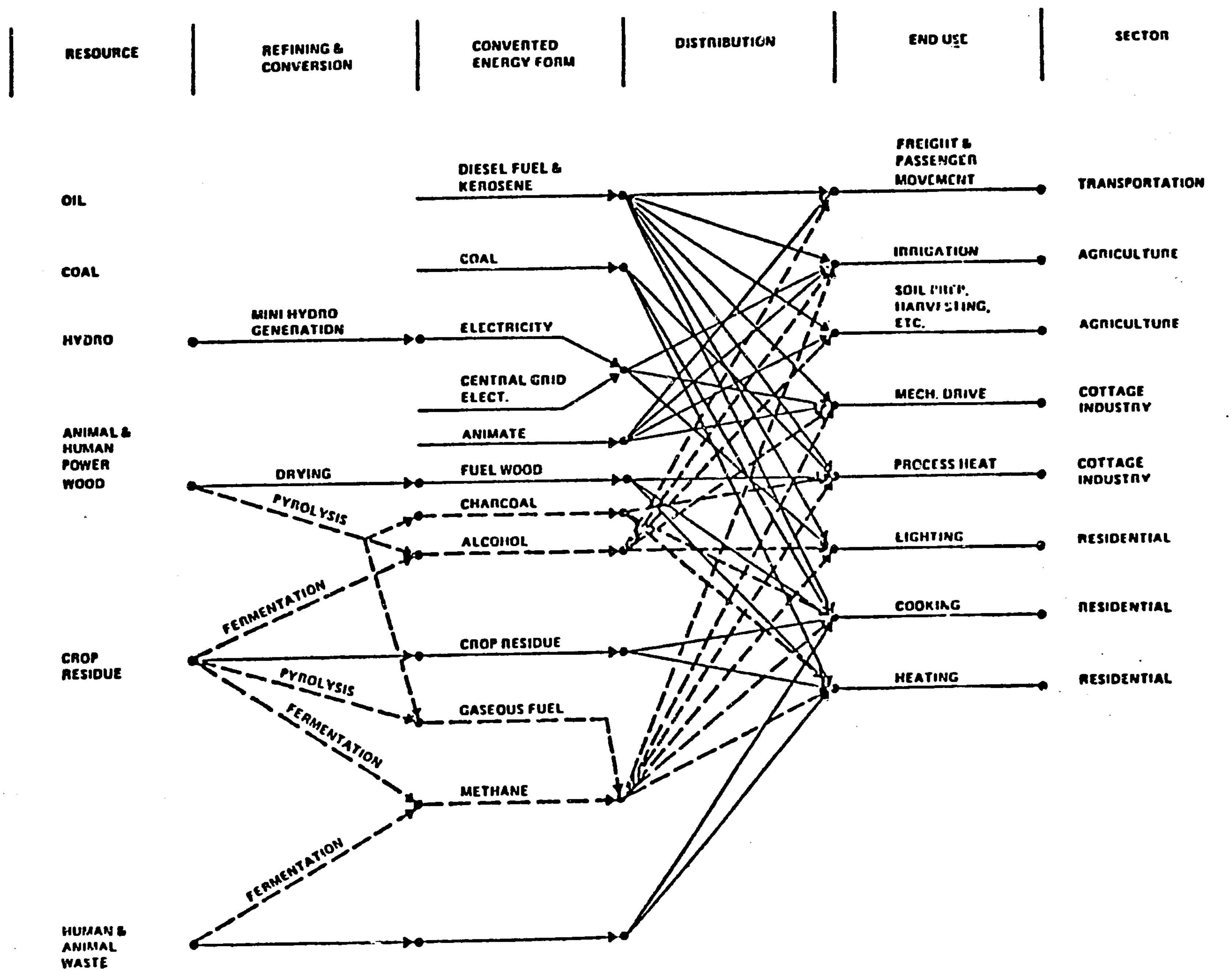
THE FUTURE POTENTIAL FOR BIOMASS TECHNOLOGIES

The information on current end-use patterns of energy consumption and information on energy supplies in each of the six countries discussed earlier have been used to construct integrated future scenarios of rural energy demand and supply in the year 2,000 in which the potential for biomass conversion technologies is displayed. The methodology used in this analysis is the construction of a general network diagram of the rural energy sector, in which detailed estimates are made of energy flows for each fuel conversion system to each major energy using activity. This approach is based on a subsystem of the Less Developed Countries Energy System Simulator (LDC-ESNS) developed at Brookhaven National Laboratory (32). Such a schematic Reference Energy System (RES) of the rural sector is shown in Figure 1. Once such a current view of rural energy flows is constructed, simulations of alternative futures can be constructed to make quantitative assessments of the impacts of new technologies, using assumptions about the future pattern of end-use demands, and about the possible range of fuels and conversion systems to be used.

A number of key assumptions in this analysis concern the future growth of energy demand and the availability of biomass resources. It has been assumed that energy for subsistence needs is likely to grow at the same rate as the average rate of population growth in the six countries, a rate of 2.5 per cent per year. Fuel requirements for productivity increases and other development objectives are assumed to grow at an annual rate of 5 per cent, or roughly in proportion with optimistic long-term projections of increases in real income. In addition, it has been assumed that 20 per cent of the current inputs of

Figure I

RURAL REFERENCE ENERGY SYSTEM



draft animal power in agriculture and transportation will be replaced through mechanization. The net result of these assumptions on the demand side are projections of end-use energy demands that may be judged to be on the high side (primarily due to assumptions concerning development-associated energy needs).

A further important assumption on the demand side concerns the efficiency of conversion at end-use. In matching projected energy demands by end-use with the future supply of fuels from biomass resources, the direct combustion of biomass fuels at comparatively low end-use efficiency levels (primarily for cooking at efficiencies usually in the range of 10 to 20 per cent) is replaced by fuels that can be utilized at much higher efficiencies (in the range of 30 to 50 per cent). We have assumed a middle estimate of future end-use efficiency, using a conversion factor of 40 per cent to estimate end-use fuel requirements in the year 2,000. The implication of this assumption is that relatively smaller amounts of fuel will be required per unit of future end-use energy.

With respect to the future supply of biomass resources, it has been assumed that biomass availability will remain constant at current levels, to provide a "lower bound" estimate of the future biomass energy potential. In fact, the future supply of biomass in the selected countries under review may well be higher than we have assumed, if increases in agricultural productivity occur, and if scientific management practices are applied to forest resources.

Our overall conclusions concerning the future potential for biomass technologies may be judged as being conservative, since our assumptions about the growth of demand are on the high side, while assumptions concerning the supply of biomass fuels are conversely on the low side. Our results for the year 2000 are shown in Table VI. The amounts of energy that can be produced by the technologies we have selected are matched against the end-use demand for energy in the six countries for the year 2000. Indicated levels of energy for subsistence are almost entirely made-up of domestic household demand for cooking and lighting. Evergy for development focusses on the energy needs of agricultural production, rural industries, transportation and improving living standards of the rural population (17,33). A very rough attempt has been made to divide the developmental energy needs into the need for heat energy and the need for motive power, which we assume will have to be met almost completely by liquid fuels, and stationary mechanical power, which can be met by gaseous fuels as well (e.g., biogas) or by conversion to electricity. This division, however, is subject to a large number of uncertainties. It is provided here as a purely normative estimate to serve as a quantitative bench mark against which the impacts of biomass conversion technologies can be evaluated.

From this preliminary analysis, it is evident, that biomass conversion technologies have the potential to meet the projected rural energy demands for both subsistence and developmental needs in five out of the six countries. Only in the case of India does there appear to be a significant shortfall and much of that is in the category of liquid fuels. This shortage reflects the fact that the technology we have chosen, methanol from wood, requires an input which is in relatively short supply in India.

CONCLUSION

It has been shown, that from an overall technological and resource standpoint, biomass technologies do appear to offer a significant possibility for meeting the future energy needs of the rural areas of a number of developing

Table VI

Projected Rural Energy Demand (2000) and Supply of Bioconverted Fuels
(10^{15} Joules)

Country	Subsistent Energy[a] Demand	Subsistent Energy[a] Supply	Developmental Energy (Heat)[b] Demand	Developmental Energy (Heat)[b] Supply	Developmental (Mech. Energy Power)[c] Demand	Developmental (Mech. Energy Power)[c] Supply	Supply/Demand (%)	Biomass Surplus[d]
Peru	130	130	3	3	40	40	>100	1040
Thailand	330	330	15	15	150	145	99	- 10
Indonesia	960	960	7	7	90	90	>100	500
India	2530	1940	505	210	370	--	63	-2250
Sudan	200	200	1	1	27	27	>100	240
Tanzania	230	230	1	1	4	4	>100	215

[a] In forms of charcoal, biogas, and pyrolytic oil. Assuming 55% conversion efficiency for anaerobic digestion and 66% for pyrolysis of crop residues and fuelwood (15 energy units of feedstock produce 6 units of charcoal and 4 units of pyrolytic oil).

[b] In forms of charcoal, pyrolytic oil, and pyrogas. Assuming 75% efficiency for gasification (10 energy units of feedstock produce 5.8 units of gas and 1.7 units of charcoal).

[c] In form of Methanol. Assuming 50% efficiency for pyrolysis/distillation of wood.

[d] ...rms of energy content of biomass wastes.

countries. In particular, biomass conversion technologies can potentially provide the kind of high-grade energy, especially liquid fuels, necessary for further development and which can serve as an alternative for scarce petroleum fuels. Biomass resources are, in many cases, locally available and renewable, if proper resource management, especially of forests, is practiced. (An exception to this for the countries studied in this paper are the forest resources of Indonesia and Peru which are remote from the main areas of rural settlement.) From a system point of view, since rural energy demand arises from a large number of dispersed and poorly connected uses, the availability of local resources which can be transformed into useful energy products on a decentralized level is a definite benefit. It avoids the necessity of investing in an elaborate centralized energy distribution system which is susceptible to a number of problems, as is illustrated, for example, by the experience of rural electrification programs in many developing countries.

However, the difficulties of implementation of biomass technologies in the rural context should not be underestimated. Current biomass use practices have evolved through many millenia of social and cultural adaptation and new ways of dealing with the same resource will have to overcome a number of institutional, cultural, and social barriers. For example, a community size anaerobic digester operating on the animal waste inputs from privately owned cattle or other animals presupposes a certain degree of cooperative arrangements among the owners for effective management of a collection scheme. Wood that was formerly gathered privately and used in individual households but now has to be turned over to a processing plant for manufacture of higher-grade fuels requires new social and institutional arrangements to ensure that benefits are properly distributed. Furthermore, even for technologies that are relatively simple, some technical skills are necessary for adequate maintenance and operation. Such skills are usually in short supply in most rural areas. This implies that training and extension programs will be needed if new energy technologies are to be implemented on a large-scale. Also important is the fact that rural areas are not 'closed' systems. Market forces could result in the export of high-grade fuels to 'better-off' urban areas, leaving the rural areas short of energy as before. The Brazilian methanol program whose output largely goes to fuel urban automobiles is an illustration of this problem.

Not least among the problems of implementation raised by biomass energy technologies are their financial costs. By comparison with traditional fuel supplies, the conversion processes discussed in this paper must be judged as being capital-intensive. Low per capita incomes, and uneven income distribution are characteristics of many rural regions in the developing countries. Capital costs, under these conditions, will pose a significant barrier to the diffusion of these technologies, even though the collection costs of the basic raw materials are likely to be low. Cost information based on operational experience with biomass technologies in the developing countries is, at best, fragmentary. But it is safe to assume that their application on a wide scale will require a large commitment of financial resources.

One recent estimate of financial reqirements for support and pre-investment activities related to renewable energy technologies in the developing countries, made by a Joint Study Group of the World Bank and United Nations Development Programme (UNDP), suggests that in the 1980s a conservative figure for such expenditures is $2.4 billions (34). The technologies included for study included photovoltaics, solar thermal, wind, biomass, and ocean energy. The potential for biomass technologies is implicitly recognized by the Study Group in its estimate that these technologies will alone require $944 millions, or 40 per cent of the total. There are few guarantees that such a large commitment of resources for pre-investment activities will materialize. Nonetheless, it is a fair assessment that in the absence of a very large effort towards field-testing, research and development, training and detailed design and engineering studies, it is unlikely that the ground will be adequately prepared for the widespread dissemination of biomass technologies.

NOTES

1. Dept. of Economic and Social Affairs, "1976 Statistical Yearbook," United Nations, New York, 1977.

2. Dept. of Economic and Social Affairs, "Trends and Prospects in Urban and Rural Population, 1950-2000," United Nations, New York, 1975.

3. Mubayi V.; Kahn, P.; Keane, J., "Some Considerations on the Use of Village-Scale Biogas Plants in Developing Countries," (Internal Report), Brookhave National Laboratory, Upton, New York, 1976.

4. Barnett, A.; Pyle, L.; Subramanian, S. "Biogas Technology in the Third World: A Multidisciplinary Review," International Development Research Center, Ottawa, Canada, 1978.

5. Makhijani, A.; Poole, A., "Energy and Agriculture in the Third World," Ballinger Publishing Company, Cambridge, Mass., 1975.

6. "Joint Peru/United States Report on Peru/United States Cooperative Energy Assessment, Volumes I and V," U.S. Dept. of Energy, Washington, D.C., 1979.

7. Henderson, J.; Barth, H.; Heimann, J.; Moeller, P.; Shinn, R.; Soriano, F.; Weaver, J.; White, E., "Area Handbook for Thailand," U.S. Government Printing Office, Washington, D.C., 1970.

8. Vreeland, N.; Just, P.; Martindale, K.; Moeller, P.; Shinn, R.; "Areas Handbook for Indonesia," U.S. Government Printing Office, Washington, D.C., 1974.

9. Fuel Policy Committee, "Report of the Fuel Policy Committee," Government of India, New Delhi, India, 1974.

10. Abayazid, O., "Prospects of Fuel and Energy in the Sudan," University of Khartoum, Sudan, 1975.

11. Herrick, A.; Harrison, S.; John, H.; MacKnight, S.; Skapa B., "Area Handbook for Tanzania," U.S. Government Printing Office, Washington, D.C., 1968.

12. Earl, D., "Forest Energy and Forest Development," Clarendon Press, Oxford, 1975.

13. Agency for International Development, "Thailand-Renewable Non-Commercial Energy" (Draft), USAID/Thailand, 1979.

14. Mubayi, V.; Lee, J., "A Preliminary Analysis of Energy Supply and Consumption in Indonesia," Brookhaven National Laboratory, Upton, N.Y. 1977.

15. Mubayi, V., "Background Information for the Assessment of Energy Technologies for Developing Countries," Brookhaven National Laboratory, Upton, N.Y., 1976.

16. Revelle, R., "Requirements for Energy in Rural Areas," AAAS Selected Symposium 6, Westview Press, Boulder, Colorado, 1978.

17. Reddy, A.; Prasad, K., "Technological Alternatives and the Indian Energy Crisis," Economic and Political Weekly, 1977.

18. Food and Agriculture Organization, "1977 Yearbook of Forest Products," United Nations, Rome, 1979.

19. Lee, J.; Mitchell, G.; Mubayi, V., "A Preliminary Analysis of Energy Supply and Consumption in Thailand," Brookhaven National Laboratory, Upton, N.Y., 1978.

20. "Workshop on Solar Energy for the Villages of Tanzania," Tanzania National Scientific Council and USNAS, Dar Es Sallam, 1977.

21. Food and Agriculture Organization, "China: Recycling of Organic Wastes in Agriculture," United Nations, Rome, 1977.

22. Parikh, J.; Parikh, K., "Mobilization and Impacts of Biogas Technologies," Energy, 1977, Volume 2.

23. Chiang, T.; Tatom, J.; Graft-Johnson, J.; Powell, J., Pyrolytic Conversion of Agricultural and Forestry Wastes in Ghana,: Georgia Institute of Technology, Atlanta, Georgia, 1976.

24. "Symposium Papers: Clean Fuels from Biomass, Sewage, Urban Refuse, Agricultural Wastes," Institute of Gas Technology, Chicago, Illinois, 1976.

25. "A Conference in Capturing the Sun Through Bioconversion: Proceedings," Washington Center for Metropolitan Studies, Washington, D.C., 1976.

26. Jones, J.; Barkhorder P.; Bomberger, D.; Clark, C.; Dickenson, R.; Fong, W.; John, C.; Kohan, S.; Phillips, R.; Semran, K.; Terter, N., "A Comparative Economic Analysis of Alcohol Fuels Production Options," SRI International, Menlo Park, California, 1979.

27. "3rd Annual Biomass Energy Systems Conference Abstracts," Biomass Energy Systems Conference, 1979.

28. Ghate, P., "Biogas: A Pilot Project to Investigate a Decentralized Energy System," State Planning Institute, U.P., Lucknow. (No date)

29. "Energy Situation in Thailand-1977," National Energy Administration, Bangkok, Thailand, 1978.

30. Yang, V.; Trindade, S., "The Brazilian Fuel Alcohol Program," Centro de Tecnologia, Promon, Brazil, 1979.

31. Schooley, F.; Dickenson, R.; Kohn, S.; Jones, J.; Meagher, P.; Ernest, K.; Crooks, G.; Miller, K.; Fong, W., "Mission Analysis - Market Penetration Modeling," SRI International, Menlo Park, California, 1979.

32. Reisman, A.; Malone, R., "Less Developed Countries Energy Network Simulation LDC-ESNS: A Brief Description" Brookhaven National Laboratory, Upton, N.Y., 1978.

33. Palmedo, P; Nathans, R.; Beardsworth, E.,; Hale, S. Jr., "Energy Needs, Uses and Resources in Developing Countries," Brookhaven National Laboratory, Upton, N.Y., 1978.

34. Joint Study of World Bank-UNDP on Financial Requirements of Supporting Actions and Pre-Investment Activities for Development and Utilization of New and Renewable Sources of Energy in Developing Countries During 1980s, Interim Committee on New and Renewable Sources of Energy, United Nations, New York, June, 1982.

ROLE OF TECHNOLOGY IN REDUCING POST-HARVEST FOOD LOSSES

ABSTRACT

Efforts to improve the world food supply have tended to concentrate on slowing population growth and increasing agricultural production. Reduction in post-harvest loss as a means of increasing food supply has received far less attention. The magnitude of food loss in developing countries varies from 5-80% depending on various factors such as location, season, post-harvest treatment, duration of storage and commodity. The National Research Council has estimated that there is a minimum of 10% loss for cereal grains and 20% loss for non-grain staples and other perishables including fish. Existing technologies are suggested in both sophisticated and simplified forms to significantly reduce the post-harvest food losses. A concerted effort must be made by respective governments and international development agencies to improve the post-harvest food yields.

ROLE OF TECHNOLOGY IN REDUCING POST-HARVEST FOOD LOSSES

Mir N. Islam
Department of Food Science and Human Nutrition
University of Delaware, Newark, DE 19711

INTRODUCTION

World hunger not only persists in our time, it is on the increase. FAO estimates put the number of chronically undernourished people in developing countries at 420 million in 1976, up from 360 million in 1971 (Anonymous, 1981). The grossly underfed represent 12.5% of the world's population, but it is estimated that close to half of the world's population has a marginal food intake (Kahn, 1981). As population increases, the number of undernourished is also expected to increase. It is estimated that world food demand in 1985 will be 44% greater than in 1970; approximately 70% of this estimate will be required to feed those in the developing countries (Kahn, 1981).

Efforts to improve the world food supply situation have tended to concentrate on slowing population growth and increasing agricultural production. Another area of effort which goes hand in hand with these, but which has received less attention, is the reduction of post-harvest food losses, or to state it more positively, as recommended by Hulse (1977), the improvement of post-harvest food yields. Much has been done to increase agricultural yields, and while these are essential activities which should continue, it must be borne in mind that the real goal is to see that more food reaches the mouths of the hungry. The nature of food production--being a seasonal and localized activity--creates a fluctuation in the supply of food. From this arises the need for food preservation, storage and transportation. The movement of food from producers to consumer can be illustrated as a food pipeline (Bourne, 1977; NRC, 1978).

Figure 1 summarizes the various factors involved in food loss from the point of harvest or production until it reaches the consumer. The major steps in transition are indicated as preprocessing, transport, storage, processing and packaging, and finally marketing. Under each of these transitio steps we see the most relevant factors that contribute to food loss.

The scientific principles governing food deterioration have been and are being elucidated, and methods for controlling post-harvest food losses are well known in developed countries. While scientific principles are universally applicable, technologies are not necessarily so (Hulse, 1977). The problem then, is to adapt and apply knowledge to the needs in a particular situation.

MAGNITUDE OF FOOD LOSS

The magnitude of food loss in developing countries cannot be stated with any degree of accuracy because losses are very specific by location, season, post-harvest treatment, duration of storage, and commodity; and reliable food loss data is lacking. The National Research Council Committee on Post-harvest Food Losses in Developing Countries, in its 1978 report (NRC, 1978), resisted extrapolating loss estimates from one situation to another to arrive at general national or global estimates. However, the need for indicative figures for use by policy planners and the like was recognized by the panel and they therefore provided minimum overall loss figures. In developing countries, the assumption may be made that there is

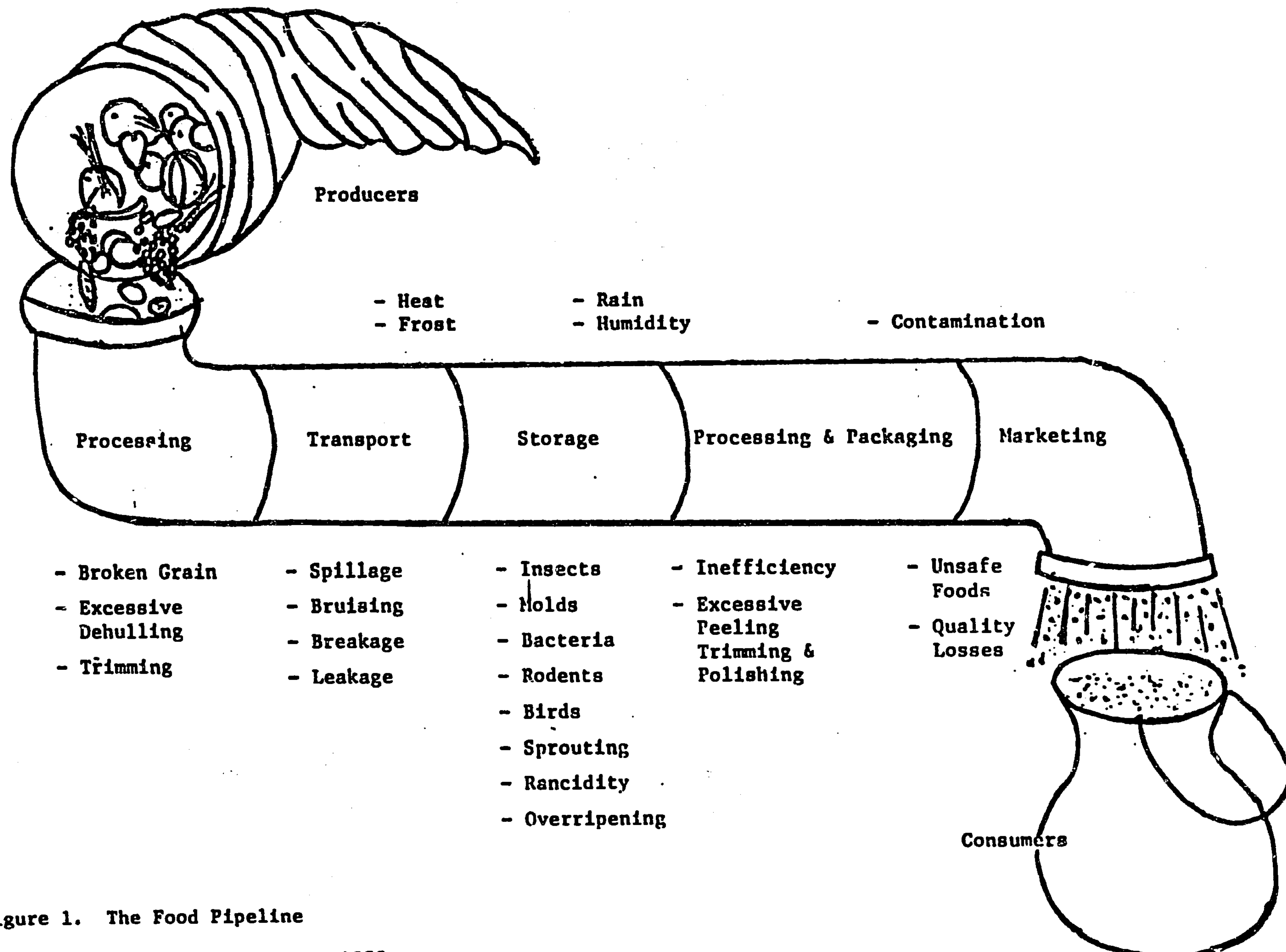


Figure 1. The Food Pipeline

Source: Bourne, 1977 and NRC, 1978.

a minimum of 10% loss for durables, i.e., cereal grains and grain legumes; and 20% loss for non-grain staples, i.e., yams, cassava, etc., and other perishables including fish (Table 1).

Table 1.

Estimates of Minimum Post-harvest Food Losses in Developing Countries, 1976

	Durables	Perishables	Fish
1976 food production (million tonnes)	420	255	
Estimated minimum loss %	10	20	
Estimated minimum loss (million tonnes)	42	51	10
Estimated price/tonne ($US)	165	25	255
Estimated loss value ($US billions)	6.9	1.3	2.3

Source: NRC, 1978.

The 42 million tonnes of grains and legumes estimated to have been lost in 1976, using the conservative minimum loss of 10%, is equivalent to 60% of the total annual cereal production of all of Africa, or 95% of Canada's total annual cereal production. This quantity of grain, 42 million tonnes, could more than suffice to meet the caloric needs of 168 million people for 1 year (NRC, 1978).

By region and commodity, there is great variation in reported loss figures. Data from FAO, 1977, Analysis of an FAO Survey of Post-harvest Crop Losses in Developing Countries (in NRC, 1978), show that losses of cereal grains and grain legumes may be much greater than 10% and loss of perishables may be greater than 20% in many instances.

Table 2 shows the loss of maize in several countries. On the right hand side column we have the national production in thousand tonnes. Brazil reported 15-40% loss which is rather high especially in view of their relatively large production. Table 2 also demonstrates the wide range of total loss between countries relative to their production.

Table 2.

Reported Losses of Maize within the Post-harvest System

Region & Country	Total % Weight Loss	Reported National Production (thousand tonnes)
Brazil	15-40	17,929
Mexico	10-25	8,945
India	6.5-7.5	6,500
Indonesia	4	2,532

Source: NRC, 1978.

Table 3 shows the reported loss of wheat in India, Pakistan and Brazil. There is quite a large variation in the degree of reported losses from India. The losses depended upon various factors such as the location, available facilities, the degree of mechanization, and the post-harvest treatments. The loss for Pakistan was reported to be 12% and that for Brazil 15-20%.

Table 3.

Reported Losses of Wheat Within the Post-harvest System

Region & Country	Total % Weight Loss	Reported National Production (thousand tonnes)
India	2-52	24,000
Pakistan	12	8,500
Brazil	15-20	906

Source: NRC, 1978.

Table 4 shows the relative percent losses of rice in India, Indonesia, Bangladesh, Thailand, and Brazil. The trend for rice is somewhat lower than the losses reported for maize and wheat. This is perhaps because the paddy is relatively more resistant to insect or microbial damage.

Table 4.

Reported Losses of Rice Within the Post-harvest System

Region & Country	Total % Weight Loss	Reported National Production (thousand tonnes)
India	6	70,000
Indonesia	6-17	22,950
Bangladesh	7	18,500
Thailand	8-14	14,400
Brazil	1-30	9,560

Source: NRC, 1978.

Table 5 gives information on losses at various stages of rice processing. On the right hand side in one column is grain input and in the other column grain output. It appears that starting with 100 kg at the time of harvest the final yield after milling was as low as 68 kg.

Table 5

Rice Loss Estimates for Southeast Asia

Stage	Loss Percentage	Grain In (kg)	Grain Out (kg)
Harvesting	1-3	100	97-99
Handling	2-7	97-99	90.21-27.02
Threshing	2-6	90.21-97.02	84.80-95.08
Drying	1-5	84.80-95.08	80.56-94.13
Storing	2-6	80.56-94.13	75.73-92.25
Milling	2-10	75.73-92.25	68.16-90.41

Source: De Padua, D.B. 1974. Post-harvest Rice Technology in Indonesia, Malaysia, the Philippines, Thailand: A State of the Art Survey. International Development Research Centre, Ottawa, Canada. Cited in NRC, 1978.

The National Research Council Committee on Post-harvest Food Losses in Developing Countries (1978), while calling for more reliable assessment of losses, recognized that often it is unnecessary or impossible to scientifically assess the degree of loss. The observations and assessment of the situation by experienced individuals often are sufficient to warrant food conservation measures.

So although the magnitude of the food loss problem in developing countries defies quantification, it is known to be enormous. World-wide attention was drawn to the problem in 1975 when the U.N. called for a goal of a 50% reduction in overall food losses by 1985. In 1977, the FAO conference established an Action Programme for the Prevention of Food Losses to be financed by a special account based on voluntary contributions with a goal of $20 million. The program is initially concentrating on the farm and village level and staple crops. Of the 52 projects approved for financing by the end of 1979, 38 involved improvement of food storage facilities at the farm, cooperative or village level (FAO, 1979).

Food "loss" as the term is presently used by experts such as the NRC Committee on Post-harvest Food Losses in Developing Countries, means a quantitative loss of food. Bourne (1977) defines "loss" as "any change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed by people". Food loss as so defined may be direct--such as disappearance of food consumed by birds, rodents--or indirect--such as the quality loss of the food reaches the point where it is rejected for human consumption. The extent of quality loss at which food is rejected depends upon the economic and cultural background of the consumer. The poor often have no alternative but to consume a certain amount of damaged food that the more affluent would reject.

ABSTRACT

Technology development and transfer have been among the major factors responsible for the remarkable agricultural achievements of most developing countries. Even so, these countries have only slightly increased their per capita food consumption. Wholly inadequate nutrition levels still prevail

Poor post-harvest treatment of foods may result in damage to the food which may not suffice to cause rejection. Ingestion of such damaged food may certainly involve costs to society. For example, foods may be contaminated with mycotoxins, toxic metabolites of molds, because of improper storage or handling. An outbreak of human disease (hepatic cancer) from ingestion of aflatoxin contaminated maize occurred in India in 1974-75 (Krishnamachari et al., 1975). Over 100 deaths were reported in this outbreak which was traced to improperly stored, rain-soaked maize.

Developing countries face problems in dealing with food preservation which are absent in developed countries. These problems include (Bourne, 1977):

1. Lack of experienced and knowledgeable personnel.
2. Insufficient capital for storage equipment and other food protection measures.
3. Accelerated rates of food spoilage and pest growth because of climate.
4. Cultural attitudes about the inevitability of large food losses.

CAUSES OF LOSS

I. Biological factors

A. Insects can cause significant weight loss of stored food products. In cases of severe attack, cereal grains and beans may be reduced to empty husks and dust. Even if the attack is not so severe, insects cause significant damage. Some are selective in what part of the seed they eat and consume the most nutritious and valuable portion of the seed, the seed embryo, which reduces nutritional value and destroys the ability of the seed to germinate. Contamination of a commodity with living and dead insects and their excreta may often be sufficient to cause its rejection as unfit for human consumption.

B. Microbiological. The low moisture content of cereal grains and grain legumes generally protects them from spoilage by bacteria or yeasts. However, fungal growth is a problem particularly in inadequately dried grain. Molds may multiply to the point where a commodity is completely destroyed, but more commonly, food loss results from rejection of the food because of visible mold growth or damage, or rejection of the food because of mycotoxin contamination. The latter depends upon whether screening for mycotoxin contamination is performed because contamination may be found in the absence of visible signs of mold growth. The point of rejection for food depends upon local custom generally. In perishables - fruits, vegetables, meats and fish - a large number of bacteria and fungi cause losses.

C. Rodents. Food loss may result from actual ingestion of grain or their befouling of the food with their excreta. Rodents also do much damage by gnawing and destroying storage structures and containers causing spillage of grain and increasing the likelihood of fungal and insect damage by providing routes of entry and exposing grain to the elements.

II. Chemical and biochemical causes of food loss refer to undesirable reactions in the food, examples of which are the browning reaction and fat oxidation, or to deliberate or accidental contamination with harmful substances, such as pesticides.

III. Mechanical. Examples of mechanical sources of loss are threshing or shelling methods for cereals and legumes which fail to separate the grains or which cause excessive damage and breakage. Mechanical injury to perishables is also a great problem because of their high moisture content and resultant soft flesh. In addition to the damage caused by the injury, the damaged flesh also provides a point of entry for microorganisms.

IV. Physical. Loss may result from exposure of foods to excessive or insufficient heat or cold. Increases in temperature increase the reaction rates of spoilage processes such as browning reactions. On the other hand, many tropical fruits are susceptible to chill damage.

V. Physiological. This refers to the natural processes occurring in the commodity (respiration and transpiration, e.g.) which often lead to spoilage, especially of perishables.

AVAILABLE METHODS FOR PRESERVING FOODS

Here we have a list of available methods of preserving foods and reducing losses (Table 6).

Table 6.

Available Methods for Preserving Foods

1. Drying	7. Canning
2. Packaging & Protective Storage	8. Irradiation
3. Refrigeration & Cooling	9. Freezing & Freeze-drying
4. Chemicals	10. Pasteurization
5. Fermentations	11. Sterile Filtration
6. Controlled Atmosphere Storage	

Those that are particularly important methods for application in developing countries will be discussed, beginning with drying.

Drying

Drying could be considered the most important food preservation method both because of its antiquity and its predominant application to preservation of grains. As shown in Table 7, cereal grains and grain legumes account for more than half of the world's food production. As staples in the diet, their supply is critical to the survival of many populations. For this reason, much of the effort to prevent food loss has been focused on conservation of grains.

Drying prevents germination and fungal invasion of seed grains; it can also have some deterrent effect on insect attack. Moisture content is usually reduced to about 14% to effect preservation. Rice at harvest, for example, may contain up to 30% moisture.

Pre-harvest and harvest factors significantly influence the process of drying grain. Pre-harvest factors include such things as the typical moisture content of a particular variety of grain at maturity. Weather conditions at harvest time are another factor. Drying of grain during the dry season is much simpler than during the rainy season. Introduction of new varieties or improvement of yields through planting of fast maturing varieties and double cropping are likely to necessitate changes in traditional drying methods.

Table 7.

Major Food Crops in Developing Countries, Ranked in Order of Estimated Production (FAO, 1977)

Crop	Tonnes (in thousands)	Percent
Paddy	186,230	21.36
Cassava	103,486	11.87
Wheat	95,048	10.90
Maize	73,328	8.41
Banana/Plantain	55,199	6.33
Coconuts	32,664	3.75
Sorghum	31,173	3.57
Yams, Taro Etc.	28,777	3.30
Potatoes	26,909	3.09
(Pulses)	25,997	(2.98)
Citrus	22,040	2.53
Millet	21,452	2.46
Barley	20,775	2.38
Sweet Potatoes	17,630	2.02
Soybeans	13,842	1.59
Groundnuts	13,502	1.55
Tomatoes	12,755	1.46
Grapes	12,720	1.46
Mangoes	12,556	1.44
Watermelon	10,436	1.20
Dry Beans	8,537	0.98
Onions	6,474	0.74
% of Total from Cereal Grains & Grain Legumes		55.34

Source: NRC, 1978.

Grains which mature during dry seasons are often adequately dried by traditional methods which utilize sun and wind. Improved designs for utilizing solar energy and natural ventilation have also been developed. Figure 2 shows the design of a low-cost rice dryer (Excell and Kornsakoo, 1978) which based on the materials used would cost less than US $50.00.

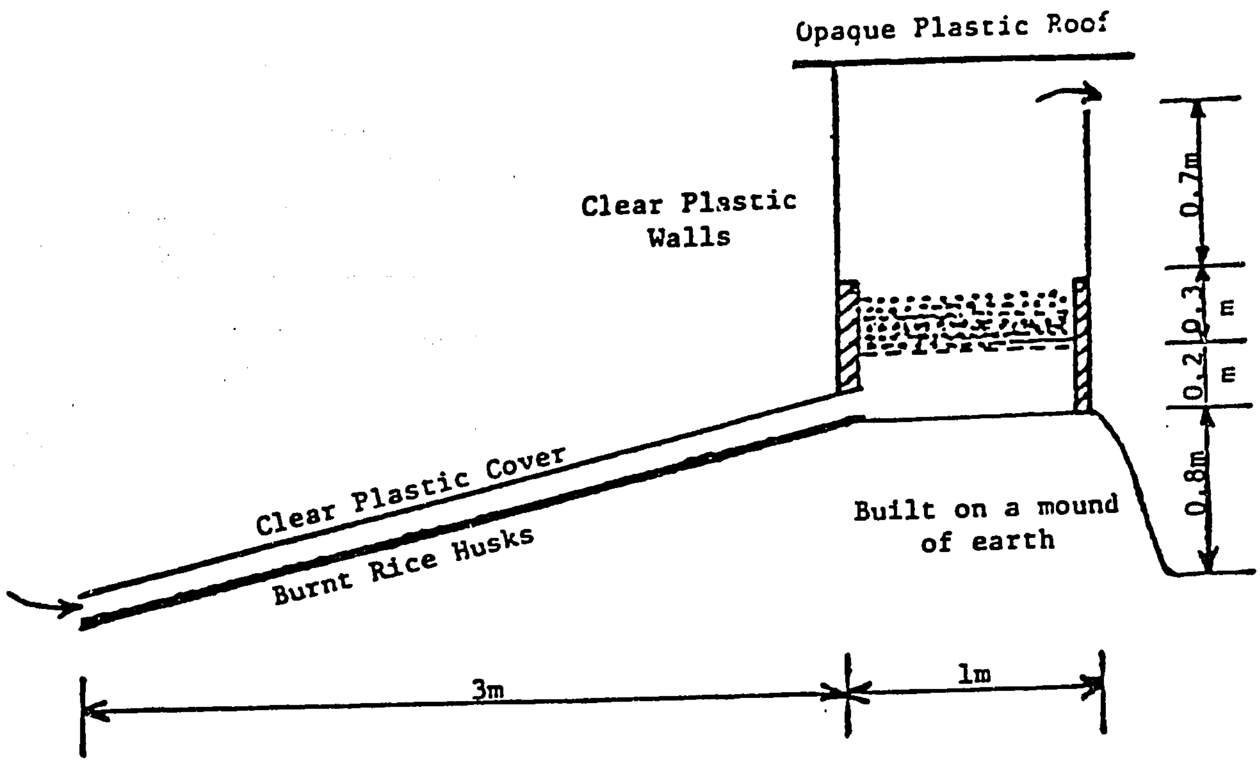


Figure 2. A low cost solar rice dryer

Source: Excell and Kornsakoo, 1972.

The greatest need for drying of grains occurs when grain is harvested in wet, humid weather. Solar powered dryers are not very useful under such conditions. Promising technologies for use under wet conditions include dryers heated by burning crop by-products such as rice husks, rather than expensive and scarce fossil fuels or wood. A number of such simple technology dryers have been described by Linblad and Druben (1976).

Drying is also an applicable preservation technique for perishables, although the problems involved in drying high moisture items are, of course, greater than in drying low moisture grains. Figure 3 shows designs for blanching and drying of vegetables in Bangladesh (Clark, 1982). It has been estimated that such a drying set-up would cost only about US $30.00.

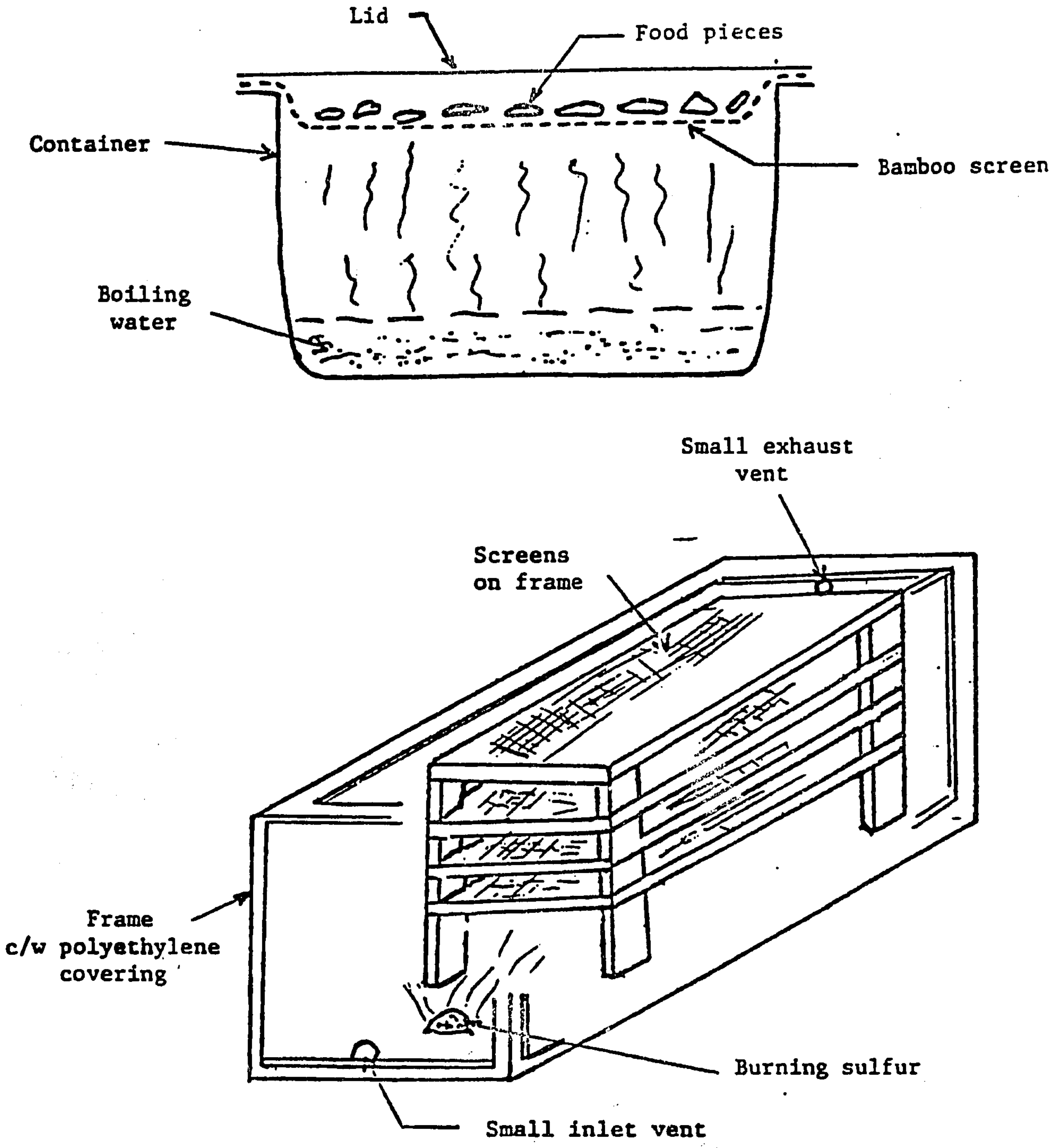


Figure 3. Design for blanching and solar drying of vegetables.

Source: Clark, 1982.

Fish is a particularly important perishable which is amenable to drying. Fish accounts for about 20% of the animal protein in the human diet. An estimated 6 million tonnes of fish are caught annually by subsistence fishermen (FAO, 1975). Improvements in fish preservation would make available larger quantities of a valuable source of protein. Drying of fish, often including salting and smoking, is a widely used technique in developing countries. Improvements such as introduction of drying racks and improvement of smoking ovens, and designing and implementing solar dryers could enhance the quality and storage life of dried fish products. Cost of such equipment may range from US $100-$500 depending on the construction material used.

Storage

> Storage technology can by broadly divided into three categories according to the place at which it is applied: the farm where farmers retain grain for their own use; the village or community, where facilities are operated on a co-operative basis; and the city where as much as 30% of the grain produced may be stored. There is a growing awareness that there is a need to build adequate storage facilities in all three categories within developing countries and that whatever techniques are used, they should be compatible with existing infrastructural facilities and should be particularly related to marketing and distribution arrangements. (UNIDO, 1979)

The importance of on-farm storage of food grains is illustrated by some Indian statistics. Food grains in India are grown on about 75% of the gross crop production area. Production reached 125 million tonnes in 1977-78; projected production figures are 164 million tonnes by 1985 and 230 million tonnes by the year 2000. Of this total production, 60-70% is retained on the farm for human consumption, seed and feed (Aggarwal et al., 1979).

There is wide variety in traditional storage structures for grains, many of which are well suited to the environments in which they are used. Improvements in the design and construction of traditional storage facilities are often sufficient to effect as much conservation as more radical methods. It has been reported (NRC, 1978) that improved maize cribs designed to use natural ventilation more effectively, coupled with external insecticide application, reduce losses from insects and fungi to 2% after 4 months of storage.

Storage of dried products is a particularly critical problem in the hot, humid regions, wherein the developing countries generally lie, because of the tendency of the product to absorb moisture from the atmosphere. Much more work in the area of packaging and practical storage methods for such conditions needs to be done (Bourne, 1977).

Refrigeration and Cooling

The cost of refrigeration prohibits its widespread use for food preservation in developing countries. However, there are simple measures which can be taken to keep foods cool--or at least to keep them from excessive heat. Temperatures around 40°C can cause metabolic damage to fruit and vegetable tissue which leads to deterioration and makes fungal invasion possible. It has been shown that the exposure of perishable produce to direct sunlight can result in considerable elevation of internal temperature: a 10-12 degree C difference between air temperature (when air temperature was approximately 34°C) and produce temperature was found in darkly colored vegetables such as eggplants, tomatoes and potatoes (Rickard and Coursey, 1979). Shading of produce from the sun can suffice to make an improvement in the storage life of the produce.

Chemicals

Bourne (1977) judged that chemical preservatives come close to being ideal for preservation of foods in developing countries because they are cheap, effective, easy to apply and generally require little in the way of equipment. The use of fumigants, insecticides and rodenticides has been well worked out for grain storage systems. The use of chemicals to inhibit spoilage of foods, however, while a widely applied method in developed countries, is underutilized in the developing countries. One chemical preservative that is widely used there is salt. However, preservatives such as propionic acid or propionates, benzoic acid, sorbic acid, etc., which are permitted as food additives in the U.S., should be studied for applications to problems in developing countries.

> The chemical propionic acid is extensively used in the United Kingdom and Europe to preserve moist grain intended for cattle feed. Propionic acid is not used on grain intended for human consumption because of its unpleasant flavor but the sodium and calcium salts of propionic acid are permitted to be added without limitation to bread in the United States as mold inhibitors. It is quite possible that a dose of propionic acid applied to moist paddy rice would prevent mold growth for several months and that most of the acid would be removed when the rice was dehulled, thus eliminating the flavor problem. The potential additional weeks that moist paddy rice could be stored would ease the problem of overloading the capacity of rice dryers during the harvest season and might even hold the moist paddy until the end of the wet season thus allowing it to be dried in the sun. Another positive feature with propionic acid is that it inhibits the growth of *Aspergillus flavus*, the mold that produces aflatoxin. (Bourne, 1977)

Now I would like to share with you some chemical preservation work which we carried out in Panama last year. Our work was on papaya. An appropriate technology for papaya preservation for use by rural farmers who sell their fruit in local markets was developed. Coating the fruit with hot paraffin into which sorbic acid had been incorporated extended papaya shelf life at ambient temperature and humidity from 4 days to greater than 9 days

(Islam et al., 1981). The paraffin coating effected a type of modified atmosphere storage by preventing exchange of gases and protected the fruit from microbial contamination. The heat of the hot wax also killed microorganisms. Such a treatment, if applied manually, would cost only about 3-4 cents (US) per papaya.

Conclusion

During the last 10-15 years we have seen a great deal of accomplishment in the overall food production in the world. There have been major breakthroughs in agriculture and aquaculture. We have seen the development of high yielding rice and wheat varieties, high-lysine corn and even hydroponics. But we have yet to find any major invention in the area of food preservation. There have been some important developments in recent years, such as flexible cans, CO_2-packaging, but by no means would these be applicable for the rural farmers in the developing world.

While some technology already exists in both sophisticated and simplified forms, new technology can and should be developed to optimize the benefits from high-yielding crops. How much is produced in the field is certainly important, but how much of that actually reaches the mouths of the hungry is far more important.

REFERENCES

Aggarwal, N. S., Birewar, B. R., Chauhan, K. K. S., Girish, G. K., Sharma, S. N., and Berman, B. K. 1979. Appropriate technology for food grain storage under Indian conditions. In: "Appropriate Technology for Food Storage and Processing," United Nations Industrial Development Organization Monographs on Appropriate Industrial Technology, No. 7, p. 58.

Anonymous. 1981. World hunger today. L'Economie Familiale 53(3):6.

Bourne, M. C. 1977. Post-harvest food losses - the neglected dimension in increasing the world food supply, Cornell International Agriculture Mimeograph 53.

Clark, C. S. 1982. A solar food dryer for Bangladesh. Appropriate Technol. 8(4):14.

Exell, R. H. B. and Kornsakoo, S. 1978. A low-cost solar rice dryer. Appropriate Technol. 5(1):23.

FAO. 1979. The state of food and agriculture. Food and Agriculture Organization Agriculture Series No. 10, Rome.

FAO. 1975. "Yearbook of Fishery Statistics." Food and Agriculture Organization, Rome.

Hulse, J. H. 1977. One should try to improve the existing post-harvest systems rather than offering new ones. Ceres. Nov. - Dec., p. 25.

Islam, M. N., Batista, R., and Aleman, R. 1981. Short-term preservation of fresh papaya by surface treatment. Presented at the Third Annual Symposium of the International Association for the Advancement of Appropriate Technology for Developing Countries, Long Island University, Greenvale, NY, Nov. 19-22, 1981.

Kahn, S. G. 1981. World hunger: an overview. Food Technol. 35(9):93.

Krishnamachari, K. A. V. R., Bhat, R. V., Nagarajan, V. and Tilak, T. B. G. 1975. Hepatitis due to aflatoxicosis. Lancet i:1061.

Linblad, C. and Druben, L. 1976. Small farm grain storage. United States Action/Peace Corps Program and Training Journal. Manual Series No. 2. Volunteers in Technical Assistance, Mt. Rainier, MD.

National Research Council. 1978. "Post-harvest Food Losses in Developing Countries." National Academy of Sciences, Washington, DC.

Rickard, J. E. and Coursey, D. G. 1979. The value of shading perishable produce after harvest. Appropriate Technol. 6(2):18.

United Nations Industrial Development Organization. 1979. "Appropriate Technology for Food Storage and Processing," Monographs on Appropriate Industrial Technology, No. 7.

TECHNOLOGY, INSTITUTIONAL DEVELOPMENT AND SOCIAL CHANGE

Previous Page Blank

ABSTRACT

Technology development and transfer have been among the major factors responsible for the remarkable agricultural achievements of most developing countries. Even so, these countries have only slightly increased their per capita food consumption. Wholly inadequate nutrition levels still prevail and the lot of most of the poor has not improved.

The U. S. Agency for International Development is utilizing three major mechanisms to help nations increase their food production. First, we are helping them evolve public policies which will give incentives for the development and utilization of improved technologies. Second, we are encouraging in-country research focused on solving national problems and helping them develop institutions through which the research can be carried out. Lastly, we are giving emphasis to the role of private enterprise in the development process. Our efforts will all be oriented toward stimulating social change on behalf of the world's impoverished people.

TECHNOLOGY, INSTITUTIONAL DEVELOPMENT AND SOCIAL CHANGE

Nyle C. Brady
Senior Assistant Administrator
for Science and Technology
U.S. Agency for International Development

INTRODUCTION

I am delighted to contribute to this conference on a subject which I believe to be as important as it has been misunderstood in recent years. In the fifties, Western-style technology was expected to transform the developing nations, accelerating their economic growth to the "take-off" point and generating benefits that would eventually "trickle down" to the base of the social pyramid. When, for a wealth of reasons, these hopes failed to materialize, many critics frequently blamed what they perceived as misguided technological optimism and a corresponding insensitivity to the social, cultural and political dimensions of development.

Overcompensating for the naivete of the past, some development specialists and donor agencies began to question whether technological progress was part of the problem or part of the solution, at least as far as "the poorest of the poor" were concerned. In other words, these second thoughts regarding technology's contribution to development were usually voiced in the name of equity. Critics observed, sometimes with justification, that Western technology easily backfired in Third World settings--displacing farm workers, for example, or serving merely to enrich the already-affluent classes.

However, others countered by saying that efforts to preserve jobs and to protect traditional ways by preventing any technological progress would serve merely to perpetuate poverty. The social effects of technological change are not determined by technology alone, they argued, but rather by the appropriateness of particular technologies for local conditions, the extent to which the new technologies alleviate specific production bottlenecks or economic constraints, their usefullness and accessibility to small-scale farmers and entrepreneurs, and, perhaps more importantly, public policies which encourage the use of the new technologies.

Today, I believe we have a more realistic awareness of both the possibilities and the pitfalls of technological change. We know that technology is far from a panacea that can overcome all the problems of underdevelopment, especially ancient patterns of social injustice. At the same time, there is widespread recognition that improved technology not only can facilitate beneficial social change but in many cases is a prerequisite for that change. Technologies provide political leaders, extension agents, teachers and most importantly farmers, with tools for raising overall living standards and specifically those of the poor majority. In this view, and it is one that I personally share, technology is a necessary but not sufficient prerequisite for equitable development. I would like now to explore some of the areas in which new technology can spur progressive social change and to give you a brief overview of what the Agency for International Development, which I represent, is doing toward this end.

TECHNOLOGY AND AGRICULTURAL PRODUCTION

The most important feature of the world food situation today is the unprecedented and accelerating growth in demand for food, thanks to continuing population pressures, rapid growth in per capita incomes in many nations, and the rise in food imports by the centrally-planned economies. Given this surge in demand, world food prices will rise beyond the reach of poor nations and poor people within all nations, unless food production continues to increase substantially in the developing nations.

As you know, a great deal has already been accomplished in this regard, thanks to the development of the high-yielding wheat and rice seeds. The Green Revolution is a good example of the ways in which technology can advance the welfare of the poorest members of society -- sometimes, if only by averting the problems that would have occurred had the new technology not been introduced. Thanks to the new seeds, millions of poor families, especially in Asia, are able to buy staple foods at prices ~~they can~~ afford, despite a simultaneous increase ~~in demand~~ and reduction in per capita arable land due to population growth.

The agricultural accomplishments of the developing countries during the past 25 years are most encouraging. Since 1955 food production in those countries has doubled. Even more rapid increases have taken place in selected countries. Wheat production in India, for example, increased from 11.4 million metric tons annually in 1967 to more than 34.7 million metric tons in 1979. Likewise rice ·oduction in Indonesia moved from 12 million tons in 1968 to over 20 million tons in 1980. These rates of increase are much higher than those achieved by more developed countries in comparable periods of time. Even the United States with its remarkably efficient agricultural production system, underpinned by the world's most extensive infrastructure support mechanisms has never had percentage rates of increase which would match those of some developing countries during the past two decades.

What have these remarkable feats meant to the developing countries and specifically to the poorest of the poor in those countries? In the absence of the new technologies associated with the Green Revolution and with enlightened policies which permitted these technologies to function, it would require 6 to 8 billion dollars worth of wheat and rice annually to provide the populations of these countries with their current rate of consumption. Even if such quantities of food could be made available at concessional rates by the U.S. and other developed countries, the cereal prices in the developing countries would undoubtedly be much higher than at present and the poorest of the poor would suffer the most. Families which even now are spending 80 percent and more of their income for food would be even more destitute. It is easy to see how the poor majority of the developing countries have benefited most from the Green Revolution of the past two decades.

In spite of the remarkable contribution of the Green Revolution to human welfare, it is apparent that it has fallen short of the unrealistic expectations placed on it. For example, the Green Revolution generally has not made income distributions more favorable to landless laborers, indeed, some studies suggest slight trends in the opposite direction. It is interestin to speculate, however, what would have been the social effects if the Green

Revolution had not occurred. I think we would all prefer to be poor Indian farmers or landless laborers in an area that had experienced the Green Revolution, rather than in a region that had not. Consideration of world food needs reminds us that the Green Revolution has significantly influenced food production in less than half the cropped areas of the developing countries.

There are large geographical areas for which there is still no applicable technology for raising food production in economically feasible ways. To put it bluntly, we have tackled only the easy problems so far. For example, today's high-yielding wheat and rice varieties are appropriate only for the most favorable physical, economic and biological conditions. We now need to spread the Green Revolution by breeding varieties that can flourish under adverse climatic conditions and can thrive with a minimum of costly inputs. We must learn how to overcome those plant and animal diseases, pests, problem soil conditions, deficiencies and excesses of water and other production constraints which still prevent millions of Third World farmers from eking more than a bare subsistence from the land.

In fact, continuing technological progress in food production is especially important in view of the economics of agricultural expansion. The cost per unit of additional food production is likely to rise, due to higher energy costs, expansion into land of lesser quality, and heavier reliance on agricultural inputs (sometimes with diminishing marginal returns). Future production costs will also be affected by resource problems of deteriorating soil and water quality, decertification and erosion. Improved technology can help to lower unit costs while simultaneously increasing the overall volume of agricultural production.

CRITERIA FOR HELPING POOR PEOPLE

If technological advances in agriculture are to benefit the lowest-income producers and consumers, important criteria must be met. First, the new technologies must provide economic and social acceptable benefits for the society as a whole. They must contribute significantly to the overall economic development of the low-income country and not just to a redistribution of wealth in a grossly inadequate economy. Only by gaining overall economic strength can a country hope to solve its development problems. Second, concerted efforts must be made to assure that the technological innovations generated by research really respond to existing farm-level constraints and conditions. If this is not the case -- either because those constraints are not understood or because national policies do not encourage their removal -- the resulting innovations may contribute little in the way of positive social change, and may even worsen the lot of the poor. Concern with this target population puts a premium on multidisciplinary efforts to better understand local farmers and farm families. We still know all too little about these rural people, their customs, needs and expectations. In particular, we need to better understand the role of women, not only as homemakers but as farmers and business managers of farm and family affairs. Third, institutions must be developed to enable the poor to benefit from the new technologies, or if the institutions already exist, to help them function. These institutions may be governmental such as extension services, or they may be private such as cooperatives or small-scale rural industries. To the extent feasible, these institutions must respond to specific needs of the poor. Fourth, there must be emphasis on small-scale labor-intensive and capital-saving technologies. These technologies may be coupled with more intensive land use such as double or triple cropping and with increased yields per hectare. They should make possible the so-called "dispersal strategies" which enable all farmers, however small their plots, to benefit from the new technologies. Dispersal strategies include such elements as research, extension, credit and availability of inputs.

The need for new agricultural technology is especially acute in Africa, where about 80% of cultivation is still dependent on human labor and the hoe, and where many additional hectares can still be brought into cultivation. However, raising food production under the rainfed conditions that characterize most of Africa will require concurrent progress on breeding appropriate seeds as well as on developing tillage and equipment innovations for improving soil and water management practices. Both are tricky and challenging tasks. For example, recent tests at the International Institute of Tropical Agriculture in Nigeria showed that manual clearing of secondary forests -- using native tools and chain saws -- took 177 man-days per hectare, as compared with only 1.94 working hours per hectare with mechanized clearing by a tractor and a shear blade attachment. On the other hand, both the soil loss and water run off caused by mechanized clearing were many, many times greater than with the manual clearing method. New technologies, both biological and mechanical, are badly needed to resolve these dilemmas. One promising approach lies in developing simple, inexpensive but well-designed animal-powered implements, for it will be many years before the majority of low-income farmers in the semi-arid tropics will be able to afford tractors and tractor-drawn equipment.

The difficulties of developing appropriate technology for Africa are compounded by institutional and human resource deficiencies on the continent -- including a very limited capacity to conduct agricultural research, weak or nonexistent national research programs, inadequate infrastructure, weak extension services and a lack of trained personnel. Hopefully, the increased attention to Africa's food production problems in recent months will result in accelerated progress over the next few years.

TECHNOLOGY AND THE EXPANSION OF RURAL NON-FARM EMPLOYMENT OPPORTUNITIES:

In addition to augmenting food production, another key challenge for technology in development is to expend rural non-farm employment opportunities. This is an increasingly serious issue. Of the one billion new workers who will enter the world's labor market by the year 2000, only one-third are expected to work on farms, although the majority will still live in rural areas.

At present, the developing countries differ widely in the percentage of the rural labor force employed primarily in non-farm activities. In Guatemala the figure is 14 percent, whereas in Taiwan it is 49 percent. In addition, rural non-farm activities usually constitute an important source of secondary employment, often on a part-time or seasonal basis. Consequently, non-farm income accounts for a significant fraction of the total income of rural households -- up to 30 percent in villages in Pakistan and Nigeria, 36 percent in Sierra Leone, and 43 percent in Taiwan. Non-farm income is especially important, naturally, for rural families who own little or no farm land.

As agricultural output increases and monetary incomes rise in the agricultural sector, rural non-farm activities will grow in corresponding measure, spurred by the growing demand for farm equipment, agricultural inputs, repair services and so forth. The development of small farm equipment that can be manufactured locally has direct and indirect effects on job-creation. Predictably, the increased demand for animal-powered implements and other relatively simple agricultural machinery will foster the emergence of machine shops and light engineering firms that concentrate initially on very simple techniques and products. Because the technologies require skills very similar to those already mastered by local artisans and technicians, their diffusion is likely to be fairly rapid. At the same time, the most competent firms will upgrade their technologies in response to demand for new and more sophisticated implements like seed-fertilizer drills or low-lift pumps.

The strengthening and diffusion of metal working skills that results from this process is of great importance because those skills are key for many other types of manufacturing. This includes a growing capacity to manufacture capital goods, and the capacity in turn is crucial to the process of adapting imported technologies to local conditions and making them widely available to producers throughout the economy.

The net results of this overall process of rural modernization is job creation, the building of local industry, and the growth of small and medium-sized rural towns, with significant foreign exchange savings in the bargain.

A.I.D.'S ROLE

Given, then, that the goals of increasing food production and creating more jobs are both closely linked with the development of new technology, what is A.I.D. doing to help bring this about? Under Peter McPherson's leadership, three particular aspects of the development process are receiving special emphasis. All three have strong implications for the design, adaptation and transfer of technology to promote rural development and equitable social change.

1. Policy Dialogue

The first is the evolution of national policy frameworks within which the development process can operate more effectively and equitable. This emphasis is grounded on a wealth of historical evidence that success or failure of the development process within a particular country depends primarily on the nature of the policies followed by that country itself. Certainly, with regard to both food production and rural non-farm employment, government policies strongly influence the relation between technological and social change in the countryside.

In the case of agriculture, farmers will not avail themselves of new technology, no matter how accessible and productive and appropriate, unless the prices the farmer receives for his produce are set high enough to allow a decent profit. These farmers also need access to credit, adequate roads to bring their produce to market, reliable and affordable supplies of agricultural inputs, and storage facilities for their surplus crop so that they are not forced to "sell cheap and buy dear". The ability of farmers to increase yields will also be determined by the nature of the technological innovations generated by agricultural research programs, extension programs and rural education. Government policies have a strong and sometimes decisive bearing on each of these aspects of a developing country's food system, and positive policies produce positive results.

For example, in Japan, Taiwan and Korea, the ratio between the price of agricultural inputs and the price of grain encourages farmers to produce more food. Unfortunately, many other Asian countries have not followed that practice, and so their farmers have had no incentive to utilize fertilizers, pesticides and other yield-increasing inputs. Similarly, Niger has been able to reach self-sufficiency in grain production while neighboring Mali -- with the same climate and more cultivable land -- suffers annual food deficits. The major difference is the higher price that the Government of Niger offers its peasant farmers for their produce.

National policies can be equally influential in stimulating rural non-farm economic activities. For example, government-supported R&D activities can foster the development, expanded use and local manufacture of farm equipment suited to the needs of small farmers with limited cash income. Unfortunately, as often as not government policies have actually impeded the growth of small manufacturing firms in the countryside. Too frequently, Third World Governments have given preferential treatment to larger firms in the industrial sector, through such measures as loans at artifically low interest rates, the ways in which foreign exchange and import licenses are allocated, and other types of preferential treatment that are usually not available to small and medium-sized farms.

Through AID's country missions, and through our cooperation with other donor agencies such as the World Bank and the IMF, the United States is seeking to engage A.I.D. recipients in a policy dialogue that can improve the local policy environment for equitable development. Naturally, this process will not always be successful and can be counted upon to require painstaking efforts, patience and time. However, the importance of policy dialogue and policy reform for social change cannot be underestimated.

2. Science, Technology and Institution-Building

The second emphasis of the A.I.D. program today is not a new one, but, rather the strengthening of an emphasis that paid handsome dividends in the past. I am speaking of institutional development, along with a heightened role for science and technology. One of the clearest lessons of the past is that economic development is closely tied to the capacity of a country to sustain its own research institutions and programs. Without this local institutional capacity for self-reliance, development becomes dependent upon the good will of others whose resources usually are not geared to solving the local problems under local conditions.

Among the donors of development assistance, the United States has a notable comparative advantage for helping to strengthen local institutions, thanks to our successful experience in the past and the wealth of highly trained scientific and technical resources in this country. From now on, U.S. universities will be playing an increasingly strong and better-integrated role in A.I.D.'s development assistance efforts. Let me briefly outline some of the ways in which this is coming about.

First, A.I.D. is now in the process of negotiating several Memoranda of Understanding with selected Universities, to permit firmer and more sustained relationships with A.I.D. Second, we are in the final stages of developing a Joint Career Corps that will make it possible for Universities and interested members of their staffs to become involved in overseas development on a continuing basis. Participation in the Joint Career Corps will enable University professors to work with A.I.D. for one-third of their careers, and with their own Universities for the remaining two-thirds. Third, we are also in the process of establishing a Joint Enterprise Mode which will enable A.I.D. to involve single individuals from a number of smaller institutions to participate in particular projects. Such institutions often have special experience and expertise in dealing with low-income farm families.

In recent months, we have also been trying to strengthen the role of science and technology in our bilateral assistance programs through certain internal organizational changes -- including the coordination of the work of a new Bureau for Science and Technology, with that of the regional bureaus and country Missions. Universities will be called upon increasingly to carry our research and extension activities in cooperation with overseas counterparts.

3. The Private Sector

The third important emphasis of the Agency is to increase the role of the U.S. and host-country private sectors in our foreign assistance activities. Market mechanisms play a major role in the creation, adaptation and dissemination of technologies. It stands to reason that new technologies suited to developing nations are most likely to be created by local business firms which would themselves have a stake in the outcome. Consequently, A.I.D. is working with both local and U.S. private sector specialists to make local market systems work more efficiently, to remove particular bottlenecks or disincentives created by inappropriate policies and, in general, to help indigenous entrepreneurs bring their under-utilized energies to bear on the rural development process in ways which benefit low-income producers and consumers as well.

I would like to conclude by emphasizing that technological change will continue to be a prerequisite for expanding food supplies and job opportunities, whatever a nation's policy dilemmas, social needs, or ideology. By substantially increasing the supply of basic food grains, new technologies can help to hold the line on food prices, with corresponding benefits for small producers and for low-income consumers who already spend most of their limited budgets on food. By the same token, technological change is the life-blood of job creation and economic growth, without which nations and individuals alike are condemned to stagnation.

Therefore, without expecting technology to do the impossible, we must bend out efforts to develop and disseminate the kind of technology that can promote social change on behalf of the world's impoverished people -- knowing that without technological advance, succeeding generations of people in the developing world will be no better off than their parents or grandparents.

INTERNATIONAL RESEARCH AND TECHNOLOGICAL CHANGE IN AGRICULTURE IN DEVELOPING COUNTRIES

ABSTRACT

By the close of this century as many as two billion additional people are expected to swell the ranks of humanity. Most of them will be born in developing countries, especially in marginal lands ill-suited for food production. This article focuses on the major achievements of the International Agricultural Research Centers supported by the Consultative Group on International Agricultural Research, addresses the issues raised by the spread of new high-yielding varieties, and explores new directions aimed at boosting food supplies in developing regions.

INTERNATIONAL RESEARCH AND TECHNOLOGICAL CHANGE IN AGRICULTURE IN DEVELOPING COUNTRIES

Donald L. Plucknett
Consultative Group on International Agricultural Research
World Bank

and

Nigel J. H. Smith
University of Florida

INTRODUCTION

In the early 1960s considerable alarm was expressed about the food prospects of the developing countries. The threat of famine, with its tendency to destabilize political regimes, was cropping up in several parts of the Third World with increasing frequency, and the possibility of large-scale starvation loomed ominously on the horizon. Then in the mid 1960s a breakthrough in food production in some developing countries occurred with the rapid dissemination of high-yielding varieties (HYVs) of wheat and rice, popularly known as the green revolution. The impressive record of the International Agricultural Research Centers (IARCs), now banded together under the Consultative Group on International Agricultural Research (CGIAR), in raising yields and protein levels of several staples grown in the Third World has raised expectations that they will continue to overcome production barriers in crops.

THE CGIAR AND THE GREEN REVOLUTION

The oldest centers within the CGIAR network, CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo) and IRRI (International Rice Research Institute), have had great impact on food production in the Third World. CIMMYT was established near Mexico City in 1943 with the help of the Mexican government and the Rockefeller Foundation and gained worldwide recognition in the 1960s for its development of short-statured wheats. CIMMYT's semi-dwarf wheats are now grown on 35 million hectares (ha) and account for half of the land devoted to bread wheat cultivation in the developing countries (3,6,15). Most of the short, stiff-strawed wheats are grown in the Sonora region of Mexico and in the Punjab of India and Pakistan. The HYVs of CIMMYT's germplasm have significantly boosted yields, from an average of 0.7 to 4 tons/ha in Mexico and from 0.6 to 2 tons/ha in India. Food supplies have increased accordingly; in 1966, for example, India had to import 10 million tons of grain to feed its 490 million people when the monsoon failed. Since then, India has become largely self-sufficient in cereals in spite of further droughts and an increase in population of almost 200 million (14,21).

IRRI, headquartered at Los Baños in Philippines, began operations in 1962 and was responsible for developing dwarf rices that now grow on one quarter of the rice producing land of the Third World. This figure masks the spectacular gains registered in certain countries, however. In the Philippines, for example, almost 70% of the rice is in HYVs, up from 53% in 1973. In Colombia, 90% of the irrigated rice is CIAT/IRRI material released through the national program. Prior to the distribution of HYVs, only half of Colombia's rice output came from irrigated land; now 90% of the national rice harvest is reaped in paddy fields (13,18,19). Whereas traditional cultivars produce around 3 tons/ha, HYVs normally yield 5 tons/ha (8). More importantly, HYVs have a shorter maturation period than older varieties, so some farmers can harvest two or more crops a year. The rapid adoption of short-statured rices has helped alleviate food shortages over large areas of Asia. Bangladesh, for example, has recently come within a few hundred thousand tons of feeding itself. The Philippines, which had been a chronic importer of rice for decades, has only occasionally had to resort to the world market to purchase rice since 1970; in 1980, the archipelago country even exported a quarter of a million tons of rice. And Indonesia's food picture is much brighter now that HYVs of rice cover more than 3 million ha (4,12).

The rapid and far-reaching pay-offs of CIMMYT and IRRI soon prompted the Rockefeller and Ford Foundations to provide seed money for two more IARCs. CIAT (Centro Internacional de Agricultura Tropical) was established in 1967 near Cali, Colombia, to pursue research into increasing the productivity of cassava (Manihot esculenta), rice, kidney bean (Phaseolus vulgaris), and cattle pastures in the humid tropics of Latin America. At the same time, the Foundations set up the International Institute of Tropical Agriculture (IITA) at Ibadan, Nigeria, to encourage research into raising yields of tropical staples such as sweet potato (Ipomoea batatas), yams (Dioscorea spp.), cocoyams (species of Colocasia and Xanthosoma), and cowpea (Vigna unguiculata). In addition, IITA was assigned regional responsibility for developing cultivars of cassava, rice, maize (Zea mays), soybean (Glycine max), pigeonpea (Cajanus cajan), lima bean (Phaseolus lunatus), and winged bean (Psophocarpus tetragonolobus) adapted to the diverse environments of Africa (2).

After launching four IARCs, the Rockefeller and Ford Founda s wanted to install more centers to improve other crops and to help certain regions overcome their specific agricultural problems, but they realized that such an undertaking was beyond their financial means. A transnational framework for sponsoring the IARCs was called for. To meet this ambitious task, the CGIAR was formed in 1971 under the sponsorship of the United Nations Food and Agriculture Organization (FAO), the United Nations Development Programme, and the World Bank, with headquarters in the Washington-based bank. The CGIAR acts on behalf of a consortium of 34 donors, ranging from multinational organizations and national governments, to private foundations, and is advised by a Technical Advisory Committee (TAC), composed of 13 scientists from both industrial nations and the developing world. TAC's secretariat is located within the headquarters of FAO in Rome. The CGIAR, unlike many international bureaucracies, is small and streamlined. Only six professionals staff the CGIAR headquarters. The TAC has a full-time staff of four; the advisory board of scientists meets twice a year.

Empowered with new resources, the CGIAR inaugurated nine new IARCs in quick succession. CIP (Centro Internacional de la Papa) was created in 1971 to work on the potato in the center of its origin in the Peruvian Andes. WARDA (West Africa Rice Development Association) was conceived in 1971 in Liberia to promote self-sufficiency in rice in 15 countries of West Africa. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) began working on groundnut (*Arachis hypogaea*), chickpea (*Cicer arietinum*), pigeonpea, pearl millet (*Pennisetum typhoides*), and sorghum (*Sorghum bicolor*) near Hyderabad, India, in 1972.

In 1974, the CGIAR began three new institutes. ILCA (International Livestock Center for Africa), based at Addis Ababa in Ethiopia, explores ways of improving the pastoral economies of Africa, while a sister institute, ILRAD (International Laboratory for Research on Animal Diseases), operating out of Nairobi, is tackling two serious diseases of cattle in the tropics: theileriosis and trypanosomiasis. These livestock illnesses severly limit the productivity of beef and dairy herds in at least 50 developing countries. The third CGIAR institute established in 1974, IBPGR (International Board for Plant Genetic Resources), is based with FAO in Rome and promotes the conservation of crop diversity by sponsoring an international network of germplasm collections.

ICARDA (International Center for Agricultural Research in the Dry Areas) was added to the CGIAR system in 1976 to examine the potential for boosting food production of the dry sub-tropics, particularly in North Africa and West Asia. Based in Aleppo, Syria, ICARDA scientists are developing new strains of bread and durum wheats, barley, triticale (wheat x rye), lentil (Lens esculenta), chickpea, broad bean (Vicia faba), and forage plants. In its work with cereals, ICARDA collaborates with CIMMYT, while ICRISAT assists in the chickpea program. ICARDA and ICRISAT thus cover the most important crops of the drought-prone portions of the developing world.

By the close of 1970s, two more centers joined the CGIAR, thereby bringing the total to 13. IFPRI (International Food Policy Research Institute) was founded in Washington in 1975 to analyze strategies for meeting the world's food needs. By monitoring food production in developing countries, as well as world trade in cereals and pulses, IFPRI provides information for policy makers drawing up priorities for agricultural research and development. To help fill a vital need to strengthen national agricultural programs so that research results generated by the IARCs benefit the inhabitants of developing countries, the CGIAR created ISNAR (International Service for National Agricultural Research) in the Hague in 1979. ISNAR helps developing countries to start or up-grade their agricultural research and extension services.

Approximately 600 scientists from a wide assortment of countries are currently conducting research at the IARCs. These scientists take advantage of good laboratory and field equipment, well-stocked libraries, and funds to attend international meetings and to conduct collaborative research with colleagues in other institutions. The IARCs avoid competing with national programs in the Third World; their mission is to help strengthen such efforts with the help of training courses, collaborative research, and improved germplasm collections. Whenever possible, the IARCs leave the finishing of crop varieties to national programs, playing a discrete, supportive role designed to build the image and effectivenss of national institutions.

NEW RESEARCH HORIZONS

The major strides in raising food production have been made in the better lands. While there is still scope for generating even more food from such regions, such as by developing crop breeds with shorter maturation periods so that more cycles can be grown each year, the next green revolution must necessarily come from the marginal lands. The dimensions of the challenge are staggering: at least 700 million people live in the semi-arid tropics, parched lands that receive an erratic rainfall between 400 and 1200 mm a year. Close to a billion people currently eke out a living in environments that produce meager yields because of ecological limitations. And most of the additional 2 billion children that are expected to be born by the year 2000 will grow up on marginal lands.

Areas handicapped by biophysical constraints for agriculture far exceed the earth's optimal zones, consequently even a modest increase in crop yields will greatly alleviate food shortages in developing countries. But drawing up a research strategy for the agricultural transformation of marginal lands is more difficult than breeding crops for fertile alluvial and volcanic soils. Nevertheless, most of the IARCs share a commitment to developing crops that can thrive in soils that are excessively saline, alkaline, acidic, contain toxic amounts of aluminum, are deficient in phosphorus and nitrogen, or tolerate drought.

To help farmers overcome the problem of saline soils, IRRI is developing rice lines that are relatively tolerant of such soils which cover between 400 and 950 million ha of the earth. IR 42 grows well in brackish areas and could prove useful where formerly productive irrigated land is now virtually useless because of the surface build-up of salts. Although water management should be used to correct this defect, limited supplies of water often do not permit an adequate flushing of fields. IR 42 could help revitalize such areas, which account for 70 million ha, or one quarter of irrigated lands, and are expanding (1,5). At CIMMYT preliminary results suggest that triticale tolerates saline soils better than other cereal crops. Triticale breeders at CIMMYT as well as the Universities of Manitoba and Guelph have developed varieties of triticale that compare favorably in yield to the best wheats, but are greatly superior to the latter in nutrient-poor, drought-prone soils. Wheat breeders at CIMMYT are crossing the world's most important food cereal with several species of Agropyron in an attempt to transfer genes that code for salt tolerance from the wild grasses.

Strongly acid soils are common in extensive regions of the humid tropics due to a prolonged leaching of cations needed for plant growth. Toxic levels of aluminum are also often found associated with acidic soils, a further complication for the farmer. Several of the IARCs are attempting to tailor crops to such adverse conditions. Triticale, for example, is being tested on the Brazilian cerrado, a savanna region of some 200 million ha with little agricultural development due to its highly leached soils containing large amounts of aluminum compounds. This man-made cereal makes excellent bread and pastries as well as a nutritious livestock feed and could help transform the cerrado into an important food producing region. In Asia, IRRI is developi rice lines that thrive in acid soils under rainfed conditions. IR 42 has demonstrated promising yields on farmer's plots with low levels of nitrogen fertilizer (7).

Another emerging priority for crop breeding at the IARCs is finding plant that thrive with less fertilizer. Most of the nitrogen fertilizer produced commercially is based on natural gas or to a lesser extent crude oil. Hence fertilizer prices have been climbing along with the prices of these fossil fuels. Even fertilizers which are not based on petroleum, such as phosphorus and potash, are also becoming progressively more expensive because they require large amounts of energy to mine, up-grade and to transport. Some of the IARCs are focusing on the potential of biological nitrogen fixation to help boost crop yields. Both IRRI and WARDA, for example, are searching for water fern-blue green algae partnerships that are especially prolific in capturing atmospheric nitrogen for the benefit of paddy rice farmers. Researchers at ICRISAT are screening germplasm collections to develop lines of pigeonpea, chickpea, and groundnut that fix unusually large amounts of nitrogen through the action of symbiotic Rhizobium bacteria in root nodules. IRRI and ICRISAT are studying associative bacteria, particularly species of Azospirillum and Azotobacter, that fix nitrogen close to the roots of rice, sorghum, and pearl millet. It is hoped that lines of the cereal will eventually achieve much higher yields than traditional varieties without resorting to nitrogen fertilizer. ICARDA, ICRISAT, CIAT, IITA, and IRRI are examining the potential for inoculating crops with symbiotic and associative nitrogen-fixing bacteria in order to accelerate the development of populations of the beneficial micro-organisms in fields.

Several centers are exploring the contribution of vesicular-arbuscular (VA) mycorrhiza in reducing the need for commercial fertilizer. Some 80 species of these fungi live in and around the surface of roots and enhance the nutrient uptake of plants. They also favor nitrogen-fixing bacteria and help plants to withstand drought. Field tests of VA mycorrhiza inoculation of onions, maize, and cowpea in unsterilized soils have demonstrated yield increases of 20-100% (10,11,16,20). CIAT has recently confirmed the importance of VA mycorrhiza to the nutrition of cassava, expecially the assimilation of soil phosphorus. Now the center is investigating the potential of this root crop to benefit from relatively cheap rock phosphate fertilizer. Although several obstacles remain before VA mycorrhiza inoculum can be produced on a large scale, ICRISAT and ICARDA are pursuing research into the ecology of the fungi and methods of mass-producing the inoculum.

Drought tolerance in crops is another high priority for breeders at the IARCs. Triticale has already demonstrated good yields in the semi-arid and highland areas of the tropics, and breeders are likely to benefit from work being done with VA mycorrhiza that increase the ability of plants to withstand soil moisture deficits. Wheat breeders at CIMMYT are crossing the cereal with a tall bunch grass from Asia, Elymus giganteus, in order to incorporate genes that confer greater tolerance to water stress. And at IRRI, scientists have developed rice lines, such as IR 43 and IR 52, that yield up to 4.6 tons/ha in rainfed fields during the wet season. Even if rainfall is well below expected levels, these new rices still produce an economic yield.

An excess, rather than a deficit, of moisture can be a problem in marginal lands. In parts of Bangladesh, Thailand and the inland Niger delta, for example, rice paddies are sometimes swamped in 1.5 m of water which drown traditional cultivars and early generation IRRI material. To help farmers cope with wildly fluctuating water levels in their paddies, IRRI has developed rice lines that can withstand submergence for short periods and grow taller. To accomplish this task, scientists turned to wild rice to acquire traits which promote the rapid elongation of stems, a counter-current to the research trend of producing semi-dwarf varieties. Although the yield ceiling is lowered because the rice plants divert more photo-synthetic effort into building stems rather than grains, at least the farmer is saved from catastropic crop failure. Yield stability, rather than striving for spectacular harvests, is thus a key element in the research strategy for marginal land crops.

Even in the semi-arid tropics, too much water can turn soils into a quagmire and render them useless for agriculture. The deep black vertisols which cover enormous areas of India and Africa are examples. In India alone, the dark, heavy clays are found over 73 million ha, some 26 million of which are left fallow during the torrential monsoon because they are too sticky to work (9,17). In such areas, farmers normally plant their crops when the rains subside so that the plants can tap the moisture stored in the soil.

In an effort to introduce double cropping to these deep vertisols, ICRISAT is testing a wheeled tool carrier, a flexible machine pulled by bullocks or water buffalo that can be used to plow land as well as to plant seeds and apply fertilizer. During the monsoon season, maize and pigeonpea or mung bean (*Phaseolus aureus*) are sown on a raised broadbed, followed by a crop of sorghum or pearl millet during the dry period. In this manner, 1.5 to 2 tons/ha of grains can be produced a year, instead of 0.5 to 1 ton/ha under traditional management. Although the yield gain does not qualify as a quantum leap, it is nevertheless significant: India could produce an additional 25 million tons of grain per year from its deep black clays. The wheeled tool carrier costs about $1,000 with accompanying implements, though cheaper models are being developed. The economics of its use in India remain to be investigated, but the tool carrier could be owned collectively or rented if individual farmers find they are unable to own one. It seems likely that the high initial cost could be recouped within a few years due to the doubling of yields. The intermediate technology is already being successfully used by groundnut farmers in West Africa and will surely be adopted in other regions of the Third World.

CONCLUSION

After a decade of spectacular growth, the CGIAR system enters the 1980's in a consolidation phase. The annual budget of the network has grown from \$20 million in 1972 to a little over \$170 million in 1983, but the supply of funds for the IARCs is tapering off or even declining in some cases due to the erosive power of inflation. Faced with new challenges to raise food production, CGIAR is hard pressed to launch new programs and to initiate more centers because funding sources are drying up, a reflection of the sluggish economic performance of most industrial nations. The sum of \$170 million may appear impressive but it pales when compared to funds allocated to other sectors, such as defense, industry, and energy. Only 3% of the global research budget is allotted for agricultural research, and most of that thin slice is spent in the developed countries (22). Funds channeled into agricultural research for food production by international agencies and national governments clearly generate an enormous pay off. The value of the increase supplies of rice generated by HYVs based on IRRI germplasm, for example, exceeds \$2.5 billion.

Agricultural research alone will not provide a panacea for the food problems of the developing world. Neither will the machines being designed by the IARCs in conjunction with private firms and national governments provide a technological fix for the complex problem of stepping up food production. Social, economic, and ecological issues will also have to be tackled, such as control of deforestation, population growth, the reduction of post-harvest losses, and the improvement of agricultural extension services. But the new varieties developed by strengthened national programs working in tandem with the IARCs will buy time for societies to tackle the many sociological and environmental obstacles that face them.

REFERENCES

1. Blair, J., 1980. Special Plants to Feed the Hungry. Front Lines, 4 September, pp. 4-5.

2. Bunting, A. H., 1981. CGIAR: The First Ten Years. Span 24 (1):3-4.

3. CIMMYT, 1981. Working Draft: 1981 CIMMYT Review. Centro Internacional de Mejoramiento de Maiz y Trigo, El Batán, Mexico.

4. Cleaver, H. M., 1972. The Contradictions of the Green Revolution. American Economic Review 62(2):177-186.

5. Epstein, E., J. D. Norlyn, D. W. Rush, R. W. Kingsbury, D. B. Kelley, G. A. Cunningham, and A. F. Wrona, 1980. Saline Culture of Crops: A Genetic Approach. Science 210:399-404.

6. Havener, R. D., 1980. International Research in Agriculture 7. CIMMYT: International Maize and Wheat Improvement Centre. Span 23(1):37-39.

7. IRRI, 1981. Research Highlights for 1980. International Rice Research Institute, Los Baños, Philippines.

8. Jennings, P. R., 1974. Rice Breeding and World Food Production. Science 186:1085-1088.

9. Kumble, V. (Ed.), 1979. Development and Transfer of Technology for Rainfed Agriculture and the SAT Farmer. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India.

10. Menge, J. A., 1980. Mycorrhiza Agriculture Technologies. Office of Technology Assessment, U.S. Congress, Washington, D.C.

11. Mosse, B., D. S. Hayman, and G. J. Ide, 1969. Growth Responses of Plants in Unsterilized Soil to Inoculation with Vesicular-Arbuscular Mycorrhiza. Nature 224:1031-1032.

12. Paddock, W. C., 1970. How Green is the Green Revolution? Bioscience 20(16):897-902.

13. Pearse, A., 1980. Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution. Clarendon Press, Oxford.

14. Pennant-Rea, R., 1981. Divided We Stand. The Economist, 28 March, p. 9.

15. Plucknett, D. L. and N. J. H. Smith, 1982. Agricultural Research and Third World Food Production. Science 217:215-220.

16. Ruehle, J. L. and D. H. Marx, 1979. Fiber, Food, Fuel and Fungal Symbionts. Science 206:419-422.

17. Ryan, J. G. and R. Sarin, 1981. Economics of Technology Options for Deep Vertisols in the Relatively Assured Rainfall Regions of the Indian Semi-Arid Tropics. Paper Presented at the Seminar on Management of Deep Black Soils, New Delhi, 21 May.

18. Scobie, G. M., 1979. Investment in International Agricultural Research: Some Economic Dimensions. Staff Working Paper No. 361, World Bank, Washington, D.C.

19. Scobie, G. M. and R. Posada, 1978. The Impact of Technical Change on Income Distribution: The Case of Rice in Colombia. American Journal of Agricultural Economics 60(1):85-92.

20. Torraca, S. L., 1978. Efeitos da Inoculacão de Micorrizas Visicular-Arbuscular (VA) no Crescimento e Nodulacão de Vigna unguiculata (L.) Walp. M. S. Thesis, INPA/Universidade Féderal do Amazonas, Manaus, Brazil.

21. Vyas, V. S., 1975. India's High Yielding Varieties Programme in Wheat 1966-67 to 1971-72. Centro Internacional de Mejoramiento de Maiz y Trigo, El Batán, Mexico.

22. Wortman, S., 1980. World Food and Nutrition: The Scientific and Technological Base. Science 209:157-164.

PRIVATE ENTERPRISE AND TECHNOLOGY TRANSFER

Previous Page Blank

ABSTRACT

The technology transfer process is discussed as it relates to private productive enterprises and in the context of less developed country development efforts. The roles of technology and the private enterprise are discussed and the elements of the technology transfer process or system are described. Technology transfer system deficiencies are identified and the means for mitigating or eliminating the deficiencies is discussed. A continuing role for governments is described. Possible publicly financed efforts directed toward increasing the technology transfer systems' efficiency and effectiveness are outlined. Particular emphasis is directed toward providing cost effective access to the system by smaller enterprises. Guiding principles are proposed for those who use the system.

PRIVATE ENTERPRISE AND TECHNOLOGY TRANSFER

Roger D. Moeller
Bureau for Private Enterprise
Agency for International Development

All programs for country economic development must ultimately lead to a system that spawns and encourages productive enterprises. The productive enterprise role in improving the standard of living and its close relationship with attaining the individual's goal of a better life is generally accepted in the United States. The economic system in use in the United States places the productive enterprise almost exclusively in the private sector and dependent on the role of the entrepreneur for innovation and growth.

In the developing countries it is often the lack of an adequate productive enterprise system that stifles growth even when capital, natural resources and labor are abundant. The productive system tends to be unevenly developed at best, or non-existent at worst, and efforts to correct deficiencies usually concentrate on the role of the agricultural productive sector based on the fundamental human need for food. The need for shoes seems less urgent and the need for multi-hued shirts isn't apparent at all. Yet a strong case can be made for the premise that a society must develop its capacity to produce its own shoes, multi-hued shirts *and* food in order to create a self-sustaining development. In fact, a society must have *broad* and *balanced capabilities* in a *wide variety* of *productive pursuits* as well as *operational support* and *service* enterprises in order to *maintain economic development* and an *improving quality of life.*

The quality of life is defined in many ways, usually starting with material things and proceeding to the less tangible contributors to life's quality, such as freedom, pride, human dignity, a sense of worth, and a sense of belonging. Few things contribute to an across the board improvement in all of these attributes with the impact of gainful productive employment. In terms of the individual, nothing is more debilitating to the human spirit and demanding of material sacrifice as the lack of gainful employment. From society's standpoint unemployment is a terrible waste of a valuable resource.

If unemployment is a waste of a valuable resource then, in a broad sense, productive employment must be a beneficial use of the resource. If the employment is not productive or if it is parasitic or make-work then the waste of unemployment is compounded by added consumption without production. The consumption of that which is produced or, if you prefer, the production of that which is consumed sustains a country's standard of living. It is the *increasing productivity of the resources being employed* that leads to a higher consumption rate and an increased quality of life. The increasing productivity can be used in many ways. A portion must be used to sustain a continuing increase in productivity. Another portion can be diverted to improve governmental services. Another portion can be allocated to the improvement of educational and health services and to increasing the skills of individuals. And yet another portion to added consumption. All of these allocations--and many not mentioned--improve the quality of life. Many contribute directly or indirectly to promoting increased productivity. At the center of all this is the first need; *to productively employ people*, and the second need; *to increase their productivity*.

The developing countries of the world tend toward an abundance of labor resulting from rapidly growing populations. The employment of this abundant labor force within a balanced, productive system will lead to a growing standard of living and improving quality of life. The nonproductive use of a significant portion of this labor force places an intolerable burden on the society and prevents the improvement desired by all.

Productive employment opportunities are found in the agricultural, manufacturing, and service sectors in large and small enterprises. However, the cost in capital per employment opportunity created tends to be smallest in the smaller enterprise. According to the World Bank Sector Policy Paper, Employment Development of Small Enterprises (February, 1978), small enterprises in developing countries use less capital, produce less value added, and pay lower wages per unit of labor, than large enterprises. These attributes mean that investment costs per direct job generated are lower in the smaller enterprises and thus the incremental demand on capital per unit of employed labor is lower.

Focusing on the smaller enterprises in the productive sector is not easy. By definition there are a large number of operational units, using a wide variety of technologies, supplying a myriad of markets, depending on a vast array of resources and skills and operating in an infinite number of combinations. Many of these enterprises in the developing countries need assistance in a multitude of ways, and the productive system itself frequently needs strengthening. The operational strength inherent in the large number of decision centers operating a tremendously diversified system turns to a handicap when attempts are made to provide assistance from a single source.

The organization of the assistance source to more nearly mesh with the organization of those needing assistance is worthy of consideration. As an example of this, the assistance source could organize into a multitude of decision centers with widely varying capabilities. Also, the assistance source could be drawn from the productive sector to minimize communication problems and to maximize the mutual understanding of motives and values.

The private enterprise sector in the United States is far from a tightly organized, monolithic and homogenous entity. Although it operates within a specific set of laws and, in limited areas, self-imposed standards, each enterprise has its own motivations, methods, objectives and relative values. Furthermore, each enterprise is a decision center where judgments are made on the basis of its own internal factors as related to external conditions and opportunities. Admittedly many generalizations can be made concerning the individual elements of the private enterprise sector, however, these generalizations tend to obscure rather than clarify many useful facts--they tend to highlight a "least common denominator."

The role of technology or know-how in increasing resource productivity is widely and universally recognized. It is technology that brings together capital, land and labor to produce and distribute goods and services. It is the expanding technology base that drives these resources to higher levels of productivity. In a very real sense, technology is the fourth great resource a people can possess--and by far the most satisfying. It is the continued access to improving technology that produces the better tomorrows. Because of this, societies have devised the means for transferring technology from one place to another and from one people to another. The increasing productivity of the other resources is significantly dependent upon the facility with which productive technology can be transferred.

What do we mean by the phrase, "productive technology"? Perhaps, in the simplest form, it is the technical data/information/experience base used in particular productive endeavors. When the phrase "technology transfer" is used we mean more than just a transportation exercise. We imply competent sources and recipients as well as suitable mechanisms for accomplishing the transfer. Also implied in the ability to adapt and use the technology, including adequate training for the participants and the existence of supporting or amplifying institutions.

The system needed to transfer technology is made up of numerous necessary elements. When transferring technology from developed to developing countries the system usually displays numerous shortcomings and deficiencies. The deficiencies are most prevalent when the goal is to transfer technology from smaller enterprises in developed countries to the developing countries. The larger tend to effectively internalize many of the technology transfer systems' elements and have the resources to mitigate deficiencies. The smaller enterprises lack the size to internalize the system and the resources to overcome the deficiencies.

Elements of Technology Transfer

The list of needed elements might start with the need for qualified recipients as well as qualified technology sources, particularly in the small or medium size class. The need for qualified recipients and sources is substantive and presents a problem of identification.

A definite need exists for institutions and mechanisms for facilitating technology transfer. The existing mechanisms most readily accommodate large sources and relatively large recipients. They accommodate these particularly well where large invested resources accompany the technology. The existing mechanisms are inadequate where the source and recipient are relatively small and little or no invested resources are transferred with the technology. The entire field of institutional adequacy is complex but a number of specific areas are worthy of clear identification. The institutional ability to train recipients in the choice and use of technology, such as in vocational schools, engineering schools, management schools and various professional training institutions, is often a readily identifiable need. The need for responsive credit and financial institutions is demonstrable in virtually every instance. The requirement for various support services in communication, transportation and professional fields is often decisive in making recipient choices. Government institutions are needed to support and encourage technology transfer and are commonly deficient in both source and recipient countries. Sometimes cultural aspects can weigh heavily on the choice and transferability of technology. Provisions for recognizing cultural influences and for adapting to this recognition are only now being institutionalized.

Though the system for accomplishing the transfer of technology may seem complex, when described in terms of particular elements the system becomes more amenable to analysis. The elements of this process are: (1) technology recipients, (2) technology sources, (3) means of communication, (4) means of transportation, (5) amplifying or suppotring institutional participants, and (6) regulating institutional participants.

System Deficiencies

With the objective being the transfer of technology to the LDCs from small or medium size enterprises in developed countries a limited description of the participants and identification of some of the related generic deficiencies can be provided. The recipient will probably be an individual working alone, in family group, or as the head of a closely run organization. The recipient may fall into one of three classes: private commercial, private non-commercial or governmental parastatal entity. The identifiable deficiencies associated with the recipient that are most commonly encountered are: (1) lack of ability to describe a technology need, (2) lack of knowledge concerning technology available to satisfy the need, (3) inability to make appropriate choices, (4) inability to communicate need, (5) limited ability to determine value of available technology, (6) limited ability to apply technology needed, and (7) limited ability to negotiate terms of transfer. Obviously all recipients do not exhibit all of these deficiencies.

The immediate technology source can be passive, as a library, open literature, or some data banks. It can also be an active source such as a government organization, commerical/industrial organization, financial institution, a public or private foundation, educational institution, research institute, individuals, or consultants. Since interest lies in tapping the large technological reservoir associated with the smaller enterprise sources, our analysis is weighted in that direction. The deficiencies that are most commonly encountered here are: (1) limited perception of the extent of the technology possessed, (2) lack of knowledge of needs or opportunities for applying the technology in LDCs, (3) lack of know-how related to the process of technology transfer, particularly relevant laws and institutions, (4) insufficient knowledge of available incentives and returns, and (5) insufficient experience in analyzing technology applicability in external markets, cultures and economic systems.

The multi-faceted element that has been labeled "means of communication" can be separated into a number of elements. The common carrier elements consist of mail, telephones, teletype and some data-transmission systems. The specific elements include language translation facilities, specialized technology information transmission systems, network or leased combinations of common carrier elements such as used by banks and government agencies, and courier systems. The deficiencies in this element are usually readily apparent and country specific. However, when considering the question of access to means of communication as well as their existence, we find the small source and recipient to be much more limited in their means of communication, and an analysis yields some general deficiencies. These are: (1) limited dedicated communication systems for transmitting technology availability and needs information, and (2) limited systematic availability of cultural and commercial considerations bearing on technology transfer. It should be emphasized that the mere existence of information does not constitute a "means of communication." The information must exist within an active system in a form that is readily useable in technology transfer and is retrievable by the prospective user.

Sometimes technology does not exist in a language form; sometimes it is an inherent part of equipment or machinery. Other times it is associated indelibly with particular people or is in the form of complicated drawings or models. In these forms the technology requires a direct "means of transportation" in order to effect the transfer. Deficiencies in "means of transportation" generally are country and technology specific and can be corrected on an ad hoc basis by the transfer participants when the deficiency is recognized. Rarely is a deficiency in a "means of transportation" of technology a serious inhibition to its transfer.

The "amplifying institutional participants" element can best be described as those institutions peripherally associated with effective use of technology. As an example, banks to facilitate financing, training institutes for skill enhancement, general communication and transportation organizations, professionals and their organizations, standards and procedures boards and the many governmental service agencies. The deficiencies that would be encountered in this element are almost entirely dependent upon the demands of a specific technology and the country or region of application. The principal problem associated with this element is the lack of readily available and disseminated information.

The "regulating institutional participants" are usually governmental institutions such as licensing agencies, project assessment boards, exchange agencies and a great proliferation of permit grantors. Here again deficiencies as such are country specific and, to a lesser degree, technology related. The general problem likely to be encountered is a lack of currently valid information on what is required, how to comply with the requirements and what response can be expected. Along with current information there frequently exists great uncertainty as to the time required for making decisions, and what may be the future substantive changes in regulations related to the technology transfer or to its use. This element tends to maximize the deficiencies of inadequate knowledge and uncertain future.

Having arrived at some understanding of what is meant by technology transfer, factors involved in the process and the system's deficiencies (summarized in Table I) it is now desirable to categorize the deficiencies in terms of possible methods of elimination. This has been done in Table II.

TABLE I

BASIC ELEMENTS OF TECHNOLOGY TRANSFER AND SOME GENERAL ASSOCIATED DEFICIENCIES WHEN INVOLVING SMALL ENTERPRISES AND DEVELOPING COUNTRIES

1. TRANSFEREE OR RECIPIENT

1a- Lack of ability to describe technology need.

1b- Lack of knowledge concerning the technology available to satisfy need.

1c- Inability to make appropriate choices.

1d- Inability to communicate or publish need.

1e- Limited ability to determine value of available technology.

1f- Limited ability to apply available technology.

1g- Limited ability to negotiate terms of transfer, where necessary.

2. TRANSFEROR OR SOURCE

2a- Limited perception of the extent of the technology possessed.

2b- Lack of knowledge of needs or opportunities for applying the technology in developing countries.

2c- Lack of understanding of the process of technology transfer, particularly relevant laws and institutions.

2d- Insufficient knowledge concerning available incentives and aids.

2e- Insufficient experience in analyzing technology applicability in external markets, cultures and economic systems.

3. MEANS OF COMMUNICATION

3a- Limited specific communication systems for transmitting availability of specific technology and existing specific technology needs.

3b- Limited systems to communicate availability of existing incentives and regulating laws.

3c- Limited systematic availability of cultural and commercial considerations bearing on a specific technology transfer.

4. MEANS OF TRANSPORTATION

4a- The deficiencies in this element are usually country specific and rarely are they a serious inhibition to technology transfer since the participants can directly correct or circumvent a deficiency on an ad hoc basis.

5. AMPLIFYING INSTITUTIONAL PARTICIPANTS

5a- Anonymity of the institutions in the technology transfer system.

5b- The deficiencies are usually country or regional specific and technology specific. However, most training and support institutions are inadequate in number and quality in the developing countries.

6. REGULATING INSTITUTIONAL PARTICIPANTS

6a- Lack of currently valid information on requirements.

6b- Uncertainty concerning time required for compliance and decisions.

6c- Uncertainty concerning possible future substantive changes related to the technology transfer or to its future use.

6d- In general the deficiencies in this element are country specific and, to a lesser degree, technology specific.

TABLE II

CONSIDERED METHODS OF CORRECTING DEFICIENCIES IN THE TECHNOLOGY TRANSFER PROCESS AS APPLIED BETWEEN SMALL ENTERPRISES AND DEVELOPING COUNTRIES

Methods	Deficiency
Retain research institutions or consultants to supply background knowledge and experience.	1a, 1c, 1d, 1e, 1f, 1g, 2a, 2b, 2d, 2e, 3b, 3c, 5a, 6b
Utilize training institutions, schools and universities for general, direct acquisition of knowledge and expertise.	1a, 1b, 1c, 1e, 1f, 2e, 5a
Access to general technology transfer marketplace or exchange.	1b, 1d, 1e, 1f, 1g, 2a 2b, 2c, 2d, 3a, 3b, 3c, 5a, 6a
Use of non-technical professionals such as lawyers, accountants, bankers, etc.	1g, 2c, 2d, 3b 5a, 6a, 6b
Others (Governmental agencies, etc.)	4a, 5b, 6b, 6c

Corrective Institutions and Actions

The broad knowledge and experience that could be provided by research institutes or consultants, at or near the place of technology utilization, is particularly useful when questions arise concerning the general applicability of technology to fulfilling a specific need. This is the important first step of associating a need with a possible technology solution and it is then that the need is transformed into a technology transfer opportunity. The next application of background knowledge and experience is in the assessment of a specific technology with respect to applicability and adaptability. Usually, this is done best near the place of application but can also be accomplished near the technology source. A third application of background and experience comes in the process of technology application and improvement. This usually is accomplished best at the place of application and is an extremely important aspect of successful technology transfer. Research institutes and consultants are often required most often at the place of use associated with the recipient.

The need for training institutions, schools, universities and ad hoc courses and seminars is required primarily at the place of utilization to be effective in mitigating the identified deficiencies. These institutions are most useful in sustaining the technology transfer process and in broadening the capabilities of the individuals directly involved. Some of these institutions provide long-term support to research institutes, consultants and the non-technical professional sector as well as directly to the technology transfer process participants. In fact, the training of lawyers, accountants, financial experts and other professionals in these institutions is usually fostered early in a country's development because of the obvious need for these people in the government sector.

The use of non-technical professionals in the technology transfer process is well recognized. However, we find a limited knowledge of the professional services specifically applicable to technology transfer that are available in some international institutions and developing countries. The recognition of the usefullness of non-technical professionals is not common among small sources and recipients. Usually the initial responsibility for the general employment of these professionals rests with the source. The use of these professionals in a representational or analytical mode can be of great value to the recipient and the source.

In the previously discussed institutional approaches to correcting deficiencies, institutions or functions were described that are common to a developed country's milieu and are well understood. The meaning of the term "marketplace" may not be as well understood and thus requires some further, more detailed, explanation. Rarely is the marketplace only a "place". In the modern sense of the term it is usually a mechanism or system that serves the single purpose of promoting and implementing a meeting of the minds. A marketplace can be as simple as a common directory or it can be a complex set of rules, brokers, data banks and sophisticated communications systems. A particular marketplace can be described in terms of the products marketed, access rules, banked data and information, and communication systems. A single marketplace may use the most complex and sophisticated electronic system along with basic hand signals to form its communication system. The access rules may be complex but are meant to regulate who has access, what is marketed, how the actual exchange is effected, what time limits are involved, what are the marketplace charges, what laws apply, the liabilities incurred by all parties, what recourse is available, and on and on. Banked data ranges from zero to extraordinarily complex historical, authenticating and regulating information about the product and the involved parties.

The analysis in Table II suggested the need for a marketplace that would deal in available technology <u>and</u> technology application opportunities to overcome a large number of identified deficiencies. Parts of this marketplace exist in both commercial and non-commercial forms but no single place performs the broad role needed by the potentially large numbers of small participants. If such a marketplace could be non-exclusive and available to anyone on a minimal charge basis, there would be no requirement to use brokers.

The marketplace might consist of a two step system in which the first step leads to the second. The second step follows the initial commitment and contains cost and proprietary considerations. Banked data would be located in the first step and would include product description, source/recipient information, and commitment terms to access step two. The first step might also contain optional information bearing on other elements of the transfer process such as laws, regulations, incentives and assistance and assisting institutions available. It could also contain general and specific country or regional data. The market communication system could consist of a worldwide data network connected to a data bank and accessible through written correspondence, verbal means, direct teletype and computer terminals. The second step in the marketplace function would be direct contact of recipient and source for completing the contractual details.

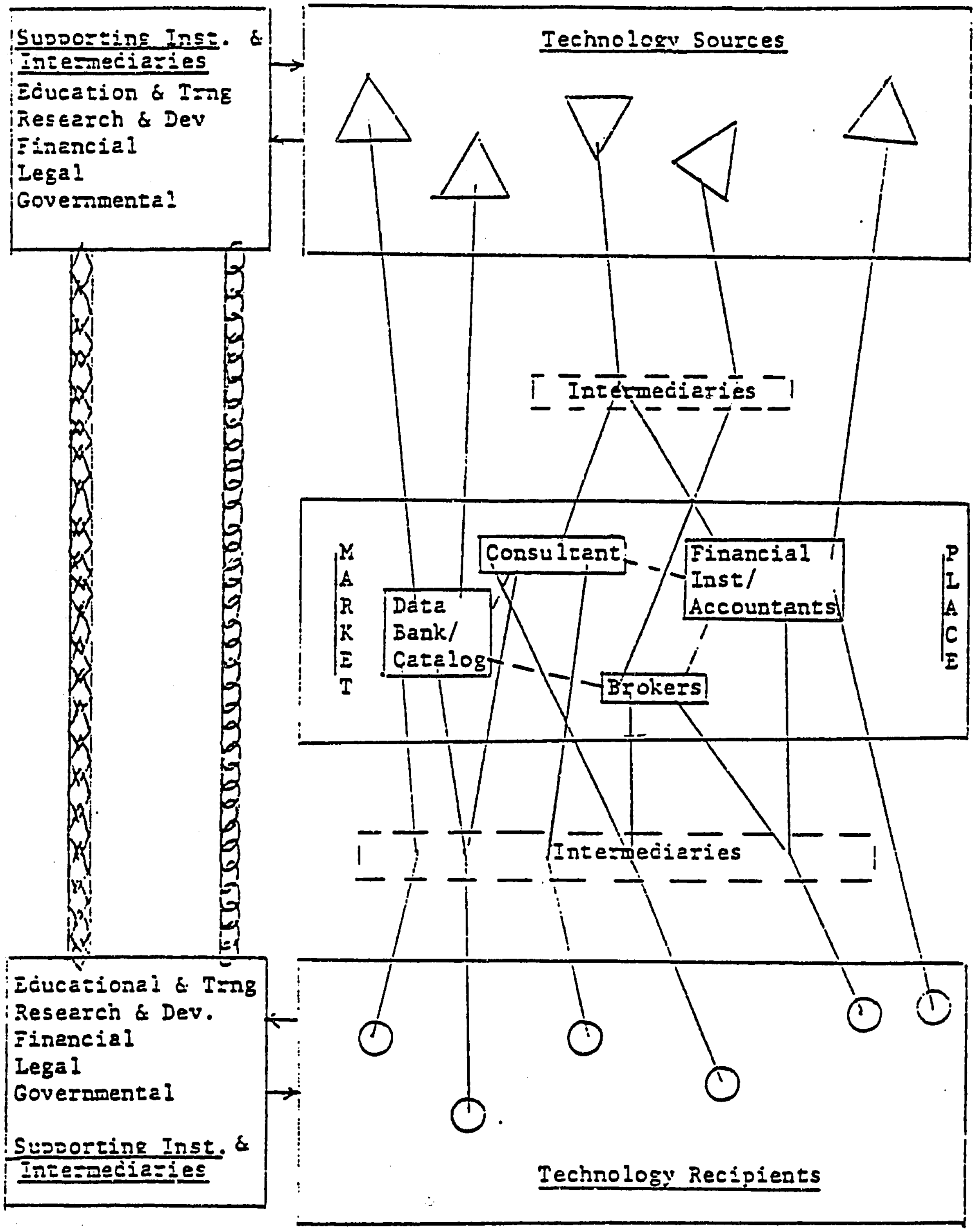
Conclusions

The foregoing discussion leads to the inescapable conclusion that an effective system for the transfer of productive technology is a highly desirable part of any effort to provide economic development. Since a large portion of these productive technologies lies in the private sector, the private sector must be strongly involved. Figure 1 is a schematic diagram of the productive technology transfer system that attempts to deal with the relationships between the participants without imparting a sense of impossible complexity.

The constructive involvement of governments is essential, particularly when the system is used by the small enterprises in the private sector. Since the productive technology transfer process is basically a contractual arrangement, sanctity of contracts is a must. Governmental powers are necessary in this relationship. Orderly economic processes are a necessity for the smaller enterprises and again governmental roles are demanded. The recognition of intellectual property rights and the establishment of product and business standards are, to a large extent governmental responsibilities. In some countries the governmental role in the transfer process has become so pervasive the government has to be considered a party to the transaction. When coupled with the sovereign position of governments, this can be chilling to the other participants.

Government policies with respect to foreign investments, convertibility of assets, international and domestic trade, social objectives and a host of other subjects can have an encouraging or discouraging effect. Outside of these general areas however, governments can play a more direct role in making the transfer process more efficient. In the field of ancillary information dissemination on political, economic and cultural matters, and in generalized need or opportunity identification area, governments can take a rather direct hand. Skill training over a wide range of subjects can be encouraged and even supported by governments. Institution and infrastructure development of many types can be effectively supported by governments.

PRODUCTIVE TECHNOLOGY TRANSFER SYSTEM
SCHEMATIC



With all of these and more possibilities, governments would do well to remember that significant direct involvement in an individual private sector technology transfer project should be the exception. There is much that government should do. Even more that it can usefully do. Too strong an embrace, however, could exclude the smaller enterprises.

Most individual practitioners in the field of private sector productive technology transfer admit to using a set of principles to guide their actions. Following is a partial list that might be considered.

1. All parties to a technology transfer transaction must, within the context of their own interests, benefit from the transaction. This must be both a real and perceived benefit.

2. All parties to a technology transfer transaction should, within the limits of their applicable resources and capabilities, ensure the maximum possible appropriateness of the technology to the specific application and the milieu of its intended use.

3. All parties to a technology transfer transaction will conform to the applicable laws of the sovereign nations governing their actions and shall recognize the sanctity of contracts under these laws.

4. All parties to a technology transfer transaction must recognize rights of technology ownership where it exists.

5. All parties to a technology transfer transaction will recognize the voluntary nature of the initial decisions to participate and the right to withdraw free of harm prior to the time of mutual commitment.

To these general principles a host of "truths" can be added. Some, such as the fact that technology is transferred mainly by people-to-people actions over extended periods, are obvious, while others are more specialized. In the end, any program of productive technology transfer supported for the purpose of country economic development must use these principles for the parallel and mutually reinforcing goals of employing the unemployed, making more productive the already employed, increasing the productivity of all assets employed and satisfying the demands of the marketplace.

INTERMEDIATE INSTITUTIONS AND RURAL DEVELOPMENT

Previous Page Blank

ABSTRACT

Observers of rural development programs recognize that often there are unintended discrepancies between development objectives and achieved consequences. Rural development programs designed for developing nations are characterized by social values as well as technical goals. The success of the program is measured by progress toward the implementation of values as well as the achievement of technological-developmental goals. Attention is drawn to the social processes by which and the social structures through which rural development projects are implemented, and it is demonstrated that these are frequently counterproductive - thwarting the realization of both technical and valuational goals. One social process in particular, incorporation, often is an integral part of rural development programs and projects, and the incorporation process typically has negative consequences for poor farmers in the Third World. Alternative ways to carry out rural development are discussed, and the major alternative explored here focuses on intermediate institutions. Implications of these ideas are explored with the conclusion that developmental priorities should be reordered. Implementing rural development through intermediate institutions would be consistent with the aims of this conference: the use of technology/rural development methods to increase the economic and social well-being of poor rural people in the Third World.

INTERMEDIATE INSTITUTIONS AND RURAL DEVELOPMENT

Kenneth W. Eckhardt
Sociology, University of Delaware

and

Norman B. Schwartz
Anthropology, University of Delaware

INTRODUCTION

A central purpose of this conference is to examine technological change processes and rural development (RD) in developing nations from several disciplinary perspectives. In this paper, written from the perspective of comparative sociology, the social processes leading to a discrepancy between the values and goals of rural development and the achieved consequences are examined.

In the first section of this paper, the social values and goals of rural development are discussed. These values and goals have been expressed both implicitly and explicitly in the statements and writings of scholars, planners, and practioners concerned with rural development. While unanimity among experts does not exist, there are several areas of relative common agreement. An examination of the processes and structures through which rural development projects are implemented reveals that human factors play a crucial role in achieving desired technical goals. However, failure by planners and practioners to accomodate these factors indicates that it is unlikely that either the social values or technical goals will be realized.

In the second section, it is argued that the processes of incorporation often prevent rural development projects from accomplishing social and technical goals. The manner in which rural development traditionally has been executed necessarily increases the incorporation of small farmers and small farm communities into national level politics and economies in counter-productive ways. Incorporation processes tend to defeat the technical aims of rural development, weaken local community solidarity, and increase local political and economic inequality. Examples in this section are drawn primarily from Latin American experience in rural development.

In the third section, an alternative structure for implementing rural development projects is suggested. Specifically, the merits of implementing rural development projects through mediating structures or intermediate institutions is explored. An examination of producers' industrial cooperatives (PICs) discloses ideas for developing intermediate institutions. The section closes by discussing procedures for developing or strengthening mediating structures in the rural regions of developing nations.

In the concluding section, several implications of the ideas discussed in this paper are explored. A major implication is that social and political development may require precedence over directed technical and economic change if the values and goals of rural development are to be achieved.

SOCIAL VALUES AND RURAL DEVELOPMENT

While "there is not yet any agreed-upon framework of development theory" (Penny 1973:5, Long 1977), there is general acceptance of the appropriate social values for rural development. In the United States, these values are frequently discussed under the heading of "social soundness" or "social and environmental impact" analysis. The specific language varies from one expert, program or country to the next, and sometimes the differences are profound rather than semantic, but more frequently variations are an umbrella for a common understanding of desired values. Thus, while some rural development experts believe that agricultural productivity is a first-order priority, and others contend that employment, family planning, basic human needs, access to the factors of production, or something else takes precedence over productivity as such (compare Adelman 1981, Greenwood n.d., Mencher 1981 and Streeten 1979), virtually all experts agree that rural development also must enhance the welfare of the poor majority in the countryside. There are virtually no rural development experts working in developing or low-income nations who contend that concentrating on production or other economic goals without considering the impact this has on the welfare of rural groups is sound or desirable policy. Among experts directly engaged in rural development, there is little support for a policy of economic growth without relatively equitable distribution of that growth.

Unfortunately, the more one specifies the social values for rural development, the greater the chances for disagreement. Nevertheless, the following list of values would probably find widespread agreement.

Rural development should:

1. "be responsive to the needs of rural people" rather than focus exclusively or even primarily on commodities (Friedman 1981:235).
2. be "compatible" with local ecological conditions and avoid degrading the natural environment (Friedmann, Ibid.).
3. ensure "growth with equity" (Friedmann, Ibid.).

4. be designed in ways which permit the intended beneficiaries to actively participate in planning, implementing and evaluating (Bryant and White 1980, Saint and Coward 1977).
5. be compatible with the values, institutions, and culture of the intended beneficiaries. One variant expression of this value is that rural development programs must respect the integrity of community institutions and should either promote, or work through the institutions of well-organized, cohesive and "socially vital" communities (Bowles 1979).

These values have pragmatic as well as humanitarian objectives. For example, although some may regard "growth with equity" or client participation as primarily consummatory goals, they also are instrumental for rural development. Thus, one of the most commonly cited reasons for rural development project failure is that planning and implementation were from the top down rather than bottom up. This leads to misunderstanding, suspicion and non-cooperation between change agents and clients, and consequently is practically a guarantee of failure. Conversely, well-informed clients actively participating in a project often work effectively with change agents to ensure its success. Somewhat similar statements could be made with reference to each of the values listed above, but the central point is that insofar as the concern focuses on the general welfare of people in the countryside rather than on commodity production or the interests of the elite, the values are means as well as ends. This is one of the major lessons learned from the past 35-40 years of development efforts.

A second lesson is that a socially vital, cohesive community is better able to utilize, cope with, and perhaps control project impact than a fragmented community. A well-bounded, well-integrated, and stable community often is able to successfully insist on participation and to participate positively in project implementation (see Bowles, 1979). Additionally, the troublesome problem of "free riders" (Bryant and White 1980) is lessened in such a community. Hence, some experts, particularly those working in the field of community development, argue that a wide range of projects should be planned to promote or enhance community integration, and the involvement of community members in locally sponsored collective events. In turn, this will facilitate community involvement with project-sponsored activities. Indeed, this step may have to precede or at least coincide with the strictly technical aspects of a development program. Here too, ends and means merge, for many development experts believe that a well-integrated community relatively free of internal conflict is a good end in itself as well as being a solid basis for successful rural development.

Much of what has been previously stated is simply a clear recognition of the fact that even the most narrowly conceived, strictly technical rural development project is part of a socially, politically and culturally embedded process. Evidence suggests that this self-evident point is commonly ignored. For instance, while experts agree that overlooking or misunderstanding client values is counterproductive for projects, many rural development projects do just that. This is one reason why many rural development plans fail to meet their stated technical and economic objectives.

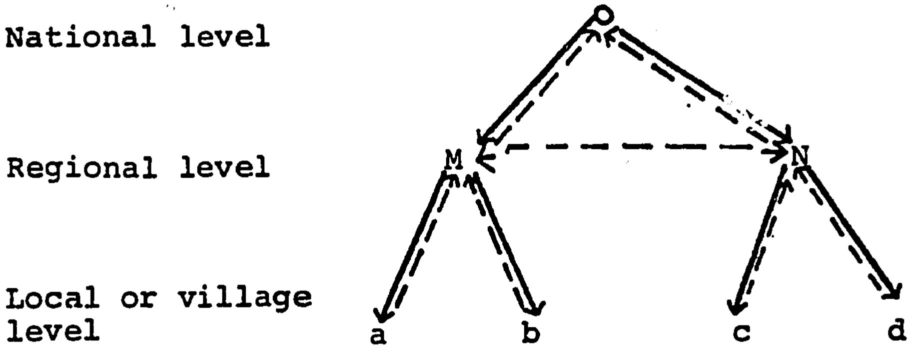
Still, some projects achieve technical and economic success, that is, increase agricultural production, although the record of achievement in Third-World countries is not particularly good (see Paddock 1973, Pollard 1981:561). More commonly, rural development fails to satisfy the social criteria for success, for instance, "growth with equity". In fact, planned rural development too frequently increases social, political and economic differentials within the countryside (see Hobbs 1980, but contrast Shingi, et al. 1981), and partly for this reason often fails to improve standards of living for diverse rural groups. Much the same may be said about the other social values listed above. On reflection, experts have discovered that most of the difficulties in rural development are social, political and cultural (see Morss, et al. 1976). There is much evidence which indicates that sociopolitical problems must be solved before technical and material objectives can be achieved (see Foster 1973). In short, so-called "human factors" are more important than technical ones if rural development is to be successful and to realize the social values enumerated above.

As an extension of the preceding disucssion, the next section deals with structures and processes which are as common as they are counterproductive for rural development.

RURAL DEVELOPMENT AND INCORPORATION

As nearly as can be determined, many planned rural development programs and projects involve transfers (such as credit, extension services, equipment, infrastructural facilities, organizational arrangements, technical knowledge, etc.) from national level agencies more or less directly to local level clients or client groups. For the most part, the transfers rarely pass through intermediate structures controlled by the clients (see Adelman's 1981 description of the Columbian coffee growers' cooperative for an excellent discussion of this process). While transfer is often simply a top down process (see Figure 1), there are instances where the transfers are responses

Figure 1: A Transfer Process.[1]



1. The solid lines are used to indicate that the transfers flow downward; the dotted lines indicate that feedback can occur, but the sources of feedback have little control over the situation. The absence of horizontal lines at the lowest level is intentional and depicts a relatively common, well-known situation in low income countries. Indeed, control over development may be so centralized at the national level that regional offices of any given ministry "usually have little more than a letter-box function or at best that of inspectorates. Only in a very few cases do field agencies have planning functions" (Hilhorst 1981:539).

to the bubbling up of client demands. Additionally, transfers may be planned with attention to local, natural and social conditions; they may be open to client participation, and they may even be articulated with local customs and institutions. However poorer clients rarely exercise genuine control over the transfers or over the agents in charge of the delivery systems. In most low income countries, the lower social strata lack expertise and are too poor to utilize the talents of the small middle classes which may have some control over rural development processes. Then too, the latter are typically dependent on socio-political elites. Also, insofar as poorer clients do participate and local institutions do become intertwined in the development process, they often are incorporated into national level structures in ways which undercut rural development.

An illustration may clarify the issues at stake here. Although the illustration is a composite, it is drawn from our personal observations and the observations of others in Central America. Consequently, parts of it will be familiar to most people. Suppose that the ministry of agriculture in a low income country decides to organize production cooperatives in a particular rural region. Although the poor majority are engaged in agriculture, the national economy is largely geared to the export of a few commercial crops and the country's farmers are unable to feed the population. In fact, despite its agrarian base, the country must import food staples (Honduras today would be a case in point; see DeWalt 1983). The coops will allow small-scale cultivators to increase production and income, for example, by the cooperative use of tractors. It is also possible that some unused, public lands may be brought into production. Moreover, if poorer farmers can increase production without major land reform, the potential resistance of the agrarian elite toward the development program will be lessened.

The ministry of agriculture charges its regional office and the extension division with the task of organizing the cooperatives in a series of small villages. The predominant majority of the villagers are small-scale farmers or peasant cultivators. Although most people are poor, there are some educational and socio-economic differences among the villagers, and there is a small middle sector in the provincial capital. The provincial capital is not only an administrative center but also a regional market, service and transportation center, and is the location of the regional office of the ministry. Many of the extension workers are recruited from middle sector families living in the provincial capital. The development plan calls for extension workers to build cooperatives in villages which have forty or more households. Villages with fewer than this number of households are to join an adjacent village in forming a cooperative. (This is similar to the way Panama handles some of its development programs.) The point to note here is that there is generally one cooperative per village. There may be some sort of regional council of cooperatives, but its officers are drawn from the ranks of larger farmers resident in the provincial capital (see Adelman 1981), and in any case real power and authority tends, at least in Latin American low income countries, to reside in the national level ministries (see Hilhorst 1981). The ministry, coordinating its activities with a development bank, provides the cooperatives with access to credit, but it does not preclude middle sector farmers from also obtaining loans from the bank. Acting on the advice of foreign consultants, i.e., economists, applied anthropologists and others, extension workers are instructed to educate and train the villages in the principles of cooperatives (see Pollnac 1978). They may combine this effort with some sort of radio program aimed at farmers

(Davidson 1976) and also group discussions on how the banks, ministries and other institutions in the country operate. There is reason to believe that this type of education enhances the effectiveness of rural groups in expressing and realizing their needs (Tandon and Brown 1981). Finally, again acting on the advice of consultants, the extension workers encourage the villagers to select or elect cooperative officers according to their own local customs.

Without going into more detail, let us further suppose that the program is initiated and after several years of operation the ministry decides to evaluate its consequences. Evaluators may discover that agricultural production in the region has increased and that at least some farmers have increased their incomes. Still, there are problems. The development bank, for example, seems to give loans more readily to large, independent farms than to the cooperatives (Nisbet 1969). Additionally, the development program increased economic differences among villages. Those villages with limited access to feeder roads to trade markets suffer from the development program. Further, it is observed that in some cases the extension workers have become, in effect, patrons for the cooperatives, and when they reduce their contacts with the villagers, a leadership vacuum occurs and the program deteriorates (Nelson 1971). But more than anything else, the more successful cooperatives are led by better educated, more affluent villagers. Still, on balance the donor agency concludes that the program is sound and recommends its continuation

Were the agency to study the situation over a 10 or 15 year period, something very rarely done, it might discover that the problems have not diminished. Instead, cooperative officials have used their administrative positions and links to extension workers and ministry elite to enrich themselves and exploit their neighbors. Some of the latter have become, in effect, wage laborers for the co-op or voluntarily leave it, and are poorer than they were prior to the development program. Even the wage laborers, known as cooperative members, find that relative economic disparities between themselves and co-op officials are greater than ever (see Halperin's 1979 description of the ejidos in Yucatán, Mexico). Nor are the extension workers or other officials responsive to complaints about the program. Morss's comment concerning evaluation is relevant here: "It would be naive to ignore the fact that formal monitoring and evaluation activities can be seen as a threat by project managers", and this is one major reason why "projects make little use" of such information (Morss 1979:151). Few underlings want to report bad news, particularly if there is any chance this will reflect on one's own effectiveness. Furthermore, some extension workers have worked out mutually beneficial relations with co-op leaders, such as exchanging political support for administrative reinforcement.

Also, it may turn out that the more successful cooperatives and middle sector farmers use their increased wealth and technical knowledge to convert crop lands to pasture lands. Cattle will be exported and food production will be further reduced (Halperin 1979). In the long run then, the development program may have initiated a process which eventually reduces the region's production of staple food crops, which increases stratification, and which also generates socio-economic and ecological conditions of the type which international donor agencies wish to correct (observe current concerns about the connections between cattle ranching, deforestation and increasing unemployment in southern Honduras [see DeWalt 1982]). Ironically the agencies may even sponsor several rural development projects to improve conditions in the area.

While the above illustration is a composite and no single rural development project reflects all of the processes, it is nevertheless useful for understanding the particulars of specific projects.

In the sequence described above, the central government is not only promoting rural development, but also simultaneously incorporating rural people into the national political system and placing them in closer contact with external market forces. Intentionally or not, villagers have been vertically integrated into the administrative apparatuses controlled by the central government. The state has not fomented horizontal linkages between villages but rather the state has drawn them, one by one, into the state system. As Corbett and Whiteford (1979) express it, the state has actively "penetrated" the local level. In some cases, it does so by instituting new arrangements, such as village cooperatives, and in other cases by building on indigenous institutions, for instance using traditional ways of selecting leaders. In both instances, village leaders are identified and linked to the national bureaucracy through the mechanism of rural projects. In one sense, the goal of client participation is partially realized, but in another sense, the potential for co-opting indigenous leaders has increased. Moreover, the process of incorporation provides local level people with new opportunities to play broker roles -- to mediate between fellow villagers and government officials. Brokers may play positive roles, but at the same time they have an investment in limiting communication between "buyers" and "sellers" -- even to the point of inhibiting the smooth flow of information and services; a broker without clients-in-need is no broker at all. It also may be noted that "participation" organized and initiated from the top down easily becomes a way to enhance central government control over local level people. For instance, under Velasco the Peruvian experiment with "participatory" institutions was consciously used to "restrict citizen influence to the work-place or residence" or village (Gilbert 1979:382). Velasco's regime had "an affinity for institutions which diffuse class conflict through hierarchical organization along sectorial lines" (which may be viewed as the functional equivalent of village by village local level rural development). In short, the insistance on participating provides a facade for "a sophisticated form of authoritarian control" (Gilbert 1979:382). In a milder way, it is suggested that the incorporation of rural groups into larger political and economic structures through rural development programs and projects may increase the subordination of those groups to state control. Unfortunately, the state's need to control its citizens often also overshadows its desire to increase their material well-being and to empower them.

In the Latin American context the situation depicted above may be connected with the "gap" in government administration. Hilhorst (1981), discussing Latin American government development activities over the last 25 years, notes that the structure of government is "incomplete", that is, the central office of any given ministry is powerful and regional branches lack authority. "Although in most countries, the ministries and normally also the autonomous agencies have field offices, these usually have little more than a letter-box function...Only in very few cases do field agencies have planning functions" (Ibid.:539; see also Sharma 1980). Nor would granting regional offices more authority solve critical problems -- "field office directors are usually only marginally acquainted with the people and their problems since their careers leave them in the same place for only a few years" (Ibid.). These offices do "provide the population with improved access to the bureaucracy;" however, those who benefit from better access are typically members of "traditional and modern elites, and industrial workers and small farmers generally remain without influence" (Ibid.:540-1). In short, the incorporation of local level units into the national political structure tends to increase local political inequality. Moreover, incorporation through government sponsored development often has left the rural poor where they began or further impoverished them (Preston 1980).

With or without strategies for participation, bottom-up planning, appropriate technology, and so forth, the results of this incorporative process are likely to be similar. Rural development projects, particularly those planned for groups with minimal access to the levers of economic and political power, are a form of vertical integration -- links to larger, more powerful agencies which are external to the local unit -- and, as such, have negative consequences for the rural poor.

In the first place, projects trigger processes which eclipse the solidarity and institutions of small communities; they eclipse just those institutions planners claim to rely on and wish to strengthen. In even outwardly cohesive villages, there are important differences of will, interest and power (Friedmann 1981) and rural development tends to intensify them, with weaker elements losing out. Most rural settlements lack the power and homogeneity to withstand the fragmenting decisions of the activist state pursuing rural development and the equally divisive demands of project management (Chambers 1974:110, Schwartz 1981:15-18). Second, rural development often increases the well-being of the relatively well-off to the relative or absolute detriment of the poorer elements of the population. Over and over again, one finds that middle sector farmers, brokers and other elites capture rural development benefits which do not trickle down as easily in low income countries as they are hypothesized to do in industrialized ones. Thirdly, rural development projects often generate communal disruption. In sum, even when the technical goals of rural development are satisfied, the social ones rarely are, and for this reason the technical-economic ones eventually may be defeated.

MEDIATING STRUCTURES

It has been argued that current rural development is an ambiguous incorporative process which works against its own aims. The literature indicates that whatever else is going on, rural development projects often depend for their success on some form of client control over the project. Yet, community control often means "slicing up a pie baked by someone else, with the community receiving the smaller slice" (Lancourt 1979:173) and/or one's better placed peers gobbling up most of that slice (see Nash, this volume). Hence, it can be concluded that local level empowerment is relatively useless without some form of regional heteronomy, some mediating structure which stands between the centralized institutions of the activist state and the local groups to which it transfers development services. In this manner, people can participate in projects without self-defesting consequences

Two examples of the sort of mediating structures envisioned for rural development are presented below.

1. Producers' Cooperatives

Although producers' industrial cooperatives (PICs) and rural development (RD) are different topics, they have several instructive common features. In both, the fundamental goal is to empower people and to improve their material well-being. Saying that industrial democracy aims at "developing both a profitable business and a successful democratic cooperative work structure" (Clamp 1981:1) sounds very much like talking about "growth with equity" in rural development. PIC and RD also confront similar problems; they both tend to fail when imposed by a government (Gilbert 1979, Stephens 1980). Also, there is often tension or conflict between management and an even spread of benefits (Chambers 1974:110, Schwartz 1981:15-18), just as there is tension and conflict between selected business practices and worker-management co-authority. Furthermore, when PICs are successful economically, they run the danger of becoming bureaucratized (Clamp 1981), just as rural development pilot projects often do when they are generalized to the national level. Functional equivalents of Michels' Iron Law of Oligarchy operate in rural development, civic action groups, industry and religion as well as in politics (see Holleb and Abrams 1975; Wallace 1956).

PICs and RD alike have a poor record of success, but the former has a much gloomier history. The reasons for failure are many and include inadequate initial capitalization, operating in hostile environments which deny loans and financing for PICs, poor management, low reinvestment rates, bureaucratization and creeping Taylorism. Partial victories, such as in Yugoslavia (Vanek 1975) are few in number, and for this reason the situation in the small Basque city of Mondragon, Spain is noteworthy. (For this section we rely on Campbell, Kenn, Norman and Oakeshott 1977; Gutierrez and Whyte 1977; and Oakeshott 1973).

The Mondragon industrial cooperatives were founded in 1956, and by 1975 there were 58 of them. By 1975, the co-ops had a "combined turnover of L 200 million and a labor force of 13,000" (Campbell, et al. 1977:4). The cooperative system is based on a network of banks, industries, farms and educational institutions. Surprisingly, given the history of PICs, most of the Mondragon industrial co-ops are in capital intensive, high technology fields. The firms are reasonably profitable, reinvestment rates are high, as is worker satisfaction insofar as this may be measured by the low labor turnover (3 percent per year) and minimal absenteeism. Workers, through elected councils, hire and fire top management and wages are comparable to those in private industry in the region. Top management is committed to the system, despite the fact that maximum-minimum wage/salary differentials are small, 3:1. Interestingly, up to 1977 there had been only one strike in the Mondragon cooperative system and this occurred at the ULGOR firm which employs 3,000 workers and where, for reasons of size, management had grown distant from workers. Most of the industrial co-ops employ 100-400 people. Without sacrificing productivity or profitability it has been noted that "the fact that management is basically run by the workers has led to a strong experimental interest in adapting machine and production processes to suit human beings (physically, socially, intellectually)..." (Campbell, et al. 1977:52). By 1975, "assembly lines (in some firms) had been eliminated in several departments. Members did their work around tables and had taken over most of the traditional supervisory functions of organizing, directing, and inspecting their own work" (Gutierrez and Whyte 1977:27). In short, the Mondragon system works well, and it is useful to identify the primary factors responsible for this remarkable situation.

Several specific historical, cultural and geographic considerations appear important in accounting for Mondragon's success. First, there is an industrial tradition in the Basque region and thus a large number of skilled workers are present. In modern times, this has been coupled with limited opportunity for agricultural labor and urban industrial unemployment. In addition, while during Franco's reign, political and trade union activity were prohibited, co-ops were permitted and occupied an enviable tax position. For historical reasons then, co-ops were a potentially viable way for workers to organize themselves. Second, Basque culture provided a context within which that potential could be realized. Self-consciously proud of their traditions and strongly separatist, the Basques believe they share a common identity and destiny which legitimates cooperative activities. Moreover, among the Basque, intense local loyalty, propensitities to save, achievement motives, progressivism, social equality and mutual trust are valorized. Third, the people of Mondragon live in an isolated, geographically small area which facilitates both social coordination and communication.

These contextual predispositions were utilized by a progressive priest, Father Arizmendi, who played a critical, precipitating role in starting the Mondragon system of industrial cooperatives. A Republican veteran of the Spanish Civil War, Arizmendi settled in the Basque area in 1941, and he turned his attention to civic action. He began his work by founding a technical work-study school financially supported by students, local enterprises and local government. The school graduated young people trained in the skills needed for the PICs and ideologically committed to industrial democracy. By all accounts, Arizmendi was a rare leader -- quick to find the proper legal forms for enterprises, practical, able to stimulate people in the art of self-criticism, and capable of channeling youthful idealism and energy. He was also able to get people to focus on their real problems rather than on himself and he was, in Alinsky's (1971) terms, the ideal catalyst and community organizer.

The ideological commitment of Arizmendi's young people also plays an important role in the system. Visitors are often surprised by the youth of top management in the Mondragon PICs, by top managements willingness to place the welfare of workers over their own financial gain, and by their proficiency. This sort of behavior is more frequently associated with vitalized beliefs than with professionalism.

The factors noted above fuel the structure of the Mondragon industrial co-ops. The organization of an enterprise begins when a group of workers indicates to the cooperative Mondragon Bank, the Caja Laboral, that they are willing and ready to invest in it. The Bank helps finance the new firm, carries out feasibility studies for the proposed product line, seconds the management for several years, and so forth, and above all all the Bank insists that worker initiative is a paramount consideration. Once a co-op is in operation, the wages of the workers depend on its success. Additionally, surpluses are not disbursed in cash but held in workers' accounts and used for reinvestment.

Workers control the firm not only as investors but as workers. They elect a Social Council which has access direct to management which is subject to approval and dismissal by the workers. However, most firms employ between 100 to 400 people, thus it is possible to maintain personal, informal relations among workers, representatives and management. Nevertheless, the rules governing these relations are explicit, specific and clear, and the size of the average firm insures that the rules are widely known. Apparently the control system, narrow salary differences, adequate wage scale and commitment of managers to worker well-being enhance social solidarity in a firm.

Workers can withdraw their share accounts when they leave a firm, but they cannot sell or transfer the shares. This not only increases a worker's stake in a firm's success, but also provides the latter with a ready source of capital for investment and growth; up to 90 percent of profits are used for expansion and for community projects. Investment in community projects helps maintain close, positive relations between a PIC and the community. Incidentally, the retirement pension is 100 percent of final salary.

When a firm reaches a certain size or begins to develop new product lines, it normally spins off a new firm. Interestingly, this was not done at ULGOR, an industrial cooperative which experienced a strike. ULGOR's size was such that each Council member represented about 50 workers, labor-management relations had become increasingly bureaucratized, and workers lost control over managers. A combination of factors, set against this background, provoked the strike -- and increasing management self-interest was an important element. In none of the firms are workers eager or able to simply push management about, but at ULGOR things went to the opposite extreme, and the result was a strike which led everyone involved to rethink some of the issue connected with a firm's size, product line and purpose. It seems clear that industrial democracy works best when it is based on genuine empowerment of the workers and that empowerment is associated with the size of a firm.

The cooperative Mondragon Bank, as indicated, plays a vital role in the Mondragon network. A new firm must sign a "contract of association" with the Bank in order to obtain its expert help and financial support. The contract assures workers and managers alike that sound business practices will be followed, a feature commonly absent in PICs. To repeat several things said earlier, the Bank insists that a firm undertake feasibility studies, be responsive to worker initiative, and experience several years of direct consultation with its expert staff. It is precisely this sort of back-up which PICs elsewhere find difficult to obtain (see Clamp 1981). Ultimate control of the Bank resides with its members -- staff and delegates from member firms. These two elements elect a control board which, in turn, appoints top management in the Bank. The managers -- perhaps because of the schools from which they come, their ideology, and the structure of their organization -- regard profits as necessary but not sufficient to evaluate a firm's viability. The Bank also judges a firm by how well it fulfills the social and economic needs of its workers. At the same time, the Bank is reciprocally supported by the cooperative schools, firms and civic groups in Mondragon.

Several things seem important in the Mondragon case, and they have implications for rural development. (1) PICs do not operate in an independent, isolated fashion in Mondragon. "The integration of mutually supporting organizations -- from education to banking to research and development to manufacturing -- has clearly been important to the success of the Mondragon firms" (Gutierrez and Whyte 1977:29). The network of educational, banking and industrial firms stands between the people of any single firm and the wider environment. (2) Although workers are empowered to take initiatives, to hire/fire management, etc., they are not arrogant in their exercise of power. Managers run the operation, but they do so for all its members. Managers, councils, control boards and workers are a team on which the powers of each balance the powers of the other (something U.S. chambers of commerce and unions might well find objectionable). Workers delegate authority to councils and managers without losing control over them and no one has total control in his hands. (3) The size of the firms and the ratio of council representatives to workers are also important structural elements in the Mondragon firms. These features make it possible for councils and managers to accurately and rapidly assess workers' needs and attitudes in a socially intimate situation. (4) Although these and other structural elements can be planned, the pre-existing historical, cultural and ideological context which made it possible to realize the plan is almost impossible to design in any conscious way. To this extent, the Mondragon situation may not be transferable to other places, but that does not prevent change agents from drawing lessons from it. For example, it may indicate that before rural development projects can achieve their social and economic goals, certain institutional arrangements must be built. An example of this is provided in the next section.

2. Agropolitan Districts

Friedmann asks how rural development "in the agrarian market economies of Asia" may be accelerated in ways which conform to the social goals outlined at the beginning of this paper (1981:232). In a now familiar refrain, he notes that the evidence from Asia demonstrates that narrowly conceived technical programs and/or those based on the individual farm, village or growth center have typically failed because they have ignored political problems and also because the units involved are too weak to resist traditional elite domination. Rural development has spurred growth, but without equity. Friedmann contends that equitable rural development depends on the prior solution of social and political problems. "It used to be thought that political organization, territorialism, and local self-governance were merely ideological issues. ...In opposition, I would maintain that rural development requires the empowerment of the people" (Friedmann 1981:261).

To carry this out, Friedmann proposes that power and authority be devolved from the central state to an "agropolitan district assembly" which, in Asia, would govern a territory comprising several dozen rural villages and 50,000 people. A geo-political unit of this size has a large enough internal market, service population and diverse natural resource base to permit economic self-reliance and to make planning efficient. The assembly would be composed of officials elected from small villages and neighborhood clusters of 500 people (note the similarity to the size of Mondragon's firms) and delegates from functional organizations. The size, complexity and novelty of the assembly would inhibit elite control over it and at the same time permit the expression and reconciliation of diverse functional and class interests. In a parallel manner, industrial democracy also inhibits the polarization of social classes. According to this perspective, the assembly could become an arena in which crosscutting coalitions of the poor and the non-poor would be built in a manner so that rural development activity would avoid the functional equivalent of "welfare backlash", something typically overlooked in most "growth with equity" and basic human needs projects, including welfare programs in the USA. The agropolitan district also would represent enough people so that the central government could not simply ignore its will in formulating development policy. In Hilhorst's (1981) terms, it would have more than a "letter-box" function.

The scale and composition of the assemblies allow for democratic participation in government, or at least they provide for close ties between assembly delegates and local groups (see the third concluding point about Mondragon). Thus, they are a political authority genuinely "capable of speaking for and acting on behalf of local people", rather than an "administrative convenience" for the state (Friedmann 1981:248-9). The agropolitan district is "the lowest territorial unit in which the state is linked directly through its several institutions and agents" (Ibid.:251). The district stands between the state and the local groups or villages, and thus prevents the former from eclipsing the latter. Ruttan (1975:24) points out that rural communities must develop social and legal instruments "which allow" them to use their resources, and the assembly permits this to happen. Given the authority which Friedmann proposes for the assembly (e.g., to raise revenues from within its territory, to plan development programs, to approve projects, to contract with private and public agencies, etc.), it could generate greater equalization of access to the bases of social and productive power and become relatively self-reliant in "bottom-up" planning and economic management. Rural development could be accelerated in ways which meet local needs, evenly distribute access to social power, and be compatible with local social and ecological conditions.

Friedmann, we believe, proposes a suitable unit for rural development. For one thing, international donor agencies and central government planners may not be able to fine tune projects at levels much lower than the district, whereas the agropolitan district assembly can. Its members are in close, daily contact with local populations, and they have the requisite experience to understand local needs and conditions (Ruttan 1975:21-2). They also are dependent upon local groups for social and political support in a way central state agency bureaucrats are not (see Hilhorst op. cit.), and so they have the motives as well as the means to grasp grassroots "felt needs". Second, devolving power to units as small as villages or rural neighborhoods, on a one-by-one basis is futile for reasons indicated previously. Conversely, Friedmann's design would link these units to the state through a mediating structure -- the district assembly -- which permits both state and village to participate in development and still shields the latter from the former. The design also gives both local elites and the poor at least one immediate common interest -- the assembly, and through it the district. Since the district will find itself at times in opposition to the state, those who live within it may discover they have a superordinate goal -- the maintenance of district power -- which reduces conflict among them (Sherif 1958). There is at least some chance that the familiar coalition of local elites and state bureaucrats acting against the interests of the poor will be broken up by new groups which represent the poor by representing the district. Finally, Friedmann's plan underscores the point that poverty, traditional technology, over-population and the like are not as such major problems in development, rather the opening of access to the social bases of power is the issue. Empowering people will not by itself solve rural development problems, but it is a necessary first step before the other objectives can be successfully tackled. When access is evenly distributed, providing assistance for increasing productive capacity can occur without unwanted socio-economic consequences.

Friedmann notes that in the interests of efficient rural development planning, there may be a need to create regional bodies subsuming the agropolitan districts. The regional assembly would have autonomous authority corresponding to that of the district, but proportionally greater in sc pe and depth. This may reduce the "potential independence of the district" and "recentalize" power at higher levels (Friedmann 1981:252). The problem here resembles the balancing act between local, intermediate and national groups of which Lancourt (1973) speaks. The danger is that the whole process may reinstitutionalize centralized, concentrated power which is precisely one of the major obstacles to rural development. There are also other, more immediate questions about Friedmann's proposals. For example, as Friedmann recognizes, his recommendations require the presence and/or training of strong leaders drawn from local communities, something which is not so easily achieved. At the same time, it should be noted that this also is a problem confronting more conventionally designed programs (Austin and Zetilin 1981:143). In addition, the crosscutting alliances within the assembly could attenuate social class conflict which some may believe necessary for the interests of the poor. There are other doubts about Friedmann's plan, but most central is the question of whether any national elite would have the will to carry it out. The devolution of power may be a necessary precondition for rural development, but who gives power away voluntarily? Friedmann (1981:257) argues that the alternatives are worse (perpetual underdevelopment, or radical land redistribution fomented by internal revolution or external pressure), but it is difficult to believe that new or traditional elites will be convinced by this contention. The best hope is that historical circumstances will eventually force powerful groups to consider the virtues of mediating structures like the agropolitan district assembly.

The proposed assembly and the Mondragon network of PICs share several common features which may be briefly outlined here. (1) Both are mediating structures in that they stand between individual villages or individual co-ops and national level politics and economic forces. They link villages or functional organizations to each other, and thus minimize the danger that any single unit will face a government development agency or a lending institution in isolation. (2) Both permit democratic participation in the process of development. The district assembly, as described by Friedmann, would prevent any single interest group -- lower sector, elite, or bureaucratic -- from monopolizing power, and it would give several such groups a common investment, such as in the autonomy of the assembly itself. In this it resembles the structure and balance of power and unified interest found among Mondragon managers, councils and workers. Moreover, none of this need prevent either type of mediating unit from acting decisively, but it does permit both to stimulate growth with equity. (3) The size and composition of the assembly permits members to maintain close, personal relationships with local populations, and this means that assembly actions can be made compatible with local social, economic and ecological needs in a way no national ministry can assure. Here too, there is similarity to the Mondragon system. Furthermore, the primary group aspects of the district assembly may forestall the bureaucratization of its processes, and much the same may be said of the Mondragon set-up. (4) The agropolitan district assembly is a way to empower people, as the Mondragon network of PICs does, and without this, rural development--like industrial growth--too commonly works against the interests of the poor. Indeed, the rural development literature suggests that without genuine participation by the poor in the developmental process, the technical side of rural development may fail. Just as Mondragon demonstrates that it is possible to build profitable, productive industrial firms on a cooperative basis, so too it may be possible to foment rural development on a democratic basis, provided that rural development is channeled through a mediating structure. (5) In short, a mediating structure can satisfy the social goals listed at the beginning of this paper and also accelerate production in the countryside. Additionally, although Mondragon's combination of history, geography and culture makes it unique, certain lessons for rural development can be taken from its social structure.

Finally, we repeat the point that the problems of development, rural or otherwise, are as much socio-political as they are technical, economic or cultural. Certain institutional arrangements, including those which commonly transfer development packages to the rural poor, often exacerbate conditions they are designed to ameliorate. Other arrangements, and specifically mediating structures, can solve the social and political problems which must be addressed before rural development can achieve its goals.

CONCLUSION

As commonly conceived, rural development is designed to satisfy not only technical goals but also social ones. Thus, rural development practitioners will claim that a particular program or project will increase agricultural productivity in some developing region and also increase local income levels in relatively egalitarian ways. But all too frequently one or both of these goals are not obtained. A major reason for failure is that the institutional arrangements by which rural development projects or packages are transferred to rural people, particularly poor people, in developing nations often exacerbate the conditions they were meant to ameliorate. For example, even when rural development projects raise aggregate levels of productivity, they also may increase social and economic inequality. By neglecting institutional consequences rural development may defeat the technical and social goals which are its very reasons for being.

In short, there are better ways for carrying out rural development than those in common use today. The lessons drawn from successful instances of producers' industrial cooperatives and the recommendations of such scholars as Friedmann are important here. Taken together, they suggest that channeling rural development through mediating structures may solve many of the social and political obstacles which thwart efficient and just rural development. From a comparative sociology perspective, the question is not who needs what, nor even who gets what, but rather who has the power and authority to decide these matters. From technical, productive, social and moral perspectives, it is best if local people, acting together through mediating structures, have that power.

This conclusion implies that development experts in many different disciplines must consider the real possibility that sociopolitical change must proceed technical-economic change, and in that sense the former is more important than the latter. In other words, developers must rethink the manner in which projects are implemented. An agronomist, for example, might seriously consider whether it helps the rural poor to invent and transfer to small farmers in a developing country an improved seed package without first helping to build intermediate institutions which give those farmers authority over the distribution of the seed. A further implication is that the agronomist must work with local level farmers in a new way, not so much as simply allowing them to participate in the rural development process, but rather in terms of yielding authority over the process to them. No one can deny the difficulty of bringing together technicians, social and applied scientists, elite power holders and local level people in this new way, but it is worth the attempt because old procedures have had too many failures.

Standard rural development, of course, has had its successes, but there have not been enough of them, and it is always important to explore ways to improve the record.

Developers who work in the field with the poor farmers of the Third World know that a first step in rural development is identifying a need, inventing solutions, and transferring them to the farmers. It is equally important that the farmers recognize and learn that they can practice agriculture in more productive ways. The same message may be sent to those of us who work in the development field. There is a need to improve performance, and some suggestions about this have been made here. The job is a difficult one, but it is important to recognize that it is feasible, and the example drawn from Mondragon is important precisely because it shows what can be accomplished. It is suggested here that the social processes which occurred in Mondragon might be initiated in the rural countryside. Since the conferees and the people they wish to serve share common goals, the effort to build mediating structures is a worthy one. That may provide a way to achieve both economic improvement and social justice, and in a sense that is what this conference is about.

REFERENCES

Adelman, A. H.
1981 Columbian friendship groups: Constraints on a rural development acquisition system. Journal of Developing Areas 15:457-469.

Alinsky, S. D.
1971 Rules for radicals. New York: Random House.

Austin, J. E. and M. F. Zeitlin
1981 Concluding remarks. In J. E. Austin and M. G. Zeitlin (eds.), Nutrition intervention in developing countries: An overview, 137-146. Cambridge, MA: Oelgeschlager, Gunn and Hain.

Bauer, P. T.
1981 Equality, the third world, and economic delusion. Cambridge: Harvard University Press.

Bowles, R. T.
1979 Social impact assessment in small Canadian communities. Peterborough: Trent University, Department of Sociology.

Bryant, C. and L. C. White
1980 Managing rural development: Peasant participation in rural development. West Hartford, CT: Kumarian Press.

Campbell, A., C. Keen, G. Norman, R. Oakeshott
1977 Workers-owners: The Mondragon achievement: The Caja Laboral Popular and the Mondragon cooperatives in the Basque provinces of Spain. A Report financed by the Anglo-German Foundation for the Study of Industrial Society. London: St. Stephen's House.

Chambers, R.
1974 Managing rural development: Ideas and experience. Uppsala: Scandinavian Institute of African Studies.

Clamp, C. A.
1981 The dialectics of merging business needs and cooperative goals: The case of International Poultry. Manuscript.

Corbett, J. and S. Whiteford
1979 State penetration and the development in Mesoamerica, 1950-1980. Paper presented at the International Conference of Americanists, Vancouver.

Davidson, J. R.
1976 The rural credit and cooperative development project in Guatemala. Washington, DC: US AID.

DeWalt, B.
1983 The cattle are eating the forest. Bulletin of the Atomic Scientists 39(1):18-23.

Foster, G. M.
1973 Traditional societies and technological change. New York: Harper & Row, 2nd ed.

Friedmann, J.
1981 The active community: Toward a political-territorial framework for rural development in Asia. Economic Development and Cultural Change 29:235-261.

Gilbert, D.
1979 Society, politics, and the press: An interpretation of the Peruvian Press Reform of 1974. Journal of Interamerican Studies and World Affairs 21:369-393.

Greenwood, D.
n.d. Contextualizing the factors of production: Baseline data for the study of family farms. In R. L. Batt and B. R. DeWalt (eds.), Social science in the planning process: Baseline data collection in developing countries. Lexington, Kentucky: Center for Development Change, 7-24.

Gutierrez, J., A. and W. F. Whyte
1977 The Mondragon system of worker production cooperatives. Industrial and Labor Relations Review 31:18-30.

Halperin, R. H.
1979 Administered land and labor: Continuities in Mexican political economy. In M. Leons and F. Rothstein (eds.), New directions in political economy. Connecticut: Greenwood Press, 113-140.

Hilhorst, J. G. M.
1981 National development strategies and regional planning in Latin America: Some reflections. Development and Change 12:525-545.

Hobbs, D. J.
1980 Rural development: Intentions and consequences. Rural Sociology 45:7-25.

Holleb, G. P. and W. H. Abrams
1975 Alternatives in community mental health. Boston: Beacon Press.

Lancourt, J. E.
1979 Confront or concede: The Alinsky citizen-action organizations. Lexington, MA: D. C. Heath & Company.

Long, N.
1977 An introduction to the sociology of rural development. London: Tavistock Publications.

Mencher, J. P.
1981 More food for whom? Culture & Agriculture Issue 13:3-4, 6-7.

Morss, E. R., J. F. Hatch, D. R. Mickelwait, and C. F. Sweet
1976 Strategies for small farmer development. Boulder: Frederick S. Praeger Publications. 2 vols.

Morss, E. R.
1979 Monitoring and evaluating rural development prospects: Barriers to the utilization of information systems. In R. F. Rich (ed.), Translating evaluation into policy. Beverly Hills: Sage Publications, 149-158.

Nelson, C.
1971 The waiting village: Social change in rural Mexico. Boston: Little, Brown and Company.

Nisbet, C. T.
1969 The relationship between institutional and informal credit markets in rural Chile. Land Economics 45:162-173.

Oakeshott, R.
1973 Mondragon: Spain's oasis of democracy. Observer January 21.

Paddock, W. and E. Paddock
1973 We don't know how: An independent audit of what they call success in foreign assistance. Ames, Iowa: Iowa State University Press.

Penny, D. H.
1973 Development studies: Some reflections. In T. S. Epstein and D. H. Penny (eds.), Opportunity and response: Case studies in economic development. New York: Humanities Press, 1-10.

Pollard, H. J.
1981 The personal factor in the success of planned agricultural development schemes. The Journal of Developing Areas 15:561-584.

Preston, D. (ed.)
1980 Environment, society, and rural change in Latin America: The past, present, and future in the countryside. New York: John Wiley and Sons.

Ruttan, W. V.
1975 Integrated rural development programs: A skeptical perspective. Manuscript.

Saint, W. D. and E. W. Coward, Jr.
1981 Agriculture and behavioral science: Emerging orientations. Science 197:733-737.

Schwartz, N. B.
1981 International development projects, communities and social impact assessment: Some observations. Paper presented to the Social Impact Analysis and Development Conference, Michigan State University, May 14-16, 1981.

Sharma, S. K.
1981 Rural development in India: Programmes, strategies and perspectives. Community Development Journal 15:2-9.

Sherif, M.
1958 Superordinate goals in the reduction of intergroup conflict. American Journal of Sociology 63:349-356.

Shingi, P. M., F. C. Fliegel and J. E. Kivlin
1981 Agricultural technology and the issue of unequal distribution of rewards: An Indian case study. Rural Sociology 46:430-445.

Stephens, E. H.
1980 The politics of workers' participation: The Peruvian approach in comparative perspective. New York: Academic Press.

Streeten, P.
1979 A basic-needs approach to economic development. In K. P. Jameson and C. K. Wilber (eds.), Directions in economic development. Notre Dame: University of Notre Dame Press, 73-129.

Tandon, R. and L. D. Brown
1981 Organization-building for rural development: An experiment in India. Journal of Applied Behavioral Science 17:172-189.

Vanek, J.
1975 The worker-managed enterprise as an institution. In J. Vanek (ed.), Self management: Economic liberation of man, Middlesex, England: Penguin, 257-270.

Wallace, A. F. C.
1956 Revitalization movements. American Anthropologist 58:264-281.

TECHNICAL CHANGE AND RURAL DEVELOPMENT:

A DEMOGRAPHIC PERSPECTIVE

3117

ABSTRACT

Population growth and distribution are important factors in determining both the rate of economic progress and the allocation of the benefits of growth. In this paper, the relationship between demographic factors, technical change and rural development are examined within a framework that includes alternative growth paths. The major element linking the three concepts is the agricultural surplus which transmits demographic pressure both intersectorally and temporally.

In the development process discussed, population growth and internal migration can provide an initial impetus for agricultural development and subsequently for urban-industrial development. Similarly, both rural and urban sector growth can contribute to the transition from high population growth to low population growth. Agricultural and demographic development are thus inexorably related in determining both the pace and course of national economic development.

TECHNICAL CHANGE AND RURAL DEVELOPMENT: A DEMOGRAPHIC PERSPECTIVE*

Wayne Schutjer
Professor, Agricultural Economics

C. Shannon Stokes
Professor, Rural Sociology

Warren C. Robinson
Professor, Economics

INTRODUCTION

Population growth and distribution are important factors in the economic and social well being of a nation's citizens. Changes in population size, arising primarily from variations in fertility and mortality, and changes in population distribution, combine to account for a significant portion of governmental activity. Each can also be a positive force in shaping the pace and composition of economic progress. The stagnation theorists of the 1930s quite correctly perceived the importance of the shifting population distribution that accompanied the settling of the Western United States, and the importance of overall population growth to the economic well being of the nation. Contemporary African economists who note the difficulties of providing adequate social and economic infrastructure in sparsely settled areas face a similar demographic reality.

---

*Wayne A. Schutjer and C. Shannon Stokes are Co-Directors of the Pennsylvania State University Agricultural-Demographic Project, and Professors of Agricultural Economics and Rural Sociology, respectively. Warren C. Robinson is Professor of Economics and Director of the Pennsylvania State University Population Issues Research Center.

The purpose of this paper is to examine the role of demographic factors in the process of technical change and rural development. Our objective is to examine change in demographic factors as both a cause and consequence of technical change and rural development. Thus, rather than an examination of cross-national data regarding per capita nutrition or health standards in relationship to population density and per capita food production, we present a conceptual view of the dynamics of demographic and technological interaction. The discussion is selective with regard to both the linkages developed and the demographic factors included. Political issues are largely neglected, although both population growth and distribution greatly influence the politics of agricultural policy formulation and implementation. Similarly, mortality per se is not considered, nor are changes in intra-sectoral population distribution.

Overview

Demographic forces influence rural development through the role they play in determining the pace and form of technical change. The pace of technical change reflects the derived demand for new production practices and inputs growing out of pressure on the rural sector for additional food and fiber. Population growth can provide the impetus for technical change, as can changes in population distribution (urbanization), changes in rural tastes and preferences, and policies designed to extract produce from the rural sector for either domestic or foreign markets. The form of technical change, in turn, depends upon relative factor prices and the response of the technology producing sector to those prices. Demographic processes influence the supply of labor in rural areas and, hence, relative factor prices. In the early stages of development it is the relative supply (and price) of land and labor that determine agricultural production processes. In later stages of development, the relative price of capital takes on increasing explicit importance.

The agricultural surplus is the major factor reflecting the derived demand for technical change, and provides the mechanism for transmission of that demand both within the agricultural sector and inter-sectorally. Food availability, rural leisure, production of nonagricultural goods, labor force participation rates, and technical change are all reflected in the agricultural surplus. Technical change, however, provides the major long term mechanism influencing the agricultural surplus. The relationship between technical change and the agricultural surplus also determines the technology that will be available to the rural sector in the future. In this case, the relationship grows out of the fact that use of the surplus in previous time periods largely determines contemporary technological possibilities. Land clearing, drainage, land leveling, minor irrigation construction, and fencing, all reflect surplus utilization that provides the basis for further technological progress. At more advanced stages of agricultural development, the link will likely be through the development of research and extension capacity and urban-industrial growth.

The final relationship in the demographic-technology interaction system is the impact of technological advance in agriculture on demographic conditions. The nature of the relationship is a function of the combination of inter-sectoral population shifts, and rural and urban fertility rates. Perhaps the mos common implicit assumption underlying the agricultural development-population growth relationship, is that development consists of a redistribution of population from rural to urban areas in response to a change in the structure of national production. This population shift, in combination with lower urban fertility rates, can be expected to contribute to a lower national fertility rate. However, as Dovring has shown, the relative decline in rural population at the early stages of development is slow and an absolute decline comes rather late in the development process. Therefore, declines in fertility in rural areas in response to changing modes of production emerge as a potentially significant technology-induced demographic change.

The concept of the agricultural surplus is developed more fully in the following section. The notion of an agricultural surplus is clearly not new, and in fact, plays a central role in most conceptualizations of the growth process. The concept has, however, been discussed many times and with such variation in meaning that, as Warriner (p. 443) has argued, it has lost precision. Given the centrality of the surplus to our discussion of technology, population growth and distribution, a consistent definition of the concept is needed. The concept of the agricultural surplus, in turn, provides the basis for an examination of alternative growth paths in a second section. A third section examines the linkage between technologically based agricultural development and demographic change.

THE AGRICULTURAL SURPLUS*

The use of the term "agricultural surplus" to define an excess of product above the subsistence requirements of the rural population, as reflected in the work of the classical economists, provided a relatively unambiguous concept. Confusion was introduced by using the term "surplus" to mean an excess of labor required under given technological conditions to produce an existing level of output. Seasonal, nutritional, motivational and other factors are involved in such surpluses and raise policy questions different than those associated with the narrower classical notion of surplus.

Confusion also results from the fact that an agricultural surplus is in part a social concept. The definition of subsistence is socially determined, a fact which was recognized by the classical economists (Spengler). And, the manner in which a surplus is captured is not only socially determined but is an essential part of its definition.

Population size and distribution both influence the agricultural surplus, but they represent only two of several forces that can generate an excess of product per worker over rural subsistence needs. An examination of the role of population and other forces in generating a surplus--and of the reciprocal relationship--requires precision in the use of the concept. The purpose of this section is to present a review of the various surplus concepts. We find that the term has five possible meanings or interpretations: (1) the classical (Malthusian-Ricardian) surplus; (2) a technological (Boserupian) surplus; (3) an "other goods" (Hymer-Resnick's Z goods) surplus; (4) a "leisure" surplus; and (5) an x-efficiency (Leibenstein) surplus.

---

*A more detailed discussion of the agricultural surplus is available in Robinson and Schutjer (1982).

The Classical Surplus

The Richardian-Malthusian Classical Model was powered by two forces: the law of diminishing returns in agriculture and the tendency for population to grow whenever output exceeds subsistence requirements (Baumol). The two forces in combination were expected to drive the average product of labor to subsistence. Prior to reaching the long-run Malthusian equilibrium, however, there is a period of increasing and then declining average product. Before the Malthusian equilibrium, a surplus is available which can be measured by the difference between the agricultural output of a nation and the subsistence requirements of the rural population (Peacock, Leibenstein).

Within the classical framework, any non-consumption (i.e., savings-investment) is surplus. This view also assumes that each level of output represents a full-employment utilization of the labor force; that labor force is a fairly stable share of total population; and that production as measured really does include the total value produced from the resources at hand. In other words, each point achieved on the production function represents a point on a production possibilities frontier.

The Ricardian-Malthusian model provides the classical view of how technical change in agriculture and population interact through the surplus. In its simplest form, technical change increases the surplus which supports continuing high human fertility in rural areas. In more elaborate forms, this model and line of thought continue to dominate most development planning. The development task is to create a current social surplus which is as large as possible, and use it to increase future output, while at the same time promoting declining human fertility. Under these conditions it is not necessary for the model to lead to a stagnation equilibrium. If population growth does not occur, or occurs slowly enough, then surplus output can be channelled into investments calculated to shift the aggregate production function upward. Were population to stabilize at less than subsistence average product, a surplus could become a regular feature of the production process. This version of the model is the optimistic "escape trajectory" variant suggested by Leibenstein and others (Leibenstein).

The Technological Surplus

The forces limiting all economic progress in classical theory are population growth and diminishing returns to labor. Ester Boserup has dealt with the same factors, but by ordering them in a different way, suggests that she ends up "standing Malthus on his head" (Boserup). She argues that population growth tends to be the stochastic variable in the model, resulting from natural, climatic and biological forces as well as variation in economic conditions. In her view the economic problem for most societies is how best to adapt agricultural output to population, given the supply of land and other factors. In other words, factor proportions, and per capita income follow from population growth as it relates to the resources available, not the other way around. The shifts from primitive, slash-burn agriculture to short-fallow rotation, and ultimately, to settled, annual cultivation are, in her model, the responses of society to population pressure. The basic point of view is thus an optimistic one which stresses that most rural societies have an unrealized potential for further "technological" adaptation if and when population pressure occurs.

Critical to the analysis of Boserup is a potential surplus of output available to the rural sector through the availability of an improved or higher-order level of technology. Thus, a technological response to changing man-land ratios such as movement from long-fallow to short-fallow represents a shift to a new production function. The production function represents a different technology and not merely a discontinuity of lumpiness associated with the existing function (Robinson and Schutjer, forthcoming).

This notion of technology is consistent with the usual economic definition. Ruttan defines technological change as: "changes in the coefficients of a function relating inputs to outputs resulting from the practical application of innovations in technology and economic organization" (Ruttan, p. 606). The Boserupian Model posits that increased population leads to a substitution of more labor-intensive techniques for existing techniques on a static set of isoquants up to the point at which average labor productivity falls to some critical (or threshold) level. When this occurs, the next higher technology is adopted, the production surface shifts upwards, and the same inputs now produce a larger output, restoring the average product (and income) of labor.

The movement from long-fallow to short-fallow, the introduction of crop rotation, irrigation, and mechanization are all examples of technological changes. But, the changes need not be so dramatic or instantaneous in effect. Smith documented the profound effect on Japanese agriculture in the late Tokugawa period (early to mid-19th Century) of a series of small changes of know-how in seed selection, better fertilization and more careful cultivation. The first "agricultural revolution" in Western Europe was of the same sort (Dumont; Jones and Woolf).

It is likely that at early stages of development new or improved agricultural technologies are available within the sector and can, with only simple adaptive research within the sector, be made suitable for local conditions and factor prices. But, if the new technologies require industrially based inputs, then the Boserupian surplus can be unlocked only with some inputs from outside agriculture, and the development of an institutional support system in order to insure their adoption and effective utilization.

Boserup has added off-farm employment by some members of the farm household as a second type of adjustment to population pressure. She has also examined the relationship between the agricultural production system, settlement patterns and the degree of urbanization of a nation. She finds that land extensive, sparsely-settled areas find it difficult to transport and accumulate the surplus needed to support a high degree of urbanization, unless transportation costs are minimized by a river transport system (Boserup). Thus, because it is the absolute size of the surplus which matters to the support of the urban complex, densely settled, land-intensive areas are more likely to produce a commercially-oriented urban system.

In a recent empirical study utilizing her basic framework, Boserup presents an impressive array of aggregate and historical data supporting her argument that technology responds to population pressure. A similar aggregate-level analysis of a single intensification strategy, irrigation, found that investments in irrigation were clearly related to population pressure on rural resources (Simon). The work of Levi in Sierra Leone also supports the Boserupian view and adds an important corollary to the basic notion. Those findings demonstrated that the first response to increased resource pressure is likely to be an additional labor input within the framework of the existing technology. For example, initially, greater attentio given to cultivation practices and subsistence crops with high labor demands. It was only at the "eleventh hour" that farmers were likely to undertake the land reclamation required for a "new" technological package. Similarly, Liu and Lu argue that the demographic response to rapid population growth in Taiwan came only after a series of labor intensive, land augumentation, and technological practices has been adopted.

In summary, the technological-response model argues that some unrealized potential for increased agricultural output with given inputs nearly always exists. The potential "surplus" is not in underemployed factors but in the choice of a technology. As a result, the principle of least-effort motivates producers, not the principle of maximizing net surplus. New technology and increased output are usually thrust on the cultivators by some pressure, population growth being the most obvious candidate.

The Labor Surplus

In a celebrated article, Lewis argued that most developing countries attempting to increase their level of output already possessed the means to do so through use of underemployed labor available in the traditional rural sectors. That is, many workers do not work, on the average, a full day's work at some productive economic activity. Tasks are shared by family members, leisure is too abundant and long idle spells are characteristic of the annual work cycle. In classical terms, the point on the production function where the marginal product of rural labor falls below the subsistence wage does not represent full employment; thus, there is a labor surplus which represents the failure to fully mobilize the resources available to the economic system.

This concept has enjoyed an enormous vogue. The Fei-Ranis Model and that of Jorgenson are elaborations of the Lewis notion that since all workers must be fed, if some are not fully employed at production activities, then their "idleness" represents a "labor surplus" which policy must aim at mobilizing. It is important to be clear, however, that this view does not present a "romantic" or "irrational" picture of peasant agriculture. But, it does argue for the existence of what Mellor called "a substantial unrealized potential" in agriculture (Mellor, p. 47).

Labor supply in rural areas that is surplus to the agricultural production process need not be unemployed. Thus, two sorts of surplus are actually involved and it is useful to distinguish between the two.

Other-Goods Surplus Labor. Hymer and Resnick focused attention on the role of non-agricultural household production (which they define as "Z goods") as one of the ways in which the allegedly-unemployed surplus labor was actually used in rural areas. Housing, clothing, tools, utensils and decorative and ornamental objects are all integral parts of "subsistence".

A peasant economy which produces nothing for the market may actually have little surplus labor. In their view the labor "surplus" may simply be a measure of the degree to which the rural labor is simultaneously engaged in agricultural and non-agricultural pursuits. Jones goes further and suggests that the labor surplus found by "... Fei and Ranis may be an illusion resulting from their refusal to take seriously when performed by non-Europeans a group of productive activities that account for the largest part of the national income of developed countries" (Jones, p. 281). Hymer and Resnick use the Z-goods notion not only to refute the labor-surplus model's key assumption that labor not employed in agricultural pursuits is unemployed, but also to argue that traditional societies may have gained little from increased availability of industrial products that substitute for the products of local manufacturers. They argue that the Colonial powers used a combination of market incentives and coercive political and fiscal power to eliminate the local Z-goods industries, thus creating markets for their own manufacturing exports and also putting the developing nations in a permanently dependent position vis-a-vis the Colonial powers (Hymer and Resnick). Thus, the view suggests that no real labor surplus in the form of leisure ever existed; the increased output of a marketable surplus was at the expense of local manufacturers producing products which now must be obtained through trade. By being more dependent, the areas are worse off and have no better prospect for real development (Wallerstein). However, labor employed in "Z" goods production could be made available for agricultural production, thus, within the definition of surplus employed in this analysis, a surplus does exist.

<u>Leisure Surplus</u>. Chayanov's theory of the peasant economy provides a second insight into the sources of labor surplus to the agricultural production process at current levels of output. He maintains that the rural household is not a net profit (or utility) maximizer in the ordinary microeconomic sense. Instead, the goals of the household are to obtain a satisfactory level of consumption for the household and to provide work for all labor available. Technology is implicitly static, so that in general, as the needs for consumption and the labor available change, the amount of land cultivated will change too. The theory suggests that there is often an unrealized potential for increased output, since when population pressure does rise, more land is cultivated; and if no further land is available, then cultivation can become more intensive on the existing plots. Chayanov is implicitly assuming subsistence cultivation with only weak ties to the market and no demand in the rural sector for industrial goods. For his model, the "surplus" is implied by the deliberate sub-optimization of the household. The "surplus" is created and transferred the moment the agricultural sector acquires a taste for nonhousehold-produced goods, or experiences pressure on food supply and is willing to sacrifice leisure to obtain more agricultural output, either for subsistence or for trade with an urban-industrial complex.

In any case, the leisure surplus is a deeply-rooted cultural phenomenon. The existing degree of labor utilization does represent a point on some socially-optimum production function, consistent with the existing leisure preferences, values and technology. Appropriating it for some non-consumptive purpose may require improved political and social organization or some exogenous force.

"X-Efficiency" Surplus

Leibenstein has recently called attention to the relevance of "x-efficiency" or system-slack for theorizing about development; arguing that there may always be a potential for further increases in output per unit of input depending upon worker motivation, organizational skill, and a host of other qualitative factors (Leibenstein). Such small qualitative changes in efficiency can amount to a technological shift. Such changes seem to have played an important role in the modernization of agriculture in many countries (Smith; Hanley and Yammura).

Leibenstein's x-efficiency paradigm is an effort to explain why producing units frequently can be shown not to be maximizing net profits or to be making the most "efficient" (output maximizing) use of their inputs. Rather than concluding that such firms are "irrational", he suggests that they are "efficient" judged by some more appropriate tests. This appropriate but unobserved criterion he calls the "x-factor". A firm may thus be foregoing "allocative efficiency" in order to obtain "x-efficiency"-market peace with competitors, serving its customers "better", keeping its workers happy, etc. Such "inefficiencies" as judged by the usual criteria are optional. They can shade off into lethargy and an increase in transactions-costs. But the point for a discussion of an agricultural surplus is that under pressure, the unit has the potential for tightening up, increasing output, reducing costs or otherwise improving on its economic position. To the extent that this is possible in the agricultural sector, an unrealized surplus exists.

Discussion: Realizing the Surplus

Only the classical surplus is an existing surplus, the others are all potential increases in output over and above subsistence needs. Yet all the surpluses require not only a mechanism for stimulating production, but a means of transferring or expropriating the surplus. The development of any of the latent surpluses requires the imposition of pressure on the existing system. The classical surplus begins to occur due to population growth and economies of scale (in the early stages), but only as the economy becomes monetized, specialized and trade-oriented. The leisure-labor surplus exists when no central political authority or colonial power exists to require full-employment or change the leisure preference. The local manufacturers surplus (if it is a surplus at all) exists when tastes are unchanging and no important penetration has occurred. The technological surplus implies a satisfactory present standard of living due to no population pressure, no demand for imports or other pressures. Much the same can be said of the x-efficiency surplus.

In retrospect, it seems clear that the great attraction of the "labor surplus" approach to development policy was that it seemed to promise the creation of an exploitable surplus without the need for any "pressure" or structural transformation. The framework presented here argues that the latent surplus implied by strong leisure preference, by poorly integrated domestic economic systems, or by limited material aspirations may not be easy to change. Thus, countries which argue that they are "under-populated" are suggesting that they are still in a range of increasing returns and have an unrealized classical surplus which population growth will stimulate.

The authoritarian approach to development creates the surplus through forced labor, mandatory fixed delivery quotas and other physical techniques. Structural transformation is achieved through economic and political coercion (Swianiewicz). The "open" or market-oriented development model, on the other hand, sees the market as achieving the transformation. Myint has, for example, shown that the classical "vent for surplus" doctrine was, for the most part, an outgrowth of growing monetization, specialization and rising output. A country necessarily adopts an export-oriented policy as structural transformation creates larger and larger actual surpluses. Under colonial conditions the export-orientation may, in effect, be imposed on a nation by foreign capitalists and plantation administrators. Voluntary or not, the point remains the same. Opening an economy with a large potential agricultural surplus to substantial foreign export demand is a type of pressure which leads to structural transformation. It is thus a policy option for creating and capturing potential surplus.

A dynamic urban-industrial sector can have the same effect as penetration by an export market. The demand such a sector will generate for agricultural output will inevitably lead to growing market-prenetration into the countryside changes in tastes, and changes in the allocation of time and other resources. Such a market-oriented expropriation may or may not be "exploitative" or non-competitive. Even in relatively primitive societies the urban sector may emerge as the producer of outputs which, when applied to the rural sector, result in increased labor productivity. Included in such outputs are military and police protection, design and control of irrigation schemes, and religious rituals to ensure a favorable harvest.*

In summary, it is suggested that a potential agricultural surplus can be produced and captured in response to three forces: (1) population growth; (2) outside market penetration and monetization; and (3) domestic urbanization, coupled with the growth of a central authority eager for the surplus. Once any one or combination of these forces sets the process of surplus creation and transfer in motion, the process becomes cumulative. That is, population growth begins by creating a classical surplus due to economies of scale. Further population growth puts pressure on the system to reduce leisure, shift to a more intensive technology, reduce production by local manufacturers, and forces a more relentless efficiency in production of the type identified by Leibenstein. Similar scenarios can be sketched out for the short versus long run effects of market penetration, and of the growth of a coercive central authority. In practice, it is likely that all three interact.

ALTERNATIVE GROWTH PATHS

Central to a demographic perspective of technical change and rural development is the agricultural surplus and its relationship to population growth, as well as to the rise of the urban-industrial sector, which

*Wallerstein and others emphasize the exploitative nature of the surplus transfer. They argue that an insatiable desire for further surplus by the ruling elites "explains" virtually all of modern Europen (and World) history. This approach is essentially neo-Marxist and, like Marx, can be criticized for a failure to see the difference between extracting a surplus by authoritarian political means as against using market incentives to stimulate increased production.

is important for sustained technological change in agriculture. In the preceding section we defined agricultural surplus to be both actual and potential agricultural output above the subsistence requirement of the sector, the surplus results from population growth, outside market penetration and/or domestic urbanization. In this section the role of the surplus in the growth process is elaborated.

Critical to the role of the surplus in national development is the source of impetus for generation of actual surpluses. If the surplus arises in response to rural population growth, we have the purest Malthusian case. Population "eats up" the surplus and eventually population growth must cease because of rising death rates (or periodic catastrophies). A surplus sent off to world markets and therefore leading to only modest increases in rural income will not bring about a structural transformation and, if rural population growth is triggered by the rise in incomes, eventually will lead to rural densities so great as to eliminate the "transferable" surplus and lead to a Malthusian outcome.

Thus, any sustained rural population growth in the absence of a structural transformation leads to this outcome. This is true because even the Boserupian potential surpluses have upper limits. With no inputs from a science-based, urban-industrial sector, traditional agriculture must eventually reach an upper level of output such that no further shifts in technology or rearrangements of factor inputs are possible. This, in short, is T. W. Schultz's "traditional agriculture"; rational, maximizing, but in a dead-end. In practical terms, adding a few more ditches or a new well or a new draft animal on the same land, using the same technology, will increase agricultural production very little. For further development to occur the agricultural sector must gain access to "high-payoff" inputs from outside the rural sector. In other words, no further technological change from inside agriculture is possible.

Under the conditions of traditional agricultural equilibrium, further surplus development and/or the accommodation of additional population requires the availability of new technologies embodied in purchased manufactured inputs and perhaps a more educated farm manager. If the surplus phase of development fails to create a modern urban-industrial sector which can supply inputs to the rural sector capable of supporting further shifts in the agricultural production function, development does end up being a Malthusian process. In this case the combined forces of diminishing returns and continued population growth drive the entire economy to subsistence, and evolution becomes involution (Geertz).

An alternative to the involuted, stagnant, agricultural solution is one in which the agricultural surplus available from traditional agricultural systems provides the basis for interacting rural-urban growth. As noted above, handicraft production of non-subsistence products virtually always exists, even in the most purely rural economies. However, there are obvious advantages of specialization and efficiency in non-subsistence production being concentrated in one geographic area so as to internalize within the industry what might otherwise be lost external effects. This occurs in what are already, or what become, urban areas. Once this begins to occur, trade grows bwtween the rural and urban sectors. The urban sector is transformed from a religious-political center to a manufacturing-service generating sector. At this stage the process of change can become self-generating as the production inputs from the manufacturing sector help continue the transformation in the agricultural sector. Labor requirements fall as labor productivity goes up and labor is transferred to the growing urban-industrial sector. Population growth will still be concentrated in the rural areas which, coupled with the rapid increases in productivity, and a fall in the amount of labor required, will lead to a growing rural to urban movement.

Thus, this type is characterized by a dynamic growth in the urban-manufacturing sector such that it exerts a demand in the rural-agricultural sector for a growing amount of foodstuff and probably also for labor. Rural to urban migration occurs on a large scale as do changes in the structure of the rural sector. Aspiration levels rise, the level of output rises, and a growing commercialization and consolidation occurs. The interaction between the sectors leads both to rising levels of output and income. This type can also be seen in demographic terms as the early stage of the demographic transition. The urban sector adopts the small family norm as the micro cost-benefit calculation increasingly is turned against large families; and this norm begins to spread outward to the rural areas as well.

Geertz, the scholar who first documented the process of involution in Java, stresses the importance of an integrated rural-urban economy. According to Geertz, Japan had and maintained an integrated economy, but Java had and lost an integrated economy. Population growth in the rural sector in Japan was absorbed by industry and output per agricultural worker rose even while yields did too. In Java, output per worker fell while yields rose because no industrial "escape valve" existed (Geertz, p. 135).

As the commercialization of agriculture goes further, one can anticipate a situation in which labor will eventually be supplied by hired persons or by some of the family members while others are contributing to the family income by working outside agriculture. The farm household will be as specialized and totally dependent on other sectors as any other household. The surplus concept is no longer relevant, any more than it is to speak of a surplus coming from a shoe factory over and above the needs of the workers for shoes. The farmer grows wheat exclusively, but buys bread at the supermarket along with everyone else. In this case, migration takes on complex new patterns. The rural-urban differences in income tend to be diminished and movement more in the nature of a commutation, rather than a permanent migration occurs. Both rural and urban populations now find microeconomic advantages to limiting family size, and fertility declines.

In the latter stages of the process, the entire economy becomes one marked by substitution of capital for both labor and land; indeed, since output per unit of both land and labor are high and the demand for food is likely to be relatively inelastic as income rises, the relative need for both labor and land in agriculture falls. The sector constitutes a continuously smaller share of total national output. In this case, agriculture's success breeds its own relative decline.

Summary

Generalizing from the Boserupian Model, one can argue that agriculture does react to "pressures" by creating more output from the potential surplus which was always there. The pressures include rural population growth itself but also other forces including: exploitation by urban-political authority; colonial exploitation and the penetration of world markets; and growing commercialization, monetization and a "taste" for manufactured goods. The increased output can come from adopting a newer, more intensive technology, but also from reduced leisure, reduced local internal handicraft production, or an expanded scale of output. If the increase in output is either caused by or accompanied by a growth in the rural population, then the outcome from the entire process will be no growth in real per capita income. Boserupian technological change eventually reaches a point at which any further "leap" to a new production function requires regular interchange with and inputs from a healthy urban-industrial sector which can provide needed new technologie The final outcome of the process of change in agriculture, once it has begun, depends critically upon the mechanism by which the surplus is achieved, and its interaction with the rate of rural population growth.

TECHNOLOGY BASED DEVELOPMENT AND DEMOGRAPHIC CHANGE

The final set of relationships in the demographic perspective on agricultural technical change and rural development grow out of the impact of technology adoption and agricultural development on demographic variables. The linkage between technically based economic development and demographic change includes both population shifts between sectors and declining rural fertility. In the first instance, agricultural development based upon purchased inputs which embody productivity increasing technology will contribute to the development of an urban-industrial sector and promote population movement out of rural areas. This shift is the basic industrial and labor force transition defined by Kuznets and provides the basis for two sector development theories. It is also true, however, that modern production processes are not limited to an urban sector, nor that urban activity is non-subsistence. In fact a four way classification would be more useful for empirical work; rural-industrial, rural-subsistence, urban-industrial and urban-subsistence. In any event, that the intersectoral economic transition and population shift will be accompanied by a decline in fertility, growing out of rural-urban fertility differentials provides an important dynamic element in the process of national economic and demographic development.

Declining rural fertility provides a second link between economic and demographic development in rural areas, although the potential for declining fertility in rural areas has been largely viewed as a passive element by development economists. Demographers and those responsible for family planning programs have not ignored rural areas, but development planners have been content to accept high rural fertility as a condition of a subsistence-oriented economy, and focus on population distribution as the medium for reducing national fertility rates.

The neglect of rural fertility decline by planners has little, if any, conceptual or empirical validity. The crude birth rate of a nation is dependent not only on the share of population in the urban and rural sectors, but upon sectoral fertility rates as well, that is:

$$r_t = \frac{P_a}{P_t} \cdot r_a + \frac{P_n}{P_t} \cdot r_n$$

where:

r_t = crude birth rate for the nation

r_a = crude birth rate for the rural population

r_n = crude birth rate for the urban population

P_a = rural population

P_n = urban population

P_t = total population

Thus, both declining rural fertility and the intersectional transfer of population are important potential contributors to declining national fertility rates. However, as Dovring has demonstrated, in the initial stage of development P_a, r_a and r_n are so large that even though P_a/P_n may decline, P_a continues to increase.

Empirical evidence also supports the importance of both high rural fertility and a large rural labor force for high total fertility, and of declining rural fertility for a national fertility decline. Table 1 presents illustrative data from seventeen nations for which comparable information on fertility, income and international labor force participation rates were available. For purposes of exposition, the nations have been aggregated into three groups based upon total fertility rates. Detailed country data are presented in Appendix Table A.

The average total fertility rates are presented in Column 1. On average, women in the high fertility nations can expect to have 5.10 children during their childbearing years if current rates of childbearing continue. Those women in middle and low fertility nations can anticipate, on average, 2.34 and 1.73 children, respectively. Data on per capita income are presented in Column 5 to provide perspective on the level of economic development of the three groups of nations. As would be expected, the high fertility nations are those with the lowest per capita income, while the nations with the highest per capita income are those with the lowest fertility.

Table 1. Demographic and Economic Characteristics of High and Low Fertility Nations.

Fertility Classification	Total Fertility Rate (TFR)	Rural Fertility (RF)	Rural/Urban Fertility Ratio $(\frac{RF}{UF})$	Rural Labor Force Ratio $(\frac{LA}{LT})$	Per Capita Income $(\frac{V}{P})$
High Fertility	5.10	185.8	1.33	50.40	$ 836
Medium Fertility	2.34	76.5	1.21	36.00	$3,070
Low Fertility	1.73	65.0	1.15	8.14	$7,854

Source: Appendix Table A.

Column 2 presents rural general fertility rates (live births per 1,000 rural females aged 15-49 per year) for each of the three groups of nations. In the high fertility nations, 1,000 rural women averaged 120 more births per year than did their counterparts in low fertility nations. Similarly, population distribution, as measured by the proportion of labor force employed in agriculture (Column 4), suggests a much greater proportion of females in the high fertility nations live in rural areas. The significance of the ratio of rural fertility to urban fertility presented in Column 3 is that relatively high rural fertility prevails in nations with relatively large rural female populations, and that with development and a changing population distribution, not only does rural fertility decline absolutely, but it falls relative to urban fertility levels.

Recent demographic research has also drawn into question the assumption that a rural fertility decline must await a national labor force transition toward the urban sector. Aggregate level historical evidence of the European fertility transition suggest that "there was no clear threshold of social and economic development required for the fertility transition to begin" (Knodel and Van de Walle, p. 225). Micro level studies of rural sectors in contemporary low income countries support that view. In a review of empirical evidence on fertility variation among farm families within a number of developing nations, Schutjer and Stokes provide evidence to support the following generalizations:

(1) Increasing land ownership will be likely to exert downward pressure on desired family size among rural households through the substitution of land for children as a store of wealth;

(2) Increasing the demand for child labor at the farm level (such as increasing farm size or irrigation) will contribute to the maintenance of a high level of desired family size by raising the potential family income contribution of children;

(3) Increasing income among farm families will lead to a lower desired family size as families seek to provide greater educational opportunities for a more limited number of children;

(4) In very low income nations or among low income segments of rural populations, improvements in nutrition and protection against infectious disease, may, when combined with increased food output and farm income, have a positive impact on the level of natural fertility.

If such generalizations are found to hold, appropriate rural development programs which both increase the agricultural surplus and lead to a more rapid reduction in rural fertility seem feasible. Viewing the decline of rural fertility as an active factor in the development process, rather than a passive element, can offer the basis for the coordination of national demographic and development policies.

CONCLUDING COMMENT

In this paper we have argued that demographic factors are both a cause and a consequence of technical change in agriculture, and that population distribution and fertility variation provide the basis for a dynamic interaction between sectors, working through the agricultural surplus. The conceptual framework presented suggests that increased agricultural output occurs in response to the desire of rural population to maintain per capita food availability in the face of increased demand for agricultural output. The demand can be generated internally by population growth or by external market and non-market forces. Per capita food availability can be maintained in the face of increased demand through reduced leisure, a shift of rural resources away from non-agricultural production, a more efficient use of existing resources, and/or the adoption of production technology available from the rural sector. In the longer term, however, the answer can be found only in the adoption and effective utilization of technology generated and produced in an urban industrial sector.

In the development process, demographic factors can provide the initial impetus for the required rural sector input to development. In the latter stages of development, technical change and urban-industrial growth can provide the basis for the transition from high population growth to low population growth. The population growth transition results from a population shift toward urban-industrial areas and the impact of the agricultural development process on human fertility in rural areas. Agricultural and demographic development are thus inexorably related in determining both the pace and course of national economic betterment.

Appendix Table A. Economic and Demographic Data For Selected Countries.

Nation	Total Fertility Rate (TFR)[1]	Urban Fertility Rate (UF)[2]	Rural Fertility Rate (RF)[2]	Rural/Urban Fertility Ratio $(\frac{RF}{UF})$	Rural Labor Ratio[3] $(\frac{LA}{LT})$	Per Capita GNP in Dollars[4] $(\frac{Y}{P})$
Pakistan	6.7	130.5	190.4	1.46	58	230
El Salvador	5.5	166.6	217.4	1.30	52	660
Dominican Rep.	5.3	164.3	200.6	1.22	57	910
Malaysia	3.9	146.6	152.6	1.04	50	1090
Panama	4.1	104.1	168.0	1.61	35	1290
Romania	2.6	70.2	87.4	1.25	50	1750
Bulgaria	2.3	63.3	63.3	1.00	40	3230
Greece	2.3	62.9	69.8	1.11	39	3250
Hungary	2.2	58.4	71.5	1.22	18	3450
Poland	2.3	62.4	90.7	1.45	33	3670
U.K.	1.7	66.3	67.4	1.02	2	5030
Finland	1.7	52.3	53.6	1.02	14	6820
Austria	1.7	50.6	78.2	1.55	10	7030
France	1.9	71.5	70.8	.99	9	8260
Netherlands	1.6	47.2	61.5	1.30	6	8410
Norway	1.8	56.5	57.9	1.02	8	9510
Denmark	1.7	58.1	65.7	1.13	8	9920

[1] 1978 Total Fertility Rate - from: IBRD. "Table 18, Demographic and Fertility-Related Indicators," World Development Report, 1980. Oxford University Press, 1981.

[2] Urban and rural fertility rates are live births per 1000 women aged 15-49 - from: United Nations. "Live-Birth Rates Specific for Age of Mother, by Urban/Rural Residence," Demographic Year Book 1979. New York, 1980.

[3] IBRD. "Table 19, Labor Force," World Development Report, 1980. Oxford University Press, 1981.

[4] 1978 Gross National Produce Per Capita - from: IBRD. "Table I, Basic Indicators," World Development Report, 1980. Oxford University Press, 1981.

LITERATURE CITED

Baumol, William J. Economic Dynamics. London: MacMillan, 1956.

Boserup, Ester. The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure. Chicago: Aldine Pub. Co., 1965.

Boserup, Ester. "Environment, population and technology in primitive societies." Population and Development Review, 2(March, 1976): 21-36.

Boserup, Ester. Population and Technological Change: A Study of Long-Terms. Chicago: University of Chicago Press, 1981.

Chayanov, A. V. Theory of the Peasant Economy. Homewood, Ill: Irwin, 1970.

Dovring, Folke. "The Share of Agriculture in a Growing Population." Monthly Bulletin of Agricultural Economics and Statistics. Vol. 8, pp. 1-11, FAO, Rome, August-September, 1959.

Dumont, Rene. Types of Rural Economy: Studies in World Agriculture. London: Metheun & Co., 1957.

Fei, John C. H. and Gustav Ranis. Development of the Labor Surplus Economy. Homewood: Irwin, Inc., 1964.

Geertz, Clifford. Agricultural Involution: The Process of Ecological Change in Indonesia. Berkeley: University of California Press, 1968.

Hanley, Susan B. and Kozo Yamamura. Economic and Demographic Change in Preindustiral Japan, 1600-1868. Princeton: Princeton University Press, 1977.

Hymer, Stephen and Stephen Resnick. "A model of agrarian economy with non-agricultural activities." American Economic Review 59(1969), Pt. 1:493-506.

Jones, E. L. and S. J. Woolf (eds.). Agrarian Change and Economic Development: The Historical Problems. London: Meuthen and Co., 1969.

Jones, W. O. "The demand for food, leisure and economic surpluses," in C.R. Wharton, Jr. (ed.), Subsistence Agriculture and Economic Development. Chicago: Aldine, 1969.

Jorgenson, D. W. "The Development of a Dual Economy." The Economic Journal, (June, 1961):309-334.

Knodel, John and Etienne Van de Walle. "Lessons from the Past; Policy Implications of Historical Fertility Studies." Population and Development Review, 5(June, 1979):217-246.

Kuznets, Simon. Six Lectures on Economic Growth. New York: The Free Press, 1959.

Leibenstein, Harvey. Economic Backwardness and Economic Growth: Studies in the Theory of Economic Development. N.Y.: John Wiley, 1957.

Leibenstein, Harvey. General X-Efficiency Theory and Economic Development. N.Y.: Oxford University Press, 1978.

Levi, John F. S. "Population Pressure and Agricultural Change in the Land-Intensive Economy." Journal of Development Studies 13(Oct., 1976): 61-78.

Lewis, W. Arthur. "Economic development with unlimited supplies of labour." The Manchester School 22(May, 1954):139-191.

Liu, Paul K. C. and Gary L. T. Lu. Projections of Agricultural Population in Taiwan, ROC, 1975-1990. Chinese-American Joint Commission on Rural Reconstruction: Taipei, Taiwan. (October, 1978).

Mellor, John W. "Toward a theory of agricultural development," in Southworth and Johnston (Eds.), Agricultural Development and Economic Growth. Ithaca: Cornell University Press, 1967.

Myint, Hla. "The 'classical theory' of international trade and the underdeveloped countries." Economic Journal (1958):317-337. Reprinted in T. Morgan et al., Readings in Economic Development. Belmont, Calif.: Wadsworth.

Peacock, Alan T. "Theory of population and modern economic analysis." Parts I and II, Population Studies 6(1952):114-122; 7(1954):227-244.

Robinson, Warren and Wayne Schutjer. "The Agricultural Surplus as a Factor in Development." Journal of Rural Development 5(June, 1982):73-90.

Robinson, Warren and Wayne Schutjer. "Agricultural Development and Demographic Change: A Generalization of the Boserup Model." Economic Development and Cultural Change (Forthcoming).

Ruttan, Vernon W. "Asher and Schumpeter on Invention, Innovation and Technical Change," Quarterly Journal of Economics, Vol. 73, No. 4 (Nov., 1959):596-606.

Schultz, T. W. Transforming Traditional Agriculture. New Haven: Yale University Press, 1964.

Schutjer, Wayne and C. Shannon Stokes. The Human Fertility Implications of Food and Agricultural Policies in Less Developed Nations, Bulletin 835, Agricultural Experiment Station, The Pennsylvania State University, January, 1982.

Simon, Julian L. "The Positive Effect of Population Growth on Agricultural Savings in Irrigation Systems." The Review of Economics and Statistics, 57(Feb, 1975):71-79.

Smith, Thomas C. The Agrarian Origins of Modern Japan. Stanford: Stanford University Press, 1969.

Spengler, Joseph John. Facing Zero Population Growth: Reactions and Interpretations, Past and Present. Durham: Duke University Press, 1978.

Swianiewicz, S. Forced Labour and Economic Development: An Inquiry into the Experiences of Soviet Industrialization. London: Royal Institute of International Affairs, 1965.

Wallerstein, Immanuel. The Modern World-System: Capitalist Agriculture and European World-Economy in the Sixteenth Century. New York: Academic Press, 1974.

Warriner, Doreen. "Problems of rural-urban migration: Some suggestions for investigation." International Labour Review, 94(1963):421-429.

RELATIONSHIP OF POPULATION POLICY TO TECHNOLOGICAL CHANGE IN DEVELOPING COUNTRIES

351

ABSTRACT

This paper makes the point that planners who are examining the impact of technological change on rural development must take into consideration the population structure and dynamics of the society. The major focus is on the momentum of growth built into the age structure of a population and the potential for declines in population growth in developing countries as an implicit strategy of development planning. The analysis points out that for all developing countries large short-term increases in population are a reality, independent of any drastic reduction in current fertility measures. The data suggest that these increases have social and economic consequences for the young, the labor force and the elderly, and the analysis demonstrates the need for urgent consideration of fertility reduction programs in national development planning.

RELATIONSHIP OF POPULATION POLICY TO TECHNOLOGICAL CHANGE IN DEVELOPING COUNTRIES

Vivian Z. Klaff
Department of Sociology
University of Delaware

In discussing the relative merits of alternative strategies for solving the technological and socio-economic problems of developing countries this conference has focused on technological change. This paper points out the importance of examining the influence of environmental, organizational and technological factors on a country's ability to satisfy the needs of a population. The major focus is on an important issue which needs to be considered when development plans are being considered; namely, the potential for declines in population growth in developing countries as an implicit social strategy and the social and demographic consequences of such strategies. This examination is designed to provide background information for viewing population reduction as an alternative or parallel strategy to heavy investment in technological innovation in rural communities.

> "In ancient times, people were few but wealthy and without strife. People at present think that 5 sons are not too many, and each son has 5 sons also and before the death of the grandfather there are already 25 descendents. Therefore people are more and wealth is less; they work hard and receive little. The life of a nation depends upon having enough food, not upon the number of people."

In a world where the average number of children per woman in large parts of Asia, Latin America and Africa are 5 or more - this could very well be a quote from a frustrated rural development official of a developing country, dealing with the relationship between population growth and food supply. It is, however, a quote from Han Fei-Tzu, dated 500 B.C. It seems that concern with the demographic characteristics of a community are far from new. Yet in the context of the rapid changes occuring in the 20th century any analysis of the impact of technological change on rural development should not overlook the importance of population characteristics.

An examination of current literature points to the increasing awareness of the importance of population as a variable in development plans. For example, in 1973, Stamper conducted an analysis of the national development plans of 70 developing countries and found that less than one-third recognized any population issues in their plans (Stamper, 1973). In recent years, however, particularly since the World Population Conference in Bucharest in 1974, the focus on population has led to a considerable debate on the nature and scope of population policies.

A very brief overview of current perspectives on population growth ranges from those who see the issue of population as a major crisis now facing mankind and is at best a serious intensifier and multiplier of other social and economic problems, to those who claim that population growth is not a problem or that it is a false issue. Statements to support each perspective are many. According to Philip Handler, National Academy of Sciences:

> "Stated most simply, if mankind is to live in the state of material well-being that technology can make possible, then, given the finite size and resources of the planet, there are just too many of us already" (Handler, 1975:425),

and Robert McNamara of the World Bank stated that:

> "Short of nuclear war itself population growth is the gravest issue that the world faces over the decades immediately ahead.... The population growth is an inseparable part of the larger, overall problem of development. But it is more than just that. To put it simply, excessive population growth is the greatest simple obstacle in the developing world."

Those who take a more optimistic view of population growth suggest that under current economic conditions; with changing patterns of consumption between developing and developed countries; and the implementation of a "new international economic order" the solutions to temporary imbalances between population and environment can be corrected. Also at the Population Conference in 1974, some Third World spokesmen called for a rejection of Western industrial patterns of development and advocated instead the local and regional adoption of development patterns that could be integrated into the cultural and environmental context of rural communities.

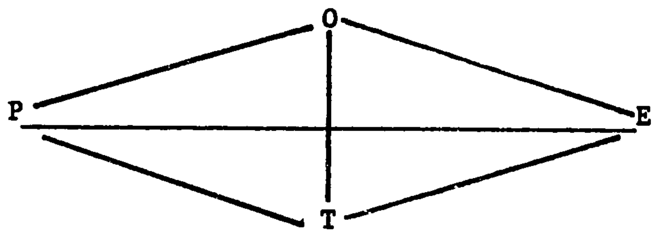
The question of to what extent the growth rate of world population is declining has in the 1970s received prominent attention in the aftermath of the conferences in Stockholm (Environment), Bucharest (Population), and Rome (Food). According to Lester Brown (1976) the rate of growth has dropped from 1.9% in 1970 to 1.64% in 1975. Additional optimistic statements on declining growth rates are found in a publication of the Population Reference Bureau (1976). In 1976, Ravenholt, Director of the Office of Population, AID, is quoted as stating that a vigorous family planning effort over the next 10 years could bring the world's birth rate below 20 per thousand, and the growth rate below 1 percent by 1985. "If this is accomplished, then the world population total should be less than 5.5 billion by the year 2000" (<u>People</u>, Vol. 3, #2, page 34, 1976).

It has been suggested, however, that these estimates are based on a somewhat over-optimistic evaluation of some shaky data, particularly estimates of trends in Chinese fertility and mortality (The Environmental Fund, 1976). Estimates of the Chinese crude birth rate (CBR) range between a low of 14 per 1000 (Population Reports, 1976) and a high of 36 per 1000 (The Environmental Fund, 1976). Considering the 1970 size of the Chineses population, a CBR of 14 and crude death rate (CDR) of 6 would result in an annual increase of 7 million people as compared to a 20 million annual increase calculated on the basis of Blackwelder's estimates. This and numerous other examples can be found, for both large and small countries, to suggest that with the best of all intentions analysis of world population data is often an exercise of faith as much as analysis of factual data.

What is certain, however, is that even with initial successes already achieved in fertility reduction, world population, and the populations of most countries, will increase considerably before leveling off.

My major issue in this paper is to point out that while technological change is obviously a major focus of direction in attempting to improve conditions in predominantly rural developing countries, the impact of technological change should be viewed in the context of population dynamics. An understanding of population characteristics of a community can assist in evaluating alternative strategies available to policy makers who are concerned with national development plans.

I would like to suggest a simple framework within which to examine our eco-system. This framework, originally suggested by O. D. Duncan (1959) examines the interrelationships between population (P), organization (O), environment (E) and technology (T).



The above figure contains these four interrelated variables, and examination of these relationships will be used to assist us in understanding the significance of alternative population policies in developing countries.

In 1865 Thomas R. Malthus published "Essays on Population" which outlined a critical connection between population and the environment. Malthus was concerned with the rapid geometric increase in population growth in an environmental climate where food production progressed through simple arithmetic growth. Malthus predicated massive overpopulation and famine. He outlined checks on population growth, both positive and negative, in order to avoid the population-environment imbalance. This Malthusian thesis has been variously endorsed and criticized. Endorsement comes from those who point to the fact that recent United Nations data estimate there are roughly 500 million people who are undernourished, that is, eating so little that they suffer from some form of energy deprivation.

A recently published report by a Presidential Commission on World Hunger (1979) concluded that the world hunger problem is getting worse and unless food production is increased in the developing nations, "a major crisis of global food supply - of even more serious dimensions than the present energy crisis - appears likely within the next 20 years".

Critics of Malthus, on the other hand, point to the fact that from the mid-19th century to the present the earth has absorbed a population increase of 3.4 billion people over the period. At the same time that the spector of additional food shortages in developing countries looms in the near future we are informed that during the remainder of the 20th century some 1.7 billion more people are projected to be added to the world's population, 90 percent of which will be added to the developing regions of the world. The United Nations Fund for Population Activities reports that "countries which feel the greatest need to balance resources and population growth are the least able to achieve this end".

On a rather simplistic level we may explain the somewhat unstable and fluctuating relationship between population and environment by looking at the other variables in the ecological complex, namely technology and organization. There is no doubt that the technological advances since the mid-19th century have played an important part in contributing to increased food production and in our ability to expand our use of natural resources. We have to take into consideration, however, that at some point practical limits to farm mechanization and farm productivity may be reached in terms of the carrying capacity of the land. Although extensive innovations have taken place in agricultural technology there are also signs that these are adverse and in some cases permanent effects on the environment. For example, land degradation and loss of fertile top soil pose a major threat to world food production, and indirectly to the health of communities exposed to chemical additives introduced to the land over extended periods of time. In addition, due to increasing demands of p(lation expansion, large areas of marginal but useable agricultural lanJ are being increasingly lost to non-agricultural use, such as urbanization, mining and industrial development.

There are direct influences of technological development on population. Medical technology has improved health conditions leading to reductions in mortality rates particularly in the area of communicable diseases and resulting in increases in overall life expectancy. The availability of birth control devices, which could potentially contribute to reductions in fertility rates, has however, not had the impact expected in most developing countries. Although the number of children born in a society is determined by the actions of individuals, the concern with the population characteristics of a country, as has already been pointed out, are often included in ideological statements concerning the importance of population in national development plans. Here we see the issue of social or political organization as influencing population.

Food production on small farms is more efficient than on large holdings according to a study by the World Bank. Yet in most developing countries due to ineffective land reforms and inheritance the land is often split into extremely small units which are then purchased by large landholders who receive governmental credit at subsidized rates. Where food production is changed from labor intensive agriculture to capital intensive technological agriculture with emphasis on high yielding crops that demand good soil and water conditions and a high level of use of fertilizers and pesticides, the displacement of population and jobs out of rural areas tends to create problems for urban areas where fertility is already contributing to high urban growth rates.

There is also some merit to the view that it is not the production process itself which has led to the dramatic imbalance in food shortages but rather organization and distribution patterns. The World Bank has stated in a recent report that "at the global level, if income were distributed differently, present output of grain could supply every man, woman and child more than 3000 calories and 65 grams of protein per day - far more than the highest estimates of requirements. Eliminating malnutrition would require redirecting only about 2 percent of the world's grain output to the mouths that need it". The poor rural family needs food, clothing, etc., but they lack purchasing power or sufficient land to produce for themselves. The economic organization of a society - its method of resource distribution and the impact of purchasing power on economic demand - needs to be examined as a contributing factor to rural development.

Rapid population growth poses complex problems for the agricultural rural sectors of developing countries. On the one hand, food production must be increased much faster than previously. On the other hand, production increase is taking place in the context of modernization of agricultural techniques which reduces the employment potential for the rural population.

in many countries the necessary intensification of production and raising of crop yields heavily on the costly implementation of technological infrastructure including changes in irrigation and drainage methods.

Although there are obviously differences in the way nations view their population situation, it is generally felt that some form of reduction in population growth is needed in order for developing countries to cope with food shortages and socio-economic problems. In fact, according to Lester Brown,

> "The goal of national population policies has shifted in several countries during the seventies from slowing population growth to stabilizing population. Among the governments seeking zero population growth are those of India, China, Mexico and Bangladesh. India and China, the world's two most populous countries, want to halt growth by the year 2000" (Brown, 1976:28).

At an Asian Conference of Parliamentarians on Population and Development (October, 1981) a final declaration called for a 1-percent annual population growth for Asia by the year 2000. It is encouraging to note that this conference, which was the first UN-sponsored conference to take place in China, called for the reduction of population growth in a number of ways, the inclusion of population policies in national development plans and specifically giving women more of a voice in development processes. It should be pointed out, however, that in 1970 many countries in Asia had high total fertility rates of 6 children or more. In order to achieve a 1-percent growth rate by the year 2000 the total fertility rate needs to be reduced to about 3 children. Assuming this decline from 6 to 3 children occurred linearly between 1970 and 2000, the population of this region would still almost double in size, from 762 million to about 1400 million. Improvements in life expectancy would lead to an even larger population size.

The examples to follow illustrate the demographic consequences of fertility reduction to a situation referred to as replacement level fertility. A society which reduces its fertility to replacement level will eventually achieve a situation of zero growth, where births and deaths in the society are equalized. Obviously, the range of possible fertility situations in developing countries are infinite and attempts to project population characteristics into the future are complex. Nevertheless, use of the replacement level option as a strategy will enable us to make sense of the widely differing demographic conditions in developing countries.

In order to illustrate what happens to population growth when a reduction in fertility occurs to replacement level we look at data for France and Mexico. These two countries are chosen because of both their similarities and their differences. France was one of the first countries to go through the demographic transaction from high birth and death rates to low birth and death rates (Bourgeois-Pichat, 1974). It is highly developed industrialized nation with a well-developed system of social and economic services. While no country can be taken as typical of developing countries Mexico exhibits many of the demographic characteristics and problems faced by countries of the Third World, although by some criteria Mexico may be classified as industrial. Officially until 1972, Mexico had always believed that more is better. "So long as the rate of economic development could be kept ahead of the population growth rate, the quality of life would somehow improve" (Nagle, 1978:3). But concern was being expressed: "The adoption of a demographic policy is urgent. In this, the Left has been no less guilty, with its silence, than have been the government and the church with their hypocritical complacency" (Turner, 1974:6). Since 1974, the official Mexican position has moved toward the value of family planning programs and the movement toward eventual replacement level fertility rates.

In 1970 the French and Mexican populations were almost identical in size, yet they differed remarkably in age composition, age specific fertility rates and life expectancy. Figure 1 presents the age composition as well as the basic demographic parameters of the two populations. The question we pose asks what will happen to the population growth pattern of France and Mexico should both achieve immediate replacement level fertility? Population change due to natural increase is determined by fertility and mortality. But it has been demonstrated that rates of natural increase in populations are determined not only by the underlying level and pattern of fertility and mortality but also by the prevailing age distribution whose shape can either enhance or depress crude rates of birth or death. (see Keyfitz, 1971; Frejka, 1973 and Keyfitz, 1970).

Fertility at the replacement level (a net reproduction rate of 1.00 in conjunction with specific mortality conditions) is often associated with an immediate cessation of growth. There is, however, built into an age structure, a demographic momentum which operates to allow growth to occur for some time after fertility rates reach replacement level. With the net reproduction rate (and Lotka intrinsic rate of natural increase) demographers have sought to eliminate the underlying effects of age composition, in order to measure the consequences of the continuation of given intrinsic conditions of fertility and mortality on the growth of populations. (See Espanshade: 1975, and Preston: 1970).

Figures 2 and 3 demonstrate various aspects of this process for both France and Mexico, based on the following procedures. The NRR (net reproduction rate) for both countries is assumed to be 1.00 for both countries. The simulation procedure retained the 1970 age specific fertility pattern and adjusted the level of fertility (through the Total Fertility Rate) at a rate which resulted in a NRR to 1.00. For France, this TFR was 2.11 and for Mexico, this was 2.28. Mortality conditions were retained at their 1970 levels. Based on these two assumptions, a population projection program was used to project each population forward. This essentially resulted in setting the 1970 fertility conditions at replacement level and any future population growth (in a closed society) was thus attributable to the impact of age structure.

Figure 2 demonstrates the trend in CBR and CDR's for France and Mexico over a 100 year period. We note that the gap between births and deaths narrows and approaches zero for France and Mexico about the year 2030. A partial explanation for the continuing growth can be seen in Figure 3 where the number of women aged 20-24 is projected as an example of the momentum. We note that despite the fact that the Total Fertility Rates remain constant, the number of births and the CBR continues to increase for some time. Summing over all childbearing cohorts, one can thus illustrate how the changing age structure, with constant age specific fertility rates, contributes to the growth of population.

Figure 4 demonstrates that for France, with its age composition of 1970, the percent increase is 19 percent, which indicates that if mortality and fertility were to be at replacement level there would nevertheless result, before zero growth was achieved, a transitional population growth of 19 percent. The population increase for Mexico would amount to 72 percent over the 1970 total. Should replacement level be achieved by 1985, the Mexican population would become stationary at about 116 million (135% over 1970) and the French at about 65 million (30% over 1970). The population total for replacement level achieved in the year 2000 would be about 156 million for Mexico (212% over 1970) and about 71 million for France (42% over 1970).

The data for France and Mexico have illustrated the point that achieving replacement level fertility is but the first step in the direction of a zero growth situation, or a stable and stationary population. Comparison of the French and Mexican data also showed that the eventual size of the zero state is highly dependent on the initial age structure. If we now extend the analysis of the momentum of growth to additional countries, we can obtain a measure of minimum population growth for a country and can examine the likelihood of population stability in the near future. Table 1 presents a summary tabulation of the demographic momentum for 126 countries by selected world regions. We see that 81, or two-thirds, of countries would grow by at least 50%, almost all of these being Asia, Latin America and Africa.

In order to display individual country data and still keep the analysis manageable, it was decided to deal only with the world's largest countries. The following analysis thus includes only 30 countries with 1970 population totals of 20 million or larger. Together these 30 countries represent over four-fifths of the estimated world population total in 1970. A list of the countries, their 1970 population and a number of demographic characteristics are presented in Table 2.

AGE COMPOSITION DIFFERENTIALS

Before examining momentum of growth the first important issue to deal with is the extent to which countries differ in age composition and to determine the extent to which each country's age structure differs from that of a hypothetical stationary age structure (a hypothetical country named STAT). For current purposes a stationary population based on a life expectancy at birth of 70 and a Total Fertility Rate of 2.1 (with age specific fertility rate similar to the U.S. schedule) was used.

Table 3 is an index of dissimilarity matrix where each cell in the matrix represents a measure of the dissimilarity of a particular country's age structure from that of another country.

The index of dissimilarity is a measure which is a function of a geometrical construct, the segregation curve (Duncan and Duncan, 1955:210-217). The index measures differences in the distribution of two age structures, and is computed as half of the sum of the absolute value of the differences between two percentage distributions. Thus it is noted that the index of dissimilarity between France and Mexico is 24.8. This implies that 25% of the populations of either France or Mexico would have to be redistributed amongst the age cohorts for the age compositions to be similar. We see that the France - Italy index is 3.4, reflecting a highly si structure. On the other hand, the United Kingdom - Philippines index is 28.0 reflecting a high degree of age dissimilarity of these two populations.

There are 465 indices in Table 3, and the possible number of paired comparisons for the index of dissimilarity matrix is 107,880. In order to determine the interrelationship of age distribution patterns for all countries simultaneously a technique was used which allows for analysis of the underlying structure of the matrix in graphic form. This is the Guttman-Lingoes Smallest Space Analysis (SSA-I), which is a technique for viewing the structure of a matrix of relationships between variables: correlations, indices of dissimilarity, or any other such measure. SSA-I "enables one to determine the smallest Euclidean space in which one may adequately portray graphically the interrelationships of a set of points... whose proximity is a function of the degree to which two points are found together relative to n other points" (Laumann, 1969:188).

The technique provides a metric representation of nonmentric information, based on the relative distance between a set of points. Each variable is represented by a point in a Euclidean space of two or more dimensions. The points are plotted in the smallest space possible that will preserve the rank order of the relations. When the correlation between the variables i and j is higher than between the variables k and l, then the distance d will be smaller between i and j than between k and l (Guttman, 1968; Lingoes, 1972). The smallest space analysis space diagram thus represents the index of dissimilarity matrix data in graphic form, where the closer together countries are on the diagram, the greater the similarity in their age distribution relative to all the other paired comparison. The space diagram is a graphic representation of the index of dissimilarity matrix for the 30 countries plus STAT.

It was also possible to prepare an index of dissimilarity matrix for differentials based on the STABLE population age structures of the 30 countries. This was done by using the projection program with the 1970 demographic parameters to simulate a STABLE population. Table 4, Column 2, presents the index of dissimilarity of each country's simulated STABLE age structure with STAT, the STATIONARY population. We see that the majority of the 1970 age structures (24 of the 30) are within 5% of their STABLE age structure. The exceptions are USA (8%), USSR (9%), Canada (11%), Yugoslavia (10%), Poland (11%), and Japan (13%). This suggests that quasi-stable population theory is highly relevant for the majority of the largest countries.

The SSA space diagram suggests that of the largest countries there is a clear distinction between the age structures of the developed world and the developing world, with China (the world's largest population and a country of considerable mystery) separating the two groups of countries. The index of dissimilarity of all countries to the left of China in the space diagram differ between 5% (United Kingdom) and 15% (Canada) from the STATIONARY structure. To the right of China, the range is between 25% (South Africa) and 32% (Philippines) from the STATIONARY structure. Now if we superimpose the population growth attributable to the age structure (See Table 4, Column 3) onto the space diagram, we see that for the developed country group the percent population increase over 1970 ranges between 14% (United Kingdom) and 42% (Canada). The range for the developing countries is between 44% (South Africa) and 72% (Mexico). The aggregate percent growth attributable to age structure for the 30 countries combined is estimated at 45%, that for the 12 developed countries is 27%

and for the 17 developing countries (excluding China) the increase is 59%. It is apparent that the more dissimilar a country's age composition is to the stationary structure, the greater the eventual increase in population. For example, the zero order correlation coefficient between the index of dissimilarity with STAT (Table 4, Column 1) and the percent increase due to the age structure (Table 4, Column 3) is .96 with an r^2 of .92.

The data on population growth attributable to age structure demonstrate the power of population momentum and the degree to which most developing countries are already virtually assured of major population increases, whatever happens to fertility levels. For comparative purposes, data are presented for the eventual increase in population should replacement level be achieved in 1985 (Table 4, Column 4, and in the year 2000 (Table 4, Column 5). This combines growth due to age structure and fertility, and the reduction is linear between 1970 and 1985 or 2000. We note that for 5 countries (USA, USSR, Japan, Italy and Poland) the year in which a stationary level is achieved makes very little difference to the eventual percentage increase in population. On the other hand, for some countries, notably Columbia, Mexico, Philippines, Thailand and Iran, delays of 15 or 30 years in reaching replacement level make substantial differences in the eventual estimated populations.

The above analysis has pointed out that there is a considerable variation in the shape of the age structure of the world's largest countries. We have also demonstrated that even with immediate reduction of fertility to replacement level, there is the prospect of considerable growth. Table 4 has, in addition, shown the estimated increase if replacement level is delayed for 15 or 30 years. The next section of this paper looks at some aspects of the demographic changes which would occur as a result of immediate replacement level fertility.

Once again, for convenience, we look at two countries, France and Mexico, the first being representative of demographic conditions in developed countries and the second representative of conditions in developing countries. One of the major issues in discussion of the impact of declining fertility on social structure is the changing proportion of the population in three major age categories: children under 15, the population aged 15 to 64 and the population 65 years and older. First, what happens to the absolute size of these three groups and to their relative proportions should replacement fertility be achieved immediately (the initial 1970 point)? A number of points can be made from the data in Table 5 as illustrated in Figure 5.

CHILDREN

In 1970, almost one-half of the Mexican population was under age 15 while the similar proportion in France was one-quarter. As we see from Figure 5, rapid fertility reduction in high fertility developing countries would result in immediate declines in the proportion of children, but after the initial decline and a slight cyclical increase the proportion of children under 15 would level off at between 20% and 25% of the population.

A statement by an official of Mexico's National Population Council stated that in 1975 Mexico was building one school room every 50 minutes, but also that in 50 minutes about 240 children were born in the country. It seems clear that the alternative to reductions in fertility is a massive investment in both fixed and operating costs for education. Educational services along with health services in rural communities could only benefit from the reduction in pressure created by an ever expanding child population, independent of any technological improvements in economic development and food production.

The immediate short term effects of drastic reductions in fertility for high fertility countries are seen as reduction in both the absolute number and proportion of children, accompanied in the long run by a leveling off, first of the absolute numbers and, later, of the proportion of the population, this proportion being in the 20 to 25 percent range. For countries with relatively low fertility over the past few decades (such as France) we see from Figure 5 that replacement level fertility leads to very little change in absolute numbers and slightly reduces the proportion of children in the population.

THE POTENTIAL LABOR FORCE (15-64)

We see from Table 5 (illustrated in Figure 5) that immediate fertility reductions in high fertility countries are accompanied by two demographic consequences. First, the population ages 15-64 continues to increase, both absolutely and as a proportion of the total population. Thus, not only is there a possibility for more women to enter the labor force (as fertility declines) but as we see, the actual labor force continues to grow. In Mexico (and most other developing countries with high fertility), the precent of population in the 15-64 age group could increase by up to 20% before leveling off at about 65% of the total population. Second, a decline in the dependency ratio accompanies the age shifts, with obvious consequences for economic activity and capital expenditure. An examination of what happens to the French population aged 15-64 shows that little change would occur in the proportion, despite a small absolute increase in the size of the 15-64 group.

In the latter years of the 1970's the Mexican population was increasing by approximately 2 million people a year, part of the increase attributable to decreases in mortality and improved health conditions. One of the problematic consequences of this growth can be found in the need to find (or create) employment for an additional 800,000 people each year. The potential labor force for the next 60 years are already born and even with dramatic declines in fertility, as is demonstrated in Figure 5, the labor pool will continue to increase. In rural communities these large increases are likely to occur in the context of technological change in agricultural production toward increased mechanization and attempts to improve the employment opportunities of women of working age. Decision makers need to be aware of these demographic conditions in order to successfully integrate any overall development plan. The image of new farm machinery moving up and down green fields surrounded by hundreds of unemployed laborers is one which must be considered very carefully as a strategy for development, and must obviously be of concern to planners.

THE ELDERLY POPULATION

The third condition which is of major concern in examining the demographic changes due to reduction in fertility is the increasing proportion of a population in the older age groups. The data in Table 5 (and Figure 5) point to an increasing proportion of the population of Mexico in the 65+ age category. This is the oft-spoken about aging process of a country attributable mainly to reductions in fertility rather than changes in health condition and mortality rates.

CONCLUSION

Figure 5 is not intended to be a new contribution to demographers' knowledge, but rather to illustrate the path of changing age structures for both developing and developed countries. Moreover, it indicates the character of the age distribution of a stagnant population, which for current high fertility countries manifests a dramatic shift.

The above analysis has pointed to some demographic consequences of fertility decline. Despite the rather poor record which demographers have had in predicting future population growth, they are able to make fairly accurate estimates of the character of a stationary (or stagnant) population. Even where mortality rates vary considerably, the age structures of countries are highly predictable. The data presented in this paper has focused on the momentum of growth with immediate reduction in fertility. As we observed in Figure 3, this can cause sharp short-term changes in the growth or decline of specific age groups. In reality, however, most of the larger countries are not likely to undergo such a dramatic short-run change in fertility reduction. This suggests that specific age groups are likely to undergo less traumatic variations from year to year as they move toward a stationary population situation. On the other hand, the population growth for developing countries is also likely to be in excess of the data presented in this paper.

What are the socio-economic consequences of demographic change? As this paper has pointed out, very few countries are currently experiencing a zero growth situation, and of those that have, preliminary indications are that there is no consistent response to the demographic reality. For the majority of the world's largest countries, the issue of a stagnant population is, due to demographic inertia, some generations away.

With regard to the stagnation thesis of zero growth, it is difficult as yet to evaluate the impact for these is very little evidence available. Ryder, in an article on zero population growth, suggests that "demographic characteristics are probably of relatively small importance as determinants of the development of capital equipment, employment levels, and the pace of social change, and therefore of the economic efficiency of a society" (Ryder, 1973: 53). The overall impression given in the Ryder article and in other articles (Ryder, 1972) included in a volume on "The No Growth Society" is that once we understand the operation of the momentum of growth and the projective changes in sub-populations within a society, the solutions to demographic consequences that seem plausible, effective and acceptable are non-demographic in character. The demographer may point out that a stationary population involves an aging work force. The economic institutions, however, have many options available to deal with this situation. Another example: It has been suggested that the recent rising crime rate in the U.S. is attributable to the increasing proportion of teenagers in the Baby Boom generation. It is also suggested that crime rates will decline in the future. The question to ask is whether similar problems are likely to occur with increased proportion of teenagers attributable to declining fertility in a high fertility country (momentum rather than boom).

Responses to demographic change as well as responses to a zero growth society would appear to rest not on the demographic characteristics themselves but on the social structural environment. Any attempt to evaluate a stationary population as leading to a loss of social dynamics or contributing to a sense of "dullness", or attempts to examine the relationship of zero population growth to zero economic growth, currently tend to be based on speculation, political philosophy or personal preference. Few convincing statements on social and economic problems directly related to the demographic conditions of a stationary population seem to be currently available.

In conclusion, I would like to suggest that in the foreseeable future it seems more expedient for population policy to focus primarily on the question of population reduction while at the same time taking a secondary interest in the eventual end result - a slow growth or no growth population. The specific issue raised in this paper is the need to understand the dynamics of population and to focus on the demographic conditions of a community as an integral and important component of national development planning. A final remark comes from a recent statement on Mexican population policy.

> "No component of development policy is more laden with human implications than demographic policy. It is here that we see most clearly that the aim of policy is man himself, and that there is nothing closer to man than the phenomenon that, viewed in its social dimensions, we call population" (de la Madrid, 1982).

REFERENCES

Bourgeois-Pichat (1974), "France" (in) B. Berelson (editor), Population Policy in Developed Countries, McGraw-Hill, New York.

Brown. L. (1976), "World Population Trends: Signs of Hope, Signs of Stress," Worldwatch Paper 8, Worldwatch Institute.

de la Madrid, M. (1982), "On Population Policy in Mexico," Population and Development Review, Vol. 8, #2, pp. 436-438.

Duncan, O. D. and B. Duncan (1955), "Occupational Stratification and Residential Distribution," American Sociological Review, Vol. 20, pp. 210-217.

Duncan, Otis D. (1959), "Human Ecology and Population Studies" (in) Hauser and O. D. Duncan (editors) The Study of Population, The University of Chicago Press: Chicago.

Espanshade, T. (1975), "The Stable Decomposition of the Rate of Natural Increase," Theoretical Population Biology, Vol. 8, pp. 97-115.

Environment Fund (1976), Special Report: Questioning the Source, May.

Frejka, T. (1973), The Future of Population Growth, Wiley-Interscience.

Guttman, L. (1968), "A General Nonmetric Technique for Finding the Smallest Space for a Configuration of Points," Psychometrika, Vol. 33, pp. 469-506.

Handler, Philip (1975), Statement in Bioscience, July, pp. 425.

Keyfitz, N. (1970), "Changes of Birth and Death Rates and Their Demographic Effects," in R. Revelle, Rapid Population Growth.

Keyfitz, N. (1971), On the Momentum of Population Growth, Demography, Vol. 8, #1.

Laumann, E. O. (1969), "The Social Structure of Religious and Ethnoreligious Groups in a Metropolitan Community," American Sociological Review, Vol. 34, pp. 182-197.

Lingoes, J. C. (1972), "A General Survey of the Guttman-Lingoes Nonmetric Program Series," (in) Multidimensional Scaling: Theory and Application in the Behavioral Sciences, R. N. Shepherd, et al (editors), Vol. 1, New York, Academic Press.

McNamara, Robert (1980), Statement in Population and Development Review, Vol. 6, #3, September, page 516.

Malthus, Thomas R. (1959), Population: The First Essay (Paperback edition) Ann Arbor: University of Michigan Press.

Nagel, J. (1978), "Mexico's Population Policy Turnaround," Population Reference Bureau, Vol. 33, #5, Washington, DC.

People, "Demography Growth Past the Peak," Vol. 3, #2, page 34.

Population Reference Bureau (1976), World Population Growth and Response, Washington, DC.

Population Reports (1976), World Fertility, 1976: An Analysis of Data Sources and Trends, Series J, #12, George Washington University.

Presidential Commission on World Hunger (1979), Washington, DC.

Preston, S. (1970),"Empirical Analysis of the Contribution of Age Composition to Population Growth," Demography, Vol. 7, #4.

Ryder, N. (1972), "Two Cheers for ZPG," (in) Daedalus, Fall, Vol. 102, #4.

Ryder, N. (1973), "The Future Growth of the American Population," (in) C. F. Westoff et al, Toward the End of Growth, Prentice-Hall.

Stamper, B. (1973), Population Policy in Development Planning, Reports on Population, #13, The Population Council, New York.

Turner, F. C. (1974), Responsible Parenthood: The Politics of Mexico's New Population Policies. American Enterprise Institute for Public Policy Research, Washington, DC.

World Bank Report (1981), Statement quoted in Intercom, Vol. 9, #5, Population Reference Bureau, Washington, DC, pages 1 and 6.

TABLE 1

Demographic Growth for 126 Countries

Percent increase for a country based on the assumption that Replacement Level fertility is achieved in 1970, by Region

Region	less than 19	20-29	30-39	40-49	50-59	60-69	70-79	Total %	Total N
Europe and N. America	31	31	18	14	7	0	0	100*	22
Asia	0	3	6	24	36	21	9	100	35
Latin America	0	7	0	7	26	44	15	100	29
Africa	0	0	5	23	45	28	0	100	40
Total (%)	5.5	7.9	6.3	18.4	31.7	24.7	5.5	100	
Total (N)	7	10	8	23	40	31	7		126

* May not sum to 100 due to rounding.

TABLE 2

Thirty Countries with 1970 Populations of 20 Million or Greater

	1970 Population Data					
	Population (in millions)	TFR	LE	CBR	CDR	NRR
U.S.A.	205	2.30	70.8	17.6	10.0	1.09
USSR	243	2.43	70.1	17.9	8.5	1.14
Canada	21	2.34	72.1	17.9	7.7	1.12
France	50	2.83	71.3	20.1	10.6	1.34
Italy	54	2.41	70.9	16.4	10.8	1.14
Spain	34	2.82	70.9	19.5	8.5	1.29
Yugoslavia	20	2.35	67.0	18.6	9.5	1.07
Poland	33	2.20	70.4	17.5	8.6	1.03
Romania	20	2.88	68.6	21.4	9.9	1.33
United Kingdom	56	2.72	71.1	18.3	11.0	1.28
Brazil	93	5.23	62.7	37.3	8.6	2.27
Colombia	21	6.60	59.8	45.4	9.7	2.76
Mexico	50	6.11	63.5	42.6	7.7	2.68
Argentina	24	2.88	67.7	21.7	9.6	1.32
Burma	28	6.19	42.2	43.7	21.7	1.92
Indonesia	121	6.46	46.5	46.9	18.2	2.18
Philippines	37	6.74	57.9	44.8	10.5	2.75
Thailand	36	6.56	60.5	42.5	9.3	2.77
Bangladesh	74	6.73	45.9	48.9	19.1	2.24
India	537	5.30	50.3	40.9	14.6	1.92
Pakistan	59	7.33	49.8	47.5	16.6	2.63
Turkey	35	5.91	56.2	40.9	12.7	2.35
China	772	3.99	60.5	29.6	10.9	1.68
Japan	104	2.13	70.3	19.0	7.4	1.00
South Korea	32	4.76	59.1	32.2	9.8	1.98
Ethiopia	25	6.11	40.0	45.4	23.7	1.76
Nigeria	55	6.62	39.8	50.8	23.9	1.90
Egypt	33	6.12	43.7	44.2	15.0	2.26
South Africa	22	5.95	51.9	41.3	15.3	2.16
Iran	29	6.88	51.6	46.8	15.3	2.55

Data: Compiled by the Population Dynamics Group, University of Illinois, based on data from the US Census Bureau and U.N. publications.

TABLE 3

Index of Dissimilarity Matrix for the Age Composition of 30 Countries and a Stationary Population (STAT)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1. USSR	-																														
2. Canada	8	-																													
3. USA	7	4	-																												
4. France	9	9	8	-																											
5. Italy	9	10	8	3	-																										
6. Spain	7	6	5	5	5	-																									
7. Yugoslavia	5	7	7	9	8	5	-																								
8. Poland	5	7	6	7	7	6	5	-																							
9. Romania	6	9	9	7	7	5	5	6	-																						
10. United Kingdom	12	11	8	4	4	7	11	10	10	-																					
11. Egypt	19	13	17	22	23	19	17	17	20	24	-																				
12. South Africa	16	11	14	19	20	16	14	15	17	21	3	-																			
13. Turkey	16	11	15	19	20	17	15	15	18	21	4	4	-																		
14. China	10	6	10	14	15	11	10	10	13	16	8	6	7	-																	
15. Japan	8	9	11	10	10	8	6	9	8	12	20	17	19	12	-																
16. South Korea	18	13	16	21	22	19	17	17	20	23	3	4	4	8	20	-															
17. Burma	17	11	15	20	21	17	15	15	18	22	3	1	4	7	18	4	-														
18. Indonesia	21	15	19	26	25	21	19	19	23	26	2	5	5	10	22	4	4	-													
19. Philippines	23	17	21	26	27	23	21	22	25	28	5	7	7	13	24	6	7	2	-												
20. Thailand	20	16	19	24	25	21	19	19	22	25	3	6	5	11	23	4	5	2	3	-											
21. Bangladesh	21	15	19	24	25	21	19	20	23	26	3	6	5	11	23	4	5	2	2	2	-										
22. India	22	16	20	25	26	22	20	20	23	27	3	6	6	11	22	5	5	2	3	2	2	-									
23. Iran	21	15	19	24	26	22	20	20	23	26	4	7	6	11	23	5	6	3	3	2	2	3	-								
24. Pakistan	20	14	18	23	24	20	18	19	22	25	3	5	4	10	22	4	4	2	3	2	1	3	2	-							
25. Brazil	18	12	16	21	22	18	17	16	20	23	2	3	4	7	19	3	2	3	6	4	4	4	5	4	-						
26. Columbia	22	16	20	25	26	22	21	21	24	27	4	7	6	12	24	4	6	3	3	2	2	3	2	3	5	-					
27. Mexico	22	16	20	25	26	22	20	20	24	27	4	7	6	12	24	4	6	3	2	2	2	2	2	2	5	2	-				
28. Argentina	6	4	5	7	7	3	4	6	6	9	16	13	14	8	7	16	14	18	21	19	19	19	20	18	15	20	20	-			
29. Ethiopia	17	12	16	21	22	18	16	16	19	23	2	2	5	7	18	4	1	4	6	5	4	4	5	4	3	6	5	15	-		
30. Nigeria	21	16	20	25	26	22	20	20	23	27	3	6	6	11	22	5	5	1	2	3	2	1	4	3	4	3	3	19	4	-	
31. STAT	14	15	12	7	6	9	14	12	11	5	28	25	26	20	14	27	26	30	32	30	30	30	31	29	27	31	30	12	26	30	-

TABLE 4

Index of Dissimilarity and Percent Growth to Stationary Population, for 30 Countries

	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5
	Index of Dissimilarity		Percent Growth to Stationary with NRR=1 in:		
	1970/STAT	STABLE/STAT	1970	1985	2000
U.S.A.	11.6	3.7	32	34	38
USSR	13.9	4.6	29	28	33
Canada	14.8	3.5	42	48	52
France	7.2	9.9	19	30	42
Italy	6.3	4.3	15	17	22
Spain	9.4	7.0	26	38	47
Yugoslavia	13.7	3.7	30	35	40
Poland	12.4	1.1	33	27	27
Romania	10.8	10.9	23	40	55
United Kingdom	5.2	8.8	14	20	29
Brazil	26.6	27.1	58	95	146
Colombia	31.1	33.3	67	138	224
Mexico	30.8	32.0	72	132	212
Argentina	11.8	10.6	29	46	54
Burma	25.6	28.1	46	57	89
Indonesia	29.8	31.1	55	105	157
Philippines	32.1	32.6	63	127	203
Thailand	29.6	32.6	58	117	189
Bangladesh	30.0	33.1	61	99	155
India	30.5	27.6	63	101	145
Pakistan	28.8	33.2	47	95	156
Turkey	25.5	30.2	52	94	149
China	19.7	19.6	41	65	90
Japan	14.2	1.0	28	25	26
South Korea	27.2	23.5	53	81	119
Ethiopia	26.4	27.8	45	76	108
Nigeria	30.3	31.0	60	95	138
Egypt	27.5	30.7	54	94	148
South Africa	24.7	26.6	44	73	114
Iran	30.6	33.3	59	114	186

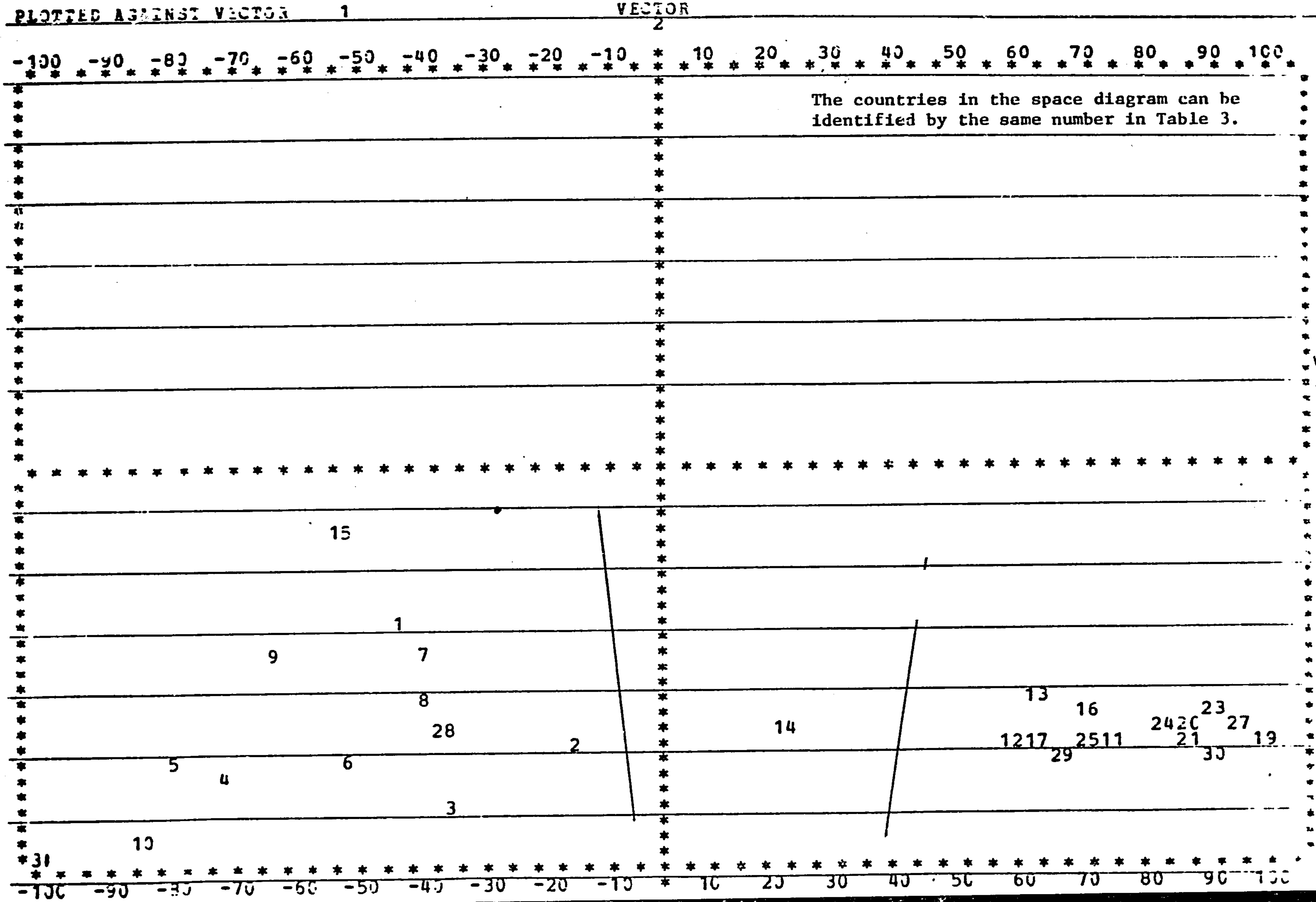
TABLE 5

Percentage Age Distribution: Mexico and France from 1970 to 2070; based on assumption that Replacement Level fertility is achieved in 1970

	MEXICO			FRANCE		
	Percent Age Distribution			Percent Age Distribution		
Year	Up to 14	15-64	65+	Up to 14	15-64	65+
1970	46.3	50.8	2.9	24.6	63.3	12.0
1975	39.0	57.7	3.4	24.1	62.9	13.0
1980	31.8	64.5	3.7	23.0	64.0	13.0
1985	24.6	71.5	3.9	21.7	66.5	11.7
1990	26.9	68.8	4.4	22.1	65.7	12.2
1995	27.9	67.3	4.8	22.1	65.3	12.6
2000	27.2	67.5	5.3	21.8	65.3	12.9
2005	25.2	68.9	5.9	21.3	66.0	12.7
2010	23.3	70.0	6.7	20.9	66.8	12.3
2015	22.3	70.0	7.7	20.7	65.8	13.5
2020	22.3	68.8	9.1	20.7	65.0	14.3
2025	22.3	66.8	10.9	20.7	64.9	14.4
2030	22.5	64.7	12.8	20.6	64.4	15.0
2035	22.3	62.5	15.2	20.5	63.9	15.6
2040	22.0	64.8	13.2	20.5	64.4	15.1
2045	22.0	66.2	11.8	20.5	64.6	14.9
2050	22.1	66.5	11.4	20.5	64.6	14.9
2055	22.1	65.9	11.9	20.6	64.5	14.9
2060	22.3	65.1	12.7	20.5	64.4	15.1
2065	22.2	64.8	13.0	20.5	64.4	15.1
2070	22.1	65.1	12.8	20.5	64.4	15.1

SPACE DIAGRAM

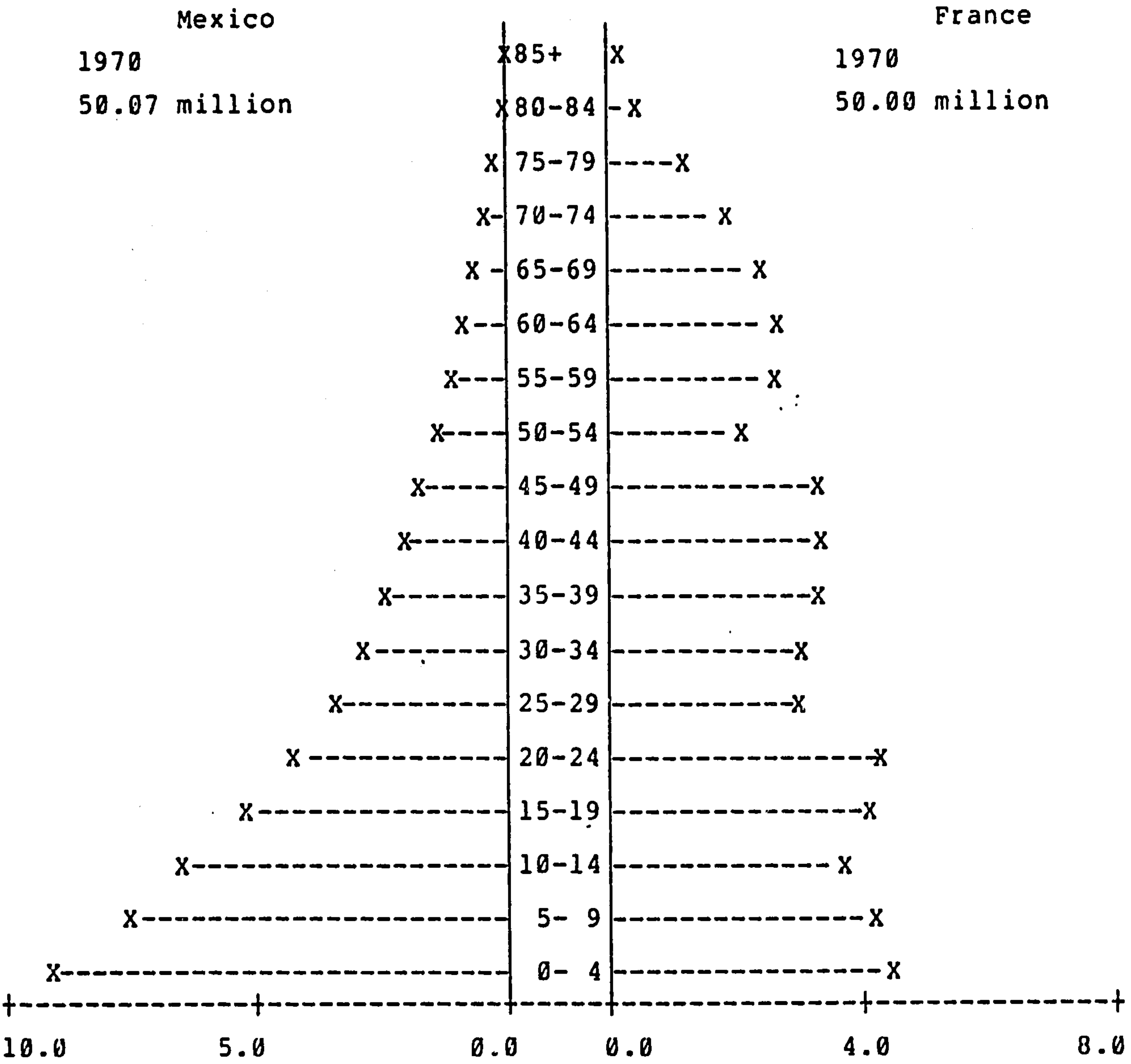
Smallest Space Solution (SSA-I) for the Age Composition Dissimilarity of 30 Countries and a Stationary Population. Based on the Index of Dissimilarity Matrix in Table 3.



283

FIGURE 1

Age Composition of France and Mexico, 1970

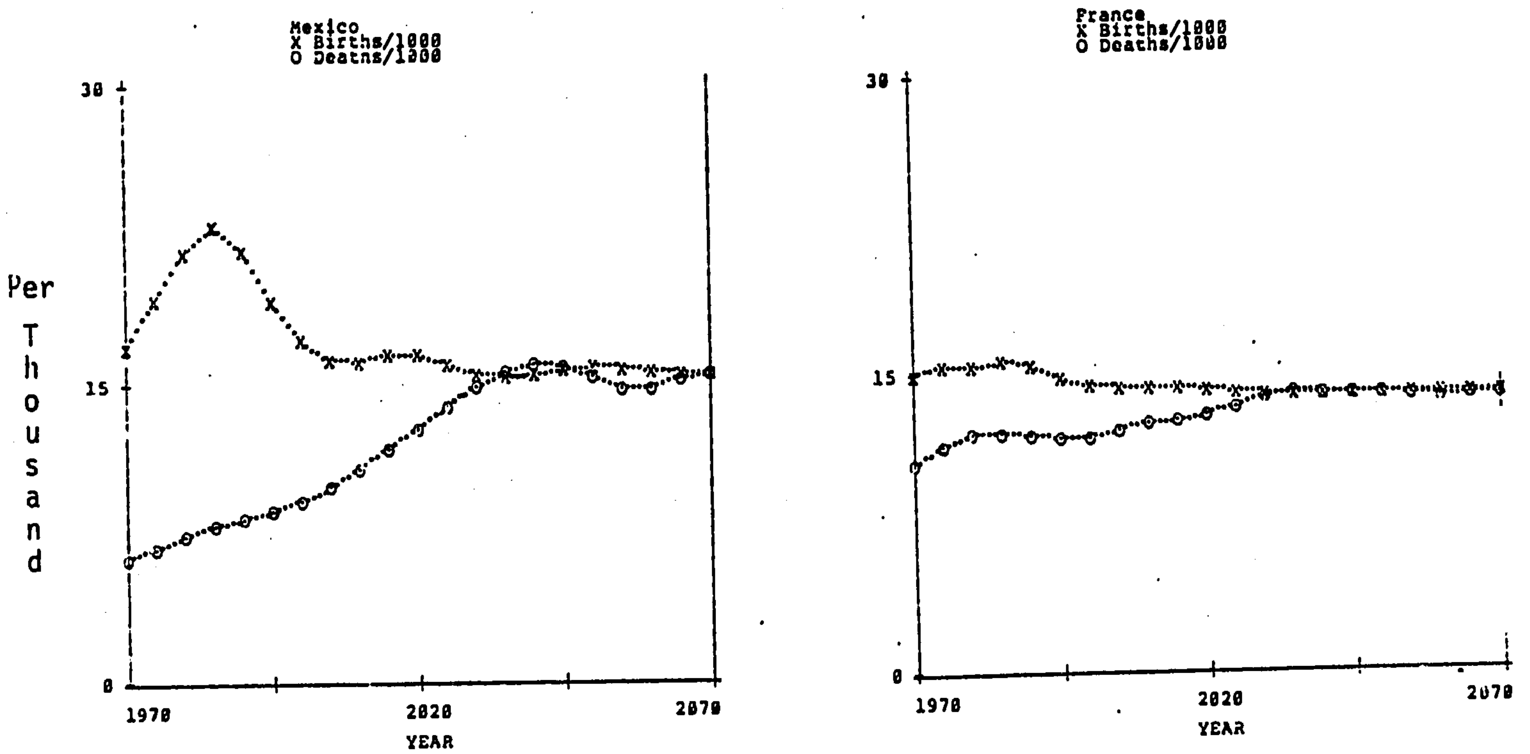


1970 Characteristics	Mexico	France
Total Fertility Rate	6.1	2.8
Crude Birth Rate	42.6	20.1
Life Expectancy at Birth	63.5	71.3
Crude Death Rate	7.7	10.6
Dependency Ratio	.97	.58

FIGURE 2

Crude Birth Rate and Crude Death Rate for Mexico and France

Projection to the year 2070 based on fertility reduction
to replacement level in 1970

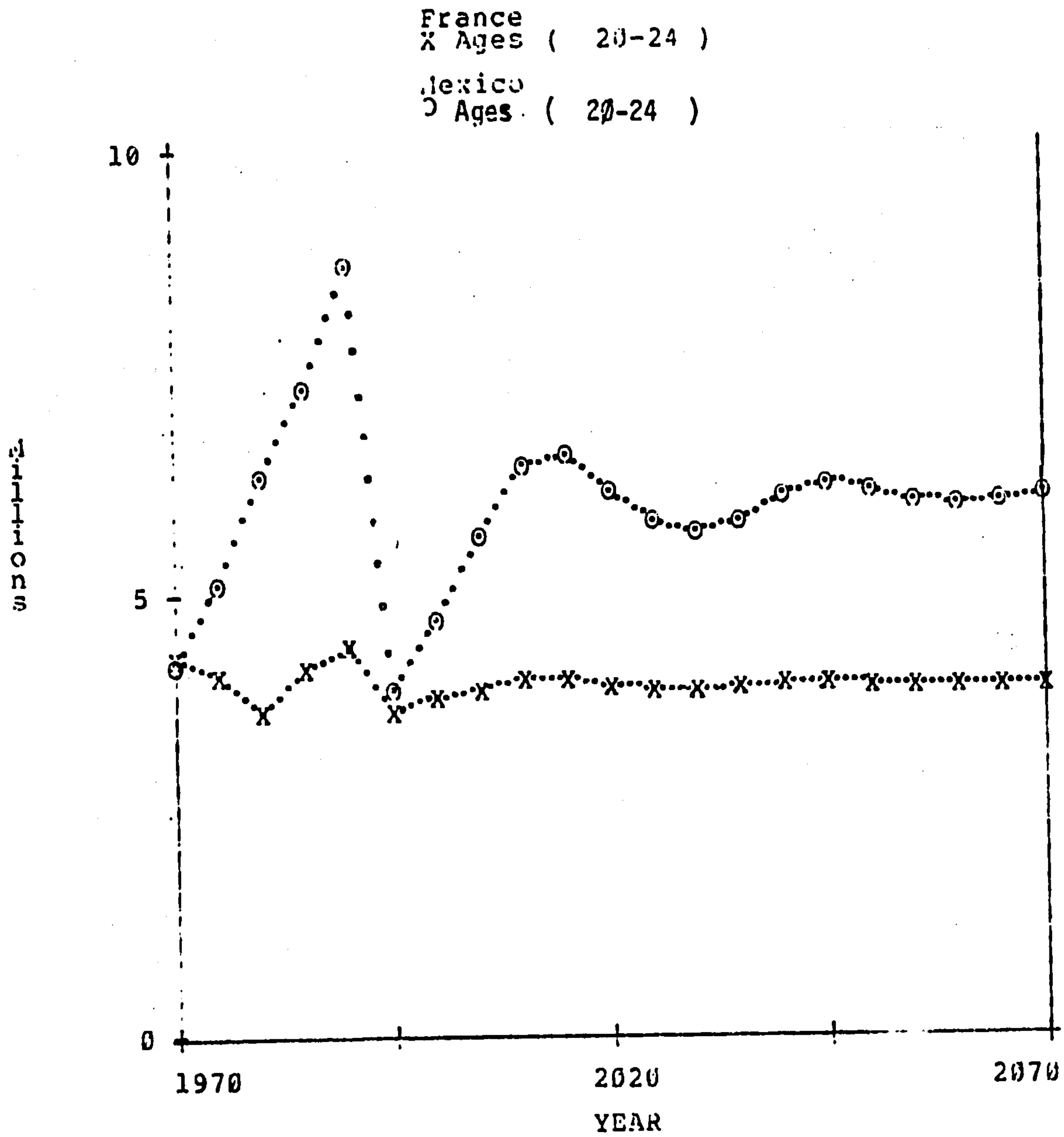


	1970	1995	2020	2045	2070
x	16.96	19.30	16.66	16.05	15.92
o	6.41	8.87	13.09	16.19	15.91

	1970	1995	2020	2045	2070
x	15.09	14.91	14.26	14.15	14.12
o	10.64	11.85	13.01	14.14	14.13

FIGURE 3

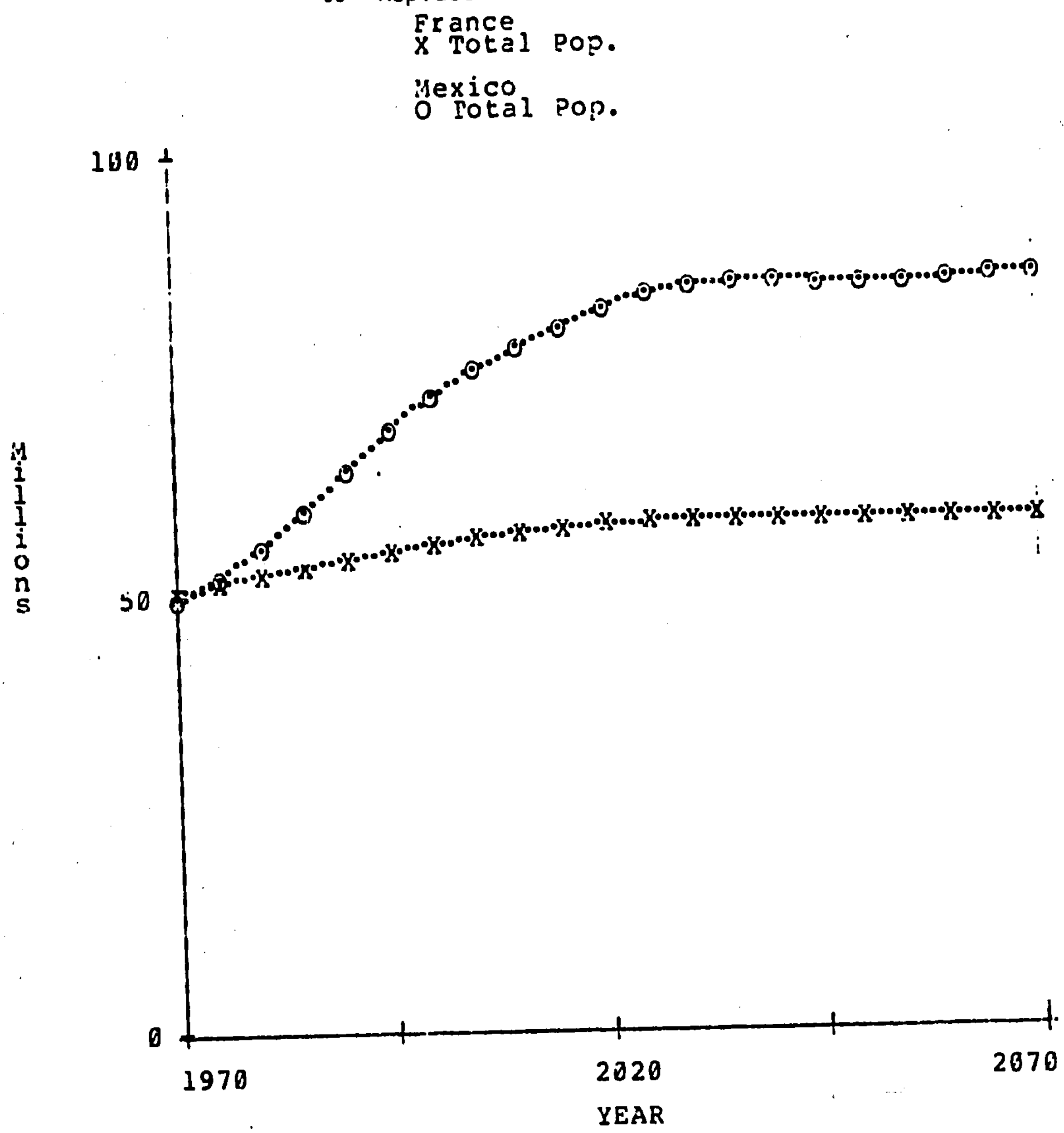
Projection of Population Aged 20-24, for France and Mexico
Projection to the year 2070 based on fertility reduction to
replacement level in 1970



	1970	1995	2020	2045	2070
X	4.34	3.72	4.03	4.05	4.04
O	4.25	3.93	6.19	6.25	6.13

FIGURE 4

Projection of Total Population for France and Mexico
Projection to the year 2070 based on fertility reduction
to Replacement level in 1970

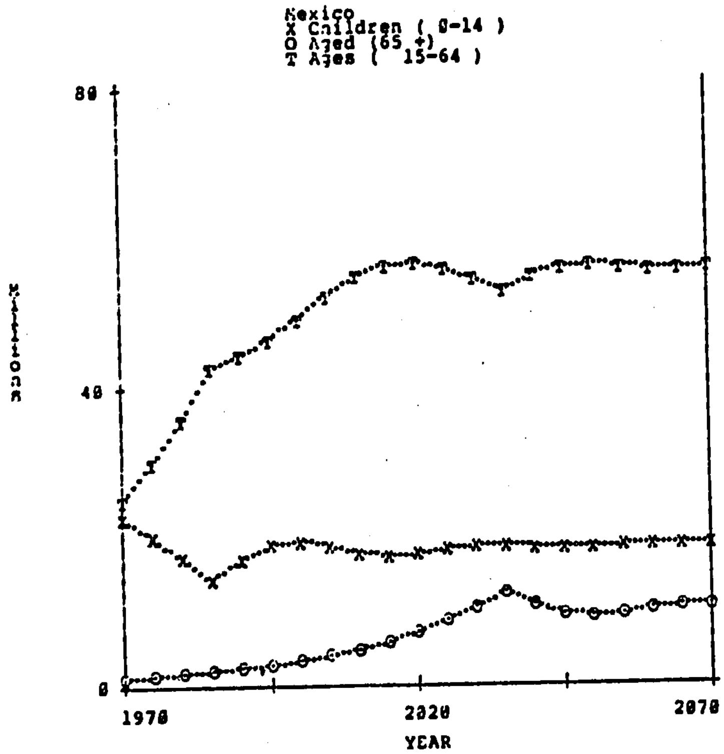


	1970	1995	2020	2045	2070
X	50.78	55.82	59.01	59.55	59.63
O	49.97	69.28	82.44	84.72	85.65

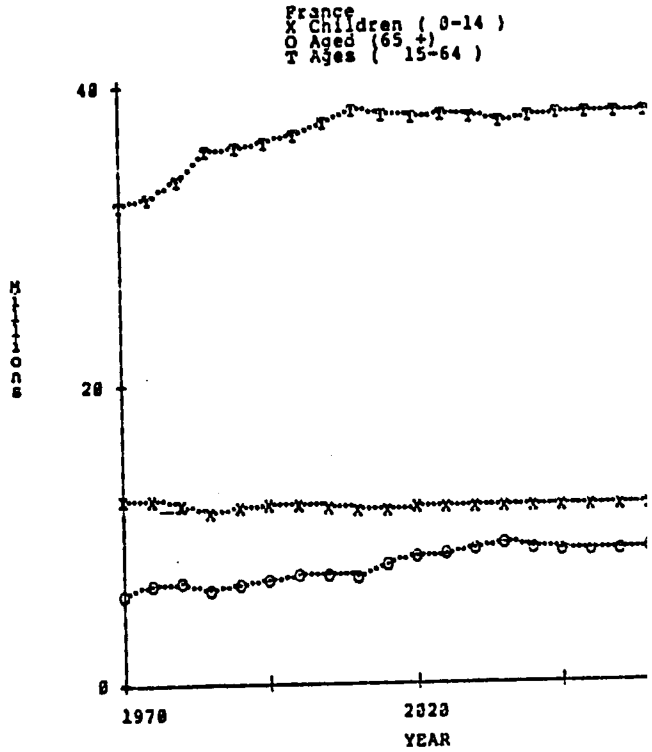
FIGURE 5

Projection of Age Groups 0-14, 15-64 and 65+ for France and Mexico

Projection to the year 2070 based on fertility reduction
to Replacement Level in 1970



	1970	1995	2020	2045	2070
X	23.12	19.34	18.21	18.68	18.95
O	1.43	3.31	7.49	10.03	10.94
T	25.42	46.62	56.74	56.89	55.76



	1970	1995	2020	2045
X	12.52	12.34	12.20	12.20
O	6.11	7.04	8.45	8.87
T	32.15	36.44	38.36	38.48

RURAL DEVELOPMENT AND LEADERSHIP PATTERNS IN SOUTH KOREA

389

ABSTRACT

Key to the success of South Korea's government-induced, top-down, rural development program has been the elective village leader whose training for self-sacrifice and authoritarian leadership established the momentum for development. Findings from this research, however, after more than ten years of the program, suggest that the government's very success in inducing self-help among villagers now calls for new training to produce democratic village leaders and for change to a grass-roots, bottom-up, participatory rural development program.

RURAL DEVELOPMENT AND LEADERSHIP PATTERNS IN SOUTH KOREA*

Byong Man Ahn
Hankuk University of Foreign Studies

and

William W. Boyer
University of Delaware

INTRODUCTION

The Korean peninsula is the one place in the world where the interests of the four major powers -- the United States, the Soviet Union, China and Japan -- directly converge and intersect. Ruled by one of history's longest dynasties, the Yi dynasty, for over 500 years (1392-1910), the cultural continuity of this homogeneous, tradition-bound, "land of the morning calm" or "hermit kingdom," was forever shattered by Japanese rule (1910-1945) and subsequent division of the peninsula into two implacably hostile countries -- communist North Korea and non-communist South Korea. The Korean War (1950-1953) only exacerbated this hostility, and the two countries have remained bitterly competitive to the present.

South Korea lagged behind North Korea and many developing countries in its nation-building process, but since the early 1960s it has become known as one of the "newly industrialized countries." Indeed, so rapid was its industrialization and urbanization, the nation's average annual economic growth rate of 9.6 percent between 1962 and 1975 ranked as one of the world's highest.

---

*The authors wish to express their appreciation for the assistance in conducting the survey of our respondents to Professors Hong Soon Hahn, Man Ki Kim, Myong Soo Kim, and Byong Wan Suh, all of Hankuk University of Foreign Studies, Seoul, Korea.

Recognizing that no comparable progress was taking place in the countryside and that a dramatic initiative was needed to introduce technological change for rural development by mobilizing the rural populace to participate in nation-building, the South Korean government in 1970 launched a rural development program popularly known as "Saemaul Undong" (New Community Movement).

The purpose of this paper is to assess rural leadership patterns in the context of this rural development program and to draw policy implications therefrom for the government of South Korea.

THE NEW COMMUNITY MOVEMENT

This new community movement was aimed at changing traditional attitudes by infusing the so-called self-help "Saemaul spirit" among rural villagers; enhancing the quality of their lives by creating a healthy, rational and productive rural environment; and effecting overall economic improvement of rural South Korea. Within five years, this movement proved one of Asia's most successful rural development programs.

Village roads, roofs, walls and sanitary systems were rebuilt. The average family income of farmers and fishermen surpassed that of urban laborers.[1] Rural Confucian, tradition-bound, attitudes were supplanted by rational, achievement-oriented, values.[2] Indeed, in one recent study, it was concluded that "the perceived attractiveness of rural traditions may be too weak to keep rural people from migrating to urban areas."[3] The new South Korean government declared in 1981 that the Saemaul movement would remain a top priority national program, whereas most other programs of the previous regime have been either abandoned or significantly modified.

What factors explain the success of this movement? First, the timing was right. Profits realized by rapid industrialization and urbanization were available to the government for rural development. Success in the industrial sector, moreover, sharpened perceptions of rural people that their participation in rural development was necessary to reduce the disparity between rural and urban economic levels. Second, the government adopted an intelligent incentive strategy to minimize error and maximize such participation.

The government launched the movement with a pilot project in 1970 by distributing free of cost 335 bags of cement to each South Korean village to build roads, retaining walls, bridges, community laundry facilities, etc.[4] In its subsequent evaluation, the government found that 16,600 villages -- about half the total -- were quite successful in making self-help improvements whereas others failed to do anything with the cement. Accordingly, in 1972, the government rewarded each successful village by giving it an additional 500 cost-free bags of cement plus one ton of reinforcing steel. Results of these efforts enabled the government in 1973 to classify villages into three categories according to their stage of development: underdeveloped (basic), developing (self-helping), and developed (self-sufficient) villages. Although each village regardless of its category was now given cement and steel, it was the government's policy to give priority assistance to those villages which had demonstrated self-helping success. Those villages with outstanding records were awarded a bonus of one million won (US $2,000 at that time) and their leaders were accorded national honors. Besides some financial assistance, all villages according to their development needs received technical assistance from the various government agencies.

This competitive village strategy of the government was so effective that by the end of the 1970s none of South Korea's 34,000 villages remained classified in the "underdeveloped" category.

RURAL LEADERSHIP

The key factor explaining success of the Saemaul movement is village leadership. Village development projects are managed jointly by the Saemaul leader, the village chief (Lee chief), and township officials. The Lee chief, appointed by the county administration, is responsible for village administration and coordination of national plan execution with the central government. The Saemaul leader, replaceable at any time by the village assembly comprised of an elective member from each household, chairs the village development committee and is responsible for exercising the initiative in development programming and implementation and for motivating villagers to become involved in self-help projects. Although the potential for conflict between the elected Saemaul leader and appointed Lee Chief is apparent,[5] their joint efforts have proven vital for village development.

In 1972, the South Korean government established the Saemaul Leaders Training Institute in Suwon to infuse the so-called Saemaul self-help spirit among village leaders in courses lasting normally one week. Similar programs were instituted by civil service training centers of government agencies. Wide popular support for the Saemaul movement was assured by including civil servants, politicians, businessmen, civic leaders, professors, students and journalists as trainees in these various programs. Frequently appearing as instructors in these sessions were village leaders who had success stories to tell. Typically, they recounted the problems obstructing development in their villages, how their persuasive efforts at first failed, how through diligence, example, and strong authoritarian or directive leadership villagers eventually were motivated to become involved in self-help activities that overcame all adversities, and finally they told of the regional and national recognition accorded them as leaders and their villages for the successes realized.[6]

By such means, a model of a village leader was formed -- one who earns the respect and trust of villagers, whose self-sacrifice and hard work is an example for all, and whose altruism and authoritarian leadership establishes the momentum for development.

RESEARCH PROBLEMS

Now that more than ten years have passed since the inception of the Saemaul movement, it is appropriate to consider whether the established model of the altruistic and authoritarian village leaders of the 1970s is functional for the 1980s. This question is raised because of findings that a number of highly motivated and altruistic village leaders were nevertheless so simple-minded and overzealous that their self-sacrifice was either non-productive or counterproductive, that some other once honored village leaders were later exposed for corruptly using their positions for private gain, and still others have been recently accused of having run political interference for the authoritarian President Park -- assassinated in 1979 -- under the guise of rural development.[7]

The necessity of altruistic and authoritarian village leaders for awakening the rural populace from the dead weight of past centuries is not questioned. It is questioned, however, whether this leadership style will continue to be effective as changes come about. Now that no South Korean village remains classified as "underdeveloped," and all villages therefore are more rational and achievement oriented, a different style of leadership may be needed. It is assumed that the continuing vitality and further development of each South Korean village will depend upon a small number of resident village leaders.[8] It is also assumed that effectiveness of the style of village leadership will depend on the attitudes of the people of a village.[9] With these assumptions in mind, the following research questions were formulated:

Question 1: What kind of images do villagers have of their village leaders? Are the Saemaul leader and Lee chief still viewed as the main problem solvers of the village?

Question 2: Are villagers, including village leaders, willing to sacrifice themselves for the village, and if so, to what extent?

Question 3: What type of village leadership do villagers prefer? Do they prefer authoritarian leadership as usually assumed in South Korea?

This survey was conducted in October, 1980, during a period of political instability in South Korea following the assassination of longtime President Park. Selected were five of the most developed and five of the least developed villages in Ichon county located about 40 miles southwest of the capital city of Seoul. Utilizing a systematic interview technique with a questionnaire of 17 questions, data were collected from 189 respondents including 21 village leaders. Although the sample is too small to be representative of rural South Korea, it nevertheless is the first study of its kind and as a pilot project is suggestive of possible solutions to rural leadership problems in South Korea.

RESEARCH FINDINGS

Before conducting the survey, it was hypothesized that villagers of the most developed villages would have more rational and democratic perceptions than those of the least developed villages, on the premise that perceptions change as development occurs. It was found, however, that perceptions of the two groups were not significantly different. Indeed, the following analys. reveals the common perceptions of the two groups concerning leadership and leadership styles as well as little difference between the perceptions of village leaders and those of village followers.

Images of Village Leaders

In order to elicit villagers' perceptions of village leaders as major actors in village development, two principal questions were asked, one concerning their roles in internal village matters and another concerning external matters. First, "When you encounter farming difficulties, from whom do you seek advice?" Of the total respondents, 61.4 percent answered they would seek advice from the Lee chief and Saemaul leader, whereas only 18 percent preferred others such as family members, while 19 percent preferred to resolve their difficulties themselves. Second, we asked: "When you encounter difficulties outside the village, from whom do you seek advice?" To this question, a surprising 76.7 percent responded they would seek advice from the village leaders instead of from others such as village elders or family members. Responses to these two questions indicate that after ten years of the Saemaul movement, the Saemaul leader and Lee chief have solidified their problem-solving leadership roles.

Other questions asked respondents what should be the appropriate ages of village leaders and how long should they serve in their positions, assuming all are competent. Although a majority (50.8 percent) answered that ages are unimportant,[10] 75.7 percent preferred a periodic turnover of village leaders.

It can be stated, then, that although village leaders are viewed as prime problem solvers for both internal and external problems confronting villagers, rather than traditional leaders such as village elders, and that the leaders' ages are unimportant, still villagers hold to a democratic notion of a periodic turnover of their village leaders.

Sacrifice versus Individualism

Central to the Saemaul movement is the spirit of self sacrifice for the sake of the village especially on the part of village leaders. Only such altruistic leadership, it was reasoned, would awaken villagers from the pull of tradition. Ten years of the Saemaul movement obviously has changed the life styles of villagers who have acquired rational oriented values. Villagers have abandoned superstitution and fatalism (more than half our respondents so indicated) and are now future oriented and task oriented (more than 90 percent expressed these attitudes). Nevertheless, the question remained whether villagers would sacrifice themselves for the village, and if so, to what extent. To determine the answer, questions were framed that dramatized village work in terms of conflicts between work for relatives, work for their immediate family, and personal work.

First, each respondent was asked whether he/she would sacrifice himself/herself for the village were he/she a village leader. Among respondents who were not leaders, 42.3 percent answered that as village leaders they must sacrifice themselves for the village, whereas 43.5 percent answered that they would serve the village without sacrificing themselves. Of 21 village leaders, 13 answered they must sacrifice themselves. Accordingly, many villagers feel that as leaders they should self-sacrifice, and this sense of self-sacrifice may be even stronger among village leaders themselves.

Second, villagers were asked: If the day your relatives plant rice is the same day when you are scheduled to work for the village, which work would you choose as more important to perform? Of the total respondents, 81.5 percent (including both village leaders and followers) chose village work while only 3.7 percent would prefer to help their relatives plant rice.

Third, they were asked: If the day you are scheduled to work for the village conflicts with work that must be done for your family, which would you choose as more important to perform? To this question only 36 percent of village followers and 6 of 21 leaders chose village work as more important than family work.

Finally, the question was asked: If you have an opportunity to earn money outside the village when you are scheduled to do village work, which would you choose as more important to perform? Only 13 percent of village followers and 5 of 21 village leaders chose village work as more important than such personal work.

From this series of questions designed to measure the extent to which villagers would sacrifice themselves for the village, aften ten years of the Saemaul movement, these conclusions can be stated: Villagers tend to be future oriented and task oriented rather than superstitious or fatalistic. Many of them still hold to the conventional idea that they should sacrifice themselves for the village, and especially should village leaders be self-sacrificing. In the practical world of conflict resolution, however, it was found that the number of those willing to put village work first at the expense of other interests decreased in the following order: work for their relatives; work for their immediate families; and their own personal business. One can tentatively conclude, therefore, that villagers are no longer so willing to put the interests of their village above their own interests, even were they to assume the role of village leaders. Both village leaders and followers tend to place their own personal and family interests above work for the village.

Leadership Styles

To discover the village leadership style preferred by our respondents, three types of leadership were distinguished: authoritarian (which prevailed throughout the 1970s), democratic, and laissez-faire. White and Lippitt defined authoritarian or autocratic leadership as "a high degree of control by the leader without much freedom by the members or participation by them in group decisions." Both democratic and laissez-faire leadership, on the other hand, imply "a low degree of control" by the leader. They further distinguished democratic from laissez-faire leadership by characterizing the democratic leader as "very active in stimulating group discussion and group decisions," whereas the laissez-faire leader plays "a passive, hands-off, role."[11]

It was assumed that at least three occasions may be identified when the preferred style of village leadership may be discerned, namely--when villagers meet together for a purpose, when a village situation required their decision, and when they must implement their collective decision. Accordingly, questions were framed to elicit their preferred leadership styles for each of these occasions.

Occasion 1: Village Meeting. For the first occasion--when all villagers meet together for some purpose--they were asked how the village leader should behave. Of our total respondents, 73 percent responded that the leader should listen to the opinions of villagers but should also express his own opinion (democratic), whereas 15.3 percent preferred the leader to listen to villagers' opinions while refraining to express his own (laissez-faire) and only 8.5 percent preferred that the leader both express his opinion but also direct and control the meeting so it will not get out of hand (authoritarian). Hence, the overwhelming majority opted for a democratic style of leadership, and even the laissez-faire type was markedly preferred over authoritarian leadership for such an occasion.

Occasion 2: Village Decision Making. For the second situation--when a village decision is required--the villagers were asked what the leader should do. Almost all the respondents--91 percent--answered that the leader should elicit the opinions of the villagers (democratic), whereas 6.3 percent responded that the leader should make the decision himself because he should be competent (authoritarian), and only 1.1 percent preferred the villagers themselves to make the decision (laissez-faire). Thus, at least nine of every ten villagers favored collective or democratic decision making whereby villagers and leaders share power and responsibility in making village decisions.

<u>Occasion 3: Village Work Implementation</u>. For the third situation--when a village decision is to be implemented--this question was asked: "When villagers are involved in village projects (e.g., building village roads, waterlines, sewage systems, etc.), what should the village leader do?" A majority--59.8 percent--responded that the leader should direct the villagers in their work (authoritarian), whereas 34.9 percent answered that the leader should listen and respond to the opinions of the villagers (democratic), and only 4.8 percent would let the villagers decide and direct the work to be done (laissez-faire). Unlike the first two situations, wherein villagers preferred a democratic style of leadership, they opted for authoritarian leadership for work implementation.

Accordingly, a fairly clear indication can be adduced that villagers prefer situational leadership styles, namely a democratic style of leadership for village meetings and decision making, but an authoritarian style once the decision has been made.

CONCLUSION

South Korea's new community movement--known locally as "Saemaul Undong"--was quite successful through the 1970s in introducing technological change of rural South Korea, in dramatically improving the rural environment, in inducing self-help and developmental attitudes of the rural people, and in increasing rural income. There is no doubt that altruistic and authoritarian village leadership accounted for much of this successful mobilization of the rural populace. After ten years of the movement, however, it appears timely to re-examine this leadership style on the assumptions that leadership will remain critical for sustaining rural development, and that the effectiveness of leadership will depend on its ability to respond to changing attitudes and expectations of villagers.

From this research, it was found that the Saemaul leader and Lee chief are still regarded by villagers as holding the most important positions for village problem-solving, and that these positions generally were filled by young and competent villagers who, nevertheless, villagers feel should be replaced periodically.

It was apparent that many of our respondents, moreso in the case of their leaders, had been indoctrinated by the government with the attitude that self-sacrifice was necessary for village development. Now that villagers have been exposed to modern rationality, however, they were found to prefer to take care of their own personal and family business before devoting themselves to village work. When we confronted them with particular conflicts, moreover, we found them to be individualistic to the extent that village work was less important to them than personal and family matters, although more important than their assistance to their relatives.

Finally, it was discovered that the overwhelming majority of respondents preferred a democratic style of leadership in the conduct of village meetings and in the making of village decisions, and that authoritarian leadership was preferred only for implementation of decisions such as for work on village projects.

Policy Implications

Regardless of the diverse stages of development of villages surveyed, the similarities of the responses among them to our questionnaire constitute a consensus that transcends their dissimilarities. Although the survey was too small to be representative of all villages in South Korea, it is contended that the findings nevertheless are suggestive of some policy implications.

First, it is suggested that the government-induced stereotype of so-called "successful cases" of altruistic and authoritarian village leadership will no longer evoke a positive response of the rural populace, and, therefore, government training programs aimed at producing that type of leadership ought to be abandoned forthwith once and for all.

Secondly, although villagers still look to the Saemaul leader and Lee chief as problem solvers and for development initiatives, they want them to behave in a democratic manner when conducting village meetings and making village decisions, preferring an authoritarian style of leadership only when implementing village projects. Continuing effective village leadership, therefore, requires new special leadership training of village position holders. The existing Saemaul leaders training institutes may be utilized for this purpose. Programs should be organized that will alter individual leader's "theories of action."[12]

Finally, the South Korean government should adjust to the changes wrought by the Saemaul movement. This movement was designed, initiated, and managed by the government. Participation in the movement was not necessarily voluntary, as the government exercised coercive authority by granting or withholding subsidies to villages on condition of their participation. This policy, of course, was one of the prime factors accounting for the success of the movement. Now that ten years have passed since the inception of the movement, however, it was found that villagers are highly achievement oriented and rational in their thinking. It appears likely that they will choose to continue to participate in development activities only when they adduce that "their benefits will outweigh the time and effort they expect to expend."[13]

It is not suggested here that it will be easy for the government of South Korea to adjust to these changed realities. From earlier research of the mid-1970s, the seeds of this challenge were foreseen when the present authors wrote that "having introduced a Korean-style democracy at the village level, the government may have embarked on an irreversible course of systemic change," and that "it is highly unlikely that any future government could reverse this new Korean-style democracy." And it was then concluded:

> It may be too early to assess the significance of initiating village democracy in a highly centralized political system, some form of which Korea heretofore always has experienced. How far can "altruism and self-sacrifice" be pushed without basic institutional change? How much can be accomplished by an ideological approach without changes in the institutional structure of rural society? Has the government unwittingly planted seeds that may grow to challenge its authority and stability? Or will village democracy actually enhance national unity and security? These are not rhetorical or abstract questions.[14]

There appears no reason to change this conclusion of yesteryear. Indeed, results of this research reenforce those remarks.

It is suggested now that the more the government intervenes in rural development decision making, the greater the risk that program implementation will fail. The government should recognize that one of the fruits of its success in inducing self-help among villagers has been their steady accumulation of influence in decision making--influence that should prove even more efficacious and productive of achievement of development goals.

The idea is proposed, therefore, of a grass-roots, bottom-up, planning and participatory rural development program.[15] The Saemaul movement should be steered toward this new direction.

NOTES

[1]William W. Boyer and Byong Man Ahn, "The New Community Movement ('Saemaul Undong') in South Korea," Journal of Korean Affairs, vol. VI, 1976, pp. 55-56.

[2]Byong Man Ahn and William W. Boyer, "Rural-to-Urban Migration in South Korea: A Cognitive-Behavioral Approach," (A paper presented at the annual meeting of the American Society for Public Administration, Honolulu, Hawaii, March 21-25, 1982), pp. 5-6, and published in Planning and Administration, 1983, No. 1 (The Hague: Netherlands), pp. 57-70.

[3]Ibid., p. 5.

[4]See: Saemaul Undong (Seoul: Korean Overseas Information Service, 1973), pp. 24-25.

[5]Boyer and Ahn, op. cit., pp. 60-61.

[6]An outstanding example can be briefly noted here. Miss Hong, a college graduate, decided to sacrifice herself by moving to a small village in Kyongsang North Province and by marrying there a poor man who had lost both legs during the Korean War and had since lost his wife leaving three children. Miss Hong totally devoted herself to this family. She also sacrificed herself for the sake of development of the village. She sold her marriage ring, organized a women's club though few women were at first willing to join, finally persuaded the village women to join, inveighed against village gambling and drunkeness evoking curses of the village men, finally persuaded the village men to give up their evil ways, turned villagers to build village roads, new roofs, fences, sanitary systems, and introduced electricity into the village, with the result that the village became wealthy. Miss Hong, of course, was given national recognition and honors, and even movies were made and shown of her self-sacrifice.

[7]Such problems were discerned during research in the late 1970s. Some Saemaul leaders were observed, while they were attending the Saemaul Leaders Training Institute in 1980, posing as sincerely devoted leaders while protesting their innocence of charges by their villagers that they were running political interference for the government.

[8]For similar assumptions, see, e.g., Abraham Zaleznik, Human Dilemmas of Leadership (New York: Harper and Row, 1966), pp. 2-3.

[9]Some authorities claim that a democratic leadership style is the most effectiv[e] style given any situation. See, e.g., Ralph K. White and R. Lippitt, Autocracy and Democracy (New York: Harper and Row, 1960), pp. 223-310. But most authorities hold to a contigent theory that the effectiveness of any particular leadership style depends on the situation in which leaders are involved. See, e.g., Fred E. Fiedler, A Theory of Leadership Effectiveness (New York: McGraw-Hill Book Co., 1967), pp. 133-151.

[10]In reality, it was found that 15 of 21 village leaders in our survey were under age 40. In another survey elsewhere in South Korea, we found that among 62 village leaders, 72 percent were under age 40. Ahn and Boyer, _op_. _cit_., p. 11.

[11]White and Lippitt, _op_. _cit_., p. 12.

[12]Argyris defines an individual's "theory of action" as follows: "When someone asked how he would behave under certain circumstances, the answer he usually gives is his espoused theory of action for that situation." Chris Argyris, _Increasing Leadership Effectiveness_ (New York: John Wiley & Sons, 1976), p. 6. He further suggests, through a series of experiments, how to alter an individual's theory of action for effective leadership. _Ibid_., pp. 41-247.

[13]Coralie Bryant and Louise White, _Managing Rural Development: Peasant Participation in Rural Development_ (West Hartford, Conn.: Kumarian Press, 1980), p. 17.

[14]Boyer and Ahn, _op_. _cit_., p. 61.

[15]Bryant and White, _op_. _cit_., pp. 13-49.

SELECTED REFERENCES

Ahn, Byong Man and William W. Boyer, "Rural-to-Urban Migration in South Korea: A Cognitive-Behavioral Approach," (A paper presented at the annual meeting of the American Society for Public Administration, Honolulu, Hawaii, March 21-25, 1982), and published in Planning and Administration, 1983, No. 1 (The Hague, Netherlands), pp. 57-70.

Argyris, Chris, Increasing Leadership Effectiveness (New York: John Wiley & Sons, 1976).

Boyer, William W. and Byong Man Ahn, "The New Community Movement ('Saemaul Undong') in South Korea," Journal of Korean Affairs, vol. VI, 1976.

Bryant, Coralie and Louise White, Managing Rural Development: Peasant Participation in Rural Development (West Hartford, Conn.: Kumarian Press, 19[illegible]0).

Fiedler, Fred E., A Theory of Leadership Effectiveness (New York: McGraw-Hill Book Co., 1967).

Saemaul Undong (Seoul: Korean Overseas Information Service, 1973).

White, Ralph K. and R. Lippitt, Autocracy and Democracy (New York: Harper and Row, 1960).

Zeleznik, Abraham, Human Dilemmas of Leadership (New York: Harper and Row, 1966).

DUALISM IN LESS DEVELOPED COUNTRIES

ABSTRACT

Most conventional theoretical analysis of development focuses on the lack of resources, such as physical capital, managerial capabilities and foreign exchange limitations. In contrast, distortions commonly found in domestic capital markets of developing countries are emphasized in this paper, identifying them as crucial barriers for the development of the agricultural sector. These distortions bring about dualistic characteristics in the agriculture of low-income economies, determining their behavior.

One of the most common characteristics of the agricultural sector in low-income economies is the fragmentation of markets. Firms and households are isolated and face different prices for labor, capital, land and produced commodities and do not have access to the same technologies. As a result, it is possible to find coexistence of a commercial and a subsistance agriculture; small and large enterprises producing similar products, using substantially different factor proportions, and widely varying degree of technological efficiency exists side by side. As a result, the capital-labor ratios between these sectors, as well as the output per hectare ratios are quite different, and will be widening in time for low-income economies.

DUALISM IN LESS DEVELOPED COUNTRIES

Dr. Luciano E. Barraza, Chief
Agricultural Development Division
Inter-American Development Bank
Washington, D.C.

INTRODUCTION

The level and growth of per capita income have always been the central focus of economies, and it is also widely recognized that the process of development implies structural transformation of the economy. Solow (1970) highlights contribution of factor inputs expansion and technical change to growth in output. Growth of factors evidently generates output expansion, but it is clear that the behavior of factor markets and alterations of its structure significantly influences the growth of factor inputs. The growth of income directly related to economic growth affects the structure of final demand, but the functioning of product market will also affect the growth process throughout the effect on consumption behavior. In short, the behavior and changes in factor and product markets are interlocked and therefore form an important component of the process of development.

The topic as sketched out above is evidently so ample that one could not possibly cover it completely. For this reason, this paper is only focused on distortion in domestic capital markets, which are among the crucial deterrents to agricultural development in many Third World countries. The hypothesis is that imperfection of capital markets tend to bring about and sustain a dualistic split in the sector: a commercial subsector made up of relatively few large farms, which tend to use capital intensive technology and have substantial control over marketing channels for production inputs as well as for products destined for sale; and the subsistence subsector, which includes a large number of small farms, which use labor-intensive technology, and have virtually little or no bargaining power in either input or product markets.

PURPOSE AND SCOPE

The twin objectives of this paper are to:

(a) Establish a plausible hypothesis explaining the existence of duality in the agricultural sector due to distortions in domestic capital markets;

(b) Stimulate to search for potential remedial actions, which would contribute "to the success... of development projects."

The analysis will consist of three sections:

(a) Definition of duality.

(b) Illustrations of extent of duality in Mexico.

(c) Hypotheses about the cases for duality.

It is expected to stimulate constructive explorations aimed at furthering conceptual understanding of the problem. Normative prescription will have to wait until some workable or plausible hypotheses were tested.

SCOPE AND CAUSES OF DUALISM

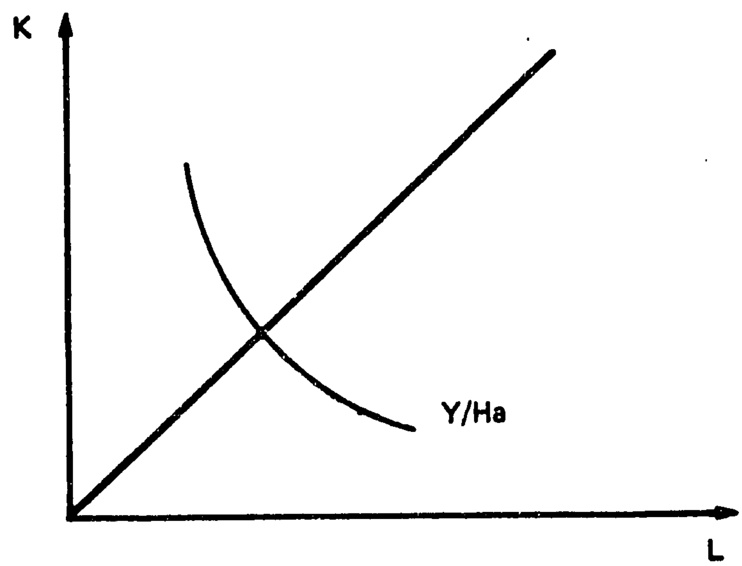
1. Dualism

The definitions of dualism used in the development literature, range all the way from vaguely stated hypotheses about sectorial differences in social, political and economic behavior, to complex formal statements implying well defined differences in determinants of economic and social behavior, as well as differences in parameters related to a given set of determinants. It is recognized that dualism stems from differences in: (1) social systems, (2) racial or ethnic background of populations, (3) demographic behavior, (4) domestic and foreign sector policies, (5) consumer expenditure and savings behavior, and (6) production conditions.

Based on hypotheses of economic behavior, the definition of subsistence and commercial farming refers to behavior of farm household either on the product or the factor markets (points 5 and 6 above). Along the line of those that emphasize demand conditions (Colin Clark, 1960): "If most of the efforts of the farmer are used to provide subsistence for him and his family, or if most of the direct consumption of the household is based on output of its own land, this type of farming is defined as subsistence agriculture. In contrast, in commercial agriculture, most of the production goes to the market." On the other hand, most models emphasize differences on technological parameters or, in production conditions as the predominant interpretation of dualism (Jorgenson, 1961). The dissertation presented follows this line.

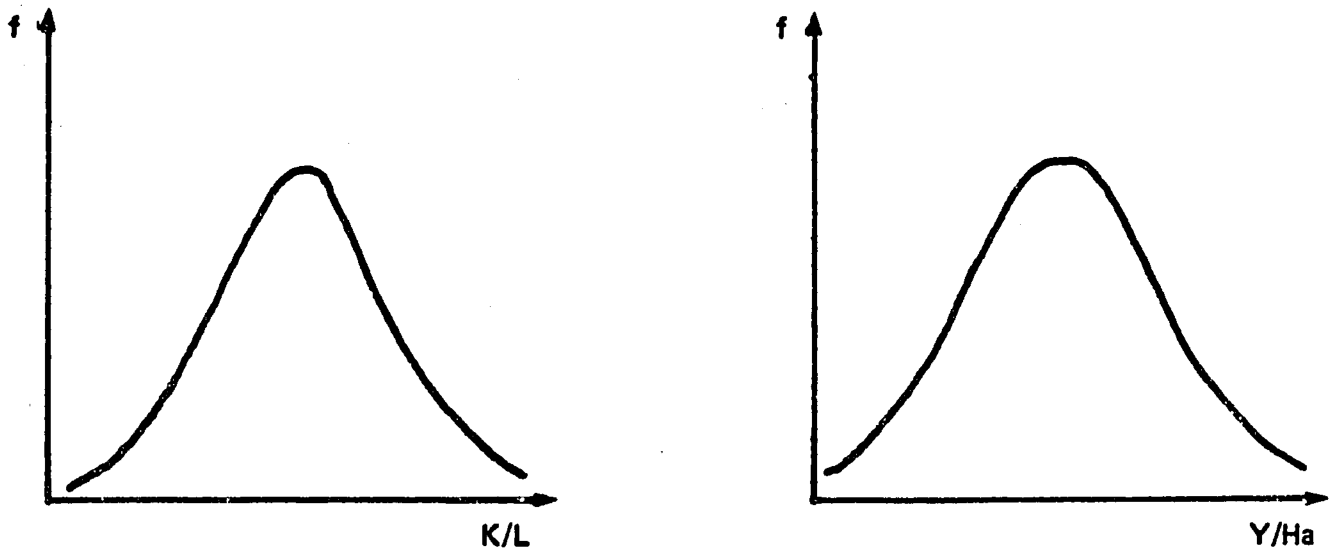
Theoretically, if there is not duality, all units of production for an homogeneous agricultural region will be concentrated around a given K/L ratio and a given output/Ha (Y/Ha) as shown in Figure 1. Thus, we expect to find a unimodal frequency distribution for capital/labor (K/L) and output (Y/Ha) ration (Figure 2).

FIGURE 1



K/L ratios for an homogeneous region.

FIGURE 2

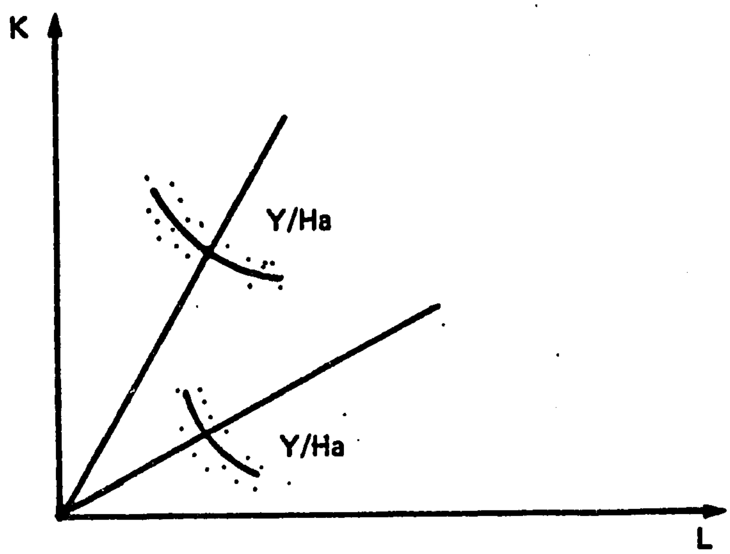


Frequency distributions for K/L and Y/Ha ratios.

The degree of dispersion of the firms around the average K/L and Y/Ha ratios could be large or small, being a function of factors such as speed of adjustment of farmers of new knowledge, degree of homogeneity of the region, etç. Essentially, therefore, a unimodal distribution for these variables is expected.

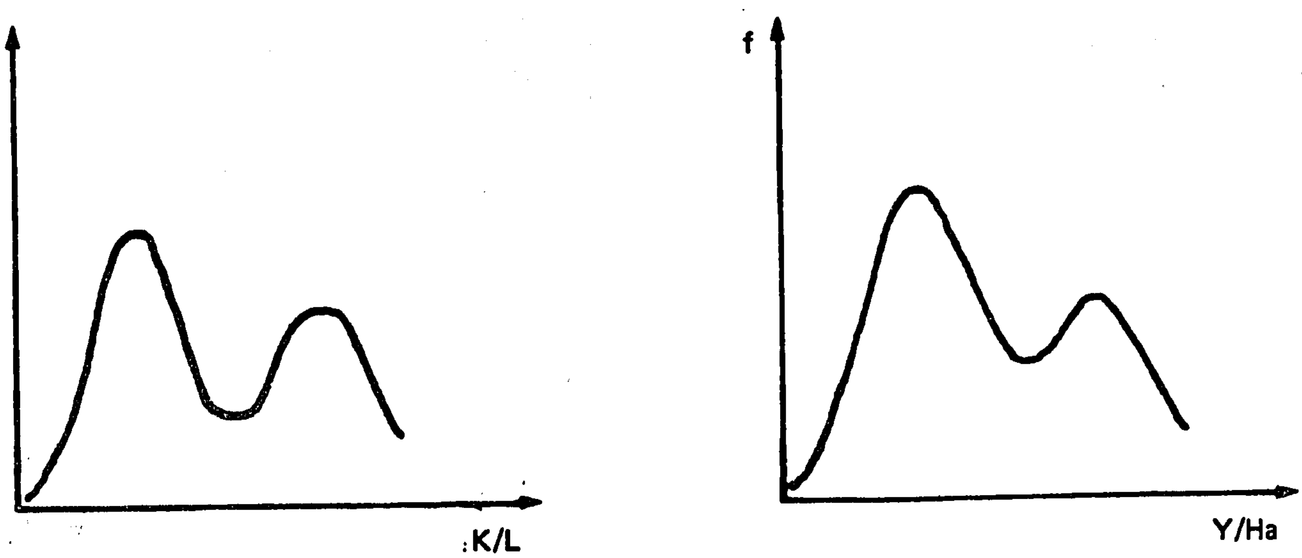
Empirical evidence suggests that in most developing economies, there is a clear dichotomy between a group of farmers with high K/L and Y/Ha ratios, which are usually receptive to technological change, and a group of farmers with very low K/L and Y/Ha ratios, which tend to have slow technological changes. In terms of the traditional isoquants diagram, this situation is shown in Figure 3. It is proposed then to define dualism in terms of K/L and Y/Ha ratios, i.e. dualism exists if there is a bimodal distribution of K/L (Figure 4), and Y/Ha.

FIGURE 3



K/L and Y/Ha ratios in a region non homogeneous.

FIGURE 4



Frequency distributions for dualistic K/L and Y/Ha ratios.

The above definition provides a basis for empirically testing existence of duality. Farms from a homogeneous region would generally tend to fall into one or several of the following groups:

(1) High K/L, high Y/Ha

(2) High K/L, low Y/Ha

(3) Low K/L, high Y/Ha

(4) Low K/L, low Y/Ha

It follows that duality exists if most of the observations fall in the first and the fourth group. By this procedure, it is possible to test if duality exists in a given period; but, is it possible to say something about what it is to happen over time to this type of agriculture? To answer this question, and if it is assumed that:

(a) the labor force will grow in constant proportion to population growth, and it is equal or greater, in the subsistence sector, than the commercial sector;

(b) the average savings ratio, productivity per hectare as well as productivity per unit of labor, and consequently income per unit of labor for subsistence is equal or less than for commerical agriculture, then the rate of capital accumulation in subsistence agriculture is equal or less than commerical agriculture, and

(c) adoption of technological improvements require capital.

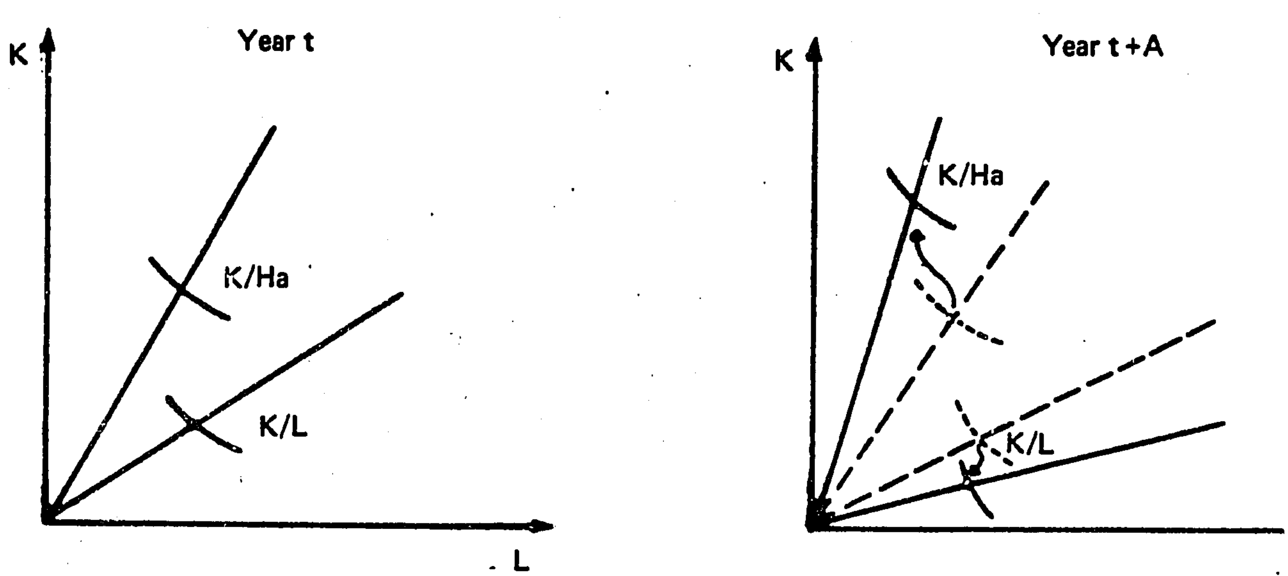
Then, it is possible to conclude that (Figure 5):

(a) the K/L ratios between commercial and subsistence agriculture will be widening over time.

(b) the Y/Ha ratio between subsistence and commercial agriculture will be widening over time.

It can be argued that improved communication between large firms and households could reduce the technological gap over time between these two types of farms; however, it is important to recognize that agricultural firms produce for commercial reasons while the production function of households is close to or the same as a subsistence level. Therefore, even with the knowledge of improved technology, its cost, the inherent risk in its implementation and the time at which results might be obtained, cause that small farmers continue to produce only for subsistence and to meet their needs in the short run. On the other hand, commerical firms can take the risk of adapting or using new technology with results in the long run. In the last section of this paper, concepts as the cost of capital are introduced to explain dualism in agriculture as a complement of the above conclusions.

FIGURE 5



K/L and K/Ha ratios (dualistic) for a t and t+A periods.

2. Empirical Verification, the Case of Mexico

To test the above hypothesis, we can consider the case of the Mexican agriculture. Table 1 shows the K/L ratio and Y/Ha for five areas of Mexico for the years of 1940, 1950 and 1960.

Table 1. Capital/Labor Ratio and Yield/Hectare by Region, Mexico, 1940, 1950, 1960. (Constant Pesos of 1960)

	K/L			Y/Ha		
	1940	1950	1960	1940	1950	1960
North Pacific	782	1339	1707	395	857	1330
North	674	1039	1189	307	542	632
Center	312	296	419	198	269	348
Golfo	278	285	328	364	493	667
South Pacific	135	149	178	138	324	435
National Average	376	487	609	243	405	533

Source: Reynolds, C. (1970)

Note: K = Capital for Agricultural Sector
L = Labor
Y = Income
Ha = Hectares

The largest differences in the K/L and Y/Ha ratios are found between the North Pacific and South Pacific regions. The K/L ratio of 1940 was about twice as large in the North Pacific, increasing to about three times in 1960. Income per hectare ratio had the same behavior, passing from 1.63 times larger in 1940 to 2.5 times in 1960.

These results are consistent with the dualistic theory. K/L and Y/Ha ratios are ranked exactly in the way that was expected, as well as their dynamic behavior.

In order to get more homogeneity, the analysis was made for two different sizes of farms for each region (Table 2).

Table 2. Extend of Duality Demostrated by Capital/Labor, Yield and Labor Productivity in Regions of Mexico, 1960
(Constant Pesos of 1960)

	Less than 5 Ha			More than 5 Ha		
Regions	K/L	Y/Ha	Y/L	K/L	Y/Ha	Y/L
North Pacific	775	1000	1104	7571	1118	3523
North	304	577	668	4413	618	4122
Golfo	232	821	652	1523	473	3893
South Pacific	111	556	420	1182	465	5174
Center	272	547	310	2015	671	3013
National Average	264	654	391	3118	630	4331

Source: Agricultural Census of 1960.

Note: K = buildings, railroads, and roads (private), irrigation works and machinery.
L = workers older than 15 years of age.
Y = total value of the agricultural production.
Ha = cultivated land.

The farms with 5 Ha or more have larger K/L ratios than those with less than 5 Ha, in every classified region. These rates range from about 7 times larger (Golfo and Center) up to 15 times in the Northern region. Again, the results are highly consistent with what was expected. Although, the division by size is not independent of the type of production, the results show once more the existence of the duality in the Mexican agriculture.

Finally, but still at aggregate level, observations on K/L and Y/Ha at country level for an important agricultural region (El Bajio) was gathered and classified around the average K/L and Y/Ha ratios (Table 3). Most of the observations as it was expected, fall in the high K/L --high Y/Ha and low K/L-- low Y/Ha groups, as a support again of the existence of duality in the Mexican agriculture.

Table 3. Production per Hectare and Capital/Labor Relations. El Bajio, Mexico (1960)

Production per Hectare Relation	Capital/Labor Relation: Greater than the Average - 1960	Capital/Labor Relation: Less than the Average - 1960
Greater than the Average	15	8
Less than the Average	9	38

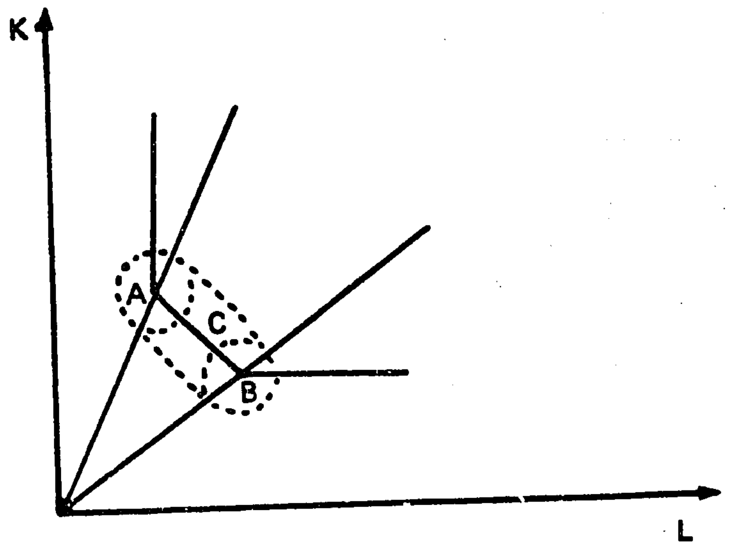
Source: Agricultural Census of 1960.

3. Causes of Dualism

To explain the suggested differences between empirical evidence and economic theory, the argument that the production function is different for each group of farms is evidently not consistent with the rational behavior criteria (Schultz, 1965). This possibility can be excluded because, by definition, a production function reflects an optimal output with a given technology and resource base. There is no reason to argue that some farmers, because inherent psychological factors, use optimal technology, while neighboring farmers continue to use technology after enough time has elapsed. It is true that the adoption process takes time and that it is possible to find farmers who lead in adapting innovative technology. This is why the dispersion around K/L ratios and Y/Ha continues to exist. The only basis of this argument, is to assume that some farmers are profit maximizers, while others are not. From an economic point of view, it does not seem to be a valid explanation, and better arguments must be found.

Assuming that the production function is relatively fixed in relation to factor endowments (Eckaus, 1955), and dependent on factor prices, three possible outcomes can be expected: all firms lie in group A, group B or among ABC (Figure 6). It is likely that a large scatter of firms around ABC will be encountered, while it is unlikely to find two distinctive and clearly defined groups such as A and B. Factor inflexibilities as an explanation for duality seems implausible.

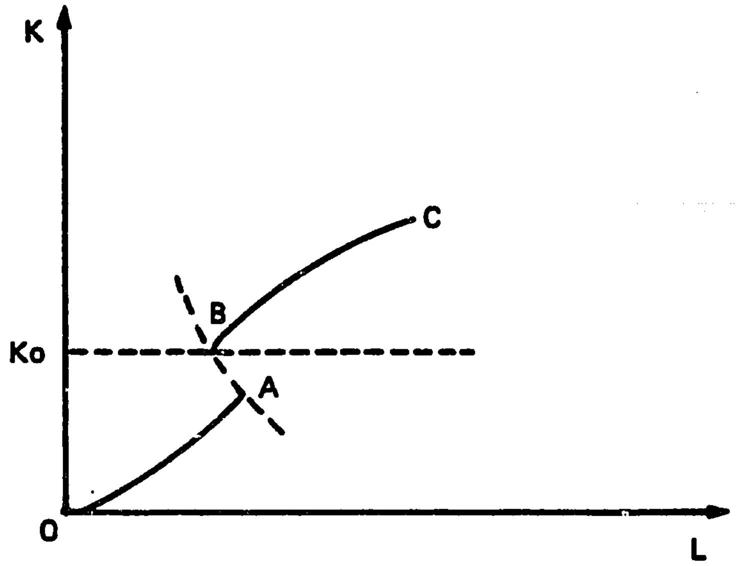
FIGURE 6



Firm's classification in a rigid production function.

It is a simple proposition that for the same production function at two different prices of capital, the expansion path will be OA and BC (Figure 7). Supposing that larger firms are able to get credit at lower interest rates than smaller firms and, if there is a farm size (measured in capital stock) Ko at which the price of capital (interest rate) changes (lower interest for firms, larger than Ko, and higher interest for firms, lower than Ko), then the price of debt on the price of capital is a plausible explanation of the existence of duality in agriculture.

FIGURE 7



Difference in the cost of capital for two different type of firms.

The imperfections on financial markets affect production in a more general way. Assuming an economy in which all physical assets are owned by firms (or corporations), which can finance their assets from two separate sources: the capital funds which the firm obtains by borrowing from outsiders (debt, borrowed funds), and the funds which are owned by the firm itself (equity, own funds). Production of the firm takes place over time and there is uncertainty attached to the mean value of the resulting stream of discounted profits. Although important, this type of uncertainty will not be considered. The main concern is with the variability of the successive elements of the stream, arguing that this variability has some bearing on the productivity to total physical assets and, consequently, over the expected return. It is argued that this is true because the production function is a weighted average of different activities or processes. Associated with each process are different degrees of uncertainty in the returns and differences in the variability over time in the accruing of these elements of the stream. Since the entrepreneur normally needs to fulfill certain obligations at specific periods of time, he combines its different processes so as to reduce to a minimum his risk to default on these obligations. If, as it is normal, the obligation has some relation with the outstanding debt of the firm, consequently the proportion of equity and debt for any firm has an effect on the productivity of its total physical capital.

In order to clarify the argument, we can take two hypothetical firms A and B and two processes 1 and 2. Firm A has only equity and firm B only debt; process 1 has a greater return than process 2 (both in present value), but process 2's return is evenly distributed in the n years, while 1's is not. Since each year firm B must pay obligations related to its debt, it cannot choose process 1, even though it is more productive.

The point is really that the financial market is not perfect and that all the differences in the utility functions of the owners of internal and external funds are not cleared through the interest rate but opportunity costs. Firms production decisions need to be considered, not only the present value of the returns but also the form of the flow of returns. This hypothesis implies that debt and equity are not perfect substitutes in production, and suggests a division of total physical capital into its components, debt and equity, freeing the elasticity of substitution between them (Barraza, 1979).

The theoretical analysis and its statistical results have several important implications for credit policy in underdeveloped countries.

Institutional constraints of bank lending behavior may tend to produce low elasticities of substitution between equity and debt and foster the existence and permanence of duality in underdeveloped economies. Rules of thumb in the lending practices of the banking system in underdeveloped countries based on the experience of developed ones are unwarranted and may block the achievement of an efficient allocation of resources. In this sense, a proper functioning of the financial system is essential to foster economic growth.

REFERENCES

1. Barraza, L., 1979, Production Functions with Capital External to the Firm, Mimeographed Paper in reproduction.

2. Censo Agropecuario y Forestal, 1960, Secretaría de Programación y Presupuesto, Dirección General de Estadística, México.

3. Clark, C., 1960, the Conditions of Economic Progress, 3rd. Edition, London, MacMillan and Co.

4. Eckaus, R.S., 1955, Factor Proportion Problem in Underdeveloped Areas, American Economic Review 45.

5. Jorgenson, D. W., 1961, Development of a Dual Economy, Economic Journal LXXXI.

6. Reynolds, C. W., 1970, The Mexican Economy; Twentieth Century Structure and Growth. New Haven, Conn., Yale University.

7. Schultz, T. W., 1968, Economic Growth and Agriculture, New York, McGraw Hill.

8. Solow, R. M., 1970, Growth Theory, Oxford Clarendon Press.

IMPLICATIONS OF TECHNOLOGICAL CHANGE FOR

HOUSEHOLD LEVEL AND RURAL DEVELOPMENT

Previous Page Blank

ABSTRACT

When the contribution that women make in production is not taken into account by development agencies, the introduction of technological change and large-scale projects may result in the destruction of the domestic economy and the impoverishment of families. Increasing rates of infant mortality are the evidence of the polarization of wealth and the limited access to the means of production that women and children in developing countries are permitted with the penetration of capitalism. As the ultimate unit of production in resisting the encroachment of capitalism, the domestic unit has subsidized the costs of capitalist production. Theories of the domestic mode of production are discussed in relation to development planning. Models focusing only on economic factors are seen as too limited to assess the outcome of development planning because of the cultural imperatives motivating behavior. Nine cases of development grouped according to type of innovation, e.g. the adoption of cash crops and mechanization, large-scale development projects such as dams, craft and industrial production, and forced migration are discussed in relation to the following variables: (1) changes in the composition of the household, (2) changes in the division of labor within the household, and (3) migration of members of the family. The author concludes the article with a series of propositions about the relationship between these variables and the success of the projects measured in terms of their contribution to human welfare.

IMPLICATIONS OF TECHNOLOGICAL CHANGE FOR HOUSEHOLD LEVEL AND RURAL DEVELOPMENT

June Nash
Department of Anthropology
City College of the City University of New York

INTRODUCTION

The global integration of capitalism has proceeded at the cost of the disintegration and growing dependency of nations, communities, and households. One of the strongest points of resistance to the advance of capitalist penetration in rural underdeveloped areas is the semi-subsistence farming household.

Paradoxically, the position the household has occupied in sustaining its members at low cost has subsidized the cost of industrialization in developing countries. The margins of autonomy gained by rural households in the development process are now crumbling as the large-scale penetration of agro-industry draws its more productive members into development contributing to the accumulation of capital. Even those programs whose target is the small-scale farmer draw the few more able households into programs requiring capital for credit, technology, and fertilizers. The higher yields gained by these advanced sectors siphon the more successful producers from the claims of the immature, older, or less favored members of the community and households.

The effect of the growing dependency of households, regions, and nations can be measured in the indices related to the global redistribution of resources in relation to food, access to technology, labor involvement, credit and markets.

1. Food

The Food and Agricultural Organization (76) found that in the "most seriously affected countries" with food shortages in Africa and the Far East, there was an increase in the population below the critical limit of food intake (1.2 basal metabolic rate) from 25 percent to 30 percent in the period 1971 to 1974. While a few of the "developing market economies" in the Middle East and Latin America had improved the distribution of food by one or two percentile points, the nations defined by FAO as having "total developed market economies" had worsened their position by one percentile, falling into the critical category. Women subsistence producers, who provide 44 percent of family food needs (8, 19, 20, 75), are ever more hard-pressed to fulfill this role as agri-industry invades their landholdings and their intensively worked lands decline in productivity (62, 65).

This increase in the number of people suffering hunger was clearly a problem in distribution. Per capita food production increased from 1970-1980 by 101 to 133 based on an index of 100 for the period 1969-71 in the case of developing countries and from 99 to 120 for developed market economies (83). In all the countries reviewed by the FAO (76) the most vulnerable are those "who don't grow enough, who can't buy enough, and women and children, with little girls last in family cues, even affecting their survival rates." Where patriarchy prevails in countries such as India, Nepal and Pakistan, the food deprivation in childhood overcomes the natural physiological advantages females enjoy and results in a higher death rate for infant girls (80).[1]

2. Technology

Technological design is itself the product of the social relations in production, reinforcing control by the dominant group (50, 55, 29) and reflecting patriarchal bias (14, 21, 67). Far from overcoming the physical disadvantages women might have in production efforts, investment in large-scale capital intensive development has often increased their disadvantage (2, 14, 21). In the U.S. AID (79) Report to the Committee on Foreign Relations of the U.S. Senate this point is elaborated:

> ...the recent expansion of capital-and technology-intensive and large-scale agricultural estates often operated by transnational corporations adversely affects women's work in basic tertiary activities such as those related to small-scale urban, semi-rural and agricultural trade, which are crucial income-generating activities and are essential for community self-reliance.

This process, the authors conclude, "has actually jeopardized food production and the distribution of food and other basic subsistence goods."[2]

Sheehan and Standing (67) define the circular process whereby women, who live in countries where their participation in the wage labor force is limited, are deprived of an education, and because they have been deprived of an education, they are not trained to use the new technology. In those countries in Africa, where women provide 70 percent of agricultural production and constitute 65 percent of the labor force (31) the contradictory decisions made in introducing technology reveal the class and patriarchal biases of the innovators. Tinker (74) notes:

> Thus, technology has been used in a way that has had detrimental and paradoxical consequences for African rural women. While, on the one hand, the technological changes in the modern agricultural sector have deprived women of employment, the shortage of simple technological improvements in food processing, energy and water supply, on the other hand, has left the rural women overburdened in their daily lives.

In a country where men plowed the land, and women weeded, the government purchased 100 tractors and only one weeder (31).

3. Labor

Despite the fact that women have limited access to wage employment in many parts of the world, their productive activities in the traditional sectors remain strong. Their share of the work in the maintenance of the family has, in fact, increased with development and/or migration. Considered estimates of the proportion of households headed by women range from 33 to 40 percent worldwide (15). Whether women enter migration streams to industrial centers within their own country or abroad, or whether they are left behind, they must bear the increased responsibilities. Where migration reaches the scale of 40 to 50 percent of the male population, as in Mali and Mauritania, or up to 70 percent as in the case of Haiti, and 80 percent in the case of Botswana and Lesotho, the results are precipitous for females. In addition to providing for subsistence needs of the family, they must often supplement uncertain remunerations from abroad with wage work. In a country such as Botswana where most of the men must migrate to the mines, women constitute 52 percent of the wage labor force (30). Chaney (20) remarks that when outmigration reaches that level, the resulting despair for women and the families they are left to support can be calamitous.

Numerous cases have been compiled (4, 5, 10, 20, 77) showing the increasing labor burdens which women bear in development projects:

*In Bangladesh, higher yielding rice with the use of fertilizers required more work by women who did the weeding, harvesting and processing. The Work Programe provided backbreaking jobs for women who were paid at 40 to 60 percent of men's wages.

*Zambian women taught to grow onions along with subsistence crops refused to continue when they were not compensated for the work done on the onion crops sold by men.

*In Cameroon, expansion of rice production resulted in profits that went to men, although women worked the paddy land.

*In Egypt, the extension of cotton cultivation drew on women workers as pickers, adding this to their usual household tasks.

*In Brazilian coffee plantations, women, who constitute 80-90 percent of seasonal workers, work at piece rates with no social security or other benefits.

*In Kenya, where one-third of rural households are headed by women, they constitute 37 percent of the regular work force.

Estimating that the rural women's working day is on the average 15 to 16 hours, Ahmad (4) notes that they receive less medical care, less food, and less education than men. Frequently men are contracted at a "family wage" for the work of women and children who are not directly compensated (3, 5). Women workers who are dependent on wage work are often left destitute when deprived of opportunities to work. Rice mills introduced in Indonesia and India put women out of work (5). Similarly, the introduction of herbicides eliminated weeding and cut the demand for a female labor force in Uganda and Kenya (77). The "green revolution" in Asia left in its wake thousands of women who were pauperized when they lost their jobs in irrigation and cultivation to men who were trained to use the new technology (6, 13, 43, 44). There was a marked increase in malnourishment among women and especially female children as a result of green revolution technology, particularly in India (43, 44). When one learns that a tool as simple as a sickle, introduced in Mwea shifted the labor force away from female workers, who used finger scythes, one realizes how delicately balanced these systems are (36, 69).

4. Credit and Markets

The limited access for women to technology and wage work is linked to the lack of credit and banking (79) in the subsistence sector. Even in those countries where they had access to land under indigenous rule, and during colonization, when they assumed the major responsibility for subsistence farming, the marginal security they possessed is becoming eroded as capitalized development or national reforms have deprived them of their land base. The very same land reforms and cooperatives that newly independent states proposed in order to alleviate the plight of poor farmers often channeled these resources only to "heads" of households, taken to be the male. In polygynous societies this was particularly prejudicial to wives who were accustomed to managing their own production and returns for it (47, 51). The Ethiopian land reform proclamation eliminated women's ownership of land (6:430), and simultaneously, their possession of collateral for raising capital. Given the importance of women in subsistence production, their lack of access to credit and markets can have disasterous results.

The few programs geared to make up the lack of available credit from traditional sources should be mentioned. The FAO is the only UN agency designed to extend credit to women, as they have done in Tasmania, India, and some countries of Africa (78:16). A remarkable development occurred in Korea with the organization of "Mothers' Clubs" set up to distribute birth control techniques when the women used these organizations as a base for developing credit pools (53). Women in Bolivian mining communities have developed extensive credit facilities through lottery pools, called pasanaku, with which they can acquire cash for their market enterprises or buy consumer durables at wholesale prices. These multi-purpose, flexible women's societies could be a base to promote credit facilities with little overhead costs (48).

Feminist scholarship emphasizes the prejudice against women in the redistribution of resources and rewards contingent upon capitalist development. This prejudice reflects the patriarchal cultural bias of the innovators as well as the economic bias inherent in private capitalist development against subsistence production. The fact that women do not gain credit reflects their chief responsibility in subsistence activities. The scarcity of credit for social reproduction in capitalist development is systemic since the motivation to invest is uniquely the drive for profit. The net effect is that people who have had marginal autonomy in semi-subsistence farming are increasingly disadvantaged in the cash economy. The allocation of resources and the distribution of rewards reinforces the process of capital accumulation by design. It is not an oversight that women, children, and the subsistence sector do not benefit from investment. This would be counterproductive to the central driving force of capital accumulation. In the following analysis of household strategies for coping with development, I shall try to put together the perspectives of feminist and Marxist analyses in order to understand the dialectical reinforcement of patriarchal cultural bias and capitalist economic bias.

HOUSEHOLD STRATEGIES FOR COPING WITH DEVELOPMENT

1. Theoretical Models of Household Economy

As the spell of British structuralism and U.S. "folk" societies (56) was losing its explanatory power during the decades of independence and revolutionary movements following World War II, anthropologists were in search of models to explain their case studies. Field workers began talking about peasants rather than tribespeople, and the household was emerging as significant unit of analysis as corporate lineage structures were becoming atomized in the new social movements. Chayanov's (22) analysis of households among Russian peasants based on data collected in the late nineteenth and early twentieth centuries became a focus. For anthropologists steeped in kinship and folk morality, it had the charm of unfamiliar terms borrowed from classical economics. "Resource allocation", the "marginal utility of work", and "opportunity costs" were the new catchwords. It was simple enough for most practitioners to use to measure and predict behavior.

The attraction for anthropologists lay in the integration of consumption and production functions for those households throughout the world which were entering the market economy to produce "exchange values" but not yet freed from the strictures of corporate groups producing "use values" whether these were structured on the basis of kinship or community. Neo-Marxists and neo-classical scholars could nod at each other across the lowering divide as they calculated the factors determining the peasants' willingness to enter wage work, sell craft products, and even accumulate capital goods. The household became the domain in which to watch the articulation of the capitalist and pre-capitalist economic systems. Representatives in three or even four modes of production united as a father producing use values on the family farm, a mother engaged in simple commodity production making pots, a son working as a tractor operator in a multinational agro-industrial enterprise, and a daughter entering domestic service came home to dine.

The question I shall raise is whether the neoclassical Chayanov model, even with modifications, is adequate to the challenge of anticipating even the simplist cultural datum in such a scene. What are they going to cook?

What is the appropriate technology with which they will prepare it? Who will gain from their surpluses? And who will be the first to experience hunger when supplies are short? What are the different attitudes and expectations cultivated in members of the household as they enter into very different relations of production, and what will they talk about when they come home to dinner?

First, I shall consider the assumptions in the updated Chayanov model and some of the advances made in using it. Then I shall analyze some of the data on households and their coping with technological change and economic reorganization in several developing areas and suggest some new approaches.

The focus in Chayanov's model is that production and consumption decisions are interrelated and vary in response to the number of producers in relation to consumers. This proposition is, of course, implicit in most ethnographies but it is not stated as simply and elegantly. Some of Chayanov's propositions can easily be translated into anthropological terms. When Chayanov states that income per capita beyond acceptable minimum has diminishing marginal utility, I relate this to George Foster's (32) "notion of the limited good" and wonder as the emic perspective of the economists' proposition. I find myself translating the "increasing disutility per worker" into some of the substantivists' critique of formalist debates. (For those who are not initiated into this occult debate, I think the substantivists are saying that principles based on market behavior such as maximizing do not work outside of economies dominated by the capitalist market. The question I ask myself is, do they work for markets dominated by monopoly capitalism?)

The "paradoxes" Chayanov encounters are simplistic hurdles for substantivists: Why is it that the poorest families will pay the highest prices for land and in rent? Why, during a harvest failure when prices are highest from agriculture, must a peasant household produce crafts at an ever-decreasing price? These are paradoxes only when it is assumed that all people are simply trying to maximize market opportunities. Anthropologists rarely, if ever, assume this even in the golden days of "tribal" and "primitive" economies.

Given the holistic analysis cultivated in anthropology, it was no problem for a "folk" anthropologist to understand why Maya women of Amatenango del Valle produced more and more pottery at ever-lower prices in the month of July when rains were heaviest and spoiled the firing. They needed money to spend on their patron saint's day in August (46). The real problem was to explain the rationality for the allocation of resources in those cases of resistance to innovation. Sol Tax did this in his analysis of the rejection of plow and draft animals by Panajachel, Guatemala Indians (71). The Indians preferred to use lands near the lake shore for growing labor-intensive crops of onions and garlic that had a much higher return, rather than to introduce the plow and draft animals. If they had chosen the latter "modernizing" course, they would have had to divert much of the corn fields where they grow their own subsistence crops to fodder for animals, thus losing the balanced complementarity of high-paying cash crop and subsistence food.

The formalist assumptions underlying the substantivist ethnographic accounts show the possibilities for convergence of anthropological and economic research. Chayanov might appear to be championing the substantivists when he argues that the capitalist concept of profit cannot apply to peasant households since there are no objective wage costs for family labor (40); he does in fact provide a model for assessing rational allocation of resources even when they are not precisely measured or measurable. Using a similar model, Schultz (64) and Bennett (11) were able to consider the degree to which allocations of resources were rational. The Maya of Panajachel, Schultz states, show a remarkable acuteness in allocating labor even though it is not paid. Similarly the Canadian plains frontier farmers analyzed by Bennett (11) showed a great deal of variation related to cultural and economic preferences in comparing the Indian, Hutterite, small-plot farmer and large cattle rancher.

Chayanov's critics have attacked his model for failing to distinguish rich and poor peasants (37:197). By going beyond this restriction, Deere (25) has shown the dynamic of class differentiation in the penetration of capitalist institutions. Hunt (40) has faulted Chayanov for failing to distinguish variations in managerial skill among households. But by remaining within an economic paradigm, the critics accept the limitations of the model itself. The failure to take into account cultural factors defining the role relations and behavior of household members means that the dynamics of decision-making are lost. Hunt, for example, accounted for the degree of willingness to innovate as a managerial function related to the education of husbands. And yet the society she analyzed is polygynous with men off the farm working in cities more often than not. Older wives, who are in fact the ones who most often make the innovations, are more likely expressing their greater autonomy in farming than carrying out their husbands' will. Again, to state that, "The sexual division of labor in productive activities is not determined biologically, nor socio-culturally, but is an economic variable" as Deere, Humphries, and Leon de Leal (26) do is to lose the interconnectedness of life issues influencing decisions in social reproduction. It is hardly predictive in the many differently structured social formations in which capitalist relations in production have penetrated.

It is easier to use such formulae at the international and national levels, but the closer we get to home, the more social and cultural variables influence the relations in production. Deere (25) is convincing in showing more intensive participation by women of lower income households in Cajamarca, Peru, so that we can predict that, with reduction in income, women are more likely to work in the fields <u>in that cultural context</u>. But not everywhere. In Amatenango, where Maya women recognize the culturally proscribed use of male tools, widows and other women without male laborers in the household will hire labor for the field even at the sacrifice of food necessary for the survival of household members. The few who were rumored to have sneaked out at dark to work in the fields were socially ostracised (46).

Given these case examples, what can we propose about the sexual division of labor in our model of the household economy? Little more than that the gender participation in the labor force responds to economic pressures, but the precise relationship between class and gender activities is not predictable in terms of an economic formula divorced from cultural constrictions. When Zambian men received cash in compensation for lands that were flooded in the Kariba Dam project (66) we could not predict that they would spend it competing for wives unless we knew that polygynous marriage was the preferred way of mobilizing more labor. Maya women in Belice did not work in cane fields on government allotments just as they had not worked in corn fields regardless of family wealth even though it meant that poorer families became proletarianized. Nor would we possibly make sense of why Mauritanian mothers continue to force-feed their daughters in preparation for marriage when men are migrating to find work in other countries and the divorce rates continue to rise and along with it the likelihood that these women, who are incapable of working, will become dependent on the family of orientation (1). To say that the family does it for the cash benefits of the bridal payments is reductionist.

These cultural variables inform the decisions made by people but do not determine the outcome any more effectively than economic variables. They may even be the crystallization of ideologies related to pre-existing economic systems. They are, nonetheless, important considerations in family decision-making affecting realms beyond the domestic. We have only to turn to the different forms taken by British and Dutch colonization to show the importance of indigenous cultural and social variations of both the colonizer and the colonized in transculturation.

The "civilizing mission" of the British (12, 31) was to turn men into cash crop producers with women carrying out subsistence production, a solution that followed culturally defined roles in many areas where the women were chief farmers in hoe cultivation. When the women were threatened with a head tax in Nigeria that would have forced them into cash production along with the men, they protested vociferously with the "Aba Riots" (54). The Dutch introduced cash cropping in Indonesia through the "culture system", in which farm families expanded and retracted their own cultivation in relation to the demand for labor in cash crops, intensifying their labor input in their own fields when labor was underutilized in commercial agriculture, and using less intensive methods when they worked on the plantations. This was less disrupting to indigenous patterns than the British system, and both systems continued to influence post-colonial adaptations (34, 69).

So we can see that the colonizing agent in the capitalist penetration of Africa and Asia exploited existing cultural patterns in the division of labor by sex in such a way as to intensify them, rather than subverting them. In the present state of capitalist penetration in agro-industry and manufacturing, it may undermine existing gender division of labor, or it may underwrite them; the outcome depends on the level of resistance on the part of the receiving group, as well as perceptions on the part of the dominant group as to their advantage. The myriad ways in which households expend their energies underline the importance of multiple strategies to maintain life (82). Rosenberg and Jean (59) point to a Sri Lanka household with 13 members that had seven sources of income: (1) operation of 0.4 acres of paddy by an adult, (2) casual labor and road construction by head and eldest son, (3) work in a rubber sheet factory by second son, (4) toddy-tapping and jaggery-making by head and his wife, (5) seasonal migration to dry zone by wife as agricultural labor--also eldest son and daughter, (6) mat-weaving by wife and daughter, and (7) carpentry and masonry work by head and eldest son. In these multiple, coexisting production strategies, people move from "traditional" to "modern", from "subsistence" to "capitalist" modes of production in ways that defy doctrinaire analyses.

I shall now turn to some of the specific cases of household adjustment to change, dwelling on the interplay between cultural and social structural features in development and change in order to assess the "historical logic" (73) in the behavior. The aim is not to construct a model of household economic behavior nor to infer a prior determinant of the behavior of its members, but rather to see it as an arena in which people respond to some of the basic forces shaping their lives. Recognizing that households are, as Yanagisake (84) says, "inherently complex, multifunctional institutions imbued with a diverse array of cultural principles", we cannot expect their economic functions to be any less diverse.

2. Case Studies in Household Strategies in Coping with Development

When we take as a starting point in constructing a model of household behavior the cultural, social, legal and political conditions that affect access to the means of production--land, water, technology, animal power and scientific knowledge--the otherwise paradoxical behavior of rural households becomes understandable. Forced to sell when the prices for the commodities they produce are lowest, to rent or sell their land when harvests increase in value, they are often branded as uneconomic production units. Seen from their own perspective their multiple coexisting strategies are ways of avoiding proletarianization and the loss of whatever remaining autonomy in decision-making that they control. I shall examine concrete cases that illuminate the process of adaptation to cash crops and large-scale development projects and the often unforeseen consequences of the strategies that rural households employ. The contribution anthropologists make with their studies is not a refinement of the models nor a search for "key variables", as Cancion (16) indicates, but is an emphasis on the complexity of the variables and the necessity for viewing them holistically. The importance of this holistic perspective is that it enables us to appreciate the dialectical interaction of these variables. In each case, I shall consider the following variables: (1) changes in the composition of the household: household head, reproductive rates, plural marriages, generational expansion or contraction, (2) changes in the division of labor within the household between males and females, parents and children, and extended generations, and (3) migration of members of the family and the impact of this on other members of the household. Cultural preferences must be taken into consideration along with the structural factors that condition the choices made by households in response to the penetration of capitalist ventures.

The cases below are grouped according to the technical innovation.

I. The adoption of cash crops and mechanization.

A. A sugar refinery in British Honduras

The government of Belice purchased land from a sugar refinery to promote sugar cane production, distributing twenty-acre plots to families who promised to plant cane, a relatively permanent crop. Credit was advanced for planting the crop to those families which had the "capacity to deliver" a harvest, but it was left up to the cultivator to find credit for fertilizer and insecticides. Since women rarely work in the fields in subsistence cultivation by the Maya indigenous population, the amount of available labor depended on the number of male family members who are productively active. Henderson (39:146) comments that, "Unless a man has a substantial pool of free labor available to him, he is unable simultaneously to maintain his former level of milpa-production and expand his cane holdings to the point where profit from the latter, at a present price levels, will meet his family's cash needs." Since cane cutting occurs at the same time as clearing bush for milpa, subsistence activities suffer and the family is forced to buy basic needs in the store. These purchases require cash, so smaller producers must work in the sugar refinery.

As a result of the shift to production of cane, the income of a few families favored with a high number of active males rose, in some cases from US $1,000 to $13,000. Stravakis and Marshall (70:11) found that this income was spent on the purchase of trucks and tractors. However, food was in short supply. The production women carried out in raising animals such as poultry and pigs in their back yards, cultivating fruits, nuts, seeds, herbs, greens, tubers, and other products was neglected. The men put less effort into cultivating the milpa or other crops for home consumption such as beans, cassava, tomatoes, and squash as they devoted their energies to sugar cane.

A survey of food and nutrition in 1973 and again in 1974, showed that many families were buying canned food. Women had lost control of the food distribution and the complementary network of social relations cultivated along with it in the exchange of truck crops. As a result, Stravakis and Marshall reported that all the men continued to eat well, but when food was scarce, the women and children went without. A high increasing consumption of alcohol by men aggravated the problem in the domestic setting and in the community.

Large-scale cane production involved risk factors and peak demands for labor that were difficult for the small farmer to absorb. The old complementarity of men and women in food production, of their regulated inputs of available labor on different crops or hunting and gathering supplements was lost. The result, according to Jones (41) and Henderson (39) was the increasing wealth differences, the proletarianization of many, and the loss of valuable subsistence products.[3]

B. Navajo wage work

Changes in the economy that increase the dependency of women on men by the replacement of subsistence activities simultaneously aggravate the dependency relations in the wider society. This can be seen in the Navajo case. In the first major government effort to improve the economic welfare of Navajos in 1933, land was surveyed for irrigation and tracts of ten acres were assigned to men as heads of household, although women were important owners of land and worked in subsistence farming (35). The men also had access to wage work for the government in the construction of projects, such as schools, hospitals and dams or in lumbering, road work, oil drilling, mining and military installations. With men away from home much of the time, women could not maintain the farms and they often had to give up their land. The decline of sheep herding which was in the charge of women owners of sheep also brought about a decline in weaving, an important source of cash for women.

Laila Shukry Hamamsy (35) reviewed the effects of a half century of the penetration of a cash economy on Navajo households in Fruitland. She observed a tendency away from matrilocality as women lost their focal position in the economy. She summarizes the position of women as follows: "Three aspects of the woman's role that have been adversely affected by the recent social and economic changes there: her economic position, the significance of her function within the family, and her sense of security and bargaining position in the family." (35:87) The poorest people in Fruitland were the middle-aged and old women with no male providers, once the most prestigious persons in traditional society.

The result of these structural changes forcing women to become dependent on male providers was endemic conflict between the sexes and between generations. Drinking exacerbated the competition for low income as the many needs of the family for cash were frustrated.

C. Mechanization in a Japanese village.

Mitsuru Shimpo (68) studied three decades in Shwa, Japan in order to assess the impact of rapid mechanization in the period 1955-60 on households. Expenditures on farm machines increased tenfold along with three times as much expenditure on pesticides and fertilizers. Correlated with this was a tenfold increase in expenditures on consumer goods.

Both men and women worked together using the new technology, but while men operated the machine, women did the bundling and feeding of the thresher and rice huller. The growing opportunities for men in urban industries caused a disproportionate migration of men. Whereas in 1950, 52 percent of the farming population were women, in 1973, 60 percent were women. Alert to the changing composition of the work force, a TV commercial showed an old man operating a small tractor. Young wife of his household runs over to do the job, saying, "Grandpa, I will do the job!" "No, I can do it with this machine!" he asserts. Along the road, waiting in line to try the machine, are twenty young men (68:51).

Shimpo studied the affect of the land reform and technological exchange on intermediate kin and community structures. The authority of the main household (honke) over the branch households (bunke) which were linked in the set called the (dozoku), was undermined and with it the power and authority of old wife over young wife. Commercial fertilizers were required as there was no longer dung from draft animals which had been replaced by tractors. The branch household gained autonomy since it no longer had to apply to the head household for manure. The cooperatives gained power through the sale of tractors and the administration of fertilizers as well as the management of labor exchange. Some women became agents of the cooperative a role which undercut local merchants.

As farm operations became distinct bases for commodity exchanges, household members began to accept responsibility for particular crops and jobs with clearly evaluated contributions from each member of the household. Shimpo (68) recounted the dismay of one household head who discovered that his wife's sale of her crop of one kilogram of mushrooms for 400 yen equaled that of his sale of 18 kilograms of apples. That night he drank a lot of sake and the following day he emigrated in search of seasonal employment in order to demonstrate that he could bring home more cash income than his wife could.

An even more dramatic story is the personal account of a young wife whose husband died in the war and who supported her four-year old son and in-laws. She lost the land which she had rented in the 1948 land reform, and the following year she lost all of her crop in the income tax. The cooperative agent advised her to keep accounts. In 1952 a dam was completed allowing her to convert an apple orchard into paddy. Twelve years later she rebuilt the house in which she lived with her in-laws along with a warehouse, and in 1970 she bought a transplanter. It was only after these successes, well documented in her accounts, that she could ignore the criticism of her in-laws.

Shimpo (68:90) concludes that while working teams still are based on seniority and sex, formal training and knowledge has changed traditional order. By 1968 women headed 94 of the 701 households. Since they are the continuous members of the cooperative, they have become the effective change agents. Their major problem is to find wives for heirs, since the opportunities for young women to make money has made it more difficult to find wives. While the favorite pastime in the past was to criticize young wives, their status had somewhat improved. The new pastime was viewing television.

II. Large-scale Development Projects

A. The Nemow Dam Project

When the government distributed land after building the Nemow dam, women-headed households received no land at all. Ingrid Palmer (52) describes their plight as the village residents' Association confirmed and strengthened existing patriarchy. Women who lived in households which acquired land are fully employed in weeding the fields plowed by men, and more prosperous households improved their lot while that of the landless declined. Women in the former fishing villages which were displaced by the dam complained that their diet was worse, but the majority were reported by Palmer (52) to have benefited from the changes. Women devote a good deal of attention to the subsistence plots where they grow beans, green vegetables, and lentils as well as maize. Nutrition has, in addition, been enhanced by the extension workers training women to preserve food. However, the system of land allocation and the institutional emphasis on maximizing marketable surpluses weakened women's control over family's labor and income. Exclusively male membership of the Farmers Association negated women's legal entitlement to land and cut them off from direct access to credit, extension services, marketing, and returns to their own labor. The subsistence plots they worked were granted only in the form of a loan by the government, while the rice plots given to men could be inherited by their children. As a consequence, women were less interested in working on rice.

Palmer summarizes the net effect of the tradeoff between women's interests and development goals as a resentment on the part of women which lowered their support of and involvement in development goals. This provides one of the more clear-cut cases where the opportunity costs for patriarchy are measurable in reduced inputs by women.

B. The Kariba Dam Project

When the Zambian government gave compensation for lands flooded by the dam on a per capita basis to men for the whole family, including polygamists with numerous progeny, there were unforeseen consequences. Men held the title to land in this patrilineal society. If the compensation had been paid to them for their land, Scudder's and Colson (66) indicate, then the dam might have simply reinforced patriarchy. As it was, the women felt that the men owed them more than the English pound given to each woman and child above toddler's age, particularly since it was women's work to clear and prepare the land for planting.

The immediate effect of the new streams of wealth was to inflate bride-wealth. The reason may have seemed somewhat remote to developers, but it was immediately connected with the need for workers in the new cultivation areas, and the principle way that men of this tribe had to mobilize labor was to marry. Scudder and Colson (66:53) note that the enormous demand for labor immediately after the move from the dam area led men "to make major demands upon their dependents, especially upon their wives and adolescent sons, who were needed in clearing, building, herding and plowing." Who, indeed is the dependent, if women had to work harder cultivating the new soils, hoeing more acreage, and brewing more beer for the more frequent ceremonies of marriage?

As a consequence of the move, men were thought to have accumulated debt to their wives and children which they had no way to repay. Furthermore, their dependence on the labor of wives was of considerable importance in making a profit from the cash crop of cotton. Scudder and Colson (66:63) comparison of the earnings of a farmer with three wives who provided the only source of labor in picking the crop and who earned 27 pounds per acre with a farmer who had only one wife and hired labor who earned 16 pounds per acre shows the clear advantage of polygynous families in such a society.[4]

III. Craft Production and Industrialization

A. Road Construction and its Affect on Rural Crafts in Amatenango del Valle, Chiapas, Mexico

For the most part, as Ruth B. Dixon states (27) rural women's craft production is easily displaced by factory production of cheap manufactured goods. Even those changes not directly connected with their craft, such as roads and electrification, threaten their trade. An exception to this generalization is that of Maya women in Amatenango del Valle in Chiapas, Mexico, who carried out the production of pottery principally pots for carrying water (46). Pottery was able to compete with manufactured substitutes, even after the construction of the Pan American highway that ran through the township, for a variety of reasons related both to government policy and the fact that there were no capital costs for tools or raw materials. Clay could be mined within the boundaries of the township at no cost except for the labor input. The women potters did not use a wheel or enclosed oven; their coiled pots were turned on a sanded board, and they fired the pottery in the streets, banking up the burning embers with boards after the initial firing to provide an oven-like enclosure for the final stages of firing. The only cost was transportation to the markets, which was fairly inexpensive (about one-tenth of the proceeds of a pot) and which the men enjoyed as an outing. More importantly, since the women traditionally did not work in the milpa except at the time of harvesting, like those Maya women of Belice discussed above, they did not have any "opportunity costs" to consider in alternative employment. They worked the pottery in with child-care, the tending of truck gardens in their patios and feeding small animals and poultry. The cash was important since it came in inter-harvest periods and, in cases of households headed by women, it was the principle source of cash income.

The quantity of pottery produced in each family is directly correlated with the number of women producers in the family. In the case of young, nuclear families, particularly when there was a child under two years of age, pottery is produced only sporadically if at all, and usually in the weeks immediately preceding the fiesta of the patron saint when cash needs are high. Production is indirectly correlated with the number of productive males in the family. Single women living alone or with their children are the most productive potters since they rely on proceeds for most of their cash needs. The only cash crop grown in addition to the milpa is wheat, a crop that was clearly uneconomic for households that had to employ most of the labor. In households with several productive boys and men, there was very little production of pottery since the household usually extended its production of both corn and wheat, and women were involved in the cooking and nutrition of the men, bringing them lunches to the fields and entering themselves to help in the harvest period. The average pottery producing household earned from ten to fifteen percent of what a man working on the average holding of 4 acres could make.

Women-headed households which produced all of the family income could earn at least half of what a man could gain from the average holding. In such families if there were sons 15 years of age or older, they could farm the ejido communally owned plots that every household was allotted. The income and available subsistence resources of women-headed households were nearly equal to that of the male-headed households, and they did not have the problem of alcohol expenditures which drained a great deal of the resources of the latter.

In the last field session that I spent in Amatenango in 1967, the Instituto Nacional Indigena, which had carried out medical and marketing projects in the town for a decade, began to take an interest in the craft production. Their attempt to introduce kilns to save wood used in open hearth firing was unsuccessful because they did not assign a trained technician to work with the women and teach them how to use the ovens. The women did try, but when the initial attempts failed, they rejected the new method.

The effect of the Pan American highway was to change the marketing procedures which men were doing. Formerly, men had brought loads of 6 to 8 dozen pots and assorted items on horseback to dispersed hamlets and townships throughout the mountainous areas, selling directly to buyers. Once the road was constructed and bus routes connected Amatenango with the departmental and state capitals, pots were loaded on the roof and carried to the larger markets. There they were sold to intermediaries. The large influx of pottery during fiesta preparations brought very low returns because of the greater competition in the markets. Indians purchased their first cooperatively owned truck in 1964 when I was working in the town. This increased wealth differences, stimulated envy and competition, and eventually led to the death of at least two of the cooperative members.

The highway made Amatenango more participant in the tourist circuit in Chiapas, and provided a new market for the pottery. The Instituto Nacional Indigenista assisted the townspeople in marketing the product in attractive tourist shops. The few tourists who had visited the town when I was living there used to buy pottery, particularly small items made by novice potters such as toy animals or small replicas of the utilitarian ware turned out by mature potters. When tourists offered to buy larger pots, they were often charged double the price given by middlemen. This was based on the premise that the buyer must have really been desperate to get a pot if they came all the way out to the village.

When I returned to visit the women in 1982, young women whom I had known in the period 1963-1967 had in some cases become entrepreneurs in a thriving business linked through government and private agencies to a developed tourist market. They contracted out work to household members and provided the warehouse and the market contacts for other women in the community. So far as I could gather, women did not suffer the fate of male entrepreneurs two decades before.

B. Government-promoted Industry in a Rural Farm Area in Mexico

San Cosme Mazatecocho was a rural community of small plot peasant cultivators up to 1950 (60). A few men commuted to the nearby city of Puebla or to Mexico City to work in the textile factories. By 1970 the proportion of factory workers, most of whom worked outside of town, had more than doubled, reaching 27 percent and by 1980, 60 percent of the economically active males over 12 worked in factories, some of which were owned by multinational corporations.

In the transition from subsistence cultivation to dependence primarily on factory work, two major changes came about in the family. Married women, who had been active participants in all phases of subsistence farming, became dependent on male wage-earners. (60) Households became child-centered and a great deal of the family earnings were devoted to the education of children. Some young women were able to find work in a garment factory opened in the area, but they were generally let go when they married or became pregnant, and most of the workers were very young. (61)

The emphasis on education was based on the factory worker families' conviction that this would provide mobility for their children. Since they hated the monotony of their work and realized that there was little chance of advancement, the family devoted their energy and resources to finding an escape for the children. Education, however, was not a guarantee of improved social and economic position since each rise in the proportions of school children in secondary schools and advanced education was accompanied by an increase in the educational requirements for entry into preferred occupations.

Children became a full time "labor-intensive" occupation for mothers as they were cut off from productive tasks in the field. The children, age-segregated in schools for much of the day and later completely segregated in boarding schools as they went on to higher education, were no longer a potential source of labor in the household. Even when the families of factory workers held on to their subsistence plots, they preferred to hire workers to work the soil. Sex segregation was sharpened along with age segregation. Preference for male children--a preference based on the expectation that they will be the chief breadwinner in the family--means that they are the most likely candidates for going on to a higher education. As a result, Rothstein (60) concludes that childhood is a costly preparation in terms of the foregone labor, the school fees, demands for clothing, transportation, etc. The entry of children into adulthood is delayed and because of the forced segregation from the adult world in their extended preparation to enter it, they often become alienated from the parents who sacrificed their own goals to make it possible. Children are not expected to, nor do they usually, provide social security for aging parents.

The attempt by workers to gain control over their own future by promoting the mobility of their children is somewhat illusory. While it does provide limited access to higher positions for a few, it does not ensure security to the parents who provided it. Furthermore, the ever-higher entry qualifications into preferred occupations negates the attempts by the mass of proletarians to gain mobility for the class as the favored few are cut off from leadership in a political field.[5]

IV. Capitalist development through forced migration

A. Bantustan policy of separate development

The Bantustan policy of separate development, as Barbara Rogers (57:40) shows, is a separation not so much between black and white as between families and communities. If one were to imagine an extreme case of alienation in capitalist development, it would probably not even come near to the reality of contemporary South African society. Production is so cut off from "use values" that it no longer relates to human needs. The reproduction of the social system is so constricted within the system of Apartheid that it is a miracle that human reproduction can take place at all. In her book summarizing the effects of Apartheid, Rogers (58:31) gives us a glimpse of what the system means in practice:

In practice, the mother of a family is forced to work full time, at rates considerably lower than those even for African men. Her efforts will help, but most probably will not bring the total family income up to the basic minimum level. In many cases she will be the sole wage-earner. The result is an acute impoverishment of the children's environment, deprived of any parental care or educational stimulus, and going all day without food, since many hours of the day will be wasted by the parents in commuting to and from the township.

If urban African families are split up and living below any acceptable income level, the situation is worse for Africans in rural areas. African farm laborers surveyed in Natal were described as living in 'incredible poverty'; the report, in a Durban newspaper, described them as the most exploited and powerless people in the country. The whole family, including the children, work six months a year for little or no payment at all. They have no rights and are exposed to beatings by employers or immediate eviction to settlement.

When mineowners go to the "homelands" to recruit blacks, they eliminate competition among themselves to keep wages below even the South African average (58:48). By maintaining the fiction that the migrant workers are residents and citizens of the homeland, Rogers points out (57:50) they can be deprived of any permanent status in their workplace:

> It destroys the family unit by physically removing the father, or other primary wage-earner, from it in the struggle for subsistence....The result, in destroying the culture and social well-being of entire communities, is not unlike that of slavery in that marriage, family, social and cultural mores were ignored there, also, in the effort of whites to split up and disintegrate families and cultures for their own profit and convenience.

The correlates of Apartheid are bigamy and illegitimacy and the evasion of all kinship obligations. It promotes commodity fetishism among men segregated from their families. At the same time, children and women are undernourished. Rogers' indictment cannot be matched by paraphrasing, so I shall continue quoting verbatim:

> For every single African wage-earner--to whom an employer can point as an example to 'progress' since he has income to spend on consumer goods--there will be a whole extended family, including the very old and very young, which is desperate for the income he left home to earn--and on the verge of starvation.

The preference for male black laborers to migrate without women results from the fear that the presence of women and families will provide a more secure base for blacks in the sectors that whites claim. Even in rural areas, the old tenancy systems are being abolished to avoid any future claims.

Some claim that the Apartheid system is a product of the agricultural past that will be overcome by industrialization. Rogers (57:66) denies this, demonstrating how the fragmentation of jobs employs a low-paid work force segregated by race.

B. Dependent Development in Lesotho

Like a Bantustan, Lesotho is a labor reserve society providing workers for South African enterprises. Over 60 percent of the male labor force migrated to South Africa in the sixties. This migration has increased about 5000 per year up to the present when it is judged to be about 80 percent of the male active labor force. Strom (71:23) estimates that 80 percent of all income in households was derived from non-farm labor--59 percent of which was from wage employment in South Africa and 21 percent from commodity production service and mining diamonds in Lesotho. The remaining 20 percent of family income was from farm lands which women worked. Since 1963 when Lesotho was established, there has been an increasing negative balance of trade between the export of unprocessed wool and mohair, livestock and diamonds, and the import of food and manufactured goods.

Many of the individually-licensed miners operating within Lesotho are women. Their technology in contrast to the heavily capitalized Johannesberg mines, is, according to Strom (71:132), "well adapted to the conditions prevailing in the area", i.e. pickaxes, spades, and water hoses. The large mine companies which attempted to enter the field failed since they were not prepared to engage in the labor-intensive prospecting that yields the highest returns in the uncertain diamond fields. Despite the claims of national miners, the government sold their shares to foreign companies in 1978. The miners staged a demonstration and the army fired on them, killing over 500 women and men (58). Local leaders have taken over the responsibility for repression from the colonial government as they cooperate with foreign investors to transfer the resources of the Basotho abroad.

The "gold widows" of Lesotho have found another outlet for employment in the service occupations of the tourist sector. The Holiday Inn Hotel, opened in Maseru in 1970, added a casino which increased the tourist flow that surpassed 100,000 in 1972. (71) In an economy distorted by dependency on foreign products and investments, high risks and low margins in mining, every human social relationship is mediated through the cash nexus as gambling, prostitution and pandering to tourists provide the main sources of revenue in the uneven exchange that goes on with the outside world.

Despite their impoverishment, women have a degree of autonomy because of their subsistence production in agriculture where they constitute 75 percent of the labor force. Women are the more active participants in village cooperatives and are members of garden committees (45:165). The mutual dependency of men and women is one in which men's pay goes for modernizing the house and educating the children, but women provide a basis for retirement when men are too sick or old to work in the mines. Their interdependence as wives working in the cooperatives and on the lands does not, according to Mueler (45:165), result in much cooperation since they are competitors for the resources men provide. Laura Ngobo (49:13) sums up the contradictions faced by African women under Apartheid:

> When men have been severely oppressed, women have risen and become dominant; this in turn has further emasculated our men and made them even more reckless in their treatment of women in general. In different parts of the world today, women are demanding equal recognition with men in all walks of life and rejecting the home-centered life; our women are denied even that. With their men in the cities, our women can't boast of caring for houses, for they stand straddled between father and children forever trying to create a kind of a family unity.

She concludes that, since men are powerless to yield any rights, women must join them in the fight for liberation.

CONCLUSIONS

The persistence of small plot household production in agriculture in many areas is proof of its flexibility in response to the changing needs of both the internal and external economy. Expanding commodity production in response to needs for cash, family labor and market opportunities, it can also intensify efforts of its members in agricultural output. It is the ultimate unit of production resisting the encroachment of the capitalist mode of production. At the same time, it hastens its own demise by subsidizing the costs of capitalist development.

Reviewing the case studies in relation to variations in household strategy, I shall summarize the changes in composition of the household division of labor among members, and recourse to migration in relation to a series of propositions about the household economy in response to technological change and development.

A holistic view of development requires that we take into account the following propositions:

1. The penetration of cash crop cultivation may be costly when the total potential of the family is not taken into account.

In the case of Belice sugar cane production, Maya farmers prospered only insofar as they controlled sufficient manpower in the family. Lacking alternative forms of labor mobilization within the family since there was a cultural preference for women not to work in the milpa, the result was polarization of wealth groups. The loss of subsistence activities both by men in milpa cultivation and hunting and by women in truck gardens reinforced the dependency of the women on men and of the household on the cash economy. The Navajo case parallels that of Belice and points up the importance of women's subsistence activities that are often ignored until their loss makes them recognized. Women's diversified economic activities in herding sheep, weaving and raising truck crops were undermined with the government stimulus to cash crops and irrigation as well as large-scale construction projects hiring men. The growing dependency of the household on wages and the government was reinforced with the increasing dependency of women on male wage-earners.

2. Technology is a two-edged sword, which may reinforce an existing hierarchy of relations or diffuse the gains of development, depending on who introduces it, who uses it, and who benefits from the increased production.

Of the many cases cited in section 1 of technology reinforcing wealth or patriarchy, an unusually successful case of mechanization and commercialization of agriculture is that of Shimbo, Japan. The case dramatizes the importance of linking the design and manufacture of technology in relation to the needs of its users. The light, small and relatively inexpensive tractors introduced into the small plot farming villages and targeted in the sales appeal to the old men and young wives who would be their most likely users was an important asset in the post-war development of Japan's economy. The integration of at least a few women into the cooperative as managers enlisted their help in the transition from a patriarchal management of extended households to one in which women had more say and higher rewards from their own productivity. This was crucial in the industrialization of post-war Japan as men left the farms to take advantage of the more lucrative jobs in industry. The success of this case seems contingent on having an expanding industrial sector that absorbed young male workers from the rural areas and indirectly fostered greater autonomy for the women.

3. The opportunity costs for maintaining patriarchy are high if one accounts for withdrawal of support by women when they are not compensated.

Large-scale development projects such as the Nemow and Kariba dam developments ignored pre-existing social arrangements and negated the support of women in the project. Ignoring the separate accounting systems that the Gwembe Tonga were accustomed to practice, the project agents compensated men for the work done by women in the new lands brought under cultivation. The expenditure of funds men received in relation to the size of the household was channeled into bride-price to secure the labor of additional wives. Added to the fact that women were not compensated directly for the cash crops they grew, their increasing resentment undoubtedly cut down their productivity. This contrasts with the polygamous Cameroon case where women, as managers of the household economy, promoted the additional polygynous marriages to secure helpers on their husband's lands.

<u>4. The enforced migration in separatist policies of development indicates the destructive potential of capitalist penetration where the social reproduction of use values is not just ignored, but deliberately subverted as the economy is devoted to production for exchange and profit</u>.

The extreme cases of Bantustan and Lesotho reveal the destructive capacities of capitalist penetration when the resistance of family and community is totally subverted. South African families are split up in the process of production as men are forced to work for months and even years apart from their "homeland". The awareness on the part of the controlling white interests that households provide a basis for resistance to domination and authoritarian control should instruct us as to the importance of this final core of resistance.

<u>5. The impact of wage labor in industry on reproductive strategies is indirect and reflects the stage of capitalist development, alternative employment for women and the demand for highly skilled, educated workers</u>.

The rising costs for children reflect both the educational costs borne by families and the opportunity costs for women not joining an industrial work force when jobs become available. The hidden costs of social reproduction in agricultural economies become more explicit when women's wage labor in a factory competes with household responsibilities (60, 61, 63). Although full socialization of the costs of social reproduction has never been attempted, the governments of those countries in the socialized countries and Sweden reveal the high cost of services hidden in the private oppression of women (23, 24, 42).

These propositions are drawn from a holistic view of development projects that addresses the issues of social reproduction. The case studies reviewed reveal the potentially harmful affects of the penetration of capitalist enterprises when women's productive potential is ignore or undermined. The rising indices of infant mortality, hunger, and impoverishment in those countries that have experienced high rates of development such as Brazil and South Africa confirm the destructive tendencies of capitalist production concerned only with the profit. Some attention is now being directed toward development projects that will promote social reproduction. Unless such projects are rapidly implemented there may be no need for them since the dislocation of families and the rising mortality of infants are destroying the basis for their success.

FOOTNOTES

[1]Studies of regional and national imbalances that have had widespread influence in changing assumptions about the development process include Amin (7), Barkin (9), Cardoso and Faletti (17), Frank (33) and dos Santos (28). A recent review article published in CEPAL (18) documents the persistent growth of inequity stimulated by export-oriented production in Latin America in the seventies and up to the present.

[2]See also the Economic Commission for Africa (3) which stressed this point.

[3]The Belice case illustrates the more frequently encountered example of men enlisted as producers in cash crop economy. Opposition by men to forced cash crop production can be seen in the case of Mozambique in the 1940's under Portuguese rule. Isaacman (41a) recounts the opposition by women to cotton production required by President Salazar. Men joined the women who resisted the cash crop because of the resulting food scarcities when land and labor was diverted to cotton. Their resistance, in contrast to the capitulation of Belice cane growers, was related to the very low rates of return on cotton sold to Portugal at below market prices. Both men and women cooked the cotton seed to discourage growth and convince the colonizers that the lands would not grow the crop. They burned fields and sabotaged the movement of the crop to market. These concerted actions by men and women show the awareness on the part of people confronted with the threat of food shortages that life itself was threatened. This awareness was expressed in their phrase, "Cotton is the Mother of Scarcity" which became the title of Isaacman's article. When one gender, usually the male, benefits from increased cash flows, this basic solidarity of the domestic unit can be broken. Even in Mozambique, many of the men resorted to flight across national borders, reflecting their greater mobility and employment opportunities, while women, "with stronger ties to their children and greater responsibility for feeding their families were undoubtedly more reluctant to abandon their homelands except as part of a larger group" (41a).

[4]The assumption underlying Scudder and Colson's work is that men are the managers of these polygynous households. A somewhat different functioning of a polygynous families is described by Weekes-Vagliani (81) in Cameroon. There one-third of the households are made up of extended families with each wife living on her allotment under the overall administration of the husband. Women cultivate crops for themselves and their children. Men act as middlemen between the family and the purchaser, and as a result they are often considered to be the economic head of the family by the outside world. However, according to Weekes-Vagliani (81:17) it is actually the first two wives who actually manage the cultivation of crops and who arrange subsequent marriages in the desire to gain more workers.

[5]Helen Safa's paper (63) comparing Brazilian and New Jersey factory workers indicates the complexity of factors entering into decisions on family size and reproductive strategies. She relates the decrease in size of families in the case of New Jersey garment workers to a later stage of industrialization where there is a sharp reduction in the demand for unskilled workers and an increasing demand for skilled workers combined with educational opportunities for the masses. Some of these same conditions are seen in the Mexican case.

REFERENCES

1 Abeille, Barbara 1979 A Study of Female Life in Mauritania. Washington, D.C.: U.S. AID, Office of Women in Development.

2 Aguiar, Neuma 1976 "The Impact of Industrialization on Women's Work Roles in Northeast Brazil," in J. Nash and H. Safa, eds., Sex and Class in Latin America. Brooklyn: J.F. Bergin, Pbls., Inc., pp. 110-128.

3 ______________ n.d. "Household, Community, National and Multinational Industrial Development," in J. Nash and M.P. Fernandez-Kelly, eds., Women, Men, and the International Division of Labor. Albany: State University of New York Press.

4 Ahmad, Zubeida 1980 Women at Work I, p. 8. Geneva: International Labour Office.

5 ______________ 1980 "The Plight of Poor Women: Alternatives for Action," International Labour Review 119, 4 (July-August): 425-438.

6 Ahmed, Iftikhar 1980 "Employment and Development Department," Women at Work II. Geneva: International Labour Office.

7 Amin, Samir 1974 Accumulation on a World Scale: A Critique of the Theory of Underdevelopment. New York: Monthly Review Press.

8 Aronoff, Joel and William D. Crano 1978 "A Reexamination of the Cross Cultural Principles of Task Segregation and Sex Role Differentiation in the Family," American Sociological Review 40.

9 Barkin, David 1972 "A Case Study of the Beneficiaries of Regional Development," Regional Socio-Economic Development, International Social Development Review 4: 84-94. New York: United Nations.

10 Beneria, Lourdes and Gita Sen 1981 "Accumulation, Reproduction, and Women's Role in Economic Development: Boserup Revisited," Signs: Journal of Women in Culture and Society, Special Issue: Development and the Sexual Division of Labor. Chicago VII, 2: 279-298.

11 Bennett, John W. 1969 Northern Plainsmen; Adaptive Strategy and Agrarian Life. Chicago: Aldine Pbls. Co.

12 Bernstein, Henry 1979 "African Peasantries; a Theoretical Framework," Journal of Peasant Studies VI, 4 (July): 421-443.

13 Billings, Martin and Arjan Singh 1970 "Mechanization and the Wheat Revolution: Effect on Female Labour in Punjab," Economic and Political Weekly (Dec.): 169-172.

14 Bossen, Laurel 1979 "Women in Modernizing Societies," in S.W. Tiffany, ed., Women and Society, An Anthropological Reader. Montreal: Eden Press Women's Publications, pp. 93-119.

15 Buvenic, Mayra and Nadia H. Youssef, with Barbara Von Elm 1978 Women Headed Households: The Ignored Factor in Development Planning. Washington: U.S. AID International Center for Research on Women.

16 Cancian, Frank 1977 "Can Anthropologists Help Agrarian Systems?" Culture and Agriculture II: 1-8.

17 Cardoso, Fernando and Enzo Faletti 1971 Dependencia y desarrollo en America Latina. Mexico: Siglo XXI.

18 CEPAL Economic Projections Centre 1981 "Problems and Orientations of Development," CEPAL REVIEW 15 (Dec.): 47-70.

19 Cepede, Michel 1971 "The Family Farm: A Primary Unit of Rural Developmen in R. Weitz and Yehuda H. Landau," eds., Rural Development in a Changing World. Cambridge, MA: The MIT Press.

20 Chaney, Elsa 1981 "Third World Women and International Migration," Paper read at the Annual Meeting of the American Political Science Association. New York, September 3.

21 Chaney, Elsa and Marianne C. Schmink 1976 "Women and Modernization: Access to Tools," in J. Nash and H. Safa, Sex and Class in Latin America. Brooklyn: J.F. Bergen Press.

22 Chayanov, A. V. 1966 The Theory of Peasant Economy. D. Thorner, B. Kerblay R.E.F. Smith, eds., Homewood, Ill.

23 Croll, Elizabeth 1979 Women in World Development; The People's Republic of China. Geneva: ILO.

24 ______________ 1981 "Women in Production and Reproduction in the Soviet Union, China, Cuba, and Tanzania: Socialist Development Experiences," Signs VI, 2: 361-74.

25 Deere, Carmen Diana 1978 "The Differentiation of Peasants and Family Structure; A Peruvian Case Study," Journal of Family History VIII.

26 Deere, Carmen Diana, Jane Humphries, and Magdalena Leon de Leal 1979 "Class and Historical Analysis for the Study of Women and Economic Change," Paper prepared for the Conference on the Role of Women and Demographic Change, Geneva ILO.

27 Dixon, Ruth B. 1979 Jobs for Women in Rural Industry and Services. Washington, D.C.: Office of Women in Development, U.S. AID.

28 dos Santos, Theotonio, Tomas Vasconi, Marcos Kaplan and Helio Jaguaribe 1969 La crisis del desarrollismo y la nueva dependencia. Lima: Instituto de Estudios Peruanos.

29 Doughty, Paul 1972 "Engineers and Energy in the Andes," in H.R. Bernard and P.J. Pelto, eds., Technology and Social Change. New York: The Macmillan Co., pp. 109-134.

30 Ducomim, Rosalie 1980 "African Women Workers," Women at Work I:9. Geneva: ILO.

31 Economic Commission for Africa 1973 The New International Economic Order; What Roles for Women? United Nations E/Cn. 14/ATRCW/77/WD 3 31 Aug.

32 Foster, George 1965 "Peasant Society and the Image of the Limited Good," American Anthropologist 67: 293-315.

33 Frank, Andrew Gunder 1967 Capitalism and Underdevelopment in Latin America: Historical Studies of Chile and Brazil. New York: Monthly Review Press.

34 Geertz, Clifford 1963 Agricultural Involution. Berkeley: University Press.

35 Hamamsy, Laila Shukry 1979 "The Role of Women in a Changing Navaho Society," in S.W. Tiffany, ed., Women and Society. St. Albans, Vt.: Eden Press.

36 Hanger, Jane and Jon Morris 1973 "Women and the Household Economy," in Robert Chambers and Jon Morris, eds., Ewea; An Irrigated Rice Settlement in Kenya. Ifo Institute fur Wirtschaftsforschung Africa Studien 83 Munchen Welforum.

37 Harrison, M. 1976 "Chayanov and the Economics of the Russian Peasantry," Journal of Peasant Studies II, 4.

38 Hein, Catherine 1981 "Employment of Women in the USSR," in Women at Work II. Geneva: ILO.

39 Henderson, Peta M. 1972 "A Sugar Usina in British Honduras," in H. R. Bernard and P.J. Pelto, Technology and Social Change. New York: The Macmillan Co., pp. 136-163.

40 Hunt, Diana 1979 "Chayanov's Model of Peasant Household Resource Allocation," Journal of Peasant Studies VI, 3 (April): 247-299.

41a Isaacman, Allen, Michael Stephen, Yussuf Adam, Maria Joao Homen, Eugenio Macamo, and Augustinho Pililiao n.d. "'Cotton is the Mother of Poverty': Peasant Resistance to Forced Cotton Production in Mozambique, 1938-1961" ms. University of Eduardo Mondlane.

41b Jones, Grant D. 1969 "Los Caneros: Sociopolitical Aspects of the History of Agriculture in the Corozal Region of British Honduras." Ph.D. Dissertation, Brandeis University.

42 Karchev, Anatoli 1973 "The Soviet Family; A Sociologist's Viewpoint," Soviet Life (March) p. 27.

43 Mencher, Joan 1974 "Conflicts and Contradictions in the 'Green Revolution': The Case of Tamilnadu," Economic and Political Weekly IX, 6-8-9: 309-323.

44 ______________ 1978 "Why Grow More Food; An Analysis of Some of the Contradictions in Kerela," Economic and Political Weekly, Review of Agriculture Dec. 23-30: a98-a104.

45 Mueller, Martha 1977 "Women and Men, Power and Powerlessness in Lesotho," Wellesley Editorial Committee, Women in Development. Chicago: University of Chicago Press.

46 Nash, June 1970 In the Eyes of the Ancestors; Belief and Behavior in a Maya Community. New Haven: Yale University Press.

47 ____________ 1977 "Women in Development; Dependency and Exploitation," Development and Change 8: 161-182.

48 ____________ 1979 We Eat the Mines and the Mines Eat Us; Exploitation and Dependency in Bolivian Tin Mines. New York: Columbia University Press.

49 Ngobo, Laura 1978 "On Liberation and Oppression," ISIS International Bulletin IX: 708.

50 Noble, David 1977 America by Design: Science, Technology and the Rise of Corporate Capitalism. New York: Alfred A. Knopf.

51 Pala, Achola 1976 African Women in Rural Development: Research Trends and Priorities. Washington, D.C.: American Council on Education, Overseas Liaison Council Paper No. 12.

52 Palmer, Ingrid 1979 The Nemow Case: Case Studies of the Impact of Large Scale Development Projects on Women: A Series for Planners. Working Paper No. 7. Washington, D.C.: U.S. AID.

53 Park, Hyung Jong et al 1974 "Mother's Clubs and Family Planning Clubs in Korea," quoted in Tinker (n.d.). Seoul: National University, School of Public Health.

54 Perham, Margaret 1937 Native Administration in Nigeria. New York: Oxford University Press.

55 Perlman, Michael 1979 Farming for Profit in a Hungry World; Capital and Crisis in Agriculture. New York: Universe Boods.

56 Redfield, Robert 1942 The Folk Culture of Yucatan. Chicago: University of Chicago Press.

57 Rogers, Barbara 1973 South Africa; The 'Bantu Homelands'. London: Christian Union.

58 ____________ 1976 White Wealth and Black Poverty; American Investments in Southern Africa. Westport, Conn.: Greenwood Press.

59 Rosenberg, David A. and Jean G. 1978 Landless Peasants and Rural Poverty in Selected Asian Countries. Ithaca: Cornell University Rural Development Committee Monographs, p. 17, quoted in Tinker (n.d.).

60 Rothstein, Frances 1979 "Two Different Worlds; Gender and Industrialization in Rural Mexico," in M.B. Lyons and F. Rothstein, eds., New Directions in Political Economy; An Approach from Anthropology. Westport, Conn.: Greenwood Press. pp. 249-266.

61 ___________ 1980 "Capitalist Industrialization and the Increasing Costs of Children," Paper read at the 1980 annual meeting of the American Anthropological Association.

62 Rubbo, Anna 1975 "The Spread of Capitalism in Rural Colombia: Effects on Poor Women," in R. Rapp Reiter, ed., Toward an Anthropology of Women. New York: Monthly Review Press.

63 Safa, Helen n.d. "Women, Production and Reproduction in Industrial Capicalism: A Comparison of Brazilian and U.S. Factory Workers," in J. Nash and M.P. Fernandez-Kelly, eds., Women, Men, and the International Division of Labor. Albany, N.Y.: SUNY Press forthcoming.

64 Schultz, Theodore W. 1964 Transforming Traditional Agriculture. New Haven: Yale University Press.

65 Scrimshaw, Nevin S. and Lance Taylor 1980 "Food," Scientific American 243, 3: 78-88.

66 Scudder, Thayer and Elizabeth F. Colson 1972 "The Kariba Dam Project; Resettlement and Local Initiative," in H.R. Bernard and P.J. Pelto, eds., Technology and Social Change. New York: Macmillan Co.

67 Sheehan, Glen and Guy Standing 1978 "A Note on Economic Activity of Women in Nigeria," Pakistan Development Review 17: 253-261.

68 Shimpo, Mitsuru 1976 Three Decades in Shwa; Economic Development and Social Change in a Japanese Farming Community. Vancouver: University of British Columbia Press.

69 Stoler, Ann 1977 "Class Structure and Female Autonomy in Rural Java," in Wellesley Editorial Committee, Women and National Development; The Complexities of Change. Chicago: University of Chicago Press.

70 Stravakis, Olga and Marion Louise Marshall 1979 "Women, Agriculture and Development in the Maya Lowlands; Profit or Progress," ISIS International Report 11 (Spring): 10-13.

71 Strom, Gabriele Winai 1978 Development and Dependence in Lesotho, the Enclave of South Africa. Stockholm: Libwr Tryck.

72 Tax, Sol 1950 Penny Capitalism. Washington, D.C.: Smithsonian Institute.

73 Thompson, E.P. 1978 The Poverty of Theory and Other Essays. New York: Monthly Review Press.

74 Tinker, Irene n.d. "New Technologies for Food Chain Activities: The Imperatives for Equity for Women," WID Resource Center, AID, Washington, D.C.

75 Tinker, Irene and Michele Bo Bramsen 1976 Women and World Development. Washington, D.C.: American Association for the Advancement of Science; Overseas Development Council.

76 United Nations, Food and Agricultural Organization 1979 "The Struggle for Security." Ms. May.

77 United Nations, General Assembly 1978 "Technological Change and its Impact on Women." Minutes, 26 October. A/33/238.

78 United Nations 1980 "Women in Rural Areas," World Conference of the United Nations Decade for Women: Equality, Development and Peace. A/Conf/94/28.

79 U.S. AID 1980 Women and Technology. Washington, D.C.: U.S. AID Office of Women in Development, Report to the Committee on Foreign Relations, U.S. Senate and Committee on Foreign Affairs, U.S. House of Representatives.

80 U.S. Bureau of the Census 1980 Illustrative Statistics on Women in Selected Developing Countries. Washington, D.C.

81 Weekes-Vagliani, Winifred 1976
in Manga Bekambo and Lynn Wallisch, eds., Family Life and Structure in South Cameroon. Paris: Development Centre of the Organization for Economic Cooperation.

82 Wood, Charles H. 1981 "Structural Changes and Household Strategies: A Conceptual Framework for the Study of Rural Migration." Brief Communications, Human Organization 40, 4: 338-44.

83 World Bank 1975 The Assault on World Poverty. Baltimore: Johns Hopkins Press

84 Yanagisake, Sylvia Yunke 1979 "Family and Household: The Analysis of Domestic Groups," in Annual Reviews in Anthropology 8: 161-205.

FARMING

SMALL F

ABSTRACT

By increasing yields, improved agricultural technology has contributed to substantial increases in food production over the past 30 years. However, there remains a dramatic difference between the increases in yields realized by developed countries when compared to those in developing countries. The obvious explanation for these differences, both between developed and developing countries and among farmers within developing countries, lies in the use of improved technologies and the availability of inputs (e.g. fertilizers, seed chemicals and water)

This paper demonstrates that the generally accepted solution to low agricultural production, that of simply providing access to inputs, will not always solve the problem of low yields on the part of farmers who may have had limited access to inputs in the past. Technology that is adopted by small farmers must fit the conditions under which the small farmer operates.

This paper advocates an approach known as farming systems research. Such an approach helps researchers to recognize and better understand the constraints under which small farmers operate. Central to a farming systems approach is that research be conducted in the farmer's field with strong emphasis placed upon farmer participation. It is proposed that technology generated in this way will have a higher probability of being adopted by farmers who farm under similar conditions.

Unlike conventional agricultural research which tends to focus on one commodity under controlled conditions, farming systems research examines the farm as a system and conducts its research in farmer's fields with the farmer's participation. Therefore, to the extent that farming systems research can identify and resolve problems common to the great number of small farmers, this approach should lead to increased food production and improved living conditions for small farmers.

FARMING SYSTEMS RESEARCH

AND

SMALL FARMER TECHNOLOGY

J. W. Beausoleil
Rural Development Officer
Bureau for Science and Technology
Agency for International Development

THE PROBLEM

By increasing yields, improved agricultural technology has contributed to substantial increases in food production over the past 30 years. There is, however, a dramatic difference between the yields realized in developed countries as compared to those in developing countries (5). For example, the average yields for wheat in developed countries is 1.8 metric tons per hectare and in developing countries it is only 1.1 metric tons per hectare. In both cases, the average yields have steadily increased but the increases have not been as great for developing as for developed countries.

There is another difference between the developed and the developing countries and that is that most of the farmers' yields in the developed countries are close to the average yields of that country. In the developing countries, there is a wide variation in farmers' yields around the country average (13, 18, P. 11-16). For example, the average developing country yield for rice is 2.2 metric tons per hectare with some farmers obtaining yields of over six metric tons per hectare and others with less than one metric ton per hectare. In developed countries, most of the farmers obtain yields close to the average of 5.2 metric tons per hectare.

The obvious explanation for these differences, both between developed and developing countries and among farmers within developing countries, is that improved technologies require inputs. Fertilizers, seed, chemicals, and water are available to farmers in a developed country. But this is not true for farmers in the developing countries. Inputs are limited in supply and available only to some of the farmers. These farmers have high yields. The yields for the others, who do not have access or only limited access, are much lower.

THE RESPONSE

This paper shows that the apparent solution of making inputs available will not always solve the problem of low yields by farmers with limited access to inputs. Technology that is adopted by small farmers must fit the conditions under which the small farmer operates. An approach known as farming systems research helps researchers to understand these conditions. Central to this approach is conducting the research in the farmers' fields with the farmers' participation. Technology generated in this way has a higher probability of being adopted by farmers who farm under similar conditions.

THE INPUT SOLUTION

The logical solution to the problem of lack of inputs is to make them available. But this is easier said than done. There are many different kinds of inputs which have to be procured and then distributed to a large number of farmers. Some of these inputs can be produced locally, others have to be imported. This may mean organizing several agri-businesses to perform such services as seed production, fertilizer importation, chemical manufacturing or farm supply retailing. Each of these endeavors may require the same effort or even more than it takes to introduce improved technology to farmers.

Seed is a good example of an input that can be produced locally (14, P. 6). Making an improved seed available to the farmers involves seed multiplication, cleaning, drying, certification, storage, and distribution. To organize a seed business, financial as well as technical assistance is needed. It takes time, skills, money, and above all, entrepreneurship to put in operation a seed supply company.

Fertilizer is the major input with most improved technologies. For most of developing countries, fertilizer will have to be imported. This means not only added transportation costs, and ultimately higher prices to the farmer, but also foreign exchange problems. Once the procurement of fertilizer is resolved, there still remains the problem of distributing it to many farmers often in relatively inaccessible places (16).

The task of making available the inputs required by the improved technologies is difficult but not impossible. But even if the inputs are available, there are many farmers who will not adopt the improved technologies. For these farmers, increased yields is not a sufficient motive for them to change from their traditional ways.

THE NON-ADOPTION PROBLEM

One of the reasons why some farmers do not adopt improved technology is because of consumer preference. The small farm is not only a production unit but also a consumption unit. The taste of the food or its cooking qualities are a very important consideration for the farm family. They will only accept a higher yielding food crop if it matches or surpasses the qualities of the food crop they presently grow. In Bolivia, for example, adaptive field tests demonstrated the superiority in yields of a Mexican wheat variety. The farmers tried the variety with the recommended practices but did not do so the following year even though the yields were two to three hundred percent above the local variety. On investigation it was found that the Mexican variety had a hard grain which required an industrial mill to grind. The farmers' wives found the grain too hard to grind with the domestic grinding stone.[1] A similar story comes out of Northern Thailand where an improved variety of rice was rejected because it did not meet the cooking qualities required by Thai wives. There the custom is to cook early in the day and save some rice for the evening meal. The local rice remained soft after cooling. The improved rice turned hard on cooling and so was rejected by the farmers.[2]

Dwarf varieties of wheat and rice have been rejected by some farmers because they value the straw as well as the grain. In the valleys of the Andes of South America, where straw is needed for thatching, farmers often prefer local varieties over the higher yielding improved varieties. In Southeast Asia where animals are an important part of the farming systems, the straw is used for fodder. Farmers there prefer local varieties that are taller and thus provide more fodder for their animals. They will also allow weeds to grow with the crop even though this means less grain production because weeds are also used for fodder. This is especially true of share croppers who would benefit from only half the increased production but would have to do all the additional work of weeding (1).

---

[1]Authors personal experience while working on a wheat production program with the Ministry of Agriculture in Bolivia, 1966-1968.

[2]Personal communication with Rapeepan Jaisaard, Agricultural Economist with the Multiple Cropping Research Team, Chaing Mai University, Thailand.

Farmers in many areas of the developing world have been reluctant to use chemical fertilizers because they feel that it damages the soil. It is a common opinion among many farmers that chemical fertilizers make the soil hard (16, Annexes B and C). What they fail to realize is that the improved technology places increased demands on the soil. Chemical fertilizers need water to affect plant growth. When there is insufficient rain, all the moisture will be taken from the soil leaving it dry and hard. When the soil is dry and hard, it is difficult and sometimes virtually impossible to prepare using animal traction. Using traditional methods, the farmer maintains a balance between what they put into the soil (manure) and what they take out (crops). Manure also adds organic matter to the soil. Chemical fertilizer does not do this. Organic matter can be added to the soil by plowing into the soil the stubble and other crop residue. This requires tractors. The traditional steel pointed animal drawn plow is unable to do this.

Some of the improved technology is labor intensive and conflicts with peak labor demand periods. Sowing wheat in rows rather than broadcasting it was demonstrated to require less seed and give increased production (16, Annex B). Farmers in Nepal did not change their ways because sowing in rows required not only more time but also the use of oxen and an extra hand to drive the oxen. Wheat is a dry season crop which is planted immediately after the rice crop is harvested. The sooner it is planted, the greater the yield since it will benefit from the moisture remaining in the soil from the rainy season.

Capital intensive technology is often rejected because of the added risk that it brings to the farming enterprise. Farmers are careful to make cash outlays for inputs when they have to depend on rain to make the investment payoff. If the rains are unpredictable, the risk to the farmer is increased. For example, a low yielding drought tolerant sorghum variety is preferable to a high yielding variety which requires a costly dosage of fertilizer but will have minimum yields if there is insufficient rain.

Capital investment technology makes no sense to farmers whose land tenure is not secure (8). Improved technology that calls for capital investment which has a long term payoff will not be adopted by farmers who do not have tenure to the land. Unfortunately, since their interests are directed to the present, they tend to use practices which extract more from the land than they return and the net result is environmental degradation.

It is easier to understand why improved technology is adopted than to understand why it is not adopted. The simple reason for adoption seems to be that it is more profitable. For non-adoption there are various reasons. From the examples given above, improved technology may be rejected because it does not produce a product with the qualities desired by the consumer, or it does not produce the by-product needed for the farm operation, or it is too disruptive to the system, or it is too labor intensive, or it is too risky. Or, the technology may be rejected because of a combination of these reasons. And there are many other reasons of which we are ignorant.

DIFFERENT CONDITIONS, DIFFERENT SYSTEMS

There is a difference, however, between the farmers that adopt and those that do not adopt. In general, the adopters are commercial farmers, while the non-adopters are basically subsistence farmers. The commercial farmers have larger land holdings, use mechanical equipment, and specialize in one crop. The subsistence farmers have smaller land holdings, depend on animals for power, and produce many commodities, some of which is consumed on the farm and part is sold in the marketplace (7, Chapter I). Described in these terms, the difference between adopter and non-adopter farmers is the degree of complexity of the farming operation. The commercial farmer has a larger but simpler operation whose primary objective is making a profit from a clearly defined agricultural enterprise. The subsistence farmer has a smaller but more complex operation in which many crops and different kinds of livestock are integrated. The primary objective may be self sufficiency in staple foods, or it may merely be supplemental income to off-farm employment.

In most developing countries, the majority of farmers fall into the self-sufficiency for staples group. And, although they have less than half the farm land, produce most of the food crops. For example, in Central America, (11, P. 1), the majority of farmers are small holders who farm less than 30 percent of the land but produce 70 percent of the food. This same pattern is true for Africa and Asia. Zimbabwe has only 300 commercial farmers but over 500,000 subsistence farmers (6, Preface). And in Nepal, 80 percent of the farmers there have less than five hectares of land (7, P. 53).

The small farmer is important in terms of food productio. But small farmers are not taking advantage of improved technology because that technology does not fit their circumstances. The challenge then is to develop improved technology that fits their circumstances.

FARMING SYSTEMS RESEARCH

Agricultural researchers have become more aware over the past decade of the need to do this (6, P. 86-119). The approach that many are using falls under the broad label of farming systems research. The objective of this approach is to develop technology that fits the farming situation. This means looking at the farm as a system. The main elements of farming systems research as practiced in many parts of the developing world are diagnosis, design, testing, and extension (6, Chapter 5; 15, P. 5-9). The kind of farming systems research that seems most appropriate for small farmers is that which bases its research on a thorough understanding of the farming system and conducts that research in the farmers' field with the farmers' participation.

Farming systems research that best responds to the needs of small farmers is carried out by a team of field researchers supported by a national or sub-national agricultural research institute. The field team is responsible for the research but relies on the support of the research institution and the extension service and on the participation of the farmers. Each element, or stage of farming systems research, has its own methodologies which have to be adapted to the environment in which it operates.

1. The Diagnostic Stage

An understanding of the farming systems in the target area is essential. Since available information on a particular target area is usually incomplete, the researchers have to begin by gathering additional information.

Formal surveys can provide a wealth of information. But formal surveys take time. The tendency is to collect too much data. Delays in processing the data often cause researchers to miss the start up date for field research.

Short informal surveys have proven to be as useful as formal surveys. One method, pioneered by Hildebrand in Guatemala (10), uses an interdisciplinary team of six to ten people who conduct informal interviews with farmers over a two to three day period. Hour-long interviews with farm families are conducted by paired members of the interdisciplinary team. After 30 to 40 interviews, the team has enough information to establish research priorities for field experimentation.

The informal survey has the advantage over the formal survey of getting the team into field experimentation in a short period of time. This of course is extremely important since the field testing should begin with the initiation of the farming cycle. If the timing is late, an entire year can be lost.

The team may not have been able to collect enough quantitative information as in the case of the formal survey, but for the purpose of initiating field work, it may be sufficient. The deficiency can be made up during the field trials. At that time, it is easier to do so because the researchers have a better idea of exactly the kind of information that they need.

As in the case of the formal survey, it is essential that the informal survey be done with an homogeneous group of farmers (6, P. 46). What constitutes homogeneity, will of course, depend on the particular target area and population. Homogeneity in farming systems research is understood as some commonality among the farmers that affects their production decisions. Examples of homogenous groups would be small maize and bean intercroppers in a specific agro-ecological zone; part time vegetable farmers who produce mainly for the local market; or small rice farmers who depend on animals for power. The important thing is not to mix essential elements such as land owners with share cropers, those that have irrigation with rain-fed farmers, similar types of farmers from distinct agro-zones, or monoculturalists with integrated (crops and livestock) farmers.

The collective knowledge of the team is the key to coming up with possible solutions to the problems that the farmers face. What they try to do is identify possible field experiments to test technology which seems to fit the farmers situation. They may also identify problems for which basic or applied research is required and, if so, pass this information on to the station researchers.

2. The Design Stage

Once the experiments that appear feasible have been identified, they are ranked by the field team. Depending on the resources available, two or three experiments are selected. In designing the experiments the field team seeks the assistance of disciplinary and commodity specialists. The particular specialists needed, of course, will depend on the nature of each experiment.

During the first years, the experiments should be simple until the field team has learned how to deal with the technical issues and logistics of on-farm research (4, P. 31). Also, it is important to be able to have some short-term results for the collaborating farmers.

3. The Testing Stage

The experiments are then conducted in the farmers' fields. It is extremely important that the farmers selected as collaborators are representative of the group, otherwise the purpose of conducting the experiment under farmer's conditions will be lost.

There are usually two phases of on-farm testing (9, P. 10-14). The first is sometimes referred to as field trials in which the management is under the direction of the researcher but with the concurrence and active participation of the farmer. The second phase involves farmer testing in which the farmers conduct the test with minimal assistance from the researcher. During this phase the researcher monitors the experiment and only steps in when needed.

The minimum time for the on-farm testing is two cycles. But three to four cycles may be necessary depending upon the complexity of the experiment. After each cycle, analysis of the data is made and often a redesign of the experiment takes place. A simple experiment often develops into a more complex one. Hopefully, some progress is made with each cycle.

4. The Extension Stage

Once the researchers are satisfied with the results, they recommend the technology to the extension service for dissemination. If the field researchers have involved the extension agents in the process, their cooperation for this stage is assured (2). Extension agents should be involved in the diagnostic work, should assist in selecting the cooperating farmers, and should be aware of the nature and results of the field trials.

GUIDING PRINCIPLES

Conceptually, farming systems research is a logical approach to developing technology that fits the circumstances of small farmers. The implementation of farming systems research programs particularly by national research institutions, however, has not been that successful. This is understandable considering the newness of the approach and the short time, less than a decade, in which serious efforts have been made to implement this kind of a program. The major weakness seems to be not with the concept but with the implementation. Specifically, the organizational model and operational methodologies have to be adapted to the particular institutional environment of each country, if farming systems research is to accomplish its objective. Experiences in African, Asian, and Latin American countries, thus far, would suggest that certain principles must be followed if farming systems research is to operate effectively in a specific national setting.

One principle is that the farm has to be understood as a system (13, Chapter VI). This means understanding the cropping patterns, the interrelationship of crops and livestock, the farm family as a consumption as well as a production unit, the competition from off-farm employment activities, etc. Conducting research on the farmers' fields and with their participation facilitates understanding the farm as a system. The weakness of the formal survey is that the date collected represents pieces of the systems and only when analysis is done is the totality understood. The informal survey technique as described above combines both collection and analysis. Although the information is more qualitative than quantitative, it does provide a quick and operational, though incomplete, understanding of the farm as a system.

The second principle is that of homogeneity (6, P. 46; 4, P. 25). Because we are dealing with a large number of small farmers, we lack the resources to deal with them on a one to one basis. But because there is so much diversity among small farmers, we cannot treat them all as equals. Some common traits must be identified and used as the basis for grouping the farmers. This will allow the researchers to work on problems that are common to the group. Homogeneity may be based on agro-ecological, resource, or institutional factors, or a combination of these.

The third principle is that the on-farm testing must be conducted with farmers that are representative of the group (9, P. 9). Otherwise, the findings of the testing will not be applicable to the other farmers.

The fourth principle is that farming systems research must be integrated into the national development program (19, P.5-9). It cannot be carried out in isolation. The field research must be part of the total national research and extension programs and these programs must be part of the national agricultural development program. Specifically, the farming systems research field teams need to be supported by the research station. Station researchers should participate in the diagnostic work, particularly on the interview teams. Their assistance should be sought in designing the field experiments. The facilities of the station are required by the field researchers to analyze their findings. The field teams should serve as a link between the farmers and station researchers. Effective feed-back from farmers to researchers should influence the establishment of the station's research agenda. The station should also serve as a link between the field researchers and the international agricultural research centers. And most importantly, the extension service should be involved in the process. Their responsibility will be that of disseminating the recommendations to other farmers.

SUMMARY

For many farmers of the developing world high yielding technology is not optimal for the conditions under which they farm and live. These farmers are generally small land holders who produce a variety of crops, rely on animals for power, consume most of what is produced, and need off-farm employment to supplement their incomes. Improved technology is being developed that fits the farmers conditions through an approach referred to as farming systems research. Unlike conventional agricultural research which focuses on one commodity under controlled conditions, farming systems research looks at the farm as a system and conducts the research in the farmers' fields with the farmers' participation. To the extent that farming systems research can identify and resolve problems common to the great number of small farmers, this approach will impact on increased food production and improved living conditions for small farmers.

REFERENCES

1. Beausoleil, J., Appleby, G., Freed, R., and Vincent, W., Report of the Farming Systems Research Team, Concept Paper submitted to the Pakistan Agricultural Research Council, Islamabad, 1981.

2. Beausoleil, J., Appleby, G., Fernandez, F., Galt, D., Hudgens, R., and Weber, M., Evaluation of USAID/Honduras Agricultural Research Project with the National Agricultural Research Program, USAID, Washington D.C. 1980, Appendices D and E.

3. CIMMYT Economics Staff. Assessing Farmer's Needs in Developing Agricultural Technology, I.A.D.S. Occasional Paper, New York, N.Y., 1981.

4. Everson, E., Beausoleil, J., Deans, R., Freed, R., and Galt, D., An Evaluation of the Small Farm Multiple Cropping Systems Research Project, USAID, Washington, D.C. 1982.

5. FAO, 1980 Production Yearbook, Food and Agricultural Organization of the United Nations, Rome, 1981.

6. Gilbert, E., Norman, D., and Winch, F., Farming Systems Research: A Critical Appraisal, Dept. of Economics, Michigan State University, East Lansing, Michigan.

7. Hagan, A.R., The Agricultural Development of Nepal, University of Missouri, Columbia, Missouri, 1976.

8. Henderson, T. H. and Gomes, P.I., A Profile of Small Farming in St. Vincent, Dominica and St. Lucia, Dept. of Agricultural Extension, U.W.I. San Augustine, Trinidad, December, 1979.

9. Hildebrand, P.E., Socio-Economic Considerations in Multiple Cropping Systems, paper presented at the XVI Annual Reunion of the IICA, Santa Domingo, D.R., 1977.

10. _______________, Summary of the Sondeo Methodology Used by ICTA (mimeograph), ICTA, Guatemala City, Guatemala, 1979.

11. Hobgood, H., Bazan, R., Ehrich, R., Escobar, F., Johnson, T., and Lindenberg, M., Central America: Small Farm Cropping Systems, USAID, Washington, D.C., 1980.

12. IIRI Cropping Systems Working Group, Guide to On Farm Cropping Systems Research, IRRI, Los Banos, Philippines, 1980.

13. Multiple Cropping Research Team, An Interdisciplinary Perspective of Cropping Systems in the Chiang Mai Valley, Chiang Mai University, 1980.

14. McDermott, J.K. and Bathrick, D., Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and its Impact of Agricultural Research and Farm Productivity, USAID, Washington, D.C., 1982.

15. Norman, D.W., The Farming Systems Approach: Relevancy for the Small Farmer, Dept. of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1980.

16. Simmons, E., Beausoleil, J., Ender, G., Heist, G., and Murphy, J., Food Grain Technology: Agricultural Research in Nepal, USAID, Washington, D.C., 1982.

17. Zalla, T., Sampling Procedure for Selecting Extensive Survey Sample Elements for Mandara Mountain Research Project, Dept. of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1980.

18. Zalla, T. Campbell, D., Holtzman, J., Lev, L. Trechter, D., Agricultural Production Potential in the Mandara Mountains in Northern Cameroon, Working Paper No. 18, Dept. of Agricultural Economics, Michigan State University, 1981.

19. Zanstra, H.G., Institutional Requirements for Cropping Systems Research, paper presented at the Cropping Systems Conference, March 3-7, 1980, IRRI, Los Banos, Philippines.

BARRIERS TO ADOPTION OF NEW TECHNOLOGIES AT THE FARM LEVEL

495

ABSTRACT

Required increases in food production in developing countries will increasingly depend on unprecedented rates of growth in yields. Increased agricultural research might provide the necessary technologies, but production increases also depend on the widespread and voluntary adoption of new technologies by many individual farmers.

Potential barriers to adoption are numerous, and constraining factors can change and interact over time in complex ways. The speed with which a new technology is adopted depends on factors such as the spread of knowledge, farmers' changing perceptions of the returns and risks involved, the availability of necessary farm inputs, and the capacity of local markets to adjust to increases in production. These constraints typically disappear with time, but the full uptake of new technologies may still be prevented because of stringent agroclimatic requirements, because of labor bottlenecks or because of excessive yield risks. Distinguishing between short and long term barriers to adoption can avoid much of the confusion that arises from studies that are undertaken too soon during the adoption process.

Adoption problems need to be anitcipated ex ante if necessary changes in research design are to be made. Mathematical models of farmers' decision problems can be a useful aid to such analysis, but they are too expensive for widespread application. Short cut methods for appraising farmers' technological requirements are needed.

BARRIERS TO ADOPTION OF NEW TECHNOLOGIES AT THE FARM LEVEL

Peter B.R. Hazell
International Food Policy Research Institute
Washington, D.C.

INTRODUCTION

During the next decade, the demand for food is likely to grow faster than the capacity of most developing countries to produce it. The problem is exasperated not only by population increases, but by the very success of rising incomes in many Third World countries, since these gains translate into significant increases in the per capita demand for food (Mellor). At the same time, the availability of new land that can be brought into cultivation, either through reclaimation or multiple cropping, is much more limited than in the past.

The required productivity growth will increasingly have to depend on unprecedented rates of growth in per acre yields. These increases depend on the development of new technologies embodied in crop varieties which have high yield potential, or are adapted to low productivity soils, shorter growing seasons and other unfavorable environments. The rapid growth of support for agricultural research at the national and international levels attests to the growing recognition of these facts. Of equal importance with the generation of new technology is the availability of inputs which are complementary to the new technology, particularly fertilizer and water.

Last, but by no means least, is the question of farm level adoption of the new technologies. In most developing countries, adoption decisions are made by a multitude of small farmers, each acting as a free and independent agent. These farmers must be persuaded that new technologies are advantageous for their own goals if they are to adopt them.

WHAT IS A NEW TECHNOLOGY?

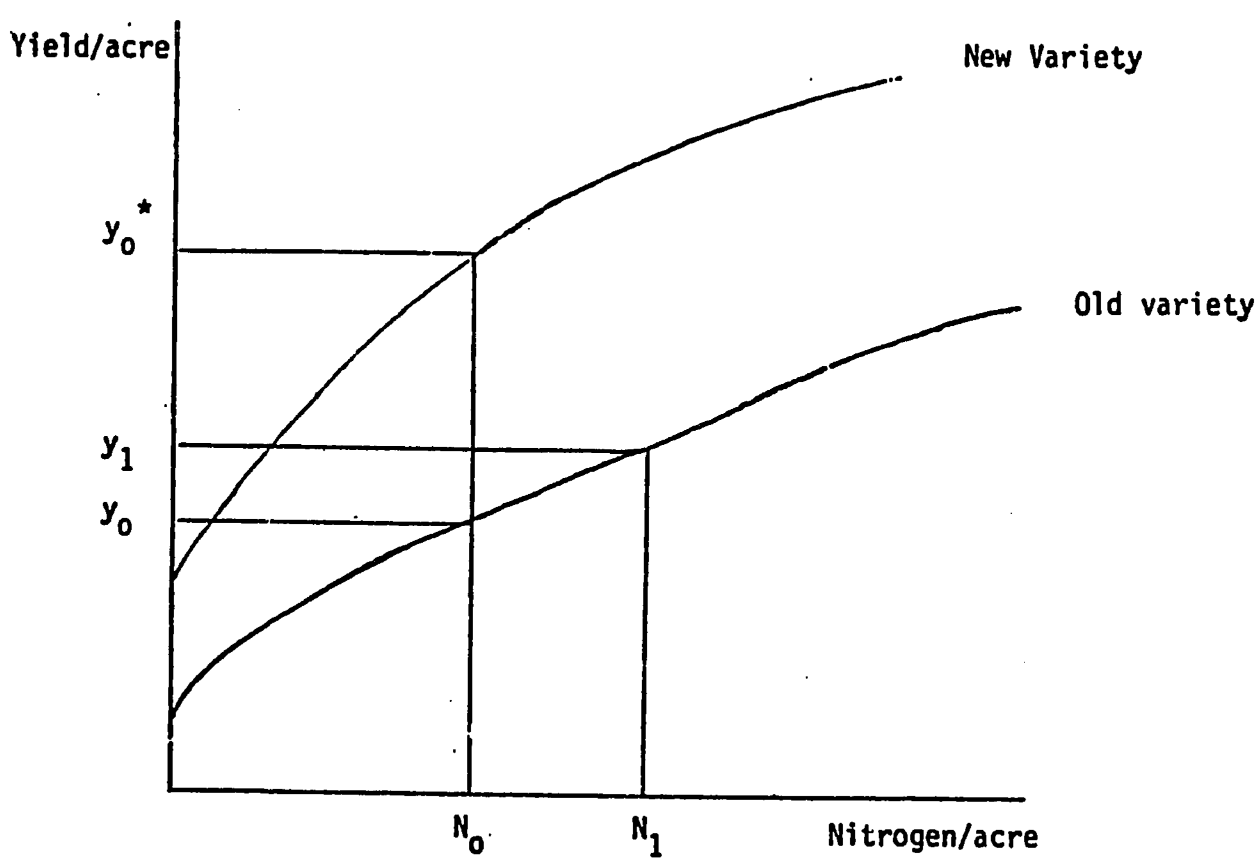
In addressing the adoption problem it is necessary to be clear from the outset about what we mean by a new technology. I want to avoid the difficulties that arise in pursuing a precise economic definition (e.g. Bell), but on the other hand, the simple and appealing definition proffered by Anderson and Hardaker--"a new technology is a different way of doing things down on the farm"--will not suffice.

If a production function $Y = f(X_1,...,X_n)$ relates the maximum crop yield per acre (y) attainable with different but permissible combinations of inputs (X_j), such as seed, fertilizer and weeding labor, then I shall take the function f( ) to define a technology. Changes in the combinations of inputs represent movements along the production function, e.g. using more or less fertilizer, and are better described as alternative "techniques". However, a change in the quality of seed which leads to a structural shift in the production function, and increases the per acre yield with the same level of inputs, is clearly a "new technology".

These concepts are illustrated in figure 1 where yield/acre is graphed against nitrogen use. With the old technology (old variety) an initial application of N_o units of nitrogen per acre gives yield y_o. If the nitrogen application is increased to N_1 units/acre, the yield increases to y_1. This is an example of a change in technique.

Consider now the introduction of an improved seed which shifts the whole nitrogen response function upwards (new variety). The original application of N_o units of nitrogen/acre now leads to a yield of y_o*, and which is clearly greater than y_o, even though the "technique" of production is the same. The new variety is an example of a new technology.

Figure 1. Illustration of Techniques and Technologies



The distinction between techniques and technologies is a useful one, because the barriers to the adoption of each are likely to be different.

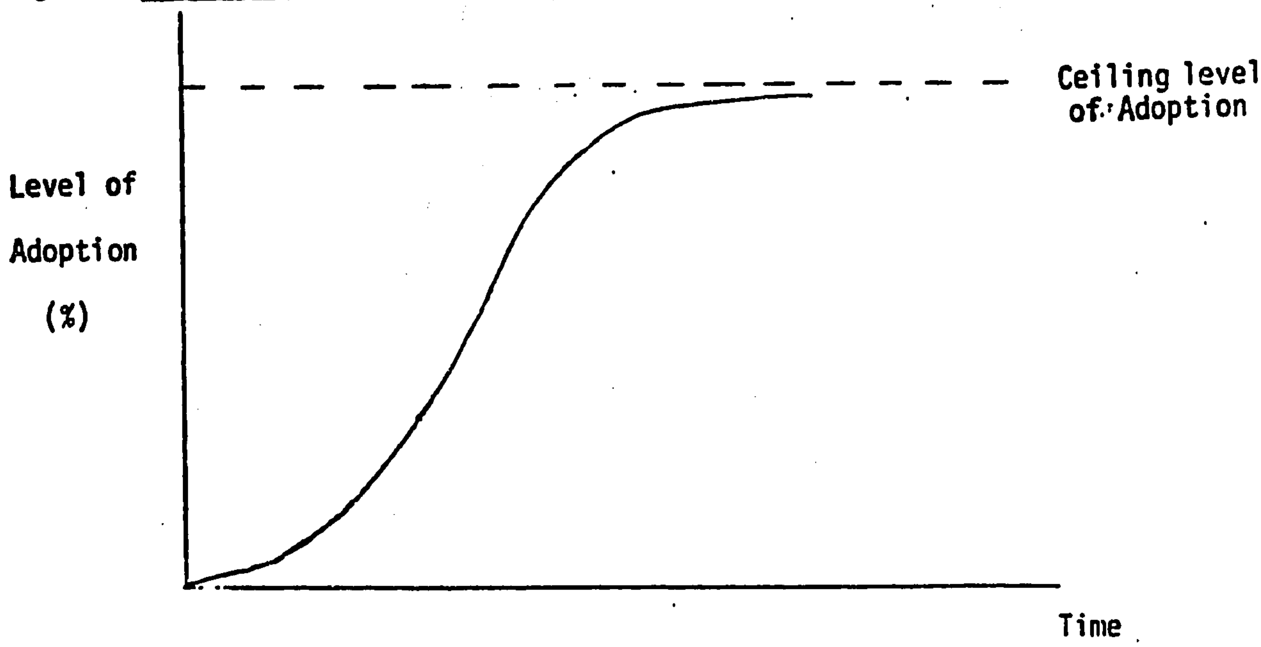
Choices of technique are typically decisions about which the farmer has a good deal of knowledge and experience. For example, decisions about how much nitrogen to apply, or how much labor to hire for weeding, are recurrent decisions which require adjustment whenever prices or wages change. New technologies on the other hand represent something new and uncertain, and may require a major reallocation of resources, as well as changes in techniques.

THE DYNAMICS OF ADOPTION

The adoption of a new technology is a dynamic process. Initially only a few of the more progressive farmers in a region may have knowledge or access to an improved seed variety. But as their experience is observed by others, knowledge spreads, and this growing enlightenment is hopefully accelerated by farm extension and the skillful use of mass media. Mathematically the spread of information is not much different from the spread of an epidemic, at least in societies where the role of mass media is limited. Not surprisingly, therefore, a plot of the level of adoption against time leads to the classic sigmoid curve for horrible diseases (Figure 2).

The level of adoption initially accelerates quite rapidly until a good share of the population is affected, and then it begins to slow down as new converts become harder to find. Eventually, the curve peaks out when all the potential adopters have been reached. This "ceiling" level need not correspond to full adoption, because there may be long run barriers to adoption for some individuals. Griliches found patterns of this kind in his classical study of adoption of hybrid corn in the US during the 1930s and 1940s.

Figure 2-Sigmoid Curve for Level of Adoption



The determinants of the speed with which farmers adopt a new technology are likely to be different from any long term barriers which prevent full uptake. Recognition of this fact can help prevent a lot of the confusion which abounds in the literature. Often, studies of adoption problems are undertaken too soon, and the analyst ends up with an understanding of short term restrictions which disappear with the passage of time.

Since the kinds of considerations which effect the speed of adoption are rather different than long term barriers to the ceiling level of uptake, it will be useful to separate them in our discussion.

DETERMINANTS OF THE RATE OF ADOPTION

Knowledge is widely thought to be the key to explaining why some farmers adopt a new technology before others.[1/] Knowledge about the existence of a new variety may spread quite quickly, and particularly in this age of mass communication. But more intricate knowledge about the required cultural techniques for the new variety (seeding rate, planting dates, fertilizer response etc.) are not so easily or cheaply obtained.

Knowledge of this kind tends to spread through demonstration by successful farmers, and by agricultural extension. This leads to differential rates of acquisition, where the farmer's age and education, size of farm and ease of access to roads and service centers play their roles in determining which kinds of farmers learn first.

Knowledge about new technologies must also extend to knowledge about the returns from adoption, and which in a risky world necessitates judgements about alternative possible outcomes of yields and profits. These in turn depend on unknown weather, pest and price variables. Full information on risk is rarely available for new technologies, simply because they are new. Consequently, farmer's perceptions about risk may dominate the adoption decision in the early years, and particularly if the early years happen to be unfavorable.

If farmers form their risk perceptions in a rational way, then eventually, with the passage of enough years, their perceptions should converge to the true objective risks relevant to their environment (O'Mara). But in the early years farmers may have exaggerated perceptions of the risks involved, and those who tend to underestimate the risks will adopt first. Of course, the more profitable a new technology is, the less likely are risk perceptions to impede its adoption.

In addition to differentials in access to knowledge, farmers may be confronted by important differentials in access to inputs and markets.

The availability of improved seed may be limited at first, until seed companies or public funded agencies have had time to multiply the initial stock. During this period some farmers may have preferential access, and particularly the larger and more progressive farmers who are often selected by extension agents for early adoption, so that they can provide a favorable demonstration effect.

If the new technology involves a substantial increase in aggregate production, or the expansion of a new crop, there may be initial lags in the development of transportation, processing and marketing channels, and which will act to slow the rate of adoption, particularly for those farmers more removed from the hub of market activities.[2/]

Differential access to credit is frequently used as an explanation of why large farmers adopt before small farmers.[3/] However, von Pischke, and Perrin and Winkelmann have argued that own and informal credit is probably much more readily available than thought within rural areas, and it is only when the new technology is but marginally more superior than existing technologies that the subsidies inherent in most public credit schemes become important in swinging the decision to adopt.

Finally, one temporary phenomenon that is often overlooked is the possibility that as more and more farmers adopt a yield improving technology, the increase in aggregate output will act to depress the market price. This effect will be greater the more inelastic the demand curve, and it can lead to two consequences. Kislev and Shchori-Bachrach have argued that as the price declines, the initial adopters will tend to give up the new technology in the quest for even more efficient methods of production.

This argument is based on the assumption that the initial adopters are more skilled, and hence have higher opportunity costs for their labor. With higher marginal costs, they are the first to find the new technology unprofitable as the price declines. Nevertheless, the technology may continue to be attractive to more tardy adopters who have lower opportunity costs.

On the other hand, if the new technology is clearly superior and acts to substantially reduce costs per unit of output (as with the HYV's), then the price decline need not impede the adoption of the improved technology, but it may lead to substantial adjustments in the amount of the crop grown by different types of farms, including a reduction in the total acreage grown. Scobie and Posada, for example, show that the introduction of HYV rice in Colombia in the mid 1960s lead to rapid adoption, but a subsequent sharp decline in rice prices bore very heavily on small upland farmers, and particularly on those whose agroclimatic conditions were unsuitable for the HYV's.

In a dynamic setting with continuously growing demand due to growth in population and incomes, these price effects should be a "short term" phenomena. But they will not be if technological change is also dynamic with a succession of cost reducing technologies. Witness for example the long term price problems in American agriculture.

Left to their own devices, short term barriers to adoption should disappear with the passage of time. The Norfolk four course rotation successfully spread throughout much of England in the last half of the eighteenth century, long before the days of government intervention through agricultural extension or farm credit schemes. Ruttan has also observed that while smaller farmers and tenants tended to lag behind large farmers in the early years following the introduction of HYV's, these lags typically disappeared within a few years. And they disappeared almost overnight in areas such as the Indian Punjab when HYV wheat was introduced in the mid 1960s.

But speedy adoption is more important today. Not only is the extra food required, but development experts and policy makers often need to see quick success to justify their efforts and positions. When project funding is involved from international development banks, it is also necessary to show a respectable rate of return on the capital invested. Given the peculiarities of the discount formula, only those production increases obtained in the early years of a project have much impact on the overall rate of return.

LONG TERM BARRIERS TO ADOPTION

The "ceiling" level of adoption is possibly most determined by the agro-climatic suitability of the new technology. New technologies that depend on irrigation will clearly not be grown on farms that do not have access to water. But on a more subtle levels, small variations in topography, soils, altitude or rainfall can make the difference between whether a new technology is suitable or not. Perrin and Winkelmann give an example from Turkey where improved wheat varieties were rejected in one village even though neighboring villages had adopted them. The problem was found to be the slightly higher elevation of the rejecting village, where frost problems precluded use of the new varieties.

This problem is particularly acute in the development of improved seed varieties, and underscores the need for increased emphasis on local research to modify and adapt new genetic material to local conditions.

Labor bottlenecks can also be a real barrier to adoption for some kinds of farms, and in some regions. High yielding crop varieties not only add to total labor requirements, but they often exasperate seasonal peaks in labor requirements. Peaks typically occur at planting, weeding and harvest times. Also, if the new varieties have a shorter growing season, and permit additional multiple cropping, there may be a consequent overlapping of the harvesting and planting of successive crops, with very sharp increases in seasonal labor requirements.

Unless local labor markets are elastic, increases in seasonal wage rates may quickly dampen the profitability of new technologies, and particularly for larger farms which cannot get by with family labor alone. Adoption may then depend on complementary and expensive investments in farm mechanization.

Protracted difficulties in obtaining fertilizer or pesticides may also be a barrier to adoption for some technologies. The problem is often not so much the availability of these inputs, but the difficulty of getting them at the right time. Supplies of fertilizer and pesticides may also be very uncertain, being subject to the vagaries of government policy in dealing with foreign exchange crises. Nigeria, for example, has recently restricted the import of fertilizers because of foreign currency difficulties. A similar policy was adopted in 1978, although this was later relaxed.

Risk aversion may also play a role in long term adoption problems. Farmers are generally risk averse (see Binswanger, for example), although there is considerable variation in their behavioral patterns. If a new technology is clearly superior to an established technology in the sense that the return will be greater no matter what happens to the weather, prices etc., then risk aversion is not likely to deter farmers from adopting (Anderson). But if the new technology is not superior under all possible eventualities, then differences in risk attitudes can play a role, even when perceptions about the riskiness of the new technology are correct.

Small farmers are usually thought to be more risk averse than large farmers, because they can least afford to take risks. If so, then they should be more reluctant to adopt new and risky technologies, even when these are more profitable on average.

Surprisingly, the empirical evidence on the importance of risk in adoption decisions is not conclusive. Roumasset has long touted his finding that risk does not explain fertilizer decisions amongst Philippine farmers growing rice under irrigated conditions. Walker also found that adoption of a hybrid corn in El Salvador was not affected by differences in risk attitudes. On the other hand there is considerable evidence to show that risk attitudes do effect cropping patterns (e.g. Hazell et al). Possibly, differences in the relative levels of risk involved in alternative crop technologies or production techniques are too small for risk to play an important role in these decisions. Risk should be more important though in choosing amongst lumpy technologies, such as the purchase of livestock or tractors, though I am not aware of any studies of this issue.

While there are a number of theoretical and empirical discussions about the possible impact of tenurial arrangements on adoption decisions, there is currently little consensus in the economics literature. In a recent review, Feder, Just and Zilberman conclude that:

"Any observed effect of tenancy may be indirectly due to the implied relation between tenure and access to credit, input markets, product markets, and technical information. If these relationships differ in different sociocultural environments, empirical results may seem conflicting if the underlying factors are not considered directly. Thus, a lack of clear empirical results on the relationship between tenure and adoption may be due to the fact that many factors are yet to be considered appropriately."

SOME ISSUES IN STUDYING BARRIERS TO ADOPTION

Adoption studies often fail to consider the dynamics of the adoption process, and are undertaken too early to reveal the long term barriers that determine the ceiling rate of adoption. Several green revolution studies fall in this category; they lead to incorrect conclusions in the 1970's about the limitations of the HYV's. (For example, see Farmer, and especially the chapter by J. Harriss; HYV's are now almost universally grown in the North Arcot study area).

Another problem has been the lack of an adequate theoretical model of adoption decisions to enable adequate distinction between true "barrier" variables and their surrogates. It seems likely, for example, that farm size is a surrogate for more fundamental problems such as access to credit and other inputs, capacity to bear risk etc. (see Feder, Just and Zilberman). Thus, empirical verification that farm size effects adoption decisions is much less useful for policy prescription than identification of the underlying causes of the observed relation.

Adoption studies also need to recognize interdependences between some of the restricting variables. Seasonal labor bottlenecks or risk consideratio for example, may on their own only explain a small part of the reason why farmers don't adopt. But when both factors are considered jointly, an overpowering case against adoption may sometimes emerge.

These kinds of inter-relationships can be handled through multivariate regression analysis, where rates or levels of adoption are regressed against a set of explanatory variables. Another approach is to build mathematical programming models of the farmer's decision problem, and to attempt to simulate or predict his response.

Benito constructed such a model for a peasant farm household in the Puebla area in Mexico. His model incorporated risk preferences, credit constraints, and the opportunity cost of labor in temporary and permanent non-farm employment. The new technology, in this case a package of inputs for increasing maize yields, also required that the farmer allocate time to organizational activities in the form of cooperative activities with other farmers to obtain the necessary inputs and credit. The model successfully explained the low level of adoption observed in the Pueblo project after seven years of experience, and showed how farm size, risk, and off-farm job opportunities impinged on the adoption decision.

I have used a similar approach in a World Bank study (unpublished) of adoption problems in northern Nigeria. In this case the Bank initiated a project which, _inter alia_, was supposed to increase cotton production in what is basically a semi arid, subsistence farm economy. Farmers typically grow sorghums, millets and cowpeas in various intercropped mixtures, and small amounts of cotton and groundnuts as cash crops. The traditional practice is to grow the cotton in combination with millets or cowpeas, and to plant quite late in the season. The Bank project called for an improved cotton variety to be grown as a sole crop, and planted in the early part of the rainy season. Fertilizers and pesticides were also recommended and supplied by the project. Despite the apparent profitability of the new technology, very few farmers adopted the recommendations.

Using a farm modelling approach, my analysis showed that risk was not an important consideration in the adoption decision. However, seasonal labor bottlenecks were. During the early part of the growing season, family labor turned out to have a high opportunity cost in growing the basic food-crops, and cotton was unable to compete at that time. By the time these crops were established, and labor became available for cotton, the season was too far advanced to allow high cotton yields to be achieved (expected yields were estimated to decline by 100 kgs/ha per week for each week's delay in planting after mid-June). The new cotton technology might have been more widely adopted if there had been more widespread opportunities for hiring seasonal labor, or if the agronomists had focused on late season cotton varieties. These results are consistent with Norman's findings in a similar area in Nigeria.

CONCLUSIONS

The potential barriers to the adoption of new technologies are numerous, and the constraining factors can change and interact in complex ways over time as the number of farmers that have adopted increases. Attempts to sort out these constraints and to identify the more important ones in an *ex post* setting can be exceedingly difficult. Furthermore, studies which are undertaken too soon during the adoption process, or which focus on only one or two determinants, whilst ignoring others, can be very misleading.

Most work on adoption problems is undertaken in an _ex post_ setting. Yet if new technologies are to be more rapidly developed for widespread adoption, as growing food shortages require, then adoption problems must be anticipated _ex ante_ so that necessary changes in research design can be made. Mathematical models of farmers' decision problems can be a useful aid in such _ex ante_ analysis. But these kinds of tools are expensive and cannot be widely applied. There is clearly a growing need for short cut methods for appraising farmers' technological requirements, and it remains to be seen whether recent advances in farming systems research, such as Hildebrand's SONDEO approach, can meet this need.

FOOTNOTES

1/ See, for example, Rogers' pioneering work in this area.

2/ Falcon has an interesting discussion of the transport problems that arose in the Sind, West Pakistan, in 1969 after HYV rice had been introduced. "It nearly required a French-style, pitchfork rebellion to obtain more rail cars, to change government policy to permit trucks to deliver rice to the port, etc." (p. 701).

3/ See Lipton and Bhalla.

REFERENCES

Anderson, J.R., "Risk Efficiency in the Interpretation of Agricultural Production Research." Rev. Marketing and Agric. Econ. Sept., 1974.

Anderson, J.R. and J.B. Hardaker, "Economic Anaylsis in Design of New Technologies for Small Farms." A. Valdes, G. Scobie and J. Dillon, Editors, Economics and the Design of Small-Farmer Technology. Iowa State University Press, Ames, Iowa, 1979.

Bell, C., "The Acquisition of Agricultural Technology: its Determinants and Effects." J. Dev. Studies. Oct., 1972.

Benito, C.A., "Peasants' Response to Modernization Projects in Minifundia Economies." Amer. J. Agr. Econ. May, 1976.

Bhalla, S.S., "Farm and Technical Change in Indian Agriculture." Agrarian Structure and Productivity in Developing Countries, ed. R. Berry and W. Cline. Baltimore, Johns Hopkins University Press, 1979.

Binswanger, H.P., "Attitudes Towards Risk: Experimental Measurement in Rural India." Amer. J. Agr. Econ. Aug., 1980.

Farmer, B.H., Green Revolution? Macmillan Press, London, 1977.

Feder, G., R.E. Just and D. Zilberman, Adoption of Agricultural Innovations in Developing Countries: A Survey. World Bank Staff Working Paper Number 444, February, 1981.

Griliches, Z., "Hybrid Corn: An Exploration in the Economics of Technological Change." Econometrica. Oct., 1957.

Harriss, J., "The Limitations of HYV Technology in North Arcot District: the view from a Village." Green Revolution?, ed. B.H. Farmer, London Macmillan Press, 1977.

Hazell, P.B.R., R.D. Norton, M. Parthasarathy, and C. Pomareda, "The Importance of Risk in Agricultural Planning Models." R. Norton and M. Solis, editors, The Book of CHAC: Programming Studies for Mexican Agriculture. Johns Hopkins University Press, 1983.

Hildebrand, P., "Summary of the Sondeo Methodology used by ICTA," paper for a conference on Rapid Rural Appraisal held at the Institute for Development Studies, Sussex University, England, December, 1979.

Kislev, Y., and N. Shchori-Bachrach, "The Process of an Innovation Cycle." Amer. J. Agr. Econ. Feb., 1973.

Lipton, M., "Agricultural Finance and Rural Credit in Poor Countries." World Development. July, 1976.

Mellor, J.W., Third World Development: Food, Employment, and Growth Interactions." Amer. J. Agr. Econ. May, 1982.

Norman, D.W., "Labor Inputs of Farmers: A Case Study of the Zaria Province of the North-Central State of Nigeria." Nigerian J. Econ. and Social Studies. Feb., 1969.

O'Mara, G.T., "A Decision-Theoretic View of the Microeconomics of Technique Diffusion." Ph.D. Dissertation, Stanford University, 1971.

Perrin R., and D. Winkelmann, "Impediments to Technical Progress on Small versus Large Farms." Amer. J. Agr. Econ. Dec., 1971.

Rogers, E., Diffusion of Innovations. New York, Free Press of Glencoe, 1962.

Roumasset, J.A., Rice and Risk: Decision Making among Low-Income Farmers. North-Holland, 1976.

Ruttan, V., "The Green Revolution: Seven Generalizations." Int. Dev. Rev. Dec., 1977.

Scobie, G.M., and R. Posada, "The Impact of Technical Change on Income Distribution: The Case of Rice in Colombia." Amer. J. Agr. Econ. Feb., 1978.

von Pischke, J.D., "When is Smallholder Credit Necessary?" Dev. Digest, July, 1978.

Walker, T.S., "Risk and Adolption of Hybrid Maize in El Salvador." Food Res. Institute Studies. 1981.

IMPACT OF FISHERIES IN RURAL DEVELOPMENT

515

ABSTRACT

Fishery activity - as extraction or cultivation of living aquatic organism - takes place in rural areas. Artisanal fishermen and rural aquaculturists live usually in rural communities. Crew members of industrial fishing boats, and workers of processing plants are normally urban dwellers. Therefore, impact of artisanal fisheries and aquaculture development projects affect positively the basic indicators of rural life slowing down the tendency to emigrate to the cities. Furthermore, fish are an efficient source of animal protein suitable for a variety of uses, mainly as food for humans as well as for animals. Both, the extraction of natural fishery resources and the cultivation of aquatic organisms do not offer competition with agriculture or with food production for human nutrition. On the contrary, they can offer complementary operations.

The increasing demand for animal protein causes almost 50% of the world's grain crops to become diverted for animal feeding. Fish products offer excellent opportunities to participate in many ways for improving supplies of both cheap and sophisticated high value types of human food as well as highly nutritious feeds for animals.

The introduction of more efficient methods and equipment are increasing productivity in fishery activities both in rural areas and in urban industrial complexes. The effect of higher returns and income in artisanal and rural fishermen have to be oriented carefully to avoid wrong utilizations or less working hours.

IMPACT OF FISHERIES IN RURAL DEVELOPMENT

Julio Luna
Chief, Fishery and Forestry Development Section
Inter-American Development Bank; Washington, D.C. U.S.A.

Before starting discussing the impact of fisheries in rural development, it is necessary to clarify what we understand as "rural development". Since "rural" could have many dimensions and "development" is a dynamic process, the problem of conceptualization of "rural development" is rather complex. Development is a process of pursuing specific targets. Depending on the point of view adopted in the process of development, it is possible to have "socio-economic targets" or "financial targets", or a combination of both. For many people the second one is not a real "development target"; nevertheless, more than a few consider financial aims a valid target for development that generates socio-economic achievements through the financial returns of the process.

The socio-economic concept involves a double target to be obtained under a reasonable balance: (a) the improvement of the physical and intellectual level of quality of life in the area to be developed, and (b) the optimum utilization of the regional human and natural resources in harmony with conservation and improvement of the ecology.

Under the financial point of view, a development process should attain the maximization of returns from capital invested in the exploitation of the ecological resources existing in the area or region to be developed. Within the socio-economic concept, efficiency and productivity may have limitations that do not exist under the financial criteria.

It must be recognized that both concepts have a certain validity although a good combination of them has not yet been achieved.

Another important concept is the meaning of "fisheries" as an economic activity. Physically, fishery is the action of extracting (by catching or hunting) and cultivating animals and plants that live or grow normally or most frequently in the water. The economic objective of fisheries is obviously to sell the products in markets, either as fresh, preserved or transformed products.

The main use of fishery products is as food, for both humans and animals. But they can also be utilized as organic nutrients for cultivating crops and as raw material for various industrial products.

Although more than one billion human beings are undernourished or in a state of hunger, or even starving, total production of caloric foods is more than 10% over that required for a minimal diet to feed the 4.4 billion persons that inhabit this planet. With reference to animal protein there is, however, a deficit of 40% needed to reach a theoretically balanced diet for everybody.

For a long time the easy excuse to explain hunger on earth was the excessive population growth. Today there is more food than mouths to feed but we still have a great deal of hunger. The justification for hunger then pointed out the unequal distribution of income and the sad fact that there are many people who do not have the purchasing power to buy enough food. Among them, children, old people and women expecting or raising children, all of whom are unable to work for their sustenance.

Nevertheless, there is another very important factor relating to the world food problem. It is the presence of a growing "food chain" that I call the "Food Chain of Affluence", whose first link is represented by the increasing demand for animal products by middle and high income people of both developed and developing countries.

Because it is physiologically impossible to have lunch or dinner two or three times per day, the purchasing power that cannot be used in buying food in big quantities is instead used to buy food of high quality and sophistication, i.e. beef, chicken, pork, lamb or fish. From all of these sources of animal products for human nutrition, the most expensive and inefficient converter of food are bovine animals, which need between 7 and 10 units of food to produce one unit of beef (although milk is an additional product). Fish is the best food converter requiring about 1 to 2 units of food to produce 1 unit of edible meat. The fact that fish are cold blooded and that they need little effort to move in water, saves them a great deal of energy.

In addition to that, fish do not need agricultural land and do not compete for human food. According to FAO fish culture production requires 1/3 to 1/30th of the energy spent in annual agriculture crops per unit of protein. Water where fish live could be utilized for many kinds of uses, from drinking water to irrigation to hydraulic power.

Of some 220 million tons of meats produced annually in the world, fish ranks first contributing with 73 million tons. Cattle is second with some 55 million; pork comes third with 44 million tons, then 24 million tons of chicken and 24 million tons of eggs. Thirty percent of the total fishery production is, however, used for animal feeding instead of human nutrition. On the other hand, 41% of the annual yield of cereals is devoted to animal feeding. Developed countries, according to FAO, are using 72% of their cereal crops for animal nutrition.

In other words, the "Food Chain of Affluence" is detracting an enormous portion of the total food available to satisfy the demand of the wealthiest market of the world. With only 10% of the cereals spent by the developed countries for animal feedings, there would be no more hunger in this planet, provided that a good distribution system could be put into effect.

Nevertheless, the "Food Chain of Affluence" is not necessarily bad or subject to criticism. It is only a result of the fact that, with reference to food mankind has acted on the basis of financial criteria for development. The "Food Chain of Affluence" should not be destroyed. What must be done is to create "Food Chains of Austerity" under socio-economic criteria of development, in order to cover the needs of those who are out of the financial cycle.

Looking now at the relationship between fisheries and rural areas one must remember that aquatic organisms require two basic, vital elements: water and light. The most abundant and less expensive sources of those two elements are found in the vast rural space, either in the oceans or in continental waters.

Depending on the field of operations, there are two scales for fishing activities. In coastal waters or in rivers, ponds, lagoons or lakes, the technical and economic scale is called "artisanal fisheries". On the other hand, fishing operations on the high seas are defined as "industrial fisheries". The main differentiation between both these types of fisheries relates to the environment in which they operate. In shallow sea waters, as well as in fresh water areas, physical conditions of the environment do not permit the use of large boats or mechanized fishing gear for catching big quantities of fish. In addition to this physical constraint there is also a biological limitation, since excessive catches of species living in these areas would affect their survival. Productivity in this case depends essentially on the skill of fishermen in using their limited equipment, or in other words, on the fishing "art" of men. That is why this activity is called "artisanal".

For industrial fisheries, productivity depends principally upon the mechanized equipment on board of large vessels rather than on the ability of fishermen, although training and ability are also required.

Depending upon the degree of control exercised over the environment, technologies for cultivation of living aquatic organism could be classified on three categories: extensive semi-intensive and intensive aquaculture. Extensive aquaculture involves the stocking of ponds and rivers with fish from other places. No food, nutrients or modifications are introduced. Intensive aquaculture, on the other hand, may involve egg hatcheries, development of larvae and post larvae, fingerlings and growing and fattening juveniles in captivity for final collection and processing. Semi-intensive or "rural aquaculture" is the cultivation of aquatic organisms under partial control of the environment, e.g. fish in artificial ponds with no additional food.

Semi-intensive aquaculture involves construction of ponds of appropriate sizes at suitable locations, and hydraulic works for adequate flux of water. Depending upon the quality of land, water, temperature, and other environmental conditions, the correct species of fish to be cultivated must be selected by experienced professionals. Semi-intensive aquaculture normally does not require feeding fish. The introduction of fertilizers into the water to improve the natural conditions for generating food, is however often necessary. Chicken, pig and cow manure are some of the most effective and less expensive nutrients which serve that purpose. Different combinations offer the small farmer the possibility of establishing multipurpose types of farms. These units include fish ponds in the proximity of poultry yards and pig enclosures and could also be used for growing ducks.

Mariculture - that is aquaculture in sea water - also offers interesting possibilities for rural coastal areas. Mussels, oysters, clams, salmon, shrimp mullet, and milkfish are some of the best known species suitable for mariculture that are actually being exploited in many countries.

The intensive type of aquaculture is rather similar to industrial fishing. Therefore, people working in this activity may be considered more like industrial workers than as fishermen. The owner may be an individual "fish farmer" but often large enterprises or corporations exist, whose impact in rural development is the same as that of intensive agricultural exploitation

Both artisanal and industrial fishing takes place in "rural areas" either in sea water or in continental fresh water. Nevertheless, artisanal fishermen are rural inhabitants while industrial fishermen live usually in urban areas.

In most of the new developed fishing countries, however, the industrial fishermen originally came from rural areas. That was the case 30 years ago in two of the major Latin American fishery nations that are now among the first ten fishing countries in the world. Many Chilean fishermen working in the anchovy fleet came from declining nitrate mines of the Atacama desert. Also, most Peruvian fishermen were rural workers who came from the hinterland. In both cases, these people accepted a drastic transformation in their way of life, becoming new urban citizens with access to a better standard of living which was never accessible for them before.

Artisanal fishermen, on the other hand, are usually rural inhabitants or peripheral urban dwellers. Fishing for them has been a subsistence activity until development projects promoted it to the level of a market-scale activity. The impact of this change has been very interesting to observe.

When income suddenly increases by 300 or 400%, many fishermen do not know what to do with it. Sometimes their first reaction is to spend more money on leisure activities, including women and alcohol. Since tolerance for these expenditures has a limit, the second reaction is to work less hours. To cope with this matter, carefully designed programs should be introduced to help the fishermen in organizing expenditures and savings.

Access to some highly appreciated goods such as new types of stoves, beds, radios, T.V. sets (when possible), bicycles, and motorcycles, give them progress and status. Retention by their Cooperative of part of the revenue of fish sales has proved to be a good system. With these savings the fishermen can pay their liabilities without excessive sacrifice and buy better equipment, foods, medicines, and even keep reserves for contingencies.

Other interesting results of fishery development in artisanal communities has been the degree of fishermen's acceptance of new types of boats and fishing gear. For centuries they used primitive "cayucos" made from logs, and nets manufactured with natural fibers of short life. The initial reaction of senior fishermen was reluctance to accept these methods due to lack of confidence, and because none of them likes to publicly recognize their ignorance about more productive methods of work. Young men, on the contrary, have been most interested and most involved in the new types of operations. This is very important since young people in rural areas are inclined to abandon their communities and emmigrate to the cities. After a short initial period, many crew members of new boats are children of the old fishermen who have preferred to remain on land in charge of the logistic support of the new fleet, taking care of supplies, net repairing, and boat maintenance.

The more productive fishing methods sharply increase the fish output of the artisanal communities making it necessary to process part of the fish to avoid spoilage. Women and children of the community are usually employed in these new activities. Women demonstrate great ability in handling the fish and preparing fish fillets, fish portions, and for smoking and drying fish. In many places women take care of marketing the fish with better efficiency than traditional fishermen. Participation of women in these operations represents a very important achievement in the development of rural communities. The family relationship gains a great sense of partnership, as they share responsibilities.

The circumstances of artisanal fisheries in rural areas discussed previously are also valid for semi-intensive types of aquaculture. In this case there is a clearer sense of ownership of the fish, since this fish is not coming from the natural environment but is a product reared by the fish farmer himself.

Furthermore, fish offer a good inexpensive source of animal protein for rural communities. "Going fishing" for lunch or dinner is stimulating to family activities. Preparation of fish, in spite of the opinion of some urban housewives, is much simpler and brief than the preparation of some other meats, especially pork or chicken.

Fisheries is a growing economic activity. Its contribution to the supply of low cost food for both humans and animals is rapidly expanding. Fish is already an important component of the "Food Chain of Affluence" as well as a solid basis for many kinds of "Food Chains of Austerity". Aquaculture in fresh brackish or sea water represents a novel productive and enjoying activity for many rural communities. It does not compete with agriculture; on the contrary, every day it seems more complementary to agriculture, forestry, energy from hydraulic source, irrigation and animal husbandry. Therefore, the effects of fisheries for rural development are positive and permanent.

FISHERIES MANAGEMENT AND RURAL DEVELOPMENT

Previous Page Blank

ABSTRACT

Development activities in fisheries often lead, paradoxically, to a net decrease in the value of output produced unless appropriate management is simultaneously introduced. Even in those cases where, absent management, there are net gains, further improvements may be possible with management. It is important to realize, however, that management activities (administration, research, and enforcement) are costly, and these costs must be weighed against potential benefits before instituting a management regime. Unfortunately, in most countries management and development often operate independently and, as a result, fisheries do not produce the national benefits of which they are capable.

FISHERIES MANAGEMENT AND RURAL DEVELOPMENT

Lee G. Anderson
College of Marine Studies and Department of Economics
University of Delaware, Newark, Delaware

INTRODUCTION

The subjects of fisheries management and economic development have both received considerable attention. Further, much has been written about economic development as it applies to fisheries. In addition to the many problems that are common to all development projects, fisheries programs also face such issues as a fugitive resource as the basic productive input, a highly perishable product, and potential international conflicts over accessibility to stocks. However, there is an equally important and, perhaps more direct, intersection of these two subject areas, which while fairly straightforward, has received surprising little attention heretofore, both in the literature and in real world practice. This is the role of fisheries management in a fisheries development context. The topic can be introduced quite briefly, but as is so true in many other instances, fairly easy concepts are often overlooked while concentrating on more conceptually difficult problems. The purpose of this paper is to show how important fisheries management can be even in developing fisheries. While the nature of this relationship is easy to comprehend, constructing fisheries development projects that properly consider it can be quite difficult, therefore, some practical suggestion are also offered.

THE PARADOX OF DEVELOPMENT IN OPEN-ACCESS FISHERIES

Development projects in fisheries are fundamentally different from most other economic development projects due to the fugitive nature of fish stocks. In most countries in the world today, all that is required to fish is ownership or control of the appropriate gear. Since there are no explicit property rights to the fish, they are fair game for all. This gives rise to what I call "the paradox of development in open-access fisheries". Simply put, the paradox is that otherwise potentially profitable development activities in open-access fisheries will result in lower gains (and sometimes even net losses) than would be possible if proper concern were given to management. The paradox of development in open-access fishing can be explained as follows. Successful development projects lower the cost of fishing, and therefore more people find it profitable to fish. This results in an expansion of the fleet and a reduction in fish stocks. Therefore, the net effect of the project is more effort catching less fish from a smaller stock at higher costs. For a more detailed explanation of this see Anderson (2)

In some sense the paradox is a result of a bureaucratic dichotomy between management and development activities. In most industrialized fisheries throughout the world, it is realized that some form of limitation on harvest is necessary to protect the stock and to maintain economic efficiency in harvest. See Anderson (1) and Gulland (3). At the same time development activities, which involve the opening of new stocks to exploitation or introducing technology improvement in existing fisheries, are also seen as legitimate roles of government. Development activities are justified on the ground that there are often barriers to development such as lack of markets, inadequate infrastructures (i.e., lack of ports, cold storage), and inadequate access to capital markets for boat construction. These barriers can prevent proper utilization of existing stocks by the optimal amounts and types of equipment. However, management and development are often considered independently. Indeed in many countries, they are under the control of different agencies with weak or non-existent linkages between them. It is unfortunate that the link between management and development is not recognized or is ignored. Development activities are analogous to stepping on the accelerator, while management activities are like putting on the brake. It is not difficult to see that an automobile could not be run very efficiently if the accelerator and the brake were run by competing or non-communicating interests.

With respect to rural development of fisheries, however, the problem is even more complex. In industrialized fisheries, management and development are both ongoing activities and in order to break the paradox it is only necessary to make the connection between the two. In rural fisheries, however, most government attention is given to development. Before the paradox of open-access development can be broken in this case, it is first necessary to show the need for management, build management institutions, and finally to integrate development and management activities.

In many instances, of course, primary focus on development in rural fisheries is quite appropriate. Providing employment opportunities and food in poor sectors is very important and the rewards achieved by building boats, piers, and processing facilitites can easily be discerned. Without a doubt, rural fishery development must start by building or improving the basic capital equipment of the fishing industry. To look at it the other way around, it makes little sense to institute management regimes in a fishery that is completely unexploited. However, once successful exploitation is assured, even in the most fundamentally artisanal fisheries, the potential benefit of fisheries management should be considered. For one thing, management is easier to impose at the outset than to wait until the fishery is overexploited and then face the problem of removing men and equipment from the fishery. In addition, management can potentially result in a better allocation of resources and hence a higher value of goods and services in the economy. A properly designed development program should consider all avenues of possible improvement and then allocate its scarce resources according to the relative net returns. At the margin, if management produces more net benefits than do other development activities, even if the benefits are not as easy to see, appropriate regulations should be introduced.

However, it is important to realize that management is costly. It requires the collection and analysis of biological and economic data as well as the formation, institution and enforcement of management regimes. It can also have effects on the distribution of income, culture, and lifestyle of the community that must be considered.

In view of the above, there are two types of errors that can be made with respect to fisheries management in rural areas. The first is to ignore management altogether and thereby suffer the effects of the paraodox of open-access development. The second is to institute management programs that are either not needed or are too costly. In certain instances management is not needed because there may be cultural restrictions that prevent the paradox from taking place. For example, in certain villages tradition decrees that only a limited number of people are allowed to fish. Therefore, developmental activities that raise returns to these individuals cannot encourage entry and the dissipation of any benefits. In other instances the cost of management may simply be larger than any potential benefits and therefore even though the paradox holds, the introduction of management would actually cause the situation to become worse.

PRACTICAL PROBLEMS OF RURAL MANAGEMENT

To avoid making either of the two types of errors mentioned above, each rural development fisheries project should be considered on a case-by-case basis. One of the things that is important in determining how much management is necessary in a particular fishery is the ability to collect and analyze data, and to make and enforce management regulations using that data. This can be a difficult and expensive and may be inappropriate for some of the more primitive artisanal fisheries. However, it is surprising how much valuable information suitable for making management decisions can be obtained in a fairly routine manner by monitoring landings.

Another important factor is the degree of biological or economic interdependency between rural artisanal and industrialized fisheries. If the fish that are harvested by artisanal fishermen are also harvested by industrial fleets, some sort of allocative or distributive management will probably be necessary or artisanal fishermen will loose the battle for fish. Yet, depending upon the real opportunity costs of operation and other goals of management, it may well be desirable to allow artisanal fleets preferential access to the stocks. This may not be sufficient, however, because the sum total of artisanal fishing effort may put undue pressure on the stock, espeically in the presence of development projects. Therefore, additional management strategies may be necessary to relieve this pressure.

Another factor which is important in determining the need for regulation is how it will affect or be affected by other government policies. If the government is concerned with earning foreign exchange from the export of fish products, then the amount of catch will perhaps be as important as the actual employment generated. Therefore restrictions on effort that reduce employment but increase catch by allowing the stock to increase may be a desirable facet of an overall governmental policy. On the other hand, if the government has a strong incomes policy, losses in total catch and economic efficiency will be acceptable if they provide jobs to individuals who would have otherwise been unemployed.

It should be pointed out that while a considerable amount has been written on managing industrial fisheries, there has been very little work on management of artisanal fisheries. Most fisheries regulation theory has dealt with vessels that are owned by small companies or individuals that can operate much like companies and it is assumed that the management authority is part of the system. In rural artisanal fisheries, however, the basic fishing enterprise is a small family unit with little financial resources. Their limited range of activities may cause them to react differently to regulations than received theory would lead one to believe, especially in the short run. At the same time the management authority is often viewed as part of the system. For these and other reasons, there is a need for considerable research on the nature of fisheries management institutions and regulations that will be most suitable to the difficult problems facing rural artisanal fisheries.

SUMMARY

While fisheries development is subject to similar problems faced in other sectors of an economy, there are others that are peculiar to it. Among them is the paradox of development in open-access fisheries that results in the almost inevitable loss of some of the potential benefits of development through overextension of the fleet and overutilization of the fish stock. The paradox can be eliminated, or its effects can be reduced, through implementation of management programs that are appropriate for the particular biological, economic, and social characteristics of the fishery.

REFERENCES

(1) Anderson, Lee G. 1977. The Economics of Fisheries Management. The Johns Hopkins University Press, Baltimore.

(2) Anderson, Lee G. 1982. "The Role of Management in Fisheries Development." Department of Agricultural Economics Working Paper. University of Wisconsin, Madison.

(3) Gulland, John. 1974. The Management of Marine Fisheries. University of Washington Press, Seattle.

FROM LABORATORY TO LABORER:

NOTES ON THE SUCCESSFUL DELIVERY OF NEW TECHNOLOGIES

IN THE DEVELOPING WORLD

537

ABSTRACT

This paper presents a number of practical techniques for the diffusion of new technologies. based on discussions with field practitioners in eight developing countries. Based on a seven step technology delivery model, the paper develops 21 technology acceptance factors (TAFs). These are project design or implementation rules of thumb that increase the probability of technology acceptance by local users. Examples of each are given, drawn mostly from small-scale renewable energy projects in Asia and the Caribbean. Particular attention is given to the TAFs concerned with the identification of the local set of basic needs, involvement of the local community and/or entrepreneurs, and operation and maintenance. These three sets of factors appear to be particularly crucial to long-term user acceptance of new technologies or techniques. The paper also briefly discusses new research required to integrate these findings into the existing literature on technology diffusion.

FROM LABORATORY TO LABORER:

NOTES ON THE SUCCESSFUL DELIVERY OF NEW TECHNOLOGIES IN THE DEVELOPING WORLD

John H. Ashworth
Associates in Rural Development
Burlington, Vermont

PART I

PRACTITIONERS VS. ANALYSTS

INTRODUCTION

Over the past twenty years, scholars have developed extensive literatures on technology diffusion and technology transfer. Starting with the path-breaking synthesis of Everett Rogers and his colleagues (Rogers, 1962; Rogers and Shoemaker, 1971), numerous subspecialties have been created, focusing on the process of the movement of concepts, techniques and goods; the role of change agents in promoting this movement; on the moral and political implications of technology transfer or its absence (Goulet, 1977); and on the problems posed for sovereign nations of transnational firms, associations, and information networks (Vernon, 1971; Chudson and Wells, 1971; OECD, 1975; Vaitsos, 1970). Inherent in all of these strands of scholarship is the search for a unifying analysis, a universal theory derived from case studies and cross-cultural comparisons that will allow us to comprehend the nature of the interaction between man and machine, as well as between the inherent nature of the innovation and its acceptance or rejection by the surrounding society.

For the field agent or project manager seeking to introduce new machines, agricultural practices, or modes of behavior, such analysis is interesting but normally irrelevant. What he or she is seeking is technique--proven methods for influencing behavior in a particular direction. He or she does not necessarily have to understand the intellectual underpinning of technology diffusion technique to use it successfully, any more than he or she has to understand the internal circuitry of a pocket calculator to add a column of figures. An extension agent is often searching for tools to achieve specific project goals, which may be only tangentially connected to overall program objectives. For example, providing demonstrations at a country fair may be an effective low-cost approach for soliciting initial local interest in solar fish dryers, while the overall long-term program goal may be to increase the amount of high-quality protein in the local diet.

Technology diffusion techniques, although invaluable for project management, are often difficult to collect and objectively assess. First, they are often created in splendid isolation and are closely held by their developers. This may be justified, due to local cultural and social constraints For example, techniques that were successful in producing the acceptance of a new hydroelectric power package by isolated entrepreneurs in the mountains of Nepal may not have much application in other South Asian nations. However, the lack of rapid transmission of successful techniques is also likely due to the fact that field project managers function in isolation. Wrapped up in day to day management problems, they learn about techniques that have proved successful in similar projects through an uncertain (often haphazard) anecdotal network. Practical problem-solvers tend to not conduct systematic searches for available technologies and techniques, but to rely on their own intuition or on information passed sporadically from other practitioners they personally know and trust. The exceptions are those that are tied to a formal information exchange network, such as the agricultural extension system, but even these networks tend to focus more on new scientific breakthroughs and equipment than on the exchange of personal experiences.

Second, since technology delivery* techniques developed in the field are often not tied to any underlying model of human behavior, their developers often have very limited confidence in their applicability even to related problems. Experienced extension agents will explain in great detail a program that has worked repeatedly in one application--for example, the training of local metal fabricators to produce simple, sturdy hand water pumps--but are unwilling to speculate on the best technique for introducing other prototypes to similar target audiences.

Nonetheless, contained within the observations of experienced field managers are valuable lessons for the technology diffusion analyst, as well as for the program designer. Theory on the diffusion of technology must be linked to what works. This is particularly true in the developing world, since much of the change being advocated is induced, rather than occurring naturally, by outside change agents for the government, social agencies, or universities.

The following paper is a tentative effort to provide a composite set of successful technology delivery techniques. They have been developed from discussions with specialists from more than twenty organizations in eight countries in South Asia, Southeast Asia, and the Caribbean (see Appendix A). While these organizations were involved in a variety of activities, ranging from university research to the delivery of "appropriate technology" to local farmers, they all had engaged in programs that required the movement of new

*The term "technology delivery process" will be used throughout this paper to signify the provision of technological goods and services to end users in developing countries. This is done mainly to avoid the confusion normally caused by the use of ambiguous or value-laden terms, such as "technology transfer" and "diffusion of technology." However, these other terms will be used when referring to specific literatures and occupational specialties.

techniques, goods, or ideas to potential rural users. While the purpose of the underlying research* was to examine organizational types and their operating procedures, I did ask managers, technology development teams, and extension agents alike to describe successful technology delivery projects in which they had participated. They were also requested to discuss the techniques that they employed to achieve that success. As already noted, while long-time field operators are often unwilling to theorize or extrapolate from their own experience, they are often eager to discuss in minute detail the little incremental changes in approach that transformed a faltering project into a success. From these anecdotes, I have synthesized twenty-one lessons, which I have labelled technology acceptance factors. They are simple but important rules of thumb for project design and execution.

For purposes of presentation, these practical dictums are imbedded within a model of technology delivery that I develop in detail elsewhere (Ashworth, 1982). The model is not, however, central to the information presented here. The injunctions are useful alone as touchstones and reality corrections for projection designers and implementers. Some will be controversial, particularly those arguing for entrepreneurial involvement and for promotion of units with rapid paybacks. Analysts can and should argue whether the existence of governmental bias toward private merchants and local landowners in some of the nations visited--such as the Philippines--may have skewed the success of the programs involving these favored groups. What is important to consider are the implications of this set of simple observations for the expansion of

*Portions of the initial research was funded by the U.S. Department of Energy. However, the following analysis does not reflect the views of the Department of Energy, the Solar Energy Research Institute, or the Midwest Research Institute.

current analytic models covering technology diffusion and for the planning of future research investigations in this field. It is here that the practical project manager and the university scholar can begin to provide each other with information necessary for both the advancement of the frontiers of knowledge and the solution of immediate rural problems.

THE RESEARCH CONTEXT

In the summer of 1980, the author visited a number of organizations in the Philippines, Thailand, India, Sri Lanka, Nepal, Trinidad, Barbados, and Guatemala. The itinerary and the duration of the travel was in part dictated by budgetary constraints, but the choice of the organizations to be consulted was not. They were selected, out of the research files of several cooperating multilateral agencies and of the entries contained in the SERI ICON* data base, according to three criteria: experience as change agents in rural areas, innovation in technology delivery techniques, and representativeness of six pre-selected organizational types.** Organizations were contacted by mail and asked to participate in the research on organizational operating procedures and methods. Additional organizations and field practitioners experienced in technology delivery were added during the course of the visits, based on local

---

*ICON or Iternational Contacts is one of several international data bases that form a portion of Solar Energy Information Data Base (SEIDB), located at the Solar Energy Research Institute in Golden, Colorado. There are currently more than 3800 entries in ICON, as well as 1000 entries in energy projects in the International Projects (INPRO) and 2200 on international manufacturers.

**The six organizational types are international agricultural research institutes, national and regional science and technology institutions, national or regional industrial research institutes, national technology production units, private non-governmental organizations, and universities and their affiliated research centers.

recommendations. However, in all cases the additions were restricted to the six pre-selected organizational types.

The organizational focus* of the primary research dictated the type of technology delivery units to be contacted, and so limited the field of individuals to be interviewed. This has undoubtedly affected the nature of the responses elicited. For example, conspicuously missing are representatives of political action groups, who seek not only to introduce new technologies and techniques but to change the political and social relationships underlying traditional roles of man, animal, and machine. Private firms are also somewhat under-represented. However, it will not be possible to predict, without further field work involving these under-represented change agents, if the list of the twenty-one technology acceptance factors would be altered and, if so, in what way. I will return to the generalizable results in Part III below.

PART II

THE ANATOMY OF SUCCESSFUL TECHNOLOGY DELIVERY PROJECTS

AN EXPANDED MODEL OF TECHNOLOGY DELIVERY

The field interviews performed for this project produced a surprising unanimity on the sequence of actions required for successful technology transfer and diffusion. This agreement is held among the various institutions

---

*The principal research sought to examine the technology delivery practices and successes, as well as other characteristics (such as recruitment procedures, familiarity with local village counterparts, etc.) of six organizational types. The six were selected because national governments and/or donor agencies were actively discussing augmenting the staffs and missions of these existing specialized agencies to include the development and diffusion of renewable energy systems. To provide the required analysis, the technology delivery activities of each group of organizations was compared to a generalized model of technology delivery and to the 21 Technology Acceptance Factors described here.

visited--institutions with widely divergent mandates, internal operating procedures, and client groups. The model derived from my field work is shown in Fig. 1 below. It is more complex than traditional technology diffusion models, introducing concepts such as market creation, operation, maintenance, and training.* This additional complexity is due to three factors. First, the model is based on the experiences of field workers in one particular type of technology delivery process: the intervention of an outside change agent (what Rogers and Shoemaker (1972, pp. 8-9) call "selective contact change"). These are induced adoptions promoted by individuals or organizations outside of the village, firm, or cultural group. Additional steps are required for induced innovations, compared with changes generated spontaneously within the social or production unit. Second, portions of the analysis are based on the observations of field operators and project managers. Factors which other observers would integrate into broader categories have been listed separately because they are recurrent problems in actual practice. Third, the field experience underlying this analysis is based on developing country experience, a fact that introduces additional project requirements (such as training even for relatively simple routine maintenance).

TECHNOLOGY ACCEPTANCE FACTORS FOR EACH STEP IN THE TECHNOLOGY DELIVERY PROCESS

In the discussions with experienced field personnel in the eight countries visited, technology delivery technique was usually explained by them in terms

*In charting the movement of information and innovation in particular settings, some analysts have found far more complex diffusion patterns, including feed back loops, multiple technology adaptation nodes, successful bypasses of technology delivery steps, etc. While these linkages and feed back loops are important and present in most projects, I have chosen to omit all but three of them in the process description in order to simplify the argument. For an example of complexity of the diffusion process in the chemical industry, see Giral and Morgan, 1974, p. 34.

of practical dictums: the do's and don'ts derived from the practitioners' personal experience. For each one of the more successful technology delivery project managers, these aphorisms serve as guiding principles for planning and executing field projects that involve the introduction or dissemination of new goods and practices. From the many such injunctions that I collected, I have distilled a set of project management suggestions, which are referred to here as Technology Acceptance Factors (TAFs). These are listed in Table 1, along with the steps of the technology delivery process that are more closely related with each factor. While there was certainly not universal endorsement of each of the 21 TAFs, there was general agreement that a strong correlation exists between the number of these injunctions followed and the ultimate diffusion of the technology being promoted. For the remainder of this section, we will discuss briefly each of the TAFs in the context of the consecutive steps of the expanded technology delivery process.

STEPS IN THE TECHNOLOGY DELIVERY PROCESS

Step One: Needs Identification

In a technology introduction or delivery project, the first requirement is a clear understanding of the nature of the development needs in that location These needs are not self-evident, and the extent and importance of any given need is not always readily apparent. Moreover, there are often a whole set of interrelated problems which may need be addressed simultaneously to solve any given basic human need. For example, one problem may appear to be low agricultural productivity, due to low local former interest in strenuous manual activities such as weeding, hoeing, harrowing, etc. One proposed solution may be to introduce mechanized plowing and harvesting techniques.

Figure 1. Technology Delivery Process Model

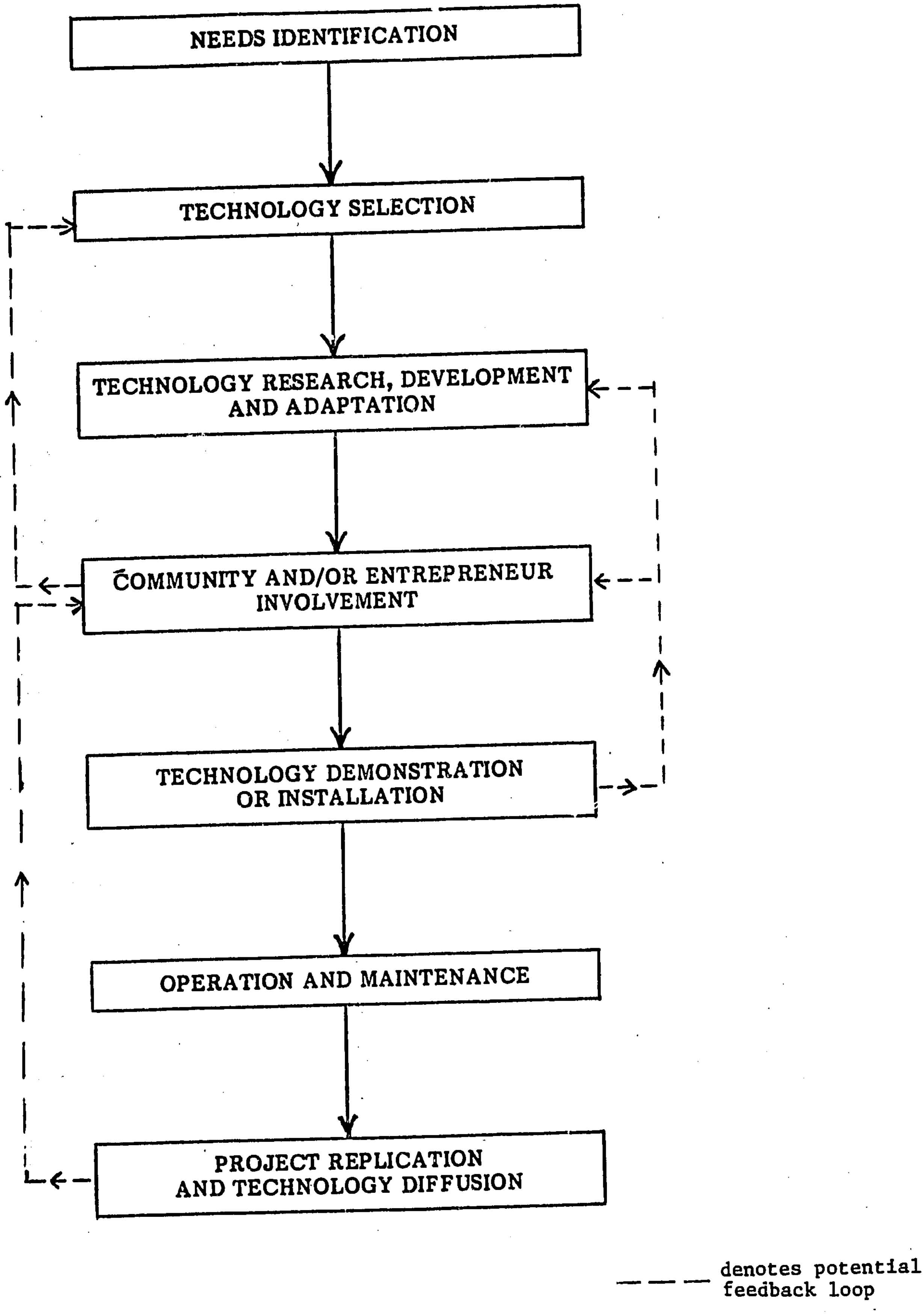


Table 1. Technology Acceptance Factors (TAFs)

I. Needs Identification

1. Start with a careful site-specific need assessment before addressing the question of technology selection.

2. Have the final or potential user define the importance of the need and rank it versus other needs.

3. Have the ultimate user define, with as much precision as possible, the size and scope of the need to be met.

II. Technology Selection

4. Consider, in the ranking technological options, the adaptability of each unit to local production facilities and local technical skills.

5. For units having a capital cost over US $25.00, give preference to systems that replace current high-cost services, that provide an income sufficient to pay back the investment in 2-3 years, or that are directed toward industrial, commercial, and agricultural cooperative customers.

III. Technology Research, Development, and Adaptation

6. Test proposed systems and materials under real load conditions in the same environmental conditions they will be used.

7. Substitute, whenever possible, low-cost local materials and local construction methods for techniques and material applications developed elsewhere.

8. Carefully size the unit to provide energy only for the task and to ensure that the energy is available when and where required.

9. Redesign systems to minimize or eliminate routine maintenance, particularly when that maintenance requires skills not normally found in the local community.

IV. Community and/or Entrepreneuer Involvement

10. Discuss the principles, expected performance, economic advantages, capital costs, and required operation and maintenance steps with potential users before beginning the demonstration of technologies.

Table 1. Technology Acceptance Factors (TAFs) (continued)

11. Have the final user partially pay for the capital costs of the unit, or invest time and labor in its installation and operation.

12. To insure the participation of small-scale entrepreneurs in the production of new technologies, either assume most of the financial risk of initial production or demonstrate an existing market.

13. Be prepared to provide substantial initial support to small-scale developing country entrepreneurs to lower the risk and uncertainty of beginning production of a new technology. Start-up assistance that may be required includes the redesign of existing production facilities, selection of new machines, staff training, production management, marketing, and financing.

V. Technology Demonstration or Installation

14. Build and install the system so that there are no requirements for subsequent service or repair callbacks.

15. Develop a trained professional installation team that can make all required on-site modifications and can complete the installation in minimal time (but still maintain the zero callbacks goal).

VI. Operation and Maintenance

16. Plan a program of routine maintenance so that downtime can be minimized year-round and eliminated during periods of peak demand.

17. Delegate the responsibility for routine maintenance and minor repairs to a local mechanic with immediate access to the technology and with a vested interest in its continuous operation.

18. Complete any training required for operation and maintenance of a technology prior to the initial operation of the unit.

19. Provide the local operator with the tools and spare parts required for emergency repairs on the technology unit.

VII. Project Replication and Technology Diffusion

20. Use professional technology promotors, particularly if they are drawn from the local community, to speed the adoption of a unit by local consumers.

21. Involve local opinion leaders with the new innovation, since their reaction often has a dramatic impact on the adoption rate within the community.

Yet the low level of labor productivity may in fact be directly linked to wide-spread intestinal parasites, which in turn may be caused by the control of the local major drinking water source for the village and its livestock, as well as the cattle grazing and watering practices of the village leader. Therefore, the set of problems must be carefully defined and articulated locally before they can be addressed and solved.

When completed by an outside agency without local consultation, the definition of the problem often depends on the preexisting interests and biases of that organization. Irrigation agencies define problems in terms of new wells required, while agronomists may focus on the cultivation of drought-resistant crops. As Hoelscher (1979, p. 97), speaking of what he calls problem identification, stated:

> The first step of the technology transfer process (problem identification) involves a plethora of organizations each promoting its own vision of a better world. Some of these organizations are political, while some are technical or planning oriented. All too often none of these has the direct mandate or skills to form a coalition, to reach agreement, to say precisely what is the problem to be attacked. The technical organizations usually lack the expertise to assess the politically feasible, and political organizations lack the skill to define precisely what can be done.

Not only should the set of needs be well defined, but it is also equally important that the need determine the technology selection rather than vice versa. In many cases when technology transfer failed, a researcher or organization developed a prototype unit and then looked for an installation site. Then, after installation the system did not service the need as well as another technology or was not needed at that site. This leads to the first practical dictum:

<u>TAF #1</u>: Start with a careful site-specific needs assessment before addressing the question of technology selection.

Needs assessment, as practiced by the organizations visited, has taken many forms. Some agencies have located a target group or economic sector needing assistance and then have found or developed units to support that group. The Appropriate Technology Development Association of India, for example, has a five-year program to provide the technological tools to revitalize seven basic cottage industries. Others, such as The Choqui Station of the Center for the Investigation and Application of Appropriate Technology (ICADA/Choqui) in Guatemala and The International Rice Research Institute (IRRI) in the Philippines, rely on traveling staff members or on full-time resident village technology promoters to locate and define needs. A good example of a thorough and professional needs assessment was that performed by the rural extension center of the Application of Science and Technology to Rural Areas (ASTRA) program at the Indian Institute of Science (Bangalore). An exhaustive survey was made of the pattern and amount of energy consumed, including traditional and animate energy. A similar survey was then done of all the available resources in the same six village areas. The information from these surveys and from discussions with villagers was used to select the appropriate technologies.

It is important not only to define the specific needs of a particular location or particular client group, but also to have a clear perception of the importance of each problem. This leads to the second needs assessment principle:

<u>TAF #2</u>: Have the final or potential user define the importance of the need and rank it versus other needs.

This injunction often is made by field operatives but seldom followed. Generally, a group of needs was defined for a particular site (for example, drying, water pumping, and communications) without any attempt to attach priorities to them. Only by defining one specific need at a time (as in the requests that Birla Institute of Technology (BIT) in India receives from industry or government for technical assistance) can the problem or priorities for limited resources be avoided.

Even when the urgency of the need can be established, the planner must know the final user's requirements to satisfy that need. There is no point in providing a 10-hp pump when a 1-hp unit will suffice. This leads to the final acceptance factor under needs identification:

TAF #3: Have the ultimate user define, with as much precision as possible, the size and scope of the need.

For example, when researchers from the University of the West Indies in Trinidad were asked by colleagues in the Department of Livestock Science to design and construct small solar crop dryers, the livestock scientists described in detail the crops to be dried, the volume of crops per unit of time, and the time allowed for drying. Given this information, the researchers could alter the basic design to get the correct temperatures and to provide only the drying surface required.

It should be recognized that any needs survey or technology selection does not take place in a vacuum. Needs definition, particularly for governmental agencies, is bounded by the guidelines embedded in national development plans and sectoral programs. Nonetheless, it was reiterated by the field managers interviewed for this project that it is those installations that address the needs felt most keenly by the local users that will receive the greatest cooperation and immediate support.

Step Two: Technology Selection

After the size, scope, and importance of the need have been determined by the final user, the planner and his technical advisor are better able to select the technology or technique that gives promise of providing a solution. Access to technological options is often a problem for small private volunteer organizations, appropriate technology centers, and university research centers. They do not have the communications network required to reach research centers or commercial firms who may have already developed an appropriate solution or successfully met the same set of needs. The smaller and more geographically isolated the developing country organization, the more difficult it may find the process of keeping up with rapidly changing fields. They tend to rely on an informal network of personal contacts, often receiving fragmentary information about a new development or a successful technology application years after it has become widespread knowledge in the industrial world or in another developing country. By contrast, international organizations (such as IRRI or the World Health Organization) and regional technology centers such as the Central American Research Institute for Industry (ICAITI) have continuous contact with fellow researchers in other institutes, have access to professional journals and technological search agencies, and can make use of data bases chronicling new products and research in progress. While one may question the utility of large-scale computerized communications networks for providing appropriate solutions for isolated rural sites in developing countries, they nevertheless do assist in broadening the range of options under consideration and provide developing country organizations with contacts necessary to gather information on the problems encountered in actual installations.

The contrast between the options available to large agencies such as ICAITI and those facing small local organizations, who are experienced at needs identification but not equipped for technology selection, highlights an important point: different steps in the technology delivery process require different individual and organizational skills. Good project planners are not necessarily good technology adapters or field-level operation directors. Technology selection in particular requires certain defined skills. As Hoelscher (1979, p. 98) describes the technology selection process:

> This second stage demands another kind of organization able to identify that technology best suited to the need. This unit must collect information on candidate technologies, on local conditions in which such technologies are expected to operate and the cost/benefit ratios associated with the implementation of each such candidate. The range of expertise required for this task is considerable, including technical, economic, ecological, sociological, and others.

When launching a search for possible technological options, several points should guide the process. For organizations working in countries with a strong import-substitution bias, systems should be rated according to their compatibility with in-country production facilities. This is important not only for the creation of political support for the project (since it offers potential employment-creation and skill-building), but also for the future diffusion of a successful technology through the local private sector. This principle can be presented as follows:

<u>TAF #4</u>: Consider, in ranking technological options, the adaptability of each unit to local production facilities and local technical skills.

For example, Belaju Yantra Shala, Inc. of Nepal selected simple thermosyphon solar water heaters as a prototype unit to construct and test market. In part, this was done because they could use the same production sites and many of the same skills that the existing sanitary engineering unit employed. Similarly, a number of the organizations visited were testing or installing Chinese biogas generator designs rather than the Indian designs. These Chinese designs eliminated the need to fabricate and weld the floating steel gasholder (welding being a skill which may not be readily available in rural areas and steel being relatively expensive).

Experienced field managers emphasized the inclusion of cost considerations in the technology selection process. Cost considerations include not only cost-effectiveness per unit of energy provided, but also initial capital requirements. To be used, technologies must be affordable to the ultimate user. This can be a major constraint when the consumer is an Indian rural laborer earning $0.60/day. ICADA/Choqui in Guatemala found that efficient cookstoves having any capital cost at all, other than locally gathered materials, were beyond the reach of most village families, in spite of the hardship imposed by gathering fuelwood for the current inefficient stoves. On the other hand, the University of the Philippines in Los Banos (UPLB) found that farmer cooperatives or even individual farmers were perfectly willing to pay US$ 350.00 for prefabricated crop dryers because of the immediate payback that they received in the form of higher produce prices. While difficult to reduce to a single principle, the importance of cost can best be summarized this way:

<u>TAF #5</u>: For units having a capital cost over US$ 25.00, give preference to systems that replace current high-cost services, that provide an income sufficient to pay back the investment in 2-3 years, or that are directed toward industrial, commercial and agricultural cooperative customers.

The technology selection process requires a great deal of information on consumer preferences, local habits and practices, the economic resources available to potential users and similar constraints. This is shown in Figure 1 as an information feedback loop, from the consumer and entrepreneur involvement to this particular step.

Step Three: Technology Research, Development, and Adaptation

Once candidate technologies have been located, the next step is to make the changes in the design or concept to make it compatible with local social and environmental conditions, usage patterns, and cost constraints. By research, we mean applied rather than basic research. System performance should be tested, components checked for durability and ease of maintenance, and the impact of different environmental factors calculated. New system subcomponents for local needs and incorporating low-cost indigenous materials may have to be developed. Adaptation is required to match the cost and performance profile of the unit to the pattern of local needs and the financial resources of the final user.

The first research step is to test the ability of alternative configurations to perform satisfactorily under local environmental and social conditions. Rapid component degradation in hostile environments, such as wind-driven sand or high tropical humidity, must be determined so that material and design substitutions can be made when required. The practical advice given by project managers and technology adaptation specialists is:

TAF #6: Test proposed systems and proposed materials under real load conditions in the same environmental conditions they will be used.

One major component of the technology adaptation process is to substitute local materials and construction techniques. Based on the field interviews and the observation of various organizations, this is one of the most strongly favored recommendations for the planner and the technology specialist. It can be put best as an injunction:

TAF #7: Whenever possible, substitute low-cost local materials and local construction methods for techniques and material applications developed elsewhere.

This point is stressed for several reasons. Local materials are often both less expensive and more resistant to local environmental hazards. For example, the substitution of galvanized pipe and galvanized iron sheeting for copper by the Belaju Yantra Shala solar water heater manufacturing facility not only lowered the final cost, but also greatly simplified the procurement and stocking of materials. Local materials and techniques also simplify installation and maintenance, since local artisans have the skills necessary to site-build or repair a unit. Because the frame of the Asian Institute of Technology's batch solar rice dryer was built of bamboo using standard village fastening techniques, members of farmer cooperatives were able to start construction immediately without additional training. The use of local materials and techniques increases the likelihood that local artisans or potential users will adopt the technology spontaneously, copying it directly from another installed system.

In addition to testing proposed units and substituting local materials, the technology adoption agency must carefully match the capacity and output pattern of the unit to the local demand and local resource base. This observation is translated into the following suggestion:

TAF #8: Carefully size the unit to provide only the energy for the task and to ensure that the energy is available when and where required.

As we have pointed out elsewhere (Ashworth and Neuendorffer 1980, pp. 17-20), there is a set of characterization criteria which can be used to describe both the pattern of energy demand and the output of the energy system. By carefully designing the energy units to meet the site-specific demand while minimizing the requirements for energy storage and conversion, the costs of the delivered energy can be lowered and the complexity of the system reduced.

In the area of research, development, and adaptation, the one other frequently repeated admonition from the technology delivery specialists was:

TAF #9: Redesign systems to minimize or eliminate routine maintenance, particularly when that maintenance requires skills not normally found in the local community.

Step Four: Community and/or Entrepreneur Involvement

This step is not normally found in the technology diffusion literature. Most analyses jump directly to what Hoelscher calls "technology release," and others refer to it simply as "diffusion of the technology." Yet the staffs at the organizations that had been successful at delivering one or more technologies emphasized the importance of building the interests and participation of potential users prior to launching a technology delivery program. These may be expressed as two general principles:

TAF #10: Discuss the principles, expected performance, economic advantages, capital costs, and required operation and maintenance steps with potential users before beginning the demonstration of technologies.

TAF #11: Have the final user partially pay for the capital costs of the unit or invest time and labor in its installation and operation.

For example, prior to building a prototype crop dryer, a model of the unit may be shown to local farmers, including a discussion of how and why it works. Samples of produce after drying are shown to interested individuals and organizations, along with information on the increased market value provided by the machine. Only after a sufficient number of local farmers have expressed interest in participating (including the provision of labor or materials for construction) should one or more units be built. This is particularly important in applications, such as crop drying, where there was no previous experience in the local community with capital investment and purchase of hardware.

This involvement of the local community or potential entrepreneur/producers before the demonstration and installation of units is important because of the induced nature of technology introduction being sought. Unlike spontaneous innovations within the social system, outside organizations are trying to introduce or transfer new ideas and new technologies. In industrial nations, such introductions are attempted on a daily basis by sophisticated consumer goods producers--but not before extensive market testing has been completed. Community involvement provides much of the same information that market testing does, namely:

- size of the demand for the particular service offered;
- existing (competing) units offering the same service;
- value placed on the service offered by the ultimate consumer;

  priority of the service offered (i.e., pumping, refrigeration, drying, etc.) versus other uses for the same funds or resources;

  current competing uses for input resources (human and animal labor, agricultural residues, wood, etc.); and

  changes in the service or the technology that would make it more desirable or more valuable.

The approach required to interest and involve the private entrepreneur is a subject requiring more investigation than it has received to date. The assumption that the private sector will simply appear when the technology becomes profitable or when the need becomes defined has not proved to be true. In a developing country, small-scale shop owners rarely have access to capital for retooling and have only limited skills in certain types of manufacturing steps. They are often adverse to risk, which reduces their willingness to enter a market until another producer has demonstrated the existence of demand for a product.

Of the institutions visited, two clearly had developed coherent and self-conscious approaches to entrepreneur involvement. The first, and perhaps the most famous, is the agricultural machinery development program of IRRI in the Philippines. The other is the Small Industries Research Training and Development Organization (SIRTDO) program of the Birta Institute of Technology (BIT) in Ranchi, India.

The Agricultural Engineering Department of IRRI, during the evolution of their agricultural machinery program, carefully noted the problems encountered in trying to involve local artisans or manufacturers in the production of new technologies developed in the laboratory machine shop.

> Commercialization of the designs originating from public industrial research institutes has been a chronic problem in most developing countries. Experience indicates that distributing the engineering drawings is in itself not sufficient for commercialization. Small- and medium-sized metalworking firms in the LDCs (less developed countries), who are potential manufacturers of simple agricultural equipment, are not too familiar with engineering drawing practices and prefer to work with prototype machines. Such firms have limited capital and are unwilling to take risks on a commercially unproven machine. These firms are generally reluctant to produce new machines unless there is an assured order. Once one manufacturer succeeds in marketing a few machines, other companies generally develop interest in its commercial production. (IRRI Agricultural Engineering Department 1975, p. 18).

Having located factors that limit the ability of small entrepreneurs to produce new equipment, IRRI then attacked each one in turn. Individual manufacturers were given prototypes of IRRI-developed units and were paid to build an additional 10 units. They were encouraged to adapt the design to their own production capabilities, making substitutions or modifications whenever required. These modified units were then returned to IRRI for durability and performance testing. The individual producers were also encouraged to test market and demonstrate these prototypes to local farmers and distributors. Within this process there are examples of two TDSFs noted by other researchers who were successful in involving entrepreneurs:

<u>TAF #12</u>: To insure the participation of small-scale entrepreneurs in the production of new technologies, either assume most of the financial risk of initial production or demonstrate an existing market.

<u>TAF #13</u>: Be prepared to provide substantial initial support to small-scale developing country entrepreneurs to lower the risk and uncertainty of beginning productions of a new technology. Start-up assistance that may be required includes the redesign of existing production facilities, selection of new machines, staff training, production management, marketing, and financing.

These principles are reinforced by the experience of the staff of other centers seeking to diffuse technologies rapidly through the private sector. The BIT program starts with a requirement for a particular piece of equipment, generally from major industrial firms or government agencies. It develops a technical solution satisfactory to the client and then locates a student about to graduate to take responsibility for production. The market for this particular good is guaranteed, which not only helps gain the interest of the student but also facilitates financing for production equipment purchases. The prospective entrepreneur is given advice and training in everything from production line management to market development. He is also given leads on other needs that potential consumers have identified and is encouraged to begin the creation of solutions that can use the same production facilities. BIT has managed to establish more than 30 small-scale production facilities by defining for each a need and a set of customers.

The University of the Philippines at Los Banos (UPLB) Institute of Agricultural Engineering and Technology has sought to interest potential entrepreneurs by actually building systems for sale and by demonstrating the units at agricultural fairs and meeting where the manufacturers can judge the response. Having sold 45 units of a coconut charcoal-fired copra dryer at a 30% mark-up over cost, UPLB has proved the appeal of the design. Several small manufacturers have now expressed interest in going into production and are negotiating with UPLB for licensing rights to the design.

Some government organizations or laboratories have found it necessary to go to great lengths to ensure active participation with prototype units even by established manufacturers. For example, the National Physical Laboratory (NPL) of India developed a liquid crystal display unit (for instruments, electronics, watches, etc.). A batch production facility was established in the laboratory to determine production costs and to solve prototype problems. A number of NPL's scientists were sent to the factory that NPL was trying to persuade to produce the liquid crystal units. These scientists ordered all the required equipment, set up the assembly line, and demonstrated that the production process would work at the site before the manufacturer took over (for additional cases, see Kohli and Virdi 1980).

Step Five: Technology Demonstration or Installation

Once local participation or entrepreneurial involvement has been ensured, the actual hardware or technique introduction--the "technology release" as defined by innovation theorists--can proceed. In the organizations and institutions investigated for this study, successful examples of this process took two different forms: commercial installation and integrated training fabrication workshops. While the two approaches are radically different, they share two common concerns: the central importance to technology delivery of an experienced team of installer/fabricators and the need to minimize labor costs. Because the two methods of organizing the installation process are so different, each will be examined separately with emphasis on the special advantages of that approach.

Commercial Installations

In a commercial venture, installation follows a successful sale. The entrepreneur's profit is bounded by the difference between two known amounts: the final sales price and the cost of hardware delivered to the site. The only unknown quantities are the installation cost and any subsequent service and repairs. For the entrepreneur, therefore, two major principles lead to a maximum profit from the fixed sales price. They are:

TAF #14: Build and install the system so that there is little requirement for subsequent service or repair callbacks.

TAF #15: Develop a trained professional installation team that can make all required on-site modifications and can complete the installation in a minimal time (but still maintain the zero callbacks goal).

The "zero callbacks" requirement was emphasized by all private entrepreneurs (and researchers or government agencies functioning as public entrepreneurs) interviewed in the study. Callbacks were considered deadly for three reasons.

First, the expense of having one or more engineers return to an often remote site usually eliminated the profit from that installation. Second, the callback interrupted the schedule of planned installations, diverting scarce installer manpower from current money-making projects to the repair of past work. Third, and most important, it tarnishes the reputation of the product and hinders future sales. This is particularly important in small communities where potential customers are long-time neighbors or relatives of current users. Sunpower Ltd., a solar water heater producer in Barbados, began as an informal effort to repair nonfunctioning units produced by another firm. Personal referrals led to requests for new units as well as repair efforts until a full-time production and installation facility (employing a staff of 32 people in 1980) evolved.

All successful commercial operations visited (including national production units such as Belaju Yantra Shala in Nepal and the Khadi and Village Industry Commission or KVIC in India) maintain professional installation teams. This is crucial in technologies where the units, such as solar water heating systems and micro-hydro units, must be adapted to the site. The field crew's experience allows for considerable modification during installation, rather than returning to consult with factory production engineers. This is vital in cases, such as micro-hydro units in the hill regions of Nepal, where the site may be a two- to four-day walk from the nearest road and much farther from telephone or telegraph communications.

Experienced installers are not only more flexible in doing on-site modifications, but they are also more productive: they perform more installations in a given period. The two more experienced installation teams of Sunpower Ltd. in Barbados are able to complete four installations per week, while the other two teams can manage only three units.

For these reasons, entrepreneurs emphasize assembling experienced installation teams and keeping them together. The more complex the technologies, the more important the role of the fabrication/installation team. The National Energy Administration of Thailand has now contracted with the private machine shop which fabricates its small-scale hydropower units to supervise the installation of units up to 3-MW capacity. This merger of responsibility for production and installation allows for the fabrication of certain bulky items (such as the penstocks that channel the water to the spinning turbines) on site, saving time and transportation costs.

Integrated Training/Installation Workshops

For government agencies, private volunteer groups, and research units, maximizing profits is normally not a central concern. Rather, these groups are concerned with ensuring that the technologies are accepted and are transferred to other users. These noncommercial organizations share the concern of commercial producers with training installers and with minimizing labor costs but for different reasons. They want to train and develop installation teams and then leave them in the village or region. These experienced installers serve as catalysts for the construction of future units, demonstrating the technology and supervising other local artisans who become interested in building their own model. These trained installers can provide routine maintenance and repair services, making the callback question less serious than to commercial producers as long as the operation and maintenance requirements can be handled by local operators who have other occupations as primary responsibilities. The Chemistry Department of the University of the West Indies in Trinidad developed several different prototype solar distillation units with widely varying performance profiles and maintenance requirements. They found that the F-series units, though less efficient than the high-performance models, remained in service after the others were abandoned. They required filling only once a week and cleaning once every several years. They were not damaged by inadvertent neglect or stagnation as were the higher output models. The local individuals trained to construct these units had enough expertise to operate them, to perform infrequent and routine maintenance, and to handle minor repairs (glazing cracked by accidents, resealing joints, etc.).

For noncommercial change agents, minimizing labor costs is a way of accelerating acceptance of the technology. The less expensive the installed unit, the more likely that a potential user will find the benefits attractive. Also, the scarcity of capital financing in many developing country rural areas is another major reason for lowering or eliminating front-end installation costs. Units which may be attractive for US$ 15.00 could become unaffordable if an additional US$ 15.00 is required for installation and construction labor.

For many technology delivery projects, the hands-on construction workshop eliminates labor costs during construction while simultaneously training local installers. Future owners or users of a technology provide their own free labor to construct one or more units, following the instructions and example of a professional trainer. This technique is used by organizations visited for projects ranging from individual bamboo and plastic fruit dryers to complete compacted earth homes. The hands-on workshop is particularly effective for low-cost or no-cost, labor-intensive construction techniques. The ICADA/Choqui Appropriate Technology experiment station in Quetzaltenango, Guatemala, for example, developed biweekly training sessions on the construction of low-cost

"Lorena"* stoves. Participants paid US$ 3.00 (or less if that cost was too high) to attend these two-day sessions. There were no capital costs for these units, since the materials required could all be gathered free locally. In recent years, ICADA/Choqui has trained professional promoters to continue this work in local villages and has trained promoters from other parts of Guatemala and Central America. A similar program run by the Bureau of Energy Development in Philippines was also successful, teaching citizens of a low-income neighborhood how to construct modified Lorena units. The Asian Institute of Technology (AIT) developed a one-ton batch rice dryer that used locally available materials, such as bamboo and burned rice hulls, and construction techniques similar to those common in rural Thai homes. Two AIT supervisors and 5-10 local workers could build a unit in 3 days, creating not only a needed agricultural processing device, but also a local team to lead future installations within the local rural cooperative system.

In some of the more ambitious skill-development projects, hands-on workshops are only part of a comprehensive program promoting labor-intensive, low-capital industries for rural entrepreneurs. The Village Technology Programs run by BIT focus on the transfer of skills to village artisans for labor-intensive cottage industries: diesel engine repair, bicycle repair and maintenance, silk production and spinning, and rearing and initially processing medicinal plants. Each participant is given the simple tools and machinery required for an industry and returns to his/her village to serve as the nucleus for a new industry. Similarly, the Appropriate Technology Development Association

---

*"Lorena" is derived from the two Spanish words "lodo" (mud) and "arena" (sand)--the chief ingredients for the stove's construction.

of India conducts a number of village programs aimed either at upgrading basic village crafts (weaving, oil extraction, carpentry, etc.) or at down-scaling to the village level activities normally done in centralized facilities (paper-making, cement production, white sugar preparation, etc.).

The demonstration of technologies may trigger a number of reactions, both within the intended audience for the technology and within the technology design community. These are shown as a two-pronged feedback loop in Figure 1. After having seen a unit at a training session, a country fair or in the home of a neighbor, there may be generated a great deal of consumer interest and demand. As noted in Step Four (above), it was the demonstration of consumer interest that resulted from demonstrations that triggered commercial production. Similarly, the comments of users and interested observers, after field demonstrations are begun, may trigger major additional adaptive research and development efforts. This may include design changes to add requested features or the bolstering of components that have proved to be prone to failure in actual field testing.

Step Six: Operation and Maintenance

Traditional diffusion literature assumes that once a technology has been adopted, it will be maintained and operated. Experienced field project managers do not make this assumption. Individuals consulted for this study recounted numerous examples of a technology performing as well as or better than planned after installation but being abandoned when one or more minor maintenance problem appeared which were not promptly resolved. A solar dryer was damaged and then abandoned when the plastic sheet glazing was not replaced as scheduled. Distillation units were destroyed when the units were allowed to boil dry, producing internal temperatures of 165°C. Hand water pumps installed in one Indian state broke down faster than new units were installed. Wind-powered pumps worked well but ceased to function when bearings burned out due to lack of lubrication.

In all these cases, the technology ceased to produce useful output due to insufficient attention to maintenance procedures and day-to-day operations. This problem cut across all the institutions examined, with the possible exception of some of the more experienced private volunteer organizations, private entrepreneurs, and national technology production units. Whatever the cause, prolonged breaks in service (or "downtime") will lead to rejection of a technology, even if it is capable of producing needed output at an attractive cost. A number of secondary planning strategies can be derived from this injunction:

TAF #16: Plan a program of routine maintenance so that downtime can be minimized year round and eliminated during periods of peak demand.

This notion of eliminating downtime is particularly important for units that experience strong seasonal demand and then are idle for periods of time, such as grinding and milling machines, crop dryers, and irrigation pump sets. A pump set that fails for even a few days during the crucial periods of transplanting can destroy an entire rice crop and bankrupt a small farmer.

In order to minimize output interruptions due to scheduled maintenance and to unscheduled repairs, three other TAFs should be noted:

TAF #17: Delegate the responsibility for routine maintenance and for minor repairs to a local mechanic with immediate access to the technology and with a vested interest in its continuous operation.

TAF #18: Complete any training required for operation and maintenance of a technology prior to the initial operation of the unit.

TAF #19: Provide the local operator with the tools and spare parts required for emergency repairs on the technology unit.

Ensuring the active participation of a local operator should be carefully planned, because it appears to be central to the continued success of most technologies. Once the novelty of being the operator of a new unit subsides, the local individual must have a reason to take the time and effort to keep the system going. The system may produce revenue (either in the form of a salary or in increased profits from a commercial operation) or a badly needed service. For example, the small-scale hydropower units produced by Belaju Yantra Shala in Nepal are typically sold to small-scale entrepreneurs who use them to operate grain grinders and oil presses in remote mountain locations. The government loans provided to these entrepreneurs must be repaid within seven years (and are often repaid in two to three years). It is crucial for each operator that the machines are always operable. In another example, one small-businessman bought a D-series, high-performance solar distillation unit from the University of the West Indies. He consistently was able to get higher yields from his machine than the original designers, despite the care required to maintain this unit. He was selling the distilled water output to local service stations and farmers for refilling batteries, obtaining a sizeable income. While other users and finally the designers had abandoned this model because of its high maintenance requirements, he was returning to the designers asking them to produce another unit for his business!

The need for training continues throughout the entire technology diffusion cycle. Local leaders and officials must be trained in the technology options available in order to select the appropriate units. Researchers must be trained in adapting technologies to local socioeconomic conditions. One of the most important and often neglected steps in the programs examined is the location and training of the local technological operator during the period prior to initial operation. This can occur in a hands-on workshop during construction, in a special session run by the technology delivery agency, or in existing educational and extension programs. By designating one or more individuals as the operators and giving them special training, the project manager is assigning responsibility for the unit's care after he/she leaves the site. Also, when the unexpected occurs, people know whom to contact.

Spare parts are a constant problem in remote sites, whether for automobile carburetors or bearings for small-scale hydropower units. Delivery of parts for imported units may take at least six months, which means the unit is inoperable unless parts are locally available or other units can be cannibalized. Even parts available in the capital city or at the factory may take weeks to obtain and install unless they are stockpiled at the installation site.

Step Seven: Project Replication and Technology Delivery

The key measure of any technology delivery effort is whether or not it is self-sustaining; i.e., whether individuals continue to adopt and use the technology without subsidies from the implementing agency. If not, then the apparent diffusion process has been artificial. Perhaps the technology has not provided the services required at an affordable price and with a reliability that consumers demand. Perhaps the institutions involved did not provide the necessary support. Even if the technology has performed well and has proven to be durable and inexpensive, the success of the diffusion process is not guaranteed. Successive individuals must be made aware of the innovation, be persuaded that adaption is worthwhile, locate the funds or materials necessary to build or purchase the unit, and follow it through to completion.

Considerable research has been done on the process of successive adoptions, particularly in the agricultural sectors of numerous developing countries. Donor groups and local extension agents have experimented with countless approaches to encourage the use of new cropping techniques, high-yield crop varieties, and integrated packages of inputs to the agricultural cycle. From this research and the experience of the many organizations visited for this report, there emerges a clear need for a human catalyst to spur the technology delivery process. This can be stated as two general admonitions:

TAF #20: Use professional technology promoters, particularly if they are drawn from the local community, to speed the adoption of a unit by local consumers.

TAF #21: Involve local opinion leaders with the new innovation, since their reaction often has a dramatic impact on the adoption rate within the community.

Within the projects reviewed for this report, there were two major types of successful technology promoters: profit-making enterpreneurs and community-based technology demonstrators. The entrepreneur offering new equipment will explore every avenue to build a market: demonstrations, trade fairs, personal endorsements, advertisements, etc. His financial well-being is dependent on identifying and cultivating potential adopters. If he is an established producer diversifying into a new product, he has a number of built-in advantages. First, he has existing customers or dealers that can distribute the new unit. Second, entrepreneurs often have repair facilities in the market areas, and these can be rapidly converted to service a new technology. Third, small businessmen have experience in the art of technological promotion and will use many of the same techniques to develop customers for the new units. Finally, he/she probably has a good sense of what "the market will bear." He has experience in pricing technologies to meet particular market sectors and in adapting the unit to provide features requested by users. For example, local entrepreneurs were very successful in promoting different agricultural machines initially produced by IRRI. In less than 5 years, 8 producers have sold over 10,000 axial-flow threshers in the Philippines alone, and the design has been successfully introduced in a number of other nations as well. Small plows initially designed by IRRI and successfully produced and sold by Philippine and Thai businessmen were subsequently modified to meet the convenience factors offered by Japanese competitors.

Professional technology promoters were used by several institutions consulted during this study. In many cases, an individual already engaged in providing technical services or promoting other units was given increased responsibility for an additional technology or technique. The Caribbean Agricultural Research and Development Institute (CARDI) has full-time professional field teams in all 12 Caribbean nations, which can be mobilized to demonstrate to farmers new techniques or processing equipment. Similarly, organizations with well-established village-level infrastructures, such as the Khadi and Village Industry Commission (KVIC) in India, can use these local employees as change agents. Other organizations will contract with an outside agency or individual to promote a newly developed technology in the field. National S&T organizations do this routinely, while others use contractors on a case-by-case basis. The Bureau of Energy Development of the Philippines, for example, is using the dean of the local college of food and nutrition to demonstrate a mobile multitray solar dryer to farmers and cooperatives and to locate those interested in purchasing one (using available low-interest government loans).

The best results seem to occur when an organization has its own professional promoters, constantly distributing information and working with potential users. As mentioned, the ICADA field station in Guatemala has full-time workers in the surrounding communities, demonstrating a variety of low-cost technologies, conducting workshops, adapting existing units, and providing feedback to the core staff on modifications to make existing units more useful to local farmers and homemakers. Many agricultural research institutes and ministries of agriculture have substantial extension services, which can serve as effective channels for the two-way flow of information.

PART III

OBSERVATIONS ON THE APPLICATION OF THE LESSONS CONTAINED IN THE TECHNOLOGY ACCEPTANCE FACTORS

All of the steps of the technology delivery process are important and interconnected. The potential success of any project may be diminished by the omission of one or more of the seven steps. This can also be said, although with far less certainty, of the 21 Technology Acceptance Factors developed in Part II of this report. However, the discussions with the representatives of the institutions visited during the research travel indicates that three of the sets of factors are crucial. Unless attention is paid to all three of these steps of the technology delivery process and the attendant TAFs, the technology, however brilliantly conceived and designed, will probably never deliver significant services to potential users. These key steps and their TAFs are summarized below.

Identification of the Basic Need

TAF #1: Start with a careful site-specific needs assessment before addressing the question of technology selection.

<u>TAF #2</u>: Have the final or potential user define the importance of the need and rank it versus other needs.

<u>TAF #3</u>: Have the ultimate user define, with as much precision as possible, the size and scope of the need to be met.

A basic needs assessment indicates the services most important to the ultimate consumer--what he or she wants. But equally important, it tells the technology designer the temporal, spatial, and cultural characteristics of the demand pattern.* With this information, the technologist can readily select an existing system and adapt it to the demand pattern with minimal excess capacity, storage, and conversion devices. Such careful matching of the system to the demand pattern will also minimize cost, a crucial factor in the acceptance of the unit by the ultimate consumers.

<u>Involvement of the Local Community and/or Entrepreneurs</u>

<u>TAF #10</u>: Discuss the principles, expected performance, economic advantages, capital costs, and required operation and maintenance steps with potential users before beginning the demonstration of technologies.

<u>TAF #11</u>: Have the final user partially pay for the capital costs of the unit, or invest time and labor in its installation and operation.

<u>TAF #12</u>: To insure the participation of small-scale entrepreneurs in the production of new technologies, either assume most of the financial risk of initial production or demonstrate an existing market.

---

*In an earlier publication, we developed 12 "characterization criteria" which describe both the pattern of the local need and the output of various renewable energy systems. These are 1) type of output; 2) temperature of output; 3) spatial dispersion; 4) seasonality; 5) time of day; 6) duration; 7) sensitivity to interruption; 8) usage by type of person; 9) historical, social, and religious influences; 10) traditional energy sources used; 11) environmental and ecological factors; and 12) cost. For further details, see Ashworth and Neuendorffer 1980, pp. 17-20.

Community participation prior to the field testing provides invaluable information on omissions or errors committed in the technology selection and design steps. These omissions may be minor details that do not alter performance but do drastically affect local acceptance. Systems have been rejected because of color, because they require a break in normal daily routines such as returning from the fields at noon, etc. Minor alterations to correct these errors are easily made.

Local participation also indicates cost constraints, the concerns of potential consumers on use and operation, and the ability of this prototype unit to compete with currently available alternative units. It provides the implementing agency with information on steps that must be undertaken (training, site preparation, etc.) prior to beginning site assembly or delivery of the redesigned units.

Operation and Maintenance:

TAF #16: Plan a program of routine maintenance so that downtime can be minimized year-round and eliminated during periods of peak demand.

TAF #17: Delegate the responsibility for routine maintenance and minor repairs to a local mechanic with immediate access to the technology and a vested interest in its continuous operation.

TAF #18: Complete any training required for operation and maintenance of a technology prior to the initial operation of the unit.

TAF #19: Provide the local operator with the tools and spare parts required for emergency repairs on the technology unit.

The emphasis on O&M must permeate all phases of the technology delivery process and all design decisions if the project is to succeed. As outlined in Part II above, the entrepreneurs and national production units interviewed constantly strive for zero service callbacks and for minimal routine maintenance. This may be unrealistic, particularly for some of the more complex systems; however, it is essential that the potential users help define what amount of time for O&M is acceptable. This information should become a major design criteria for the technology selection and adaptation steps. Training and institutional arrangements required for O&M must be considered during the predemonstration discussions with local entrepreneurs or communities. The actual O&M requirements of the field trials should be fed back into subsequent system modifications prior to widespread technology delivery and diffusion.

The remaining steps in the technology delivery process depend on the successful execution of these three and their TAFs. During the field work for this paper, a substantial number of failed prototype technologies were examined at universities, research centers, and village sites. Most were conceptually sound, providing adequate technical performance. Many were well executed in an engineering sense. All were abandoned. In every case, one or more of the three key technology delivery steps had been neglected. In most cases, all three crucial steps had been bypassed. Lacking the information provided by the needs assessment and local involvement, technologists made design and material errors. Where O&M considerations were ignored, the installed systems were rejected by local users as too complex, unreliable, or bothersome.

THE DIFFICULTY OF INCLUDING ALL THE TECHNOLOGY ACCEPTANCE FACTORS IN REAL WORLD FIELD PROJECTS AIMED AT DELIVERING TECHNOLOGY

The sets of do's and don'ts just identified as crucial to successful technology delivery projects--those built around needs identification, local involvement, and carefully planned operation and maintenance--are, in fact, rarely observed. It is not that development organizations or their program designers are blissfully unaware of the need for these project components; rather, the main reason for their omission are rooted in the limitations that exist in the organizations that fund and run development projects on a day-to-day basis. First, it is difficult to administer projects that designed to contain all these TAFs, since they contain components such as detailed needs assessments and local participation and require a certain measure of local control over both the project's direction and its day-to-day implementation. As Derick Brinkerhoff (1980, pp. 34-35) recently noted in the context of rural health project in Mali, the "New Directions" philosphy of decentralization, interagency coordination, and local participation has significant financial and administrative costs, particularly in developing country settings.

> Decentralization in the rural development context is difficult to manage. Where communications links are tenuous and uncertain, field operations can easily 'get away' from the center, resulting in a loss of unity of effort. Integrating with existing government units means to some extent sharing the deficiencies and problems of those units, as well as gaining access to their experience and competence. Incorporating participation of various actors--from clients to donors- project operations necessitates dealing with their concerns, going at their pace, and adjusting to their perceptions and administrative requirements.

Second, many of the project components that are needed to follow these injunctions require sets of skills that are scarce in most developing country organizations, particularly when dealing with new technologies such as renewable energy systems. Traditional ministries of energy or rural electrification authorities, for example, may not possess the expertise required to conduct detailed village-level assessments of energy use patterns, of the annual and seasonal availability of resources such as wind, solar insolation, or biomass residues, etc. To gain such skills, an organization must train existing personnel, hire new staff, or enter into a cooperative agreement with local groups that possess them. Any of these options will be expensive and difficult to execute rapidly. Third, giving central importance or even major attention to these factors may require a major reorientation for the mission of the implementing agency. This is particularly true for elite, single-purpose research organizations and university-based research units, which have little or no experience and interest in mundane questions such as the reduction of routine maintenance and the elimination of downtime during periods of peak demand or the provision of tools and spare parts to local operators.

PART IV

LESSONS LEARNED AND ADDITIONAL RESEARCH REQUIREMENTS

TECHNOLOGY DEVELOPMENT AND TESTING SHOULD NOT BE ISOLATED FROM THE OTHER STEPS IN THE TECHNOLOGY DELIVERY PROCESS

A great deal of technology experimentation is underway in developing country institutions. Much of it is disembodied research, divorced from any contact with potential users of the units under development. This is doubly true in renewable energy systems. Testing existing systems and alternative materials can be defended as part of the technology adaptation process, but prototype system development should not be undertaken without a set of design parameters derived from the demands of potential users. It makes no sense to develop a $3,000, high-efficiency flat-plate collector for water heating if potential users cannot afford the unit, do not have access to electricity to power the pump, and would not be able to maintain the system or replace broken parts. If the project is to deliver useful services to end-users, then it must be structured to include all the necessary components of the technology delivery process. This is particularly essential if the ultimate objective is for the project to become self-replicating, either through the initiative of private entrepreneurs or through local community efforts.

IT IS IMPORTANT TO CLEARLY DIFFERENTIATE BETWEEN TECHNOLOGY TESTING AND TECHNOLOGY DELIVERY PROJECTS

The purpose of a project must be foremost in the minds of those individuals designing and implementing it. With new or unfamiliar technologies, projects are often developed to gain working knowledge of the performance, durability, and approximate costs of installed systems. In these cases, the project should be structured to collect the maximum amount of information required for future policy decisions on the widespread use of this technology or for further adaptive R&D. Such experimental testing projects should not be disguised as technology delivery projects, where the emphasis should be on the delivery of cost-effective and locally acceptable services. It is perfectly legitimate and indeed necessary to test photovoltaic-powered water pumping and stand-alone rural electrification systems in remote developing country sites. However, foreign assistance organizations should not assert that this unit is the best choice for a given need: this is a matter to be proved by comparing its cost and performance with locally available energy options and with local capital resources. It is only when a technology passes these tests that the government or private entrepreneur should concentrate on technology diffusion and distribution.

THE IMPORTANCE OF PREVIOUS FIELD EXPERIENCE WITH TECHNOLOGY DELIVERY IN ORGANIZATIONS MANAGING FIELD PROJECTS

More attention should be paid to proven expertise in the technology delivery process when selecting the implementing institutions for major renewable energy projects. It is easier and less costly to provide technological expertise to organizations successful in needs identification and local involvement thau to impart principles of field operation to technology testing and development organizations. For example, a major effort should be undertaken to involve private and public entrepreneurs in the production, marketing, and maintenance of renewable energy systems. More emphasis should also be given to strengthening the technical and management capabilities of small volunteer organizations and other experienced field agencies. This should include not only transmitting specific skills to NGO field staff and management, but also encouraging information exchange among field practitioners on successful implementation procedures for technology delivery projects.

THE ADVANTAGES OF DECENTRALIZATION OF PROJECT DESIGN

Careful needs assessment and continuous local community or entrepreneur involvement imply a degree of local autonomy in project design and implementation, including technology selection and adaptation. This will require a basic restructuring of the procedures used by many central planning ministries and foreign assistance agencies. Far greater time, effort, and funds will have to be devoted to needs assessment and project design, slowing the process of technology selection and delivery. This delay, however, should be balanced by an increased likelihood of technology acceptance and self-sustaining diffusion.

THE NEED TO TEST THE APPLICABILITY OF THE EXPANDED TECHNOLOGY DELIVERY MODEL AND THE TECHNOLOGY ACCEPTANCE FACTORS IN A WIDE SAMPLE OF DEVELOPMENT PROJECTS

The TAFs and the accompanying technology delivery model presented in this paper should be viewed as tentative hypotheses, derived from direct observations of a limited number of attempts to move a variety of technologies to Third World users. Only a subset of organizational types were examined, and those were located only in three regions. What is required now is a systematic research effort to compare this model with the practical experience of a large set of veteran technology delivery specialists. A number of questions need to be asked in a controlled and systematic way, such as: are all the elements of this technology delivery model and all of the Technology Acceptance Factors really necessary, or can there be a major simplification? Are there other elements which are equally important to those presented here which are essential to a technology delivery model? Is there some underlying technology model that explains project success or failure for a wide variety of technologies and geographical regions, or are there, in fact, a series of models, each with its own set of Technology Acceptance Factors? What is the relationship between the nature of the technology or technique being introduced and the technology delivery model required for successful introduction of the technology?

THE NEED TO SYSTEMATICALLY SURVEY EXISTING AND COMPLETED PROJECTS TO GATHER THE DATA ON THE ELEMENTS OF A SUCCESSFUL TECHNOLOGY DELIVERY PROJECT

Major donors and developing country central ministries have been funding technology delivery projects for decades. Many different Technology Acceptance Factors have been developed in the course of the implementation of those projects. Sometimes these have entered into the collective memory of the executing agency, but often they have been neglected or forgotten at the end of the project (particularly if the project was a major failure). So that we are not doomed to repeat these mistakes, a major effort should be launched by donors to systematically assess the key project components that contribute to project success or failure, and the lessons that can be derived across projects for future project design and implementation. Such an examination should ideally be run at the same time in several sectors, such as rural health delivery, agricultural support services, and energy systems, since they affect many of the same clients and use portions of the same rural infrastructure. Such simultaneous investigations would provide much needed information on whether there can be a universal technology delivery process, and whether the practical Technology Acceptance Factors unearthed in one discipline have applicability in other fields as well.

REFERENCES

Ashworth, John H. 1979. Renewable Energy Sources for the World's Poor: A Review of Current International Development Assistance Programs. SERI/TR-51-195. Golden, CO: Solar Energy Research Institute.

Ashworth, John H.; Neuendorffer, Jean W. 1980a. Developing Common Information Elements for Renewable Energy Systems: Summary and Proceedings of the SERI/AID Workshop, 20-22 February 1980. SERI/TP-744-661. Golden, CO: Solar Energy Research Institute.

Ashworth, John H.; Neuendorffer, Jean W. 1980b. Matching Renewable Energy Systems to Village-Level Energy Needs. SERI/TR-744-514. Golden, CO: Solar Energy Research Institute.

Ashworth, John H. 1982. Delivering the Renewable Energy Promise: Institutional Options for Providing New Energy Technologies to Developing Country Users. SERI/TR-760-1098. Golden, CO: Solar Energy Research Institute.

Benor, Daniel; Harrison, Janem Q. 1977. Agricultural Extension: The Training and Visit System. Washington, DC: The World Bank.

Blackledge, James P. The Industrial Research Institute in a Developing Country: A Comparative Analysis. Denver, CO: Denver Research Institute for U.S. Agency for International Development.

Brinkerhoff, Derick W. 1980 (Nov.). Realities in Implementing Decentralization, Coordination and Participation: the Case of the Mali Rural Health Project. Discussion Paper No. 105. Cambridge, MA: Harvard Institute for International Development.

Brown, Lester R. 1970. Seeds of Change: The Green Revolution and Development in the 1970s. New York: Praeger Publishers.

Cilingiroglu, A. 1975. Transfer of Technology for Pharmaceutical Chemicals: Synthesis on the Experience of Five Industrializing Countries. Paris: OECD, November.

"CIMMYT Training." CIMMYT Today. No. 9: O ober 1978.

Commer, James M.; O'Keefe, Robert D.; Chilensl as, Al A. 1980 (Feb.). "Technolog Transfer from Government Laboratories to Industrial Markets." Industrial Marketing Management. Vol. 9 (No. 1): pp. 63-67.

Chudson, Walter A.; Wells, Louis T., Jr. 1971. The Acquisition of Proprietary Technology By Developing Countries from Multinational Enterprises: A Review of Issues and Policies. New York: United Nations Institute for Training and Research.

General Accounting Office. 1978 (27 Jan.). U.S. Participation in International Agricultural Research. Washington, DC: General Accounting Office.

Giral, Jose B.; Morgan, Robert P. 1974. "Appropriate Technology for Chemical Industries in Developing Countries: Report of a Summer Research Training Project in Mexico." Technos, April-June, pp. 18-38.

Goulet, Dennis. 1977. The Uncertain Promise: Value Conflicts in Technology Transfer. New York: IDOC/North America Inc.

Government of Netherlands. 1979. Netherlands' Development Cooperation Policy 1979. The Hague, Netherlands: The development cooperation information department, ministry of foreign affairs.

Haglund, Howard H.; Schlie, Theodore W. 1975. Transfer of Technology from Federal Laboratories: Preliminary Findings in the Development of an Experiment to Realistically Explore and Promote the Transfer of Technology from Federal Laboratories. Denver, CO: Denver Research Institute.

Hoelscher, H.E. 1979 (Aprl). "Transfer of Science and Technology to Lebanon." Science and Public Policy; pp. 91-106.

International Rice Research Institute, Agricultural Engineering Department. 1975. Agricultural Machinery Development Program: Terminal Report for USAID/IRRI Projects No. CSD-834 and CSD-2541. Manila, Philippines: International Rice Research Institute.

Kidd, Charles V. 1979. Building National Institutions for Science and Technology in Developing Countries. Proceeding of a workshop conducted by the American Association for the Advancement of Sciences; 18-19 April 1979. New York: American Association for the Advancement of Sciences.

Kohli, P. K.; Virdi, M. S. 1980 (Feb.). "Some Problems of Transfer of Technology from an R&D Laboratory to Industry in a Developing Country." R&D Management. Vol. 10 (No. 2).

Meunier, Richard. 1981 (June). Development Assistance in Renewable Energy: International Efforts and U.S. Participation. SERI/Internal Working Paper. Golden, CO: Solar Energy Research Institute.

Moravcsik, Michael J. 1979. "Local Institutions for the Building of Science and Technology in Developing Countries--An Overview." Building National Institutions for Science and Technology in Developing Countries. Charles V. Kidd, ed., Washington, DC: American Association for the Advancement of Science; pp. 27-50.

OECD. 1975. Transfer of Technology by Multinational Corporations, Volume II: Background papers presented at the International Meeting of Researchers on the Transfer of Technology by Mu[illegible]inational Corporations. Paris: Organization for Economic Cooperation and D[illegible]lopment, November.

Pugwash Conference on S[illegible]ence and World Affairs. 1974. "Draft Code of Conduct on Transfer of Technology." World Development. Vol. 2, (No. 4) April-May 1974.

Ramesh, Jairam; Weiss, Charles; Kamenetsky, Mario. 1979. "Technological Capacity as an Element of Development Strategy." Building National Institutions for Science and Technology in Developing Countries. Charles V. Kidd, ed. Washington, DC: American Association for the Advancement of Sciences; pp. 51-64.

Rao, K. Nagaraja. 1974. "Technology Transfer--A New Name for an Old Game." Technology Transfer: Successes and Failures. G. K. Mannine, ed. San Francisco: San Francisco Press; pp. 73-87.

Rao, K. Nagaraja. 1978 (Apr.-June). "University-Based Science and Technology for Development." Impact of Science on Society. Vol. 28 (No. 2); pp. 117-126.

Rao, K. Nagaraja. 1979. "Institutional Infrastructure for Training and Education in Developing Countries." Building National Institutions for Science and Technology in Developing Countries. Charles V. Kidd, ed. Washington, DC: American Association for the Advancement of Science.

Rochin, Refugio I. 1978. "Why Small Farmers Do Not Adopt and Utilize New Technology." Lahore, Pakistan: Increasing the Productive Capacity of Small Farm

Rochin, Refugio R. 1979. "Responsiveness of Subsistence Farmers to New Ideas: Dwarf Wheat on Unirrigated Small Holdings in Pakistan." Tan Bock Thiam and Shao-Er Ong, eds. Readings in Asian Farm Management. Singapore: Singapore University Press.

Rogers, Everett M. 1962. The Communication of Innovation. New York: The Free Press.

Rogers, Everett M. 1976. "The Passing of the Dominant Paradigm: Reflections on Diffusion Research." Wilbur Schramm and Daniel Lerner, eds. Communications and Change: The Last Ten Years. Honolulu: East-West Center.

Rogers, Everett M. 1980 (Nov.). "The Diffusion of Technological Innovations: Applications to Renewable Energy Resources in Developing Nations." Washington, DC: Paper prepared for the Panel on the Introduction and Diffusion of Renewable Energy Technologies of the National Academy of Sciences.

Rogers, Everett M.; Shoemaker, Floyd. 1971. The Communication of Innovation. New York.

Schlie, Theodore W. 1977. The Past and Potential Role of the United States in the Transfer of Agri-Food Technology to Developing Countries. Denver, CO: Denver Research Institute.

UNIDO. 1975. Industrial Research Institutes: Organization for Effective Resea[r] Technical, and Commercial Services. New York: United Nations Industrial Development Organization.

Vaitsos, Constantine V. 1970. "Bargaining and the Distribution of Returns in the Purchase of Technology by Developing Countries." Institute of Development Studies Bulletin. Vol. 3, (October).

Vernon, Raymond. 1971. Sovereignty at Bay: The Multinational Spread of U.S. Enterprises. New York: Basic Books.

Wells, Louis T., Jr. 1972. The Product Life Cycle and International Trade. Cambridge, Mass: Harvard University Press.

APPENDIX A

INSTITUTIONS VISITED DURING THE FIELD RESEARCH FOR THIS PROJECT

Identification Code

IARI	International Agricultural Research Institute
IRI	Industrial Research Institute
S & T	National Science and Technology Ministries or Institutes
NPU	National Production Units
NGO	Private Nongovernmental Organization
UNIV	University and University-based Research Institutes
ENTPNR	Entrepreneur or Private Firm
UTIL	Utility
OTHER	Other organizations not included in above categories

THAILAND

1. National Energy Administration (S & T)
2. Asian Institute of Technology (UNIV)

PHILIPPINES

1. Bureau of Energy Development, Non-Conventional Resources Division (S & T)
2. National Electrification Administration (UTIL)
3. University of the Philippines, Los Banos (UNIV)
4. International Rice Research Institute (IARI)

SRI LANKA

1. Ceylon Electricity Board, Colombo (UTIL)
2. U.N. Environment Program Rural Energy Center, Pattiyapola (NGO)

INDIA

1. Department of Science and Technology, New Delhi (S & T)
2. National Physical Laboratory, New Delhi (S & T)
3. Khadi and Village Industry Commission, New Delhi (NPU)
4. Indian Institute of Science (ASTRA unit), Bangalore (UNIV)
5. Birla Institute of Technology, Ranchi (UNIV)
6. Appropriate Technology Development Association, Lucknow (NGO)

NEPAL

1. Belaju Yantra Shala, Kathmandu (NPU)
2. Research Center for Applied Science and Technology, Tribhuvan University, Kathmandu (UNIV)

GUATEMALA

1. Central American Research Institute for Industry or ICAITI, Guatemala city (IRI)
2. Center for the Investigation and Application of Appropriate Technology, Choqui Station or ICADA/Choqui, Quetzltenango (NGO)

BARBADOS

1. Caribbean Development Bank, St. Michael (OTHER)
2. Christian Action for Development in the Caribbean or CADEC (NGO)