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9. ABSTRACT

The recommendations of this ad hoc Panel are as follows: 1) The pivotal problem is to expand remunerative employment to meet the needs of a rapidly growing population. 2) The resources needed to develop a modern agriculture in East Pakistan are gigantic. 3) The general strategy for economic development should assure a balance between expanding employment and associated increases in personal income and food supply. 4) A dynamic investment strategy is needed for East Pakistan that considers all sectors of the economy in relation to agriculture. 5) Adaptive research and assessment of local situations relative to their readiness for agricultural innovations should have greater emphasis in the agricultural development program. 6) Priorities for water management projects should take into account more fully the degree of risk involved. 7) Institutional development and manpower training are needed to provide the organizations and skills essential for carrying out the proposed research and comprehensive studies, agricultural development, and water management programs. 8) A comprehensive study of resources and development plans and a central repository for data are needed. 9) Agricultural research and training, population control, food aid, and sectoral loans for broad institutional support are suggested for USAID emphasis.

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EAST PAKISTAN LAND AND
WATER DEVELOPMENT
AS RELATED TO
AGRICULTURE

A Report of an ad hoc Panel of the
Board on Science and Technology
for International Development
of the
National Academy of Sciences
National Research Council

Prepared for the
Agency for International Development
Washington, D. C.

January 1971

This report has been prepared by an ad hoc Panel under the auspices of the Office of the Foreign Secretary, National Academy of Sciences—National Research Council, for the Office of Technical Support, Bureau for Near East and South Asia of the Agency for International Development, Washington, D. C., under Contract No. csd-2584. No portion of this report may be reproduced or cited without approval of the contracting agency.

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NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

OFFICE OF THE FOREIGN SECRETARY

February 4, 1971

Dr. Harrison Brown
Foreign Secretary
Office of the Foreign Secretary
National Academy of Sciences

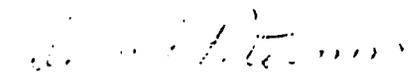
Dear Dr. Brown:

The report of the ad hoc Panel on East Pakistan Land and Water Development as Related to Agriculture, appointed by the National Academy of Sciences, Office of the Foreign Secretary, is transmitted herewith. In preparing this report, the Panel reviewed the draft Plan of Action proposals of the International Bank for Reconstruction and Development and discussed these plans, as well as programs and problems of East Pakistan in general, with officials of the Bank and of the Agency for International Development. The Panel is greatly impressed with the IBRD plan and compliments the Bank on the plan's comprehensive nature.

In submitting this report on East Pakistan, the Panel recognizes its own limitations of time and of specific background in that Province. A number of questions and suggestions are raised, however; these are intended to be instructive and helpful. We hope they are. While there are risks in the plans, the greatest risk by far is to do too little.

East Pakistan may well constitute that critical case which first really tests the commitment of the developed nations to the ideal of a humane world. The time is so short, the task is so difficult, the stakes are so great, and the potential for human indignity and suffering are so large, that men and nations of good will, including Pakistan itself, must rise to an entirely new level of intelligent commitment if a great disaster is to be avoided. Imaginative and vast though it is, the Bank's plan, from such a viewpoint, may be scarcely more than a next minimum step.

Sincerely yours,



Dean F. Peterson, Jr.
Chairman

dw

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

OFFICE OF THE FOREIGN SECRETARY

BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT Ad Hoc Panel on East Pakistan Land and Water Development as Related to Agriculture

Panelists

Dr. Dean F. Peterson, Jr. (Chairman) Dean, School of Engineering Utah State University Logan, Utah	Mr. Walter B. Langbein Research Hydrologist Water Resources Division U.S. Geological Survey Washington, D. C.
Dr. James M. Coleman Associate Professor Department of Marine Sciences Louisiana State University Baton Rouge, Louisiana	Dr. John W. Meller Professor, Department of Agricultural Economics, and Department of Asian Studies Cornell University Ithaca, New York
Dr. Walter P. Falcon Director of Research Development Advisory Service Department of Economics Harvard University Cambridge, Massachusetts	Dr. Arthur T. Mosher President Agricultural Development Council, Inc. 630 Fifth Avenue New York, New York
Dr. Robert M. Hagan Professor, Department of Water Science and Engineering University of California at Davis Davis, California	Dr. L. Sterling Wortman, Jr. Director, Agricultural Sciences The Rockefeller Foundation 111 W. 50th Street New York, New York

Consultant to the Panel

Dr. D. Wynne Thorne
Vice President for Research
Utah Agricultural Experiment Station
Utah State University
Logan, Utah

FOOD AND WATER PROGRAMS FOR EAST PAKISTAN

Summary and Recommendations

In response to a request by the U.S. Agency for International Development, the ad hoc Panel appointed by the National Academy of Sciences has studied available information about East Pakistan, has consulted with various scientists who have investigated problems of the Province and has reviewed the proposals of the International Bank for Reconstruction and Development for an action program. The Panel commends the Bank for its broad evaluation of the conditions of East Pakistan and for its extensive development plans which provide a comprehensive attack on the difficult problems of the area. The Panel's comments and recommendations are summarized herein. In presenting its recommendations the Panel recognizes the need for capital transfer at something like the scale and rate proposed by the Bank.

The magnitude and complexity of the problems confronting East Pakistan have deeply impressed the Panel. Conscious of its limited collective experience in East Pakistan, the Panel offers its comments in the hope that they can provide a useful perspective for planning assistance to the region. The Panel recognizes that the realities of development may necessitate less than ideal solutions, that the situation is growing increasingly desperate and risk will have to be taken in the context of constructive suggestion but not obscuring the necessity for massive and decisive action. Also, such comments can only be adjunctive to the longer, more detailed studies that are being

undertaken by the aid-giving community. Even more importantly, the Panel emphasizes that their ideas cannot substitute for the studies of and basic decisions on the necessary approach and strategy, that must be made by the Pakistanis themselves.

1. The pivotal problem is to expand remunerative employment to meet the needs of a rapidly growing population.

The most basic problems of development in East Pakistan are those inherent in any region largely engaged in traditional agriculture, with an already dense and rapidly expanding population. These difficulties are accentuated by location of the Province on the low-lying delta of one of the world's largest river systems that is subject to alternating periods of annual extreme excesses and deficits in rainfall, combined with recurring floods and cyclonic storms. East Pakistan thus must deal with one of the most difficult water problems in the world.

Under the existing circumstances of high population density and traditional agriculture, the basic goals must be:

- (1) to reduce the population growth rate,
- (2) to increase opportunities for remunerative employment as rapidly as possible, and
- (3) give simultaneous attention to the problems growing out of the serious water situation faced by the Province.

Increasing opportunities for remunerative employment and adequate food can be achieved by a combination of: creating a modern agriculture over as much of the Province as possible, utilizing mechanization in agriculture as a means for increasing production and providing

opportunities for the profitable use of labor; generating non-farm employment as rapidly as possible through industrialization with a major objective being to employ the maximum number of people, and utilizing labor-intensive methods insofar as possible in public works and other construction projects, but not losing sight of the necessity to create a significant increase in the rate of real economic growth and of local generation of new capital.

The flood, drouth and occasional catastrophic storm problems of East Pakistan are dramatic, serious, and difficult to deal with. They complicate and they have to be attacked, but they should not be allowed to deflect attention from the urgency of East Pakistan's basic problems of population and under employment.

Similarly, the Panel agrees that vast investments in physical works are required to develop East Pakistan's economy, but these must not be allowed to obscure the equally important need for (1) completion of detailed adaptive research designed to increase agricultural production; (2) implementation of ways to provide trained manpower for the broad range of technical competencies that are needed; and (3) development of organizational forms and institutions—public and private—within which trained men can work effectively.

The great difficulty of the Bank's task in generating effective programs to attack East Pakistan's problems and the urgency under which the Bank has worked is recognized by the Panel. The Panel compliments the Bank on achieving a new high level of large-scale planning to cover East Pakistan's conditions.

The Panel agrees with the concepts of the plan, but recommends that the program be made more effective by bringing the employment, human, institutional and research elements involved into a better balance with the proposed investments in structures and commodities.

2. The resources needed to develop a modern agriculture in East Pakistan are gigantic.

While the primary need is for expanded total resources, this expansion must be closely balanced against composition of resources and include short-run priorities and procedures to accommodate the growing economy to limited resources. The Panel urges the Bank to develop in greater detail the type and priorities of projects in the action program that would be consistent with varying levels of aid. The Panel is also concerned that rupee funding be adequate to support the land and water program (as well as the other sectoral efforts), and urges that the Bank include local costs within its loans, where these cannot be generated locally. In the long run most of the local capital will have to be generated by the Pakistanis themselves and attention needs to be given to the potential for the creation of savings and for means of making these accessible for development financing.

The underwriting of programs with a high local cost component such as the Thana Irrigation Program appear to be ideally suited for a sector loan from AID.

The Panel recommends that major efforts be made by all aid donors to help meet the region's resource needs over an extended period.

3. The general strategy for economic development should assure a balance between expanding employment and associated increases in personal income and food supply.

Employment expansion is necessarily accompanied by greater total personal income and increased income for the poor is spent first on food and second on consumer goods. Food, thus is an essential incentive for enhancing income, and consequently a sustained rapid increase in employment depends upon even more rapid increases in agricultural production or major importations of food. The Panel believes that the close complementarity between massive capital developments, employment growth, income expansion, food supply—including external purchases—and prices will require that expansion in employment be accompanied by enhanced food aid sufficient to prevent sharp increases in food prices but administered dynamically so that it does not become competitive with local farmers' incentives.

This situation lends urgency to striking a balance between the capital inputs (which are usually provided by aiding nations) and consumer goods, particularly in the form of food, which are necessary to expanding employment.

The Panel recognizes that in the longer run agricultural development programs should result in substantial increases in food availability. But employment increasing programs should not wait for that eventuality.

Food aid is not a substitute for domestic production, but a supplement that can tide over short-term deficiencies and simultaneously contribute to capital developments such as roads, which in turn

facilitate long-range agricultural development. Without food aid, capital investments will tend not to be labor intensive, and the poorest segments of society will correspondingly suffer most. Food aid programs can also help provide the local financing that will be in short supply to meet the program needs. If the objectives of food aid are to be attained, excessive profiteering by middlemen cannot be tolerated.

The Panel therefore recommends that food aid be included as a balancing strategy in the Bank's action program, that this be grant and not food lending, and that every effort be made to ease food aid regulations, such as the like commodity clause, which tend to exacerbate problems of internal and external trade for Pakistan.

4. A dynamic investment strategy is needed for East Pakistan that considers all sectors of the economy in relation to agriculture.

Little has yet occurred in East Pakistan to foster development of a base for commercial agriculture or industrial system. Without such a base, standard cost-benefit analyses of program investments are relatively meaningless because they assume an economic environment that probably does not exist. Cost benefit analyses thus tend to overemphasize large-scale irrigation and flood control projects relative to investments in transportation and electric power and research. More active attention must be given to vitalizing the general relationships among various investments and growth. Intensive district-by-district studies of agricultural production potentials and

needs might well indicate a necessity for substantial modification of currently-stated investment priorities. Very possibly, increased investments in roads in the non-flooded areas and in electric power might take precedence over some of the high-risk water development projects.

Emphasis on a remunerative employment investment policy raises questions concerning investment allocations not only between agriculture and industry, but within those sectors as well. While agricultural development is conducive to direct and indirect creation of employment, specific forms of agricultural development may interfere with attaining this objective. The question of whether an investment in farm mechanization or rural flood control will do more to foster growth in remunerative employment than would the same investment made in other parts of agriculture or the economy should be continually reevaluated.

The Panel recognizes that the dynamics of economic growth in East Pakistan cannot be forecast in detail; however, the Panel recommends that additional study be given to dynamic strategy in which all sectors of the economy are considered in relation to agriculture. It further recommends that increased distribution be given more weight in making evaluations of alternative investments.

5. Adaptive research and assessment of local situations relative to their readiness for agricultural innovations should have greater emphasis in the agricultural development program.

Creating a highly productive agriculture as rapidly as feasible over as much of the Province as possible requires that attention be

devoted to two sets of factors.

First, stress must be placed on providing the major components of a program to stimulate agricultural growth:

- (1) Agricultural research, with emphasis on improved crops, including rice, fertilizers, pest control, crop and water management;
- (2) Farm inputs—new seeds, fertilizers, pesticides, tools, etc.
- (3) A rural system of roads, markets and extension services that satisfy farmers' needs and make markets readily available.
- (4) Adequate production incentives for farmers.
- (5) Land development for irrigation, drainage and flood protection.
- (6) Training programs for agricultural specialists and technicians.
- (7) Irrigation water distribution among small, fragmented holdings.

Decisions about programs and public investments related to each component should be made considering which activities must be publicly financed and which can be left to private initiative, and which activities are seminal; that is, if successful will induce other essential activities. (Research and extension are likely to be seminal, marketing structures can probably be induced.)

Second, attention should be directed toward identifying and implementing those factors and indicated actions connected with local

readiness for the immediate growth of agricultural production in each part of each region of the Province. Assessing district by district the prospects for and requirements of agricultural growth can identify priorities for different types of activity for the near future.

While a modern agriculture could ultimately be created over most of East Pakistan, the immediate and long-term obstacles and opportunities differ among the districts and thanas. Among the factors that might be assessed under different local conditions are: suitability of available technology (varieties, fertilizers, pest control practices, etc.) for attaining high yields of quality crops, availability of water for irrigation; potentials for flood protection and costs and time required for project development, and willingness of farmers to cooperate in developing facilities and practices suitable for an improved agriculture.

Some areas would move into modern agriculture with minimal short-term investments; some may require major project development before favorable agricultural innovations can be established; others may have a low growth potential without some technological breakthrough that cannot be foreseen; still other situations may not be suitable for the existing improved varieties but could be helped with further research.

The Panel recommends that the World Bank place a higher priority on adaptive agricultural research and promote a detailed assessment of local obstacles and opportunities for implementing modern agricultural programs.

6. Priorities for water management projects should take into account more fully the degree of risk involved.

Water development projects involve social and economic risks on the one hand and geophysical, ecological, human life, and engineering risks on the other. The bank's plan tends to reduce risks by scheduling the smaller projects first, thus providing opportunity for further study of the larger, higher-risk projects; however, the Panel feels that there are many unknowns in the larger projects and that some project commitments may need to be deferred until the level of risk can be ascertained more fully.

The Panel supports the general scheme of the World Bank proposals for extensive development of low-lift pumps, for expansion of tube-wells and for developing the Chandpur flood protection and irrigation project as a model for intensive agriculture in an embanked area. While planning and designs for the various proposed projects are being developed, careful evaluation should be made as to benefits from alternative non-water investments such as roads, electric power and flood protection for cities.

The Panel recommends that priorities for projects be reviewed with detailed evaluation of risks in order to better insure that specific designs will result in desired benefits, including protection to human life.

The following observations are offered in regard to suggested evaluations:

Low-Lift Pumps and Tubewells. Small-scale water development with low-lift pumps operating from natural channels can be pursued with confidence. Ground water development is somewhat more hazardous, but offers the best means for rapid expansion of irrigation and food production; and might be developed further than the Plan proposes with relatively less risk than the larger surface water developments. Ground water resources should be evaluated further and tubewells used in all suitable regions as is being done in the northwest. Hazards of saline water intrusion and relations of ground water to surface supplies need continuing study.

River Management. Considering the nature of available construction materials and the erosive power of the rivers, the integrity of river training works is under question. The present partial embankment scheme, which leaves a wide river-bank area as a floodway, minimizes risks by allowing for experience to be obtained for modifying the program as it develops; but based on experience elsewhere, probably will lead to public demand for including the floodway areas in the program as well.

In view of the hazards involved, the Panel underscores the essential need to explore not only the hydrology and river engineering aspects of diking proposals but also the closely interacting ones of extent, degree, and scheduling of partial protection to agricultural areas and high protection to urban areas, and the degree of protection and the adjustments in land occupancy that might be made in response to flooding.

Inland Flood Abatement and Polders. In many areas, the depth of water accumulation in empoldered areas approximates the depth of rainfall over the 3-to 4-month period of flooding. Flood protection from river overflows depends in large part on the effectiveness of the river embankment components. Enclosed areas are subject to excessive water accumulation in summer and to exclusion of needed waters in winter. In either event each enclosed area will require almost continuous pumping and will entail possible problems of drainage and waterlogging and each will require the continuous attention of resident specialists.

There is need for a large-scale study and demonstration project to determine the most effective procedures for managing an empoldered area and for finding the most effective ways for attaining a modern agriculture therein. The Chandpur project could provide such a study-demonstration area.

Coastal Flooding. Short of enormous embankments and dams across embayments, protection against typhoons is not possible. Greater attention needs to be given to methods of life protection and refuge, warning plans and response tactics, methods for recompense for property loss, and to hurricane research for attenuating and redirecting these storms.

International Agreements. Every effort should be made by concerned nations to develop international agreements which could lead to unified management of the Ganges-Brahmaputra river system.

7. Institutional development and manpower training are needed to provide the organizations and skills essential for carrying out the proposed research and comprehensive studies, agricultural development, and water management programs.

Innovative programs have been initiated for training farmers, mechanics and administrators under the Comilla District Program and the Thana Irrigation Program. These should be strengthened and expanded and the training of scientists, engineers and skilled technicians should be greatly increased and improved through the universities and in conjunction with the agricultural research and testing activities. Trained personnel and building strong institutions are primary products of a successful development program. These should be emphasized in all assistance programs even if this results in some reduction in efficiency.

The Panel recommends that increased emphasis be given to developing manpower and organizational capability especially in agriculture and for such problem areas as hydrology, ground water management, soil subsidence, river engineering and planning.

8. A comprehensive study of resources and development plans and a central repository for data are needed.

All data concerned with climate, geology, soils, water resources and including state-of-the-art documentation of developments and regional differences should be centrally assembled and made available to all East Pakistan agencies and consultants.

The Bank has proposed a three-year comprehensive study of land and water resources and of proposed and potential resource and

agricultural development schemes. The Panel commends such an endeavor, and believes the Bank should give it increased emphasis, but urges that the terms of reference for the various schemes be assessed with respect to risks involved in the various alternatives, including geophysical hazards, floods, typhoons, river regimens, and sediment imbalance. There should also be on-site research or verification of programs and development of improved planning procedures.

The Panel believes best long-range accomplishments will be attained by having Pakistani personnel and organizations carry out the comprehensive studies with assistance of international consultants, in contrast to a Bank-managed study as proposed.

The Panel supports a comprehensive study of land and water resources and of agricultural development schemes for East Pakistan and urges that East Pakistan personnel and institutions have the primary responsibility.

9. Agricultural research and training, population control, food aid and sectoral loans for broad institutional support are suggested for U.S AID emphasis. The Panel recognizes the basic need for substantial U.S. participation in consortial capital assistance to the Province. In addition the Panel has identified six areas which seem logical, but not necessarily exclusively so, for the U.S. AID emphases.

- (1) Continue massive emphasis on birth control.
- (2) Expand programs to increase rice production through enhanced research and technical assistance, and

promote similar activities to increase production of other important crops.

- (3) Develop institutions and programs to train technicians for extension, marketing, credit, distribution of farm inputs, etc., through in-service training as well as by strengthening academic training.
- (4) Promote an immediate survey to determine the readiness of different parts of each district and thana for short-term agricultural growth as a basis for setting priorities for programs best suited to immediate local needs.
- (5) Develop an enlarged food aid program to expedite rural public works projects without engendering exorbitant food prices.
- (6) Provide sectoral loans to East Pakistan to increase the total resources for agricultural development, and to underscore the necessity for funding broad organizational programs which are difficult to fund under strictly defined projects.

I. Introduction

Faced with a rapidly rising population, limited land resources and serious problems from floods and drouth, East Pakistan must increase either her food production or her massive imports of food, or else encounter famine. Recognizing this crucial situation, the International Bank for Reconstruction and Development (World Bank) has prepared a series of proposals whose activation would help increase food production by developing irrigation potentials, providing flood protection, and promoting the adoption of improved crop varieties and related newer technologies.

Food scarcity is crucial, but it is only one of many urgent problems confronting the country. Floods and drouth affect the supply of food, but are also direct factors in the health and safety of millions of people. Population control, employment, communication, transportation and industrial development are all in urgent need of attention.

The United States is a major participant in supporting the World Bank and assists developing countries directly. To advise it in carrying out these responsibilities, the U.S. Agency for International Development requested the National Academy of Sciences to convene an ad hoc Panel on East Pakistan Land and Water Development as Related to Agriculture. The assigned Panel accepted the broad charge of reviewing the World Bank "Proposals for Action Program," and of providing AID with recommendations on the most effective ways to employ limited resources in improving food supplies and water management in East Pakistan.

All members of the Panel are impressed with the problems and potentialities of East Pakistan, and although specialists in the field of water and agricultural development, the Panel members wish to emphasize the tentative nature of their ideas and recommendations. Few in the group have spent any extended period in East Pakistan, and their time as a Panel has been too short to allow them to grasp fully the enormous complexity of what may be the most difficult development problems in the world. They offer their comments, therefore, in the hope of providing another perspective on the planning process, while knowing full well that such comments cannot be a substitute for the longer, more detailed studies that are being undertaken by the aid-giving community. Even more importantly, they realize that their ideas cannot substitute for the study and basic decisions on approach and strategy that must be made by the Pakistanis themselves.

The Panel was confronted with a sense of urgency—the dire need of a large group of people for immediate action programs that will provide positive and immediate solutions to persistent and disastrous problems of hunger, floods and drouth that are growing more acute with time. Nevertheless, the spectre of too many examples of other well-intended action programs that failed for lack of adequate preparatory investigations and evaluations, constrains the Panel to urge deliberation so that ultimate investments will be sound and provide the maximum benefits for the people of East Pakistan.

The World Bank is complimented for its extensive evaluation of the East Pakistan situation and for proposing a strategy for land and water management directed toward meeting some of the most urgent problems of

food supply and economic development. The Panel agrees with the Bank's general strategy of giving high priority to activities designed to increase agricultural production, while concurrently carrying on studies of surface and ground water conditions, examining in detail proposals for major irrigation, drainage and flood control projects; and proceeding with training, organizing, and stimulating individuals and groups at the local level. The Panel acknowledges the extensive assistance provided by the personal reports of and discussions with representatives of the World Bank and the U.S. Agency for International Development.

A brief description of conditions in East Pakistan and of recent developments in water management is included in the Appendix, pp. 52-61.

II. Strategy for Economic Development

Employment and Food Problems

A strategy for economic development within East Pakistan should emphasize expansion of remunerative employment. This in turn will require that capital investment schemes be kept as labor intensive as possible. Construction of roads, improved water channels and embankments are public investments that can provide substantial employment. More labor intensive small industries would also be helpful.

Increases in personal income from expansion in employment of the poor will be spent first on food and second on consumer goods. If food supplies are inadequate to meet the increased demand, one of the major incentives for work is lost. Consequently, agricultural production needs to be accelerated as rapidly as possible to take care of the increasing food demand. Although the long-term prospects for agricultural production increases are good, short-run production may be inadequate to provide the food needed in an expanding employment situation. The result would be rapidly escalating food prices unless food imports are increased to maintain a reasonable balance. There is, therefore, a close complementarity between massive capital investments, which come primarily from foreign assistance, employment growth, income growth, and food aid, and these must all be maintained in a balanced relation to each other.

Food aid, is of course, not a substitute for domestic production, but a supplement to it, which helps tide over short-term deficiencies. Food aid programs are also vital to the internal economy of the Province,

and can help provide rupees for developmental programs and assist East Pakistan in meeting local currency requirements under the World Bank development program.

Under conditions of East Pakistan, in which relatively little development has occurred toward a commercial agricultural or industrial system, conventional assumptions about cost-benefit analysis have resulted in an overemphasis on large-scale irrigation and flood control projects relative to investment in transportation, electric power, education and research. In such circumstances, standard cost-benefit analysis of individual investments in transportation, power, education or research is not likely to be more than an artificial exercise. With the existing conditions of substantial complementarities among investments, more attention must be given to understanding the general relationships between alternative investments and growth. The proposed intensive district-by-district study of agricultural production potentials and needs might well call for substantial modification of currently-stated priorities.

Emphasis on remunerative employment investment policy raises the question of alternatives for employment generation. This question must arise concerning investment choices between agriculture and industry as well as within those sectors. Agricultural development is generally conducive to direct and indirect creation of employment. However, specific forms of agricultural development may interfere with attaining this objective. One must constantly raise the question whether investments in such efforts as farm mechanization or rural flood control will do more to foster growth in remunerative employment

than would investment of those resources in other parts of agriculture or in other parts of the economy.

Goals of an East Pakistan Development Program

In view of the critical convergence of the problems of a soaring population level, inadequate increases in food supply, lack of an industrial base, limited mineral resources and a history of natural disasters from floods and typhoons, the Panel suggests that the following goals be considered in evaluating any proposed agricultural and economic development program:

1. Reduce the rate of population growth.
2. Provide non-farm employment opportunities to accommodate much of the anticipated large increases in the labor force.
3. Increase agricultural productivity per acre to provide, inter alia, more food and more agricultural employment and savings for development capital.
4. Develop flood protection facilities with first priority being for cities and urban and industrial zones and for protection of human lives in rural areas.
5. Develop such general public services as transportation, electric or other power sources, market towns, communications and health services.
6. Manage economic developments and social changes, so that the benefits are widespread among the population, thereby promoting political stability.

While these and other goals are essential aspects of planning for Province development, and many of them are interdependent, the assignment of this Panel and the areas of specialized capabilities of its members limit our major considerations to agriculture, food production and management of land and water resources.

III. Laying the Base for a Modern Agriculture

No matter what may be done about industrialization, East Pakistan cannot ignore the need to create a modern agriculture over as much of its cultivable land area as possible, and as rapidly as possible. That goal should dominate its development policy and dictate its priorities. We agree that irrigation and flood control are important, but we believe they must be placed within the perspective of the total agricultural modernization task that the Province faces.

Six components of a modern agriculture deserve attention.

Adaptive Research

Over the past 20 years the science and technology for increased crop production have established the biological means of effecting a dramatic revolution in agriculture and a basis for hoping for augmentation of the world's food supply. Consequently, the time was ripe in the 1960's for the breeding and adoption of new high-yielding strains of crops. A long period of collecting and testing different selections of important crop plants, of studying and charting the heritability of different characters, and improvements in breeding methods had prepared the way for developing new crop strains with made-to-order characteristics.

This new technology is the foundation for the hope that East Pakistan can resolve its food problems. However, this new-found optimism must be tempered with realism. Spectacular as have been the increases in crop yields in other countries, the introduction of new varieties into East Pakistan has barely begun. Only preliminary tests

have been conducted with new rice varieties. While these preliminary studies indicate some suitability of the IR-8 strain for the rabi season and of IR-20 for the Kharif season with limited flooding, the hazards associated with introducing these varieties and their accompanying fertility, disease, insect control, management and harvesting practices have not been evaluated specifically for East Pakistan.

Consequently, a large-scale adaptive research program is one of the components of the modern agriculture that East Pakistan must develop promptly. Such research is needed partly to test the adaptability of varieties of rice and wheat developed elsewhere, partly to provide disease protection under conditions specific to the Province, and partly to develop improved technology for other crops that are, or could be, important in the agriculture of the Province. It is our impression that very little has been done on adaptive research to date. We would assign it high priority not only for the presently irrigated parts of the Province, but for the entire country.

Adequate Supplies of Farm Inputs

The results of crop research provide only a potential; they must be embodied in farm supplies and equipment before they can affect production. We have noted earlier the steady increase in recent years in the use of fertilizers and pesticides in East Pakistan. But that increase is miniscule when compared to the increase that must take place within the next decade if the Province is to move rapidly toward a modern agriculture over much of its land area. Consequently, high priority should be given now to examining the feasibility of domestic manufacture, particularly of fertilizers.

Creating a modern agriculture does not in general require large amounts of foreign exchange. But if farm inputs have to be imported the foreign exchange requirement can become enormous. Arranging for domestic manufacture takes considerable time. Feasibility studies, therefore, need to be completed at once and followed as quickly as possible by investments in plant capacity if domestic production proves economic.

Developing the Rural Infrastructure

The largely subsistence agriculture that dominated East Pakistan in the past had relatively little need for rural transportation, a regionally-articulated marketing system, or farm production credit. But a modern agriculture must be a commercial agriculture, utilizing purchased inputs, financing production from seed-time to market, and selling a substantial part of its produce. It thus requires a circulatory system adequate to deliver to farms all of the inputs of materials, credit, and information that they need, and to move farm products to urban centers and seaports.

A good start has been made on this at Comilla, but the process needs to become Province-wide as rapidly as increased production possibilities are provided by research.

Attention to Farmers' Incentives

Efforts to create a modern agriculture must include incentives for the farmer. Basically, this requires public policy adjustments that insure favorable relative prices for farm inputs and farm products. At the same time, care must be exercised that the incentives provided do not encourage those forms of mechanization that primarily save labor.

Irrigation, Drainage and Flood Protection

An agricultural strategy that seeks to increase agricultural production and create a modern agriculture throughout East Pakistan must recognize that full crop production depends on major planning for the capital investments in irrigation that will be effective, both during the dry season and, for many parts of the Province, during rain-deficient periods of the wet season. Intensive crop production in summer will also require improved management of flood waters. Also, the coastal embankments for exclusion of tidal floods of sea water are important in efforts to attain high yields in extensive areas of low-lying lands, provided the embankments are accompanied by provisions for irrigation water in dry seasons and some control of excessive water depths in summer.

These capital-intensive programs should be placed within a general strategy for agricultural development rather than being the starting point. Increased investments in fertilizers, improved crops, credit and marketing facilities, for example, may bring quicker and greater returns in the short run, and in the long run help to ensure returns from the large capital investments. Moreover, in the opinion of the Panel many of the projects now being proposed need more detailed study and evaluation. The Panel notes, with concern, the lack of data adequate to allow an objective evaluation of the relative merits of specific projects, or (in many instances) the practical feasibility of some of the proposals. The delays and inadequacies of planning relative to the Kushtia unit of the Ganges-Kobadak Project constitute a stern reminder of the need for extensive studies and

carefully checked planning before construction is initiated.

Training of Agricultural Technicians

The final component in creating a modern agriculture is the development of staff competence to perform the tasks involved in all of the other five components. Some of this training should take place in schools and colleges. Much of it could be more effectively accomplished through on-the-job and in-service training. East Pakistan has made a good beginning on this component, but obviously its facilities must be greatly improved in quality and greatly expanded.

IV. Comments and Recommendations

(A) Research

The Panel recommends that increased emphasis be placed immediately on adaptive research to insure access to the base needed for a constantly rising agricultural production and effective water management programs.

Crop Production Factors and Training of Specialists

Unless investments in irrigation and drainage are accompanied by a serious effort to develop new, efficient cropping systems, commodity by commodity, there is little hope that East Pakistan will be able to accelerate output. These systems must include development of: (a) varieties that can efficiently convert high levels of plant nutrients and favorable moisture conditions into harvestable and marketable products, (b) controls for major diseases and insect pests, (c) fertilizer and water use technologies that are integrated with cultural practices necessary for maximum economic production with genetically improved crop types, and (d) techniques for land preparation, crop production, harvesting and storage tailored to the needs of small farms.

Some technology developed for use in other parts of the world will be directly useful in East Pakistan, but much of what is needed, especially the biological components and land and water management procedures, will have to be developed in East Pakistan. There is no alternative, and the existence of adequate, new systems of crop production, specifically tailored to East Pakistan conditions, is a prerequisite to accelerating either agricultural or general economic development.

Rice. East Pakistan is establishing a semi-autonomous provincial rice research and training center, with some assistance from the International Rice Research Institute (IRRI) and Ford Foundation. This is a major and hopeful development. The Institute should be assisted in its efforts to develop a first-rate, interdisciplinary research team of Pakistani scientists on the IRRI model, and a technical program sharply focused and directed to East Pakistan's most urgent rice production and related problems. An essential part of this program is the training of hundreds of East Pakistanis as rice production specialists who know first-hand how to achieve higher yields on farms, who can diagnose farm production problems, and who can either prescribe remedies directly or turn to research specialists for help. Unique conditions within East Pakistan will need special attention. One extensive problem is the potential for increasing rice production under fluctuating flood conditions with water depths of up to 14 or more feet.

The Rice Department of the Ministry of Agriculture of Thailand is working with new strains of rice derived from introducing dwarfing genes into Thai deep-water rice varieties. These appear highly promising, and have the potential for enabling greatly increased yields on East Pakistan's flooded lands. These should be studied and improved under East Pakistan conditions. Results with new varieties adapted to variable water depths should also be assessed against cost and benefits from various flood abatement schemes.

The Panel fears that the extensive acceptance of IR-8 rice for the winter season and IR-20 for the summer may involve extensive risks from disease or other disaster that could shake farmer confidence in the

agricultural program. Intensive testing and research with these and other varieties and a breeding program to develop adapted strains is the only answer to this hazardous situation.

The Panel recommends that research and training programs utilizing interdisciplinary teams of Pakistani scientists be developed for other important crops in a manner similar to that used by the Rice Research Institute. Some of the crops urgently needing such attention include:

Jute. With an annual acreage in excess of two million, traditionally low yields and laborious production, harvesting and retting practices, jute is in need of comprehensive research and a cadre of skilled technicians and specialists. Marked improvement in this crop would benefit the economy of the Province and provide needed increased foreign exchange.

High Protein Seed Crops. Pulses and gram are the principal protein-rich foods for the Province. The yields are low, averaging less than 700 pounds per acre. Present plantings are about 900,000 acres per year. In view of their strategic role in the national diet and the long history of inattention and low yields, these and other legume seed crops should be energetically studied for improvement, and should be prominently featured in the government's agriculture and food policy. Crops such as soybeans may have potential value for the area, and should be investigated. Introduction of high lysine cereals and other improvements in the protein quality of food crops could also be important in meeting protein dietary needs.

Oilseeds. The annual harvested area of these crops is only slightly less than that of pulses. The principal crops grown are

rape, mustard, sesamum, linseed and groundnuts. Groundnuts acreage has increased most in recent years. These and such other crops as soybeans should be improved through selection, breeding and improved production practices. Coconuts grow extensively and are under-utilized. Improvements are needed in their production, handling and processing. More edible oil and oil products are needed, but research to provide higher yielding strains of crops and improved production practices must provide a sound base for an effective program.

Wheat and Other Cereal Grains. Short, stiff-strawed "Mexi-Pak" wheats are reportedly doing well in the winter months in the northern irrigated areas. The yields are good, and water requirements are much lower than for rice. This crop seems to merit greater production. Sorghums, millets, maize, barley and other seed grain crops are important in India and other nearby countries, and might play an important role in East Pakistan. Such crops should have extensive evaluation.

Potatoes. Potato plantings increased from 400,000 to 710,000 tons between 1964-65 and 1968-69. According to the 1969-70 economic survey, increases are attributed to the establishment of a number of cold storage plants and to the production, procurement and distribution programs of the Agricultural Development Program, which is headquartered in Mexico, has provided a specialist to work with the Pakistani group. Because of their potentially high food value per acre and general acceptance as a food, potatoes justify more study and education as a basis for increased food production.

Miscellaneous Crops. Other crops that are important to the people of the Province and in need of research and training programs include

tea, sugar cane, tobacco, vegetables and fruits. Improvements in the yield and quality of these crops would help both the people and the general economy.

Assessing Available Farm Technology

It is important to assess the farm technology now available for promoting agricultural growth in different parts of the Province. Such an assessment would:

1. Identify the parts of the Province that have an immediate potential for agricultural growth, based on farm technologies now available.
2. Define specific cultural practices that should be recommended in each locality that has an immediate growth potential.
3. Provide vital information on optimum combinations of production factors (crop varieties, fertilizer types and rates, irrigation needs, pest control practices) under the varied conditions of the Province.
4. Help identify the factors that preclude for the time being the possibility of quick agricultural growth, thana by thana.

It is recommended that the way to achieve this assessment of available farm technology is to set up as quickly as possible a large number of what might be called "local verification trials," in which different varieties of crops (including those presently grown and possible introductions) are tested against each other with different levels of fertilization and other appropriate variations in cultural practices with respect to each variety being tested. Each of these sets of local verification trials could be conducted on an area of one to two acres.

If some of the agriculture of a thana is to be irrigated while other parts are not, then the trials should include irrigated and non-irrigated conditions.

The purpose of these trials is research; it is not "demonstration." The purpose is to test different farm technologies against each other; it is not to demonstrate to cultivators only the most productive combination of practices. The general objective is to study the interactions between production factors under representative conditions. Demonstrations of the most profitable combination of farm technologies are an extension technique that may be used subsequently.

Such trials are not techniques to be used for only a year or two. They must be maintained for a considerable period of time, since, if other steps are simultaneously being taken, particularly in adaptive research and in the extension of irrigation facilities, the farm technologies will have to be continually updated by results from new sets of trials.

Local verification trials are like test borings. They can define current possibilities and indicate: (1) what farm practices should be recommended locally, (2) what kinds of adaptive research may be needed, and (3) where in the Province it would be worthwhile to expand irrigation and/or drainage facilities.

Farm Mechanization

Machinery for labor-intensive small farms has received inadequate attention. The rapid developments in Japan and the equipment being used in Taiwan, Thailand and other countries may be adaptable to East Pakistan. In developing agriculture human drudgery and people's

aspirations for fuller lives must be related to the availability and use of equipment to relieve arduous tasks. The University of Mymensingh and commodity research institutes should assign high priority to the design and testing of simple, effective equipment.

Power equipment versus animal power is a continuing problem in developing countries. Often farmers move faster than program planners and administrators in adopting power equipment. The trade-offs inherent in animal feed for meat or dairy production as compared with using them for draft animals should be continually studied. Adoption of new crop technology with marked increases in yields can quickly alter established relationships. Small threshers and dryers may have a special place in reducing waste and shortening intervals between crops. Such studies should be carried out by farm mechanization research groups and by economists.

Fisheries and Livestock

Because of the country's extensive area of fresh inland waters, the potential for fish production is significant to the diet of the people and the economy of the country. Newer technologies in managing water for high fish production through use of fertilizers and other practices have not been used extensively in the Province. Additionally, aerial application of insecticides without proper precautions against contamination of waters and the influx of industrial pollutants are reported to have caused damage to fish. The industry needs intensive research, training and extension support. Undoubtedly the approximately 700,000 tons of current fish production could be increased several fold.

The large livestock population has received little research attention as to nutrition, health, breeding, or alternative uses. A livestock research and training program is urgently needed. Part of this can be carried out in association with the University of Mymensingh, but one or more special research and training institutes charged with examining livestock problems in all parts of the Province and carrying out studies on cattle, buffaloes, goats, chickens and ducks appears necessary to mount the extensive program so urgently needed. As with crop institutes, an integral training component is highly desirable to train extension workers and others who can help to upgrade the entire livestock enterprise.

Economics and Social Science

Although not specifically identified in the World Bank Reports, intensive and continuing studies by well-qualified specialists in economics and social science seem essential as a background for public policy decisions and program planning. Among the activities needed are the collection, analysis and projection of demographic data and trends. The collection and crucial analysis of data on the internal economy of the Province and in relation to international trends, should be undertaken by a semi-independent group. Also in need of measuring and assessing are the full implications of demographic data, social changes, trends in popular interests and attitudes, and the political implications of events and public policy alternatives. These are appropriate areas of investigation for Pakistani specialists. The stresses in a country that is in transition continually threaten political stability. An informed and responsive government should be

able to adjust to change. Research is the avenue to the requested information.

Proposed Research

During the next three years the World Bank proposes to spend \$308.5 million with an additional \$210.5 million in local currency for fertilizers, plant protection, new seeds, and related material expected to increase agricultural production. Compared with this is a projected World Bank investment of \$10 million in agricultural research and \$8.4 million in special studies. Total local currency for these two items are projected at \$2 million and \$5 million. Even though the need for massive agricultural improvement has been recognized for years, the detailed adaptive agricultural and hydrological research to support the program has not been done and is not adequately provided for in present plans. This seems to be an area for which no one accepts adequate responsibility. The Panel hopes that these deficiencies will be recognized and rectified. As the primary investment agencies, the World Bank and the U.S. AID have an opportunity to provide foresight and leadership in supporting adequate research in advance of project development.

(B) Water Control & Management

Panel members and specialists reporting to the Panel have raised many questions concerning the adequacy of information for deciding objectively among water development alternatives relative to irrigation and flood protection projects. The quantity of water available for tubewell pumping has not been adequately assessed. There is also an

informed concern that the relationships between surface waters used for low-lift pumps and underground waters supplying tubewells have not been determined, and that extensive tubewell development may seriously reduce surface supplies. Predictable duplications or conflicts between proposed diversion projects and between diversion projects and pumping operations from rivers and from tubewells should be avoided.

The general impacts of one project proposal on another have received inadequate attention. Planning for water management and for agricultural development should be approached as a Province-wide strategy with numerous alternatives for the attainment of goals. This broad integrated approach is generally lacking.

Many existing and expected water-related problems and controversies cannot be resolved until further information is available on the underground storage capacity, rates of recharge, rates of water transmission through substrata aquifers and potential for land subsidence for the different physiographic areas of the Province.

Since East Pakistan is at the lower reaches of several rivers, and the countries controlling the upper watersheds have plans for diverting many of these waters, the impact of these proposed diversions should be fully assessed before large investments are made in barrages and canal systems in East Pakistan. International agreements may be possible and should be investigated. Other questions concern the stability of river channels and the possible effects that any shift in the locations of rivers could have on proposed pumping stations and barrage installations.

The coastal embankment enclosures apparently incorporate many unknowns, and are in need of further investigation. Will pumping of surface or ground waters in the southwest increase saline water intrusion? Some polders were apparently designed without adequate attention to topography, and irrigation was introduced as an afterthought. The possibility of land subsidence following ground water withdrawal may threaten successful polder operation. The effects of embankments on the movement of country boats can complicate the transporting of harvested crops. Typhoons pose still another hazard, not only in terms of damaging embankments, but also by entrapping sea waters in polders, with resulting damage to crops and soils. Results from the two recent typhoon-induced inundations of land with extensive overtopping of embankments and probable prolonged retention of sea water within polders should be studied in relation to designing and operating additional coastal embankment projects.

River embankments and the relations of these to other flood protection projects involve many technical questions. The total impacts of all projects when in full operation have not been fully assessed. The management of the heavy sediment load is another troublesome question. One specialist* reported that his analysis indicated the sediments move out to great depths in the Bay of Bengal so that properly stabilized river embankments would not result in stream-bed aggregation.

*Dr. Daryl B. Simons of Colorado State University, Consultant to the International Bank for Reconstruction and Development.

The many questions raised concerning the practical feasibility of and benefits from expensive irrigation development, particularly those involving barrages, large pumping installations, and special canals require intensive study. So also do the capital-intensive flood control proposals. Adequate planning and evaluation of such schemes depend on a complete analysis of the hydrology of the entire Province, with the total impact of all projects as well as the costs and benefits of individual and total projects being considered. Most of such analyses can be undertaken within each of the four regions of the Province.

Before the required studies can be advantageously activated, all available hydrologic data must be assembled at a central location and systematically evaluated and a retrieval system established so that information pertaining to particular resources and projects can be conveniently assembled and organized.

A related concern of the Panel is the present practice of having most studies of capital-intensive development projects done by international consultants or engineering firms, instead of utilizing capabilities of Pakistani nationals or using project activities as training vehicles for them. Even though special competencies must continue to be imported, such situations should be viewed as opportunities for training indigenous specialists.

The following data collection and research needs deserve attention:

1. Analysis and appraisal of data obtained from the net of climatological stations within East Pakistan as well as within the drainage basin of the Ganges-Brahmaputra

should be done to provide greater detail than is afforded in the Master Plan.

2. A thorough appraisal and analysis of hydrologic records (river stage, water discharge, sediment discharge and quality of water) collected at various stations throughout East Pakistan are needed.
3. Climatological and hydrological data programs should be examined in accord with the principles of network design as outlined by the WMO/IHD report No. 12, Geneva 1969.
4. Aerial photographs, completed at several times in the past, should be assembled and made available for study. These photographs should be utilized to construct geomorphic, geologic, vegetation and land use maps and to trace changes in river beds, in population shifts, and in cropping patterns.
5. The subsurface conditions of East Pakistan are poorly known, but zones of weakness (faults, fractures, etc.), rates of different subsidence tendencies and location of major lithological units are critically important in planning future engineering projects. Borings have been quite numerous, but the data are scattered. Collecting and correlating data on past and future borings would provide important basic information on these

problems. Supplemental seismic or other studies may also be needed.

6. Conditions in the river mouths of the Ganges-Meghna system are poorly known. Water removals upstream from these rivers could facilitate an increased salt wedge penetration. Extensive knowledge of the river mouth areas could be used to help avoid serious reductions in irrigation water quality.
7. River navigation and transportation facilities are poorly developed, yet the river maze that criss-crosses the country is its most important communication network. A study of this system is needed before effective planning and development can safely be implemented for its improvement.

(C) General

The Bank has proposed a three-year comprehensive study in East Pakistan. The Panel agrees on the needs for the comprehensive study, but is concerned that the urgency implied by a short-term exercise will lead to a purely Bank study without building the Pakistani competence to do this over and over again. The Panel believes this effort should be placed under the leadership of Pakistani personnel, utilizing and developing Pakistani organizations and institutions to the maximum extent possible, recognizing that external assistance is essential. The institutional arrangements should assure that the output is of immediate practical usefulness to Pakistan and that a continuing program will be sustained under Pakistani agencies.

Terms of reference for proposed programs should be thoroughly reviewed and should include assessment of the risks involved in the several planning alternatives, including geophysical hazards, floods, typhoons, river regimen and sediment imbalance. Also needed are a basic data plan with feedback of the results, an on-site research or verification program and further studies on methods of water planning.

Human labor is the most important resource available in East Pakistan. It is generally recognized that human labor must be complemented by physical capital if its productivity is to be raised. What is not so generally recognized is that increasing employment of human labor necessarily involves steps for increasing the incomes of such labor. In the context of a low-income country increased incomes will be spent primarily on food. Consequently, increasing employment requires not only a capital complement but also a consumer goods complement, particularly with respect to food. In East Pakistan food production is still increasing relatively slowly, and thus there is not the basis for a rapid increase in employment because the expected reward is an increase in food. In the longer run, agricultural development programs, including irrigation, new varieties, and so on, should result in substantial increase in the availability of food. Development programs should not, however, wait for that eventuality before proceeding with employment-increasing programs. It is precisely this situation which lends urgency to striking a balance between the capital inputs which are usually provided by aid-giving nations and the consumer goods, particularly food, which are necessary to expanding employment.

Difficult problems arise in providing the food input. There is a tendency of food-aid providing nations, particularly the United States, to put aid on a dollar repayment basis. If food aid is used for long-term capital investments such as flood control and major irrigation projects, it will be difficult to develop the flow of income necessary in the short-run to commence repayment. There is, therefore, a strong argument for food aid being "aid" and not "food lending."

A second problem arises from the relationships between East and West Pakistan. West Pakistan might conceivably have supplies of food which could be exported to East Pakistan and thereby provide a basis for more rapid expansion of employment in East Pakistan. A number of difficult problems with respect to commercial sales and aid between the east and west wings arise in this respect. In addition, there is the difficult problem of United States assistance regulations which make it difficult to have major agricultural exports from West Pakistan if food aid is to be received in East Pakistan.

It should be kept clearly in mind that if major capital investment is made in East Pakistan without increasing food production or food aid in the short run, then that capital investment is likely to be capital intensive and to create relatively little employment. This will not only give a relatively uneconomic form of development but will almost certainly result in a distribution of income, benefits going very little to the relatively lower income class.

(D) Education and Training Programs and Organizational Development, Thana Irrigation Programs and Related Activities

In many instances international technical assistance has been employed for the engineering design and construction of irrigation projects costing several hundred dollars per acre, with little attention being given to the improvement of agricultural production or irrigation practices. As a result, traditional primitive agricultural methods have been superimposed on expensive project lands that would require multifold increases in crop yields to provide reasonable returns on the investment. With numerous such failures in mind, the Panel urges increasing emphasis on organizing, motivating and training farmers, technicians, administrators, and the wide range of artisans essential for a successful productive agriculture.

Promising starts have been made in the above direction in East Pakistan and these should be strengthened, coordinated and expanded. Among the endeavors that have had success in organizing and motivating small farm operators is the system of cooperatives initiated by the Pakistan Academy for Rural Development (PARAD) working through the Kotwali Thana Central Cooperative Association in the Comilla District. The success of this trial enterprise in developing farmer cooperative groups (who have subsequently worked together in securing and operating low-lift pumps) and in training personnel at the various levels, has been widely referred to as a model of grass roots development. This approach has been further expanded under the Thana Irrigation Program (TIP).

The TIP organizing and training program is still in the development stages. There seems to be a genuine effort to improve the quality of training and the response of trainees appears satisfactory. Plans call for expanding the program to work with various development projects including tubewell installations, pumping or diversion projects, and flood control schemes. The Panel recommends increased emphasis on this approach and the related Rural Works Program, in close association with an ever-improving extension training effort. It is further urged that every effort be made to simultaneously organize the farmers to manage the program and without providing needed educational services to insure that affected farmers are informed about practices that can produce the most profit from the changes being induced.

Training of Specialists and Extension Workers

If the goals of irrigated agriculture and increased crop production are to be attained, there will have to be a large increase in number of well-trained specialists and extension workers.

One immediate opportunity to achieve this end is the implementation of a strong training program in association with commodity research activities and local verification trials. Trainees might vary in their previous training from having pre-college agricultural education to being college graduates. Participation in the field research activities should be an integral part of the training and would provide an intensive practical background for diagnosing field problems and prescribing practices to improve crop growth. Patterning the training components of other research institutes after IRRI practices, as is apparently being done at the Rice Research Institute, is recommended.

Training at College and University Levels

Conditions in East Pakistan are so difficult and variable that a strong advanced educational program is essential, with emphasis on such topics as crop breeding, production principles and practices, soil management, principles of pest control, and broadly based engineering sciences that stress hydrology, water management, farm machinery and tillage; and irrigation and drainage. One of the most important investments that can be made is in the further development and strengthening of such institutions as the Agricultural University at Mymensingh.

Training in water and land development programs and in the engineering aspects of flood control, irrigation and drainage, and project design need special attention. It is recommended, therefore, that such a program be developed at one of the universities such as Mymensingh, or that a new water management institute be established for the training of these personnel. Such an institute might be associated with a university oriented toward agriculture, or be affiliated with one having strong programs in civil and mechanical engineering. In the latter instance, precautions should be taken to see that students have a strong agricultural orientation.

There is also need for high-level educational programs to train leaders for research and extension in livestock health, feeding and management. The potentials of dairy and poultry products to improve the quality of the national diet make them worthy of increased support through research and related educational programs. Much of the advanced training program can probably be developed at the University of Mymensingh. Applied technical training at many levels can be provided

in association with research institutes as previously recommended. At this level, also, representative farmers can be trained in the management of production units of chickens, ducks, dairy cows and other livestock.

(E) Facilities and Services for
an Improved Agriculture

In order for the "green revolution" to succeed in East Pakistan, farmers must have readily accessible, stable, and increased supplies of many goods and services. In particular, fertilizers, insecticides, herbicides, new seeds, necessary tools, oil and fuel and other materials needed for effective farm operation should be available at the local level.

There must also be assured markets for farm products at fair prices. This calls for improved transportation and communication systems and may require improved storage and processing facilities and government action to stabilize prices.

Some effort has been made to provide credit to small farmers at less than usurious rates. Needed credit must be supplied in greater amounts. Government participation seems essential to insure that necessary financial resources are provided at reasonable interest rates. Present attempts to attract local money into the credit pool is commended, those involved are encouraged to expand their efforts.

These services will require the development of market centers strategically located so that all farmers can reach a center without excessive effort. Improved roads and communication facilities are important adjuncts to market centers and price stabilization, and to making all public services available to more citizens.

(F) Investments in Water Development
and Management Facilities

There is broad support among Panel members for the provisions in "Proposals for an Action Program" and for the types of investments proposed by the International Bank for Reconstruction and Finance. The Panel, however, places the "Research" and "Rural Development" components in first priority. This emphasis is based on their considered opinion that a greater infusion of international assistance into these activities is both appropriate and necessary to insure success of the planned strategy for agricultural development. The Panel is also of the opinion that these activities are essential to both the "Short-run", "Quick-impact Programs" and the "Long-range Programs."

The planned substantial investments in fertilizers, plant protection, and production and distribution of new seeds, and storage facilities are sound only if preceded, or at least accompanied by, vigorous research and practical educational activities.

In ranking the capital investment proposals, the Panel agrees that first priority should be assigned to financing increased numbers of low-lift pumps to service favorable situations that have suitable soil and cropping conditions. Priorities in pump installations should go to organized farmer groups that are committed to fulfilling required obligations and are prepared to undertake new agricultural technologies under skilled supervision. Means should be sought for encouraging private investment in tubewells and low-lift pumps.

Tubewell installations should be expanded, but with more restraints than for the low-lift pump program. Ways should be sought to reduce

the cost of tubewells. Pumping of tubewells should be accompanied by studies of likely rates of ground water depletion and recharge, and of such possible adverse consequences as land subsidence, salt water intrusion and reductions in the surface waters supplying low-lift pumps. Consideration should be given to drilling wells with local labor as is being done in West Pakistan and in Kotwali Thana of Comilla District in East Pakistan. Tubewells and low-lift pumps should be approved only when integrated and improved production practices (such as are included in the Thana Irrigation Program) are complied with.

The Panel lacks the specific local background, experience and information to justify assigning priorities among the proposed irrigation and flood control projects or judging at what point information, planning and design are adequate. The Panel also realizes that the time schedule is critical if disaster is to be averted. However, because of the numerous observations made and questions raised in this report about the practical and technical aspects of many of these schemes, the Panel suggests that every effort be made to obtain the information needed for sound planning prior to construction.

The Panel notes that the Chandpur flood protection and irrigation project has been funded for construction under a revised plan. This project is to serve as a test for the many technical questions concerning joint operation of an embankment-flood control and an irrigation development scheme. The Panel believes that implementation of a comprehensive TIP or similar organization-education program at the local level throughout the project area, with general adoption of

"package practices" and the attainment of rapid increases in crop yields are critically important to a valid test. The development of this project should also include the construction of roads and the establishment of market centers with adequate supplies for servicing the development farm technology. Credit and good markets for produce should also be provided. This total development of a project area has apparently not been successfully accomplished in East Pakistan. This seems, therefore, to be a crucial and excellent area for testing a complete strategy for project development. Probably only when such a model has been developed and observed in action can a development strategy be confidently planned for other areas.

The possible political hazards in delaying flood control and irrigation projects are important. However, large investments are still needed to make recently constructed projects fully operable in the comprehensive way recommended for the Chandpur Project. The Coastal Embankments, the Kushtia Unit of the Ganges-Kobadak Project, and the Brahmaputra Embankment are examples of projects constructed with inadequate attention being given to developing on-farm technology required to justify the large construction investments.

The social and economic risks inherent in changing the traditional land-water environment for thousands of farmers, without informing them about the change and helping them to cope with it, also could create a delicate political situation. Projects of the type planned do not automatically insure economic improvement of the people directly involved. Benefits come only from improved agriculture. This may be facilitated by the project, but only if the farmers are prepared to

adopt the more sophisticated operations that it makes possible.

Many improvements can be made in agriculture without major project development. Improved seeds, fertilizers and pesticides can enhance production on most farms. Farmers that profit from such practices are best prepared to gain from project development.

During the suggested restricted period relative to construction of new projects, progress can be made by perfecting projects already constructed and implementing improved agriculture with them, and by planning and designing proposed projects.

Any future success in East Pakistan that is to be associated with using water from the rivers during the dry season depends on diversions and removals by other countries above East Pakistan in the watershed, therefore river systems need study as a whole and undoubtedly international negotiations will be required. This has not been accomplished to date.

There is also an urgent need to implement flood protection for some city areas and for related urban and industrialized zones. Appropriate priority should be given to this situation.

V. Appendix

(A) East Pakistan: Land, People and Food

Consisting largely of the deltas of three large rivers, the Ganges, the Brahmaputra and the Meghna and their tributaries, the east wing of Pakistan consists of about 35 million acres, and has a population approaching 75 million.

Land, Climate and Agriculture

Extremes in water supply and precipitation are limiting factors in crop production. Rainfall ranges from 60 inches in the west central districts to 200 inches in the hills of the northeast. Precipitation is sparse in November, December, January and February; rains increase slightly in March and reach their peak in June, July and August. The high-intensity rains during the summer months, combined with high run-offs from the Himalayas and the hills of Aswan and Nepal, commonly result in an overflowing of the rivers. The country thus is subject to extensive floods in the summer and drouth in the winter.

The soils are reported to be of good quality, suitable for a wide range of crops and conducive to high yields. Extremes in water availability constitute the major limitation affecting crop production capabilities. About 22.5 million acres of land are cultivated, 3.9 million are classed as unsuited for cultivation, 1.03 million are considered cultivable waste, 5.54 million acres are in forest, and 2.24 million acres are occupied by rivers. Studies reported indicate there is no reasonable way in which the total acres of cultivable land can be significantly increased. Multiple cropping beyond the present 1.5 per year can, however, provide a substantially greater harvest.

The principal crops in the early rainy season are rice (aus), jute, sugar cane, and tobacco; during the main rainy season rice (aman) is the principal crop. The larger variety of crops grown in the dry (rabi) season includes: rice (boro), wheat, rape and mustard, sesame, linseed, groundnuts, cotton and pulses. About 100,000 acres of tea are also grown, and there are about 63,000 acres of coconuts, mostly in dispersed plantings.

In 1968-69, 7.66 million acres were growing crops in the early rainy season, 14.4 million in the main rainy season, and 2.04 in the drier winter months.

Rice yields are generally low. In the 1968-69 season aus averaged 780 pounds per acre, aman 1070, and boro yielded 1780. Except for boro, yield increases have been only modest, averaging only slightly above two percent per year over the past decade. Adoption of improved high-yielding varieties of rice and other crops is just starting, and the information needed for adapting modern agricultural technologies to the somewhat unique local conditions is largely lacking. Although agriculture is focused primarily on rice and jute, the climate and soil are well suited to a wide variety of crops and to good crop growth throughout the year.

The farms are small and segmented, the average farm size is about 2.4 acres, one-fourth of the farms are smaller than one acre, and only 10 percent are larger than 7.5 acres. However, 64 percent of the cultivated land is in farms exceeding 2.5 acres in size. Efficiency in farming is further hindered by the division of farms into segments that average about one-third acre each and are often widely separated.

People and Food

East Pakistan has one of the most critical population problems in the world. The estimated population for 1971 is between 70 and 75 million, indicating a 15- to 20-million increase for the 1960's, or about 35 percent!

The population density is now 1300 per square mile, or 3.3 persons per cultivated acre. With an estimated population of 125 million for 1985 and 205 million for the year 2000, and assuming no increase in cultivated land, the number of individuals per cultivated acre would increase to 5.5 in 1985 and to 9.1 in the year 2000. The country is largely rural, with less than 10 percent of its population estimated to be living in towns or cities exceeding 5,000 people. Per capita annual income, estimated at about \$60, is among the lowest in the world.

Cereal grains make up about 80 to 85 percent of the common diet, and the average per capita consumption is about 465 grams per person per day. Protein is derived 73 percent from cereals, with the remainder from pulses and some animal meats and fish (about 20 pounds per capita per year).

The 12.7 million tons of cereal grains estimated to be produced in 1970 plus 1.7 million tons of imports, reportedly allow an adequate average nutritional level with respect to both total calorie intake and protein. This evaluation is supported by a recent nutritional survey of the country and is consistent with a calculated daily calorie requirement of 1830 calories per day, based on lower body weights than are used for estimating nutritional requirements of western people.

Since, however, the average daily food supply is at the minimum required level a substantial proportion of the people must live with chronic hunger.

Based on predicted population levels and anticipated increases in per capita food demands, the present requirement of 14 million tons of food, which includes a 1.7 million ton deficit, will double to 28 million tons-of-rice equivalent in 1985. By the year 2000, the need would be for almost four times the present level, or 55 million tons. Even without any increase in food demand per capita, the present rate of population increase will result in 65 percent greater food needs in 1985 than in 1971, which represents a growth in food demands of 3.4 percent per year. To meet the total anticipated food requirements, the government projects an average increase in rice production for the country of 7.5 percent per year for the next five-year period.

Crops other than rice demand attention. Protein intakes depend importantly on pulses, and the Fourth Five-Year Plan anticipates that the present 290,000 tons per year produced on 900,000 acres are to be increased by 4.5 percent per year to 1974-75. Potatoes are becoming more important, and annual increases in production of 9.5 percent are forecast by the government of East Pakistan. Jute is a major base for local industries, and exports of jute products constitute the principal source of foreign exchange. The projected yield increases of 5.3 percent per year will require improved seeds and significantly improved production practices.

Projections of employment needs indicate an urgent requirement for economic development beyond that which can be provided on the farms.

Based on maintaining a man-land ratio near that of the present, (1.5 gross cultivated acres per worker) only about 24 million workers would find productive farm employment in 1985. This leaves a non-agricultural labor force of 18.5 million, more than three times the present 5.7 million non-farm workers.

If the man-land ratio were increased to one worker for each 1.2 gross cultivated acres, an additional six million workers would be employed in agriculture, but the net effect of substituting hand labor for mechanized equipment might be losses in food production because of the time consumed in harvesting and preparing seed beds and establishing new crops.

The space (land) required for housing and transportation facilities, flood protection, and essential businesses to accommodate the additional 50 million people in 1985 will likely offset any additional land brought into cultivation. Clearly, possibilities for adding new industries must be pursued as avidly as the potentials for increasing food production. The rising expectations of the people of East Pakistan will demand far more than food over the next few decades.

Low literacy and inadequacies in the educational program further hamper immediate progress. An estimated 21.5 percent of the people over five years of age were classed as literate in 1961. The supply of trained teachers is inadequate, and building facilities and instructional materials are often poor.

The country also lacks a well developed base of industries or general services, although progress has recently been made in fertilizer production and jute processing, and a small steel industry is entering production.

Transportation is another limitation to economic development. Most agricultural products are transported by small boats. Roads and railroads are being expanded, but the lack of construction resources and the barriers of numerous large, shifting rivers makes such efforts slow and expensive.

Floods and Typhoons

Flooding of the land constitutes one of the major problems of East Pakistan. The three major rivers, Ganges, Brahmaputra and Meghna have a total drainage area of 600,000 square miles, with only 7.5 percent lying within East Pakistan. During peak flow, these rivers discharge up to 5 million cusecs (2.5 times the all-time record of the Mississippi River), and carry an enormous sediment load of about 2.4 billion tons annually, greater than any other river system in the world. The riverbed material is fine, having an average diameter of about 0.15 mm, and is devoid of gravel or rocks. Projects designed to confine the rivers to narrower channels and to control the depths of the flood waters must provide management for the sediments as well as for the water, and the solution appears highly complex.

Further complicating factors are the low elevation and the slope of the delta within East Pakistan. With nearly all of the flood plain in the Province reported to be below the 30-foot contour above sea level, the gradient between the points where rivers enter the country and the points of discharge into the Bay of Bengal is very low. Because of the low gradient and large sediment load, the rivers readily shift their courses and overflow, inundating large segments of the

country. About a third of the cultivated land is flooded by overflows from the principal rivers and by local runoffs from the heavy monsoon rains, which are backed up by flood levels in the river channels. Flood depths exceed 20 feet in some areas and any depth exceeding a foot is a major limiting factor in crops grown, production practices and yields.

In the coastal area, some three million acres have been subject to flooding from ocean tides and the tidal surges associated with typhoons. A total of 17 million acres, or two-thirds of the cultivable land, is subject to flooding, although this large an area has not all been flooded in any one year.

Typhoons compound the troubles associated with the monsoons and floods. These violent wind storms usually come in in April and May, or in September, October and November. Two violent storms in 1960 took over 14,000 lives. Another on October 23, 1970 was reported to have taken 1000 or more lives, injured 5000 people, and inundated almost ten million acres of delta land. The catastrophic storm in mid-November 1970 is one of the greatest disasters on record, taking more than 250,000 lives, large numbers of livestock, destroying buildings and levees, and inundating millions of acres with sea water. The effects of this on embankment projects needs careful evaluation before the additional construction is undertaken. Protection against such an unusual storm may not be feasible, but the risks can be determined and evaluated.

Since much of the land is deltaic and still under active deposition, natural subsidence is estimated at three feet each 100 years.

The potentials that flood protection and pumping of ground water have for accentuating this problem emphasize the need for cautious planning.

(B) Recent Developments in Water Management

Over the past ten years there has been a continuing public effort to increase agricultural production. Fertilizer distribution has increased about five-fold, from 66,000 tons in 1960-61 to an estimated 355,000 in 1969-70. Similarly, pesticide usage reached over 10,000 tons in 1969-70 and is expected to double in the next three years. A beginning has been made with high-yielding varieties of rice and wheat, but the acreage is still small. These expansions do, however, provide a base for the new agriculture and establish incentives for irrigation and flood control investments. The major increase in irrigation has been through the installation and operation of low-lift pumps to raise water from natural waterways to the land for irrigation. During the last decade the number of such pumps has increased from 1360 to 18,000, and the area irrigated from 62,000 to 700,000 acres.

Tubewells have been installed to develop underground water, particularly in the northwestern part of the Province (Dinajpur). In April of this year, 700 had been installed, and 539 were in operation, irrigating an estimated 60,000 acres. A total of 1360 tubewells providing water for 280,000 acres is reported for the Province.

Two small projects that will divert surface waters for irrigation are partially completed. The Dacca-Demra project provides flood

protection for about 15,000 acres and irrigation for 9000 acres. The Kushtia unit of the Ganges-Kobadak project has been delayed by pumping difficulties and unsuitable canal design. At present about 90,000 acres are receiving water.

The largest capital investment has been for the construction of embankments in the coastal area and on the right bank of the Brahmaputra River. In the coastal area 61 polders have been enclosed by embankments to protect about one million acres of land against sea water intrusion.

The Chandpur project was planned as a combination irrigation and flood protection scheme covering 140,000 acres gross. Initially, irrigation was to be from water pumped into canals elevated above the terrain. Irrigation was dropped as a goal, and construction of embankments was started in 1965. This was halted in 1967 and replanning was carried out. In April 1970 the International Development Association granted a loan to construct the project, which was to include distribution of water through natural drainage channels and use of low-lift pumps to replace the water on the land. This is the first flood protection irrigation project approved for construction that combines features now considered essential for successful polder schemes.

Reports indicate that tubewells cost several times as much per acre as low-lift pumps. The capital-intensive instruments for diverting and distributing surface waters and the embankments for flood protection have not been fully evaluated, and further major developments in the Chandpur Project area have been delayed to permit detailed

study of the situation. Present plans are to develop an intensive agriculture in the area, with emphasis on irrigation, flood protection, new seeds, fertilizer and pest control.

A distinctive program for improving agriculture as a part of irrigation development has evolved in the Thana Irrigation Program. The program was developed on an experimental basis by the Pakistan Academy for Rural Development in Comilla Kotuali Thana. Based on the experience and procedures developed, an extensive program is being implemented, especially in conjunction with installations of low-lift pumps. The system involves: a village or union cooperative organization that is to promote good agricultural practices, collect charges for water, manage credit, and carry out other agreed-on activities; a Thana Council that reviews union plans and requests; a series of central workshops to repair and maintain equipment; and training programs for farmers, managers, pump operators and for skilled mechanics. This management system is being rapidly expanded to include such local projects as road improvement and storage and marketing of products. The Thana program is providing a basis for efforts to organize, motivate, and implement educational and technological developments among rural people throughout the Province.

Staff

Messrs. B. K. Wesley Copeland and Julien Engel
Board on Science and Technology for International
Development
Office of the Foreign Secretary
National Academy of Sciences
Washington, D. C.

Discussants

Agency for International Development-Bureau for Near East
and South Asia (NESA):

Curtis Farrar, Acting Assistant Administrator
James M. Blume, Director, Office of Technical Support
William D. Romig, Hydraulic Engineer, Office of
Capital Development and Engineering
Townsend S. Swayze, Desk Officer for Pakistan, Office
of South Asian Affairs

Department of State-Bureau of Near Eastern and South Asian Affairs (NEA):

Alexander S. C. Fuller, Senior Economic Officer for
Pakistan
William F. Spengler, Country Director, Pakistan,
Afghanistan

Harvard University-Center for Population Studies:

Peter P. Rogers, Research Associate in Population
Studies

Harvard University-Development Advisory Service:

John W. Thomas, Associate Director

International Bank for Reconstruction and Development (IBRD):

Hugh Dugan, Engineer, Special Projects Department
Ristow Harma, Chief Agricultural Economist for East
Pakistan Water Development Program, Special
Projects Department
Phillip Kirpich, Engineer, Special Projects Department
Robert Picciotto, Program Coordinator, East Pakistan
Agriculture and Water Development Program,
Special Projects Department
Daryl B. Simons, Consultant to the Bank, Specialist in
River Engineering
Hendrick van der Heijden, Economist, South Asia
Department

National Academy of Sciences-Office of the Foreign Secretary:

Roger Revelle, Deputy Foreign Secretary for
Development

Observers

- Henry A. Arnold, Deputy Scientist (Technology), Office of Science and Technology, Bureau for Technical Assistance, Agency for International Development
- Walter Bollinger, Assistant Desk Officer for Pakistan, Bureau for Near East and South Asia, Agency for International Development
- James A. Brown, Economist, Planning Division, Office of Development Planning, Bureau for Near East and South Asia, Agency for International Development
- Allen F. Clark, Jr., Executive Vice President, Philadelphia Port Corporation, Philadelphia, Pennsylvania
- Ann Damsgaard, International Relations Officer, Pakistan Desk, Office of South Asian Affairs, Bureau for Near East and South Asia, Agency for International Development
- Wolfram Drewes, Regional Development Specialist, Special Projects Department, International Bank for Reconstruction and Development
- Priscilla Gray, Summer Intern, Pakistan Desk, Office of South Asian Affairs, Bureau for Near East and South Asia, Agency for International Development
- Ted Glickman, Economist, Special Projects Department, International Bank for Reconstruction and Development
- Tom Hexner, Economic Consultant, International Bank for Reconstruction and Development
- Teddy Herman, Center for Population Studies, Harvard University, Cambridge, Massachusetts
- Ronald W. Jones, Director, Office of Population Programs, Bureau for Near East and South Asia, Agency for International Development
- Michael Lav, Economist, South Asia Department, Pakistan Division, International Bank for Reconstruction and Development
- Samuel M. Levine, Economist, Planning Division, Bureau for Near East and South Asia, Agency for International Development
- Princeton N. Lyman, Chief, Civic Participation Division, Office of Policy Development and Analysis, Bureau for Program and Policy Coordination, Agency for International Development
- Donald G. MacDonald, Assistant Administrator, Bureau for Near East and South Asia, Agency for International Development
- N. C. Matalas, Hydrologist, Water Resources Division, U.S. Geological Survey
- David Mathiasen, Director, Development Planning, USAID Mission to Pakistan, Agency for International Development
- William McCulloch, Loan Officer, Pakistan Division, South Asia Division, International Bank for Reconstruction and Development
- C. C. Murray, Dean Emeritus of Georgia Tech., Executive Director, Southern Consortium for International Education, Inc., Athens, Ga.

Robert Muscat, Chief, Planning Division, Bureau for Near East and South Asia, Agency for International Development

George W. Ramsey, Agricultural Officer, Agricultural Branch, Office of Technical Support, Bureau for Near East and South Asia, Agency for International Development

C. H. Rees, Director, Office of South Asian Affairs, Bureau for Near East and South Asia, Agency for International Development

Norman Reynolds, Young Professional, East Pakistan Agriculture and Water Studies Program Division, International Bank for Reconstruction and Development

Edward B. Rice, Evaluation Staff, Office of Policy Development and Analysis, Bureau for Program and Policy Coordination, Agency for International Development

Emory Roberts, Chief, Engineering Division, Office of Capital Development and Engineering, Bureau for Near East and South Asia, Agency for International Development

Anthony Schwartzwalder, Program Evaluation Officer, USAID Mission to Pakistan, Rawalpindi

Joseph E. Upson, Research Hydrologist, Water Resources Division, U.S. Geological Survey

Kenneth F. Vernon, Director of Engineering, Agency for International Development

Joseph C. Wheeler, Director, USAID Mission to Pakistan, Rawalpindi

Michael Wiehen, Chief, Pakistan Division, South Asia Department, International Bank for Reconstruction and Development

Agenda

I. First Meeting

August 27, 1970

AM -- Welcome to the NAS
Dr. Roger Revelle

Opening Presentation
Dr. Dean Peterson

Introduction: Background of AID Involvement
in East and West Pakistan and Current World
Bank Initiative
Mr. Curtis Farrar

Current Political Situation with Special
Reference to Indo-Pakistan Relationships
and Their Effect on Water Management,
East Pakistan
Messrs. William F. Spengler and Alexander
S. C. Fuller

Population and Food in East Pakistan
Dr. Roger Revelle

PM -- Review of AID's Agriculture and Water
Programs
Dr. James Blume and Mr. William Romig

Review of General Water Management Problems
Dr. Peter Rogers

August 28, 1970

AM -- Review, Primary Socioeconomic Issues in East
Pakistan and Identification of Some Basic
Issues Involved in Water and Agriculture
Development
Mr. Townsend S. Swayze

Review of Rural Development, Government
Administrative Capability, and Absorptive
Capacity
Dr. John W. Thomas

General Discussion

PM -- Executive Session of the Panel

II. Second Meeting

October 21, 1970

AM

— Opening Remarks
Mr. Robert Picciotto

Review of World Bank's Proposals for
Water Development in East Pakistan

Mr. Phillip Kirpich

Review of the World Bank's Proposals
for Agricultural Development in East
Pakistan

Mr. Ristow Harma

Analysis of the Behavior of East Pakistan's
River System and its Relationship to Pro-
posals for Development

Mr. Daryl B. Simons

PM

— Presentation of the Dacca Southwest
Project and its Interrelationships
with other Projects

Messrs. Ristow Harma, Hugh Dugan,
and Daryl Simons

Pakistan's Economic Setting

Mr. Hendrick van der Heijden

General Discussion

October 22, 1970

AM

— Executive Session of the Panel

PM

— Executive Session of the Panel

III. Third Meeting

November 23, 1970

- AM — Executive Session of the Panel
Report of Current Conditions in East
Pakistan Resulting from Typhoon which
Occurred in November
Messrs. Alexander S. C. Fuller, William
Romig, and Townsend S. Swayze
- PM — Executive Session of the Panel

November 24, 1970

- AM — Oral Report of Panel's Findings to AID
- PM — Executive Session of the Panel