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THE WORLD BANK
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The World Bank
1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

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OFFICE MEMORANDUM

TO: Mr. Emmerich M. Schebeck, Chief, AGRNU

FROM: Samir Sanad Basta, Nutrition Expert, AGRNU

SUBJECT: Nutrition Policy Research Proposal

DATE: May 31, 1978

1. I fully support Mr. Wilkie's memo on this. The fundamental issue is not whether the topics chosen make sense or not but rather on the choice of country.
2. Brazil has more ongoing nutrition research, Bank supported or otherwise, than any other country I know of, apart from the USA! In addition, our project's objectives are formulated in such a manner that much of Mr. Reutlinger's research objectives could be met by his continued participation in supervision of certain components, especially for example, the FIPE supported evaluation and IBGE exercises. FIPE, as you know, is a first class research institute and much in the above proposal could be and will be undertaken via FIPE. In addition, it is my own personal judgment that neither FIPE nor the majority of Brazilian research institutes really need Bank specialists to tell them what to do.
3. Much more to the point, I feel that the services of Messrs. Reutlinger and Selowsky and Chernichovsky (as a group) could be much better put to use in another country or region which has not been subjected to such an intense scrutiny as has Latin America and in particular Brazil. I do believe that it is both morally and technically necessary to move nutrition planning research into countries which need it the most, rather than the opposite, as is being currently contemplated. Let us move out of this belief that "easiest is best" or where "data exists the Bank persists...". What about the Haiti's, the Bangladesh's, the Upper Volta's of the world? Also, let us make use of the group at the preparation stage of a project - not at supervision.

SSBasta:jm

Research - Gen

OFFICE MEMORANDUM

TO: Mr. Emmerich M. Schebeck

FROM: Neil A. Wilkie *AW*

SUBJECT: Nutrition Policy Research Proposal

DATE: May 23, 1978

1. This is in response to Mr. Reutlinger's memo of May 10 on this subject, the draft proposal and your request for comments.
2. I find the proposal weak, inadequately developed and unconvincing. Some of my pencilled comments in the margin illustrate why. Most disturbing however, is the notion that the research proposal, if applied to Brazil, would (a) ride on the back of the existing nutrition project, and (b) apparently duplicate or tangle with the elaborate monitoring and evaluation exercise which has already begun to assess the cost-effectiveness of alternative interventions. Except if it were to examine the nutritional implications of alternative federal and/or state agricultural and food supply policies on a macro-economic basis, I do not see what the research would add to the existing project's operational program.
3. Even more serious in my view is the implied view that policy-oriented research should follow Bank involvement in program operations. Surely it is the opposite need that exists, i.e. for research assistance to governments in formulating the nutrition policy from which optimum program interventions would then logically be determined. In Ecuador, Bolivia or Morocco, for example, where there is nutrition interest and where governments are edging towards policy formulation as a prelude to a more sharply defined, better integrated program of nutrition interventions, the case for research is surely stronger. It is stronger still in countries where resources are limited and infrastructures for local interventions are crude or undeveloped, where surely macro-scale policy adjustments might be the speediest way to effect nutrition change.
4. In short, I am uneasy both about the vagueness and jargonistic approach of the proposal as it now stands, and about the philosophy behind the proposal. The next round of discussions on this, assuming that the Bank should expand its portfolio of nutrition research activities, could usefully focus on (a) objectives, (b) the question of emphasis on (macro) food policy or (micro) nutrition interventions, (c) country selection criteria.

NAWilkie:jm

Messrs. F. Hotes, M. D. French-Mullen,
D. Turnham, J. Kalbertmatten
Fred Golladay, OERA

December 29, 1977

Research Study on the Planning of Schistosomiasis Control Program

The attached proposal is being submitted to Research Committee at the end of the second week of January for possible funding. It has been reviewed fairly extensively inside and outside the Bank and appears to us to be highly promising. The ultimate purpose of the study is to formalize the planning of Schistosomiasis control activities, particularly in new irrigation schemes. The study focuses on the choice of control techniques and the timing of interventions. It incidentally develops a simulation model for predicting the prevalence of the disease and the possible effects of control activities, and constructs an econometric model for analyzing the costs of control programs. These two outputs are inputs into the larger planning model and would be available prior to completion and evaluation of the planning model. The proposal is phased, with the first year being devoted to study of control in Puerto Rico and St. Lucia and the second year to research in Africa. A review of progress could be made near the end of the first phase.

We would appreciate your comments and suggestions and would also like to include your department under the required section of the proposal "Interdepartmental Coordination." We would like to obtain signatures on the original cover sheet for the proposal about January 10 and will contact you before circulating the submission copy. Thanks in advance for your help.

 FGolladay:mc

Attachment

THE ECONOMICS OF SCHISTOSOMIASIS CONTROL ACTIVITIES

The World Bank

November 29, 1977

THE ECONOMICS OF SCHISTOSOMIASIS CONTROL ACTIVITIES

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THE ECONOMICS OF SCHISTOSOMIASIS CONTROL ACTIVITIES

INTRODUCTION

1. Schistosomiasis, also known as bilharziasis and snail fever, is a tropical parasitic infection that victimizes an estimated 250 million people in 71 developing countries. An additional 600-800 million people are continually exposed to the risk of infection. Due to its association with agriculture, this infection is considered as one of the major occupational hazards in the rural sector of developing economies. Already ranking as one of the most prevalent water-related diseases, the public health and economic menace of schistosomiasis is spreading at an alarming rate as the habitat of the intermediate host (vector) snails is increasing with the development of water resources.^{1/} This "disease of development" is chronic and insidious, undramatic and inconspicuous. Gradually sapping the energy of its victims (who almost exclusively are rural, poor, and economically and politically powerless), it causes long histories of agonizing debility which in some severe cases culminate in death.

2. In order to realize the investment as well as consumption benefits of health care; to avert the potential damages of what is sometimes referred to as "the careless technology"; and to pursue the goal of redistribution of benefits of economic development to the lowest income groups who often lack basic health services, the World Bank has made significant contributions to the control of endemic diseases. Schistosomiasis is currently one of the most important health issues in Bank-financed development projects. Since 1971, the Bank has directly addressed the schistosomiasis problem in connection with 30 development projects in 18 countries. The Bank has financed the control of this endemic disease in 21 of the projects and has obtained assurances that the borrowers would undertake control in the remaining 9. The 30 projects cover a total area of 37,774,224 ha. and a population of 13,260,300. The total cost of the control activities in these projects amounts to US\$63,360,000 (or 4.13% of the total cost of the 18 projects which have financial allotment for control purposes).^{2/}

3. Due to the recent upsurge in the number of Bank-financed irrigation and rural development projects, the degree of the Bank's involvement in the control of endemic diseases in general and schistosomiasis in particular is likely to increase in the future. It must be pointed out, however, that regarding schistosomiasis control, the Bank's objective is not eradication-- which though highly desirable is still an elusive ambition particularly in

^{1/} See Annex 1 - Transmission, Disease, Control and Economic Significance of Schistosomiasis.

^{2/} See Annex 2 - Schistosomiasis Control in World Bank Projects.

view of the limitations of the current state-of-the-art of control--but rather to minimize the risk of spread and transmission of the infection in the development projects it finances.

4. Control programs are generally expensive to undertake and impose heavy demands on scarce health resources. This point can hardly be over-emphasized, especially in view of the fact that the per capita health budget in most affected developing countries is still in the order of US\$1.00. The cost of control in World Bank projects ranges from approximately US\$1.00 per capita per annum in Egypt to US\$6.59 in the Philippines to as high as US\$90 in one health care component which includes schistosomiasis control in the Malagasy Republic. The limitations of the current arsenal of antischistosomiasis techniques notwithstanding, the lack of knowledge of the optimal choice and application of control measures--i.e., the economic efficiency and optimality of control activities--partly accounts for the expensiveness of control programs.

5. This study focuses on the problem of designing an economical control strategy for schistosomiasis. The methods of control now available--destruction of the breeding areas of the snail, mollusciciding, and chemotherapy of infected persons--are costly and difficult to administer. Although much has been published on the epidemiology of the disease, little attention has been given to the economic feasibility or cost-effectiveness of schistosomiasis control.^{3/} Three studies have recently appeared (Jobin, 1972; Paulini, 1974; and Rosenfield, 1975) which analyze the costs and efficiency of control activities; however, all of these are exploratory investigations and none rigorously analyzes the costs of specific control activities, the dynamics of intervention or the identification of optima.

6. The present study is concerned specifically with construction of an optimal strategy of control using mollusciciding and chemotherapy. It addresses the problem of designing control programs for irrigated agricultural development. While earlier works have examined the relative cost-effectiveness of these two measures, the present investigation examines dynamically efficient strategies of control. The underlying issue is that with settlement of a scheme, the magnitude of the infected population, and hence the cost of chemotherapy will change. Meanwhile, the scale of the snail infested water habitat will be modified by irrigation, drainage and snail control activities. Thus, the problem is to select a method, or combination of methods of control which minimizes disease prevalence, given a budget and any prior commitments to equipment, facilities or infrastructure.

^{3/} See Annex 3 - Schistosomiasis Transmission Models and Cost-effectiveness Analysis.

The Analytical Model

7. The proposed model is constructed of three modules. The first represents the epidemiology of the disease and therefore simulates the impact of control activities on prevalence of infection and the magnitude of the human reservoir of infection. Initially, the simplest, i.e., the least data demanding and mathematically most tractable, epidemiological model available will be selected for this purpose. The second portrays the relationship between the cost of intervention and the important determinants of cost including scale of operation, timing of investments and characteristics of the habitat and infected population. The third module provides an explicit optimization framework for design of a strategy. It expresses the goal of minimization of the prevalence of infection and the constraints of budget and prior investment in programs. Operation of the model thus identifies the strategic program of disease control which would be cost-effective in controlling schistosomiasis over a well-defined time period.

8. The model may be represented formally as follows.

9. The Transmission Model. A number of schistosomiasis transmission models are reviewed in Annex 3. These models are of two broad types. All of the catalytic models and some of the life cycle models considered are suitable for the purposes of this study. Catalytic models are constructed on the basis of a posteriori reasoning from the shape of the frequency distribution of age prevalence of infection. Life cycle models are based on a priori reasoning of the development of the worm in snails, humans, and in its two free living states. The data required to implement catalytic models--observations of the age prevalence of infection--are routinely collected in control programs. Hence, these models are empirically implementable. The life cycle models, on the other hand, are mathematically complex and require data that are rarely collected in the field. In terms of generating information, the catalytic models can only describe age prevalence of infection either in humans or snails, but not simultaneously in both populations, as a function of two macro parameters, the force of infection and the force of deinfection. They have thus been criticized as describing only a fraction of the transmission phenomena. So far, only Rosenfield (1975) has succeeded in using a catalytic model to predict transmission measured in terms of prevalence of infection (or the proportion of humans infected). The transmission phenomena involve three populations: a) humans (or the definitive hosts), b) snails (or the intermediate hosts) and c) the parasite (schistosomes). The life-cycle models attempt to capture the essential relations between these populations in the transmission phenomena. Correspondingly, they generate information on the status of the three populations as functions of initial conditions and a set of parameters that measure the relations between the three populations. The unit of account in these models is the worm pair; and hence, disease (or intensity of infection) is measured as a function of worm load. The unit of account in catalytic models is the proportion infected. The number of worm pairs and their distribution in humans are not accounted for in catalytic models.

10. The strategy that will be followed in this research study is to first adopt a simple transmission model, preferably one that has been verified on field data, modify the model as necessary to suit the purposes of this study and use it to implement cost-effectiveness analysis. In successive stages of elaboration of the study other transmission models that can generate more information will be adopted for the same purpose. A transmission model that is simple, has already been verified and can be easily modified and used in the initial phase of this study is Rosenfield's (1975) Schistosomiasis Transmission Model. In successive phases of the study, modified versions of Holford and Hardy's (1976) model, Nassel and Hirsch's (1973) model, Lewis' (1975) model, and possibly also Macdonald's (1965) model are attractive candidates for adoption.^{4/} (See Annex 3). In the remainder of this section, the manner in which Rosenfield's model will be modified and estimated for adoption in this study will be elaborated.

11. Rosenfield (1975) developed a predictive model in which the state variable is prevalence of infection based on the reversible catalytic model of epidemiology by Muench (1959). The model is expressed as:

$$Y_t = I_t \left(1 - Y_{t-1} \right) - bY_{t-1} + Y_{t-1} \quad (1)$$

where Y = prevalence of infection (or proportion of humans infected)
 I = incidence of infection
 \underline{b} = force of deinfection (or the rate at which infection is lost).

To estimate I and \underline{b} , Rosenfield fitted the reversible catalytic model whose general solution is given by Muench as:

$$Y_t = \frac{\underline{a}}{\underline{a} + \underline{b}} \left(1 - e^{-(\underline{a} + \underline{b})t} \right) \quad (2)$$

where \underline{a} = force of infection (or the rate at which infection is acquired by humans)
 Y and \underline{b} are as defined above.

^{4/} Some experts in schistosomiasis transmission modeling are in agreement with the idea of successively improving the transmission model. In private communication with Theodore Holford, it was pointed out to us that his model can easily be converted to the form of Rosenfield's model. Joel Cohen suggested investigation of the sensitivity of results based on different transmission models. Furthermore, Cohen suggested that the macro variables T_1 and T_2 in the Nasell and Hirsch model could be estimated in regression equations where the independent variables are the same environmental factors used in Rosenfield's model.

Assuming that $Y_0 = 0$, she calculates the incidence rate as:

$$I = Y_1 - Y_0 = \frac{a}{a + b} \left(1 - e^{-(a + b)} \right) \quad (3)$$

Rosenfield then explains the force of infection, a , as a function of measurable environmental factors in a regression equation of the form

$$\underline{a}_t = \beta_0 H_t \beta_1 P_t \beta_2 \quad (4)$$

where H = meters of accessible snail habitats

P = numbers of infected people

$\beta_0, \beta_1, \beta_2$ are constants

She sets b equal to its mean and only allows it to vary within one standard deviation for sensitivity analysis.

12. Substituting equation (4) for a in equation (3) and then substituting for I in equation (1), Rosenfield predicts Y_t as a function of Y_{t-1} , H_t , P_t , and b . To simulate the impact of control activities, H is revised as a function of mollusciciding and/or engineering activities, and P is revised as a function of chemotherapy activities. The model is successfully verified on data on an irrigation project in Iran. So far, Rosenfield's model is one of only two transmission models to have been verified on data collected in the field.^{5/}

13. A major weakness of Rosenfield's approach to modeling transmission is her use of the reversible catalytic curve which gives a monotonically increasing prevalence of infection with age. Observed age prevalence of infection peaks between ages 10 to 20 and then tends to fall to some positive asymptote. Better fit to such data and hence better estimates of the parameters a and b are obtained with the two-stage catalytic model. In some instances, it may not be necessary to use a catalytic model. As incidence figures are routinely collected along with prevalence of infection, one could directly obtain data on I and b from successive survey data. One could then express I as some function of H , and P .^{6/}

^{5/} The other model is by Jobin (1972).

^{6/} Private communications with Professor Warren M. Hirsch, the Courant Institute, New York University.

14. The major strength of the model is that it explains transmission as a function of measurable environmental factors H and P which are surrogates of the snail population and the production of worm eggs respectively.^{7/} Furthermore, these same variables constitute the link between the transmission model and the cost model for cost-effectiveness analysis.

15. Rosenfield's model can be modified in two ways. First is the estimation of the parameters a and b and therefore I. Second is the estimation of the regression equation explaining the parameter a.

16. As stated above, better estimates of the parameters a and b are obtained by fitting the general solution of the two-stage catalytic model to age prevalence of infection. The two-stage model adequately describes the phenomena of peaking of age prevalence of infection initially and then declining to some positive asymptote. Further improvement in estimation can be obtained by incorporating selective host mortality according to Cohen (1973) and loss of immunity and immigration death rates of worms according to Lewis (1975). Therefore, a modified two-stage catalytic model will be used to estimate a and b.

17. The regression equation explaining the force of infection parameter, a, will be respecified to include water contact as an independent variable. The existence of snail habitats, and the release of schistosome eggs only constitutes the necessary conditions for transmission to take place. Human contact with habitats of infected snails provides the sufficient condition for transmission of infection. Hence, the respecified regression equation may be expressed as:

$$a_t = \beta_0 H_t^{\beta_1} P_t^{\beta_2} W_t^{\beta_3} \quad (5)$$

where W = human water contact measured in terms of frequency, duration of contact and area of skin exposed per contact.

Where nonhuman definitive hosts are involved in transmission, another variable, Q, will be included to account for their contribution of schistosome eggs.

18. Data permitting, the independent variables in equation (5) will be disaggregated as follows:

H will be disaggregated by type of habitat, accessibility of habitat, density of infected snails
P will be disaggregated by intensity of infection (egg output)
W will be disaggregated by pattern of contact.

^{7/} Hence, though the snail population and the worm population are not explicitly entered in the analysis as is usually done in life cycle models, the variables H and P implicitly represent the two populations in the transmission phenomena.

19. In this study, only mollusciciding (chemical control of snails) and chemotherapy (drug treatment of infected humans) will be evaluated for cost-effectiveness. Quite obviously, the model as specified can be used for evaluation of other control measures. For instance, other methods of snail control--biological and engineering (alteration of habitat)--can be used to revise H in equation (5). Sanitation, water supply, health education, fencing of habitats, and footbridges can be used to reduce W. To simulate the impact of control activities on transmission of infection, additional statements will be needed. Corresponding to mollusciciding and chemotherapy activities the following equations will be included:

$$H_t = H_{t-1} + (1-h)\tilde{H}_{t-1} + H'_t - \tilde{H}_t \quad (6)$$

and

$$P_t = P_{t-1} + (1-p)\tilde{P}_{t-1} + P'_t - \tilde{P}_t \quad (7)$$

where h = success rate of mollusciciding, $0 < h < 1$
 p = success rate of chemotherapy, $0 < p < 1$
 \tilde{H} = size of habitat molluscicided
 H' = size of new habitat
 \tilde{P} = size of population treated
 P' = size of infected migrants.

20. The transmission model that will be used in the initial phase of this study will thus consist of equations (1), (3), (5), (6) and (7).

21. Estimation of the Transmission Model. The method of moments or the method of maximum likelihood may be used to fit the catalytic curve to age prevalence data in order to estimate parameters a and b. The former is elaborated by Muench (1959) who gives numerous examples of using the technique to fit various forms of the catalytic curve. Cohen (1973) and Rosenfield (1975) have used Muench's approach. Hairston (1965) modified the approach so as to be able to fit two curves, one to lower age groups and another to higher age groups. The method of maximum likelihood has been used only by Lewis (1975). This method is somewhat laborious though perhaps more elegant. As there have not been any attempts to compare the relative efficiency of the two approaches to estimation, the simplest method--the method of moments-- will be used to estimate parameters a and b.

22. A cross-section of age prevalence of infection data from as many endemic localities as possible will be used to estimate a and b. Naturally, as the different endemic localities are likely to be at different levels of steady-state equilibrium (precontrol epidemiological status) the values of a and b will differ from locality to locality.

23. To estimate equation (5), the dependant variable \underline{a} will be regressed on the independent variables H, P, and W from the corresponding localities. Hence, H, P, and W are cross-section data as are the values of \underline{a} which are estimated from a cross-section of age prevalence of infection data.

24. The purpose of estimating \underline{a} and \underline{b} is to enable the calculation of I, the incidence rate. It appears that incidence figures may be available from survey data along with prevalence and intensity figures. Where surveys are conducted in successive years, it will also be possible to directly calculate \underline{b} , the force of deinfection (or the rate at which infection is lost). In such blissful cases it will not be necessary to fit a catalytic model to estimate \underline{a} and \underline{b} , and further estimate \underline{a} as a function of H, P, and W. Instead, I may be regressed directly on H, P, and W.^{8/} For lack of satisfactory explanatory variables, \underline{b} will be assumed to have a constant value at its mean.

25. The constants h and p in equations (6) and (7) will be calculated on the basis of historical information from control programs. Their values will depend on a variety of factors: h, for instance, is likely to be influenced by climatic factors, characteristics of habitat, and the residual effect of the molluscicide used. Constant p is likely to depend on the discipline of patients in complying with the recommended dosage regimen, intensity of infection, and possibly also on anthropometric and cultural characteristics.

26. The Cost Model. The state of the epidemiology, as portrayed in the transmission model described above, is controlled through changes in the size of habitat, H, and the size of the infected population, P. The time path of the two variables are expressed in equations (6) and (7). In these equations, H and P change as functions of \tilde{H} and \tilde{P} in the current and preceding periods, and H' and P' in the current period. Since only mollusciciding and chemotherapy activities will be evaluated for cost-effectiveness, the relevant choice variables, or control variables, are \tilde{H} and \tilde{P} .^{9/} The next logical step is then to estimate the recurrent and investment costs of mollusciciding and chemotherapy activities.

^{8/} This approach is suggested to us by Warren M. Hirsch of the Courant Institute, New York University [private communications].

^{9/} In succeeding phases of elaboration of the study, \tilde{W} or the amount of water contact prevented could be included to evaluate the effectiveness of sanitation, water supply, health education, etc...types of control programs. \tilde{H} could also be used as a control variable representing biological and/or engineering methods of snail control. H' can serve as a control variable in conjunction with \tilde{H} in evaluation of the efficacy of engineering design of irrigation. P' can be a control variable where screening and treatment of migrants is undertaken.

27. The recurrent costs of intervention are expressed as a function of the scale of activity and characteristics of the habitat or population (for mollusciciding and chemotherapy, respectively). Costs of snail control are postulated to be influenced by PH, turbidity, temperature, rainfall, vegetation and velocity of flow; other characteristics of the habitat would also be investigated if data were available or field research indicated their importance. Costs of chemotherapy are assumed to depend on the size of the population treated but also on intensity of infection, nutritional status, and accessibility. The corresponding cost functions may thus be written generally as:

$$C_t^m = \phi^m(\tilde{H}_t, X_{1t}, \dots, X_{mt}) \quad (8)$$

$$C_t^c = \phi^c(\tilde{P}_t, Z_{1t}, \dots, Z_{nt}) \quad (9)$$

where C_t^m = cost in each period of mollusciciding
 C_t^c = cost in each period of chemotherapy
 \tilde{H} = size of habitat molluscicided
 \tilde{P} = size of population treated
 X_1, \dots, X_m = characteristics of habitat molluscicided
 Z_1, \dots, Z_n = characteristics of population treated

Functions will be estimated for four types of habitats--dry-moist, shallow inundated, still waters of varying extents and depths, and flowing waters; and for two types of infections--S. haematobium, and S. mansoni. Due to certain peculiarities in its transmission and control, S. japonicum will not be considered until sufficient experience is acquired in modeling and implementation of cost-effectiveness analysis. As relatively more complete data is available from control projects in Puerto Rico and St. Lucia, cost-effectiveness analysis in the initial phase of this study will begin with S. mansoni.

28. The investment cost of any program would depend upon the rate of expansion and the scale of investments. Functions of the following form will be estimated from engineering data and historical information:

$$k_t^m = \theta^m \left(K_t^m \right) = \theta^m \left(\tilde{K}_t^m - \bar{K}_t^m - 1 \right) \quad (10)$$

and

$$k_t^c = \theta^c \left(K_t^c \right) = \theta^c \left(\tilde{K}_t^c - \bar{K}_t^c - 1 \right) \quad (11)$$

- where k_t^m = investment cost in mollusciciding
 k_t^c = investment cost in chemotherapy
 K_t^m = expansion in capacity to molluscicide
 K_t^c = expansion in capacity to apply chemotherapy
 \tilde{K}^m = desired capacity to molluscicide
 \tilde{K}^c = desired capacity to apply chemotherapy
 \bar{K}^m = depreciated capacity to molluscicide left over from the previous period
 \bar{K}^c = depreciated capacity to apply chemotherapy left over from the previous period.

A unit of capacity in this study will be defined as that combination of facilities, equipment and transport required to molluscicide a given size of habitat, or to treat a given number of infected people in a year. Capacity will be assumed nontransferable between control activities. A single technology of delivery will be assumed for each activity. Further, the supply of labor for each activity will be assumed infinitely elastic and nonconstraining. Hence, there will only be a capital capacity constraint for each activity. These assumptions will be relaxed in successive phases of elaboration of the model. Accordingly, both the cost functions and the relevant restrictions will be respecified to reflect the modified assumptions.

29. Thus, in addition to the above equations, statements are required which constrain control activity to levels for which capacity is available, and budgetary resources are sufficient. Existing capacity for control may be expressed in hectares (for mollusciciding) and persons (for chemotherapy). The capacity available represents initial (preprogram) capacity plus expansion undertaken by the model; allowances would be made for depreciation of capacity. In addition, the model would permit scrapping of redundant capacity and supplementation of the program's budget with the proceeds of sales of scrapped properties. The requirement for capacity is proportional (by definition of capacity) to level of activity. More formally, this capacity restriction may be expressed as:

$$\tilde{H}_t = (1 - d^m)^t \bar{K}_0^m + r \sum_{s=1}^t [(1 - d^m)^{t-s} - r (K_r^m - J_r^m)] - e_t^m \quad (12)$$

and

$$\tilde{P}_t = (1 - d^c)^t \bar{K}_0^c + r \sum_{s=1}^t [(1 - d^c)^{t-s} - r (K_r^c - J_r^c)] - e_t^c \quad (13)$$

where d = annual rate of depreciation
 J^m = scrapped capital in mollusciciding activity
 J^c = scrapped capital in chemotherapy activity
 e^m = excess capital in mollusciciding activity
 e^c = excess capital in chemotherapy activity

Appropriate subroutines will be included in the optimization procedure to permit expansion in capacity, and scrapping and sale of redundant capacity.

30. The total expenditures in any period may not exceed allocated budget plus proceeds of sales of scrapped capacity. The model permits transfer of unspent funds, U , into the following period:

$$C_t^m + C_t^c + k_t^m + k_t^c - f(J^m)_t - f(J^c)_t + U_t = B_t + U_{t-1} \quad (14)$$

where

$f(J^m)$ = revenue from scrapped capital in mollusciciding capacity
 $f(J^c)$ = revenue from scrapped capital in chemotherapy capacity
 U = unspent funds
 B = predetermined budget of the program.

31. In addition, the program is formally restricted to activity levels no greater than the total volume of habitat and population; trivially, all activities must be non-negative.

32. Estimation of the Cost Model. The recurrent cost functions will be econometrically estimated from cross-section data. Binary or multivalued dummy variables will be used (as found appropriate) to represent characteristics of habitat and population treated. It could also be possible to use dummy variables for different types of habitat and infection and thus increase the sample size.

33. The investment cost functions could also be econometrically estimated on cross-section data. Alternatively, they could be directly calculated from engineering information.^{10/}

34. The capacity restrictions of equations (12) and (13) are purely engineering data.

35. Required expansions in capacity, K^m and K^c in each period, and scrapping and sale of scrapped properties will be specified as subroutines to the optimization model.

^{10/} See F.A. Holland, et. al., Introduction to Process Economics, London: John Wiley and Sons, Ltd., 1974, Ch. 5.

36. The restriction expressed in equation (14) depends on institutional arrangements of budgetary allocation.

37. Data for estimating the cost need not be from the same field study so long as common variables are dimensioned similarly. Thus, the two models can be estimated from two different sets of data. It will hence, be possible to use the cost model in conjunction with different transmission models (including life cycle models) in successive phases of generalization. It would also be possible to use the cost model (without a transmission model) for purposes of budget preparation and other aspects of financial analysis in schistosomiasis control programs funded by the World Bank as well as others.

38. The Optimization Framework for Cost-Effectiveness Analysis. In previous cost-effectiveness studies the procedure used has been simulation. Some of the obvious weaknesses of the simulation approach to cost-effectiveness analysis are discussed in connection with the review of studies by Rosenfield (1975), Jobin (1972) and Paulini (1974) in Annex 3.11/ In this study, the dynamic programming framework of optimization will be employed to investigate:

- (a) the optimal amount of each control activity given capacity and budget restrictions, or the least costly control activity given target levels of prevalence of infection; and
- (b) the optimal combination of control activities given either capacity and budget constraints, or target levels of performance.

The dynamic programming approach will render both analytical and numerical solutions.^{12/} Hence, it will permit a larger degree of freedom in analysis of the issue of cost-effectiveness as it will permit investigation of the sensitivity of results to a variety of forms of objective functions and restrictions.

39. A sample of objective functions and their correspondingly appropriate constraints is given in Section D of Annex 3. For illustrative purposes, a simplified formulation of the optimization problem will be sketched below.

11/ For some general statements on simulation versus analytical solutions, see Howrey and Kelejian (1971).

12/ The possibility of obtaining analytical solutions will depend entirely on the form of the transmission model used. Some of the models can only be solved numerically. With some modification, however, some of the mathematically simpler models can be reduced to analytical forms.

40. Let the objective of the control program be to minimize the prevalence of infection over a specified period of time, $1 < t < T$. The control activities to be used are mollusciciding and chemotherapy. The program manager is interested in knowledge of the optimal combination of the two activities. Such knowledge may be required for preparing or revising "a plan of action that will serve as basis for a budget proposal" [Paulini, 1974]. A correspondingly simple objective function may be formulated as:

$$\text{Min } \sum_{t=1}^T (Y_t - A_t)^2 R_T \quad (15)$$

where A_t = target level of prevalence of infection
 R_t = a discounting factor expressing subjective trade-offs in the timing of program benefits.

The above objective function, also called a welfare loss function, has a number of attractive qualities. First, it expresses the desire to minimize deviations from target levels of prevalence. Second, squaring the deviations penalizes large deviations disproportionately more than small deviations. To avoid evenhandedly penalizing below target deviations the same as above target deviations, A_t may be assigned unrealistically low values so as to make it virtually unreachable. Third, in differentiation of the corresponding Lagrangian expression, the squared deviation term permits the derivation of feedback equations. Fourth, by virtue of the dynamic programming solution algorithm of solving the system of equations of partial derivatives of the Lagrangian expression with respect to the state variable, the control variables, and the costate variables for the last period and substituting backwards to the initial period, it is possible to set $Y_T = A_T$ in the feedback equation, and hence, incorporate the desired terminal state condition in the optimization problem.^{13/} To illustrate the last two points, a Lagrangian expression may be formulated and optimized for the last period as follows:

$$L_T = 1/2 (Y_T - A_T)^2 R_T - \lambda_{1T} \left(Y_T - I_T (1 - Y_{T-1}) + bY_{T-1} - Y_{T-1} \right) \quad (16)$$

$$\frac{\partial L_T}{\partial Y_T} = (Y_T - A_T)R_T - \lambda_{1T} = 0 \quad (17)$$

^{13/} Mr. J. Duloy, Director of Development Research Center, IBRD, had suggested that terminal state condition be explicitly expressed in the optimization problem. According to the formulation of the objective function in equation (15), additional statement to express the desired value of terminal state condition is not required. For a different objective function, however, additional statements may be required.

$$\frac{\partial L_T}{\partial \tilde{H}_T} = \frac{\partial L_T}{\partial I_T} \frac{\partial I_T}{\partial \tilde{H}_T} = \dots = 0 \quad (18)$$

$$\frac{\partial L_T}{\partial \tilde{P}_T} = \frac{\partial L_T}{\partial I_T} \frac{\partial I_T}{\partial \tilde{P}_T} = \dots = 0 \quad (19)$$

$$\frac{\partial L_T}{\partial \lambda_{1T}} = - \left(Y_T - I_T(1 - Y_T - 1) + bY_{T-1} - Y_{T-1} \right) = 0 \quad (20)$$

where λ_{1T} = the costate variable corresponding to a Lagrangian multiplier in static optimization.

First solving for λ_{1T} in equation (17) and then using the result to solve for \tilde{H}_T and \tilde{P}_T in equations (18), (19) and (20) will specify the choice of optimal values of these control activities with respect to terminal target A_T and the value of the state variable Y_{T-1} . The solution for \tilde{H}_T and \tilde{P}_T so obtained in effect constitutes a system of feedback equations. This is made possible by the quadratic formulation of the welfare loss function. In a linear form of the function, Y_T would have disappeared in differentiating L_T with respect to Y_T . The same procedure--the quadratic formulation of the welfare loss function--permits optimization of the system through the period $1 < t < T - 1$, while setting $Y_T = A_T$. Hence, an additional statement expressing desired terminal time condition is not needed in the dynamic programming formulation with a quadratic welfare loss function.

41. Solving the problem as formulated above will identify the most effective combination of control activities, \tilde{H}_t and \tilde{P}_t in each time period. The problem can be made more interesting by including capacity and budget restrictions in the Lagrangian expression. The solution to the new problem will identify the cost-effective combination of control activities in each time period. With the possibility of the level one of the control activities being zero at any point in time in the optimal solution, the cost-effective combination of control activities may be interpreted as the cost-effective scheduling or the optimal reswitching of control activities.^{14/} The problem can also be solved for the optimal scheduling of each control activity separately used by excluding the other control activity from the Lagrangian expression.

^{14/} The possibility of a reswitching phenomenon occurring in the choice of control activities depends on the relative magnitude of H_t and P_t at any point within the period of analysis and also the relative effectiveness of each control activity and its associated cost.

Sensitivity Analysis

42. The sensitivity of optimal results will depend on the choice of a transmission model, the form of the objective function and the restrictions imposed on the optimization problem. As briefly indicated above in the discussion of the transmission model, different types of transmission models will be modified and used in this study. The objective is to investigate differences in optimal results of choice of control activity or activities. Should there be radical differences in results, some further investigation will be undertaken to select the transmission model that will generate the desired information. On the other hand, if the differences in results are minor, there will be computational and empirical implementation advantages in retaining the simple transmission model sketched above.^{15/} Having chosen the transmission model, sensitivity analysis of optimal results with respect to different forms of objective functions and restrictions will be required to identify the strengths and limitations of the model in generating the desired information. This exercise would enable the choice of policy recommendations with some degree of assurance. Reliability of control program policy results will be directly related to their degree of insensitivity to both objective function and the corresponding set of restrictions.^{16/} In other words, the exercise would also enable the choice of realistic control program objectives.^{17/}

43. A third type of sensitivity analysis, completely different from the two mentioned above, is investigation of robustness of a chosen optimal set of control activities. The issue of robustness will be investigated in two ways: a) what are the likelihoods of a control program breakdown due to radical increases in input prices, physical and/or institutional bottlenecks in the delivery of control; subsequently, what are the epidemiological states resulting from the breakdown; and b) how stable are the epidemiological results obtained from the implementation of a chosen optimal set of control activities, i.e., what are the expected epidemiological states in the post-control period?

^{15/} Joel Cohen, Professor of Populations, The Rockefeller University, has strongly emphasized this point in his comments on the abstract of this research proposal as well as in recent discussions we have had with him.

^{16/} Adelman, I., and F.T. Sparrow (1966), p. 291.

^{17/} This issue is not to be confused with the subjectively selected set of target levels of prevalence of infection in the objective function proposed above. The choice of realistic control program objectives is between prevention of spread, transmission reduction, morbidity control and eradication [see Ansari, (ed) (1973) pp. 422-437; and Miller, (ed) (1972) pp. 13-15]. It is repeatedly pointed out in the literature on the control of schistosomiasis that a clear statement of realistic objectives would curtail cynicism and enable the proper evaluation of the efficacy of control programs.

In other words, this study will consider cost-effectiveness analysis within the framework of the economic and epidemiological risks associated with a chosen control strategy. Thus, a cost-effective control strategy will be identified as that which renders the least sum of prevalence of infection over the control period plus some judiciously chosen length of post-control period.

44. Phases of the Research Study and Expected Minimum Results. This Study will be conducted in two phases, each requiring one year of research work including four months of data gathering in the first phase and approximately five months of data gathering in the second phase. The first phase will focus on verification of a simple transmission model, estimation of a cost model of mollusciciding and chemotherapy activities, and implementation of cost-effectiveness analyses of the two control activities in a dynamic optimization framework. Data from control programs of S. mansoni infection in Puerto Rico and St. Lucia will be used in the first phase. In the second phase of the study, control of S. haematobium and S. mansoni infections will be jointly considered. A more elaborate transmission model will be verified and implemented. Water supply will be included in the cost model of control activities and the optimization framework for cost-effectiveness analysis.

45. At least two simple transmission models will be considered in the first phase--Rosenfield's (1975) model and Holford and Hardy's (1976) model. The former is a phenomenological model based on a reversible catalytic curve of age prevalence of infection. The model will be modified by using a two-stage curve instead of the reversible curve, and (data permitting) by incorporating selective host mortality and loss of infection parameters. These modifications are expected to result in significantly less biased estimates of the parameters of the model. 18/

46. The Holford and Hardy model is an excellent alternative to Rosenfield's model. It is a partial life cycle model whose parameters, the immigration and death rates of the worm, can be estimated by fitting a curve through age prevalence of infection distribution. It is capable of generating information on age prevalence of infection as well as intensity of infection measured as the mean worm burden. Rosenfield's model can predict only total prevalence of infection. To permit analysis of effectiveness of control activities, the worm immigration rate will be regressed on controllable variables such as size of accessible snail habitats, number of people passing eggs, the water contact pattern and where necessary, the nonhuman definitive hosts factor. Hence, this latter model will be converted to a phenomenological type as is the Rosenfield model.

47. The control activities that will be considered in the first phase are mollusciciding and chemotherapy. Investment and recurrent cost functions

18/ For details on development of the model's specification, see pages 2-5 of Annex 3.

for those activities will be estimated econometrically. These cost functions will then be used in conjunction with either of the two candidate transmission models sketched above in a dynamic programming framework to select and analyze cost-effective control strategies.

48. At minimum, the first phase will produce a detailed qualitative and quantitative analysis of cost of control activities that will be useful in financial planning of control programs of S. mansoni infection. In addition, the study is expected to produce a verified transmission model and a decision model for preparation of cost-effective control programs.

49. The second phase will further elaborate and generalize results obtained in the first phase. A more elaborate transmission model--preferably a complete life-cycle model will be selected. The major parameters of the model selected will be statistically estimated as functions of controllable variables the same as in the first phase.

50. The control activities in the second phase will be mollusciciding, chemotherapy and water supply. Data permitting, engineering methods of snail control, selective chemotherapy or chemosuppression (i.e., reduction of the worm burden of infected persons without necessarily curing them), and the provision of latrines will also be included in the analysis of effective control strategies. Investment and recurrent cost functions for the control activities for which data is available will be econometrically estimated.

51. The second phase of the study will be based on data from control programs of S. mansoni and S. haematobium infections in Puerto Rico, St. Lucia, Egypt, Sudan, Tanzania and Ghana. This phase will generate a detailed qualitative and quantitative cost analysis of mollusciciding, chemotherapy and water supply activities in the control of the two forms of schistosomiasis infection in the Caribbean Islands and Africa. Here again, the cost analysis irrespective of the transmission model and the optimization framework, will be useful in financial planning of control programs.

52. Data for implementation of the first phase will be obtained from Puerto Rico and St. Lucia. The leading expert in Puerto Rico, Dr. W.R. Jobin, has offered to let us use the data he has collected for his own study of the history of control activities in that island and data on 41 pilot control projects around the world he collected for a study he had done for the Edna McConnell Clark Foundation. Dr. Jordan, Director of the Research and Control Department of St. Lucia, has also indicated to us that his program has the most detailed data than any other program and has offered to give us his help in anyway possible.

53. In the second phase of the study, additional data will be collected from control programs in Egypt, Sudan, Tanzania and Ghana. Dr. A. Davis, Chief of Schistosomiasis and other Helminthic Infections in the Division of Malaria and other Parasitic Diseases, WHO, has indicated to us that data on the WHO/Tanzania Schistosomiasis Pilot Control and Training Project,

Misungwi, Tanzania (1967-73) is available on magnetic tape at WHO headquarters. The data includes many of the variables listed in the abstract of this research proposal which were sent out with requests for comments and assistance in identifying sources of data. Dr. Davis also indicated that data collection is still going on in the UNDP/WHO Lake Volta Program in Ghana (1971 - present). Dr. G. Webbe of the London School of Hygiene and Tropical Medicine who is currently serving as consultant to the IBRD schistosomiasis control work in Upper Egypt has indicated that many useful data will be available from this project in due course. In addition, attempts will be made to obtain data on WHO's earlier pilot control programs in the Nile Delta area, and the mollusciciding campaign in the Fayoum Governorate of Egypt financed by the Federal Government of West Germany. Some interesting results of a large-scale mollusciciding trial in the Gezira irrigation scheme in Sudan have been published recently. One of the major participants in this campaign is being contacted to explore the possibilities of obtaining data on this scheme. Detailed data on control programs in irrigated sugar estates in Tanzania, and the Mangoky project in Madagascar is also being sought.

SCHISTOSOMIASIS

ITS TRANSMISSION, DISEASE, CONTROL AND ECONOMIC SIGNIFICANCE

Introduction

1. Schistosomiasis, also known as bilharziasis and snail fever, is a tropical parasitic infection that currently victimizes an estimated 250 million people in 71 developing countries. An additional 600-800 million people are constantly exposed to the risk of its infection. Schistosomiasis is ranked as one of the major occupational hazards in the rural sector of developing economies. The public health and economic menace of this infection is spreading very rapidly as the habitat of its intermediate host (vector) snails increases with the development of water resources. The dynamics of its transmission, aided by the limitations of the current state-of-the-art of control, has rendered schistosomiasis a major scourge of mankind; furthermore, the extent of the problem is not retarded but, rather, augmented by development efforts. Not the least important among the factors that have contributed to the fast spread of this infection in the developing world is the undramatic and inconspicuous nature of the development of its disease syndrome. It is a chronic disease with insidious and lingering effects. It gradually saps the energy of its victims and causes long histories of agonizing debility which in some severe cases may culminate in death.

Transmission of Schistosomiasis^{1/}

2. Of the six known species of the parasite (schistosomes) that cause human schistosomiasis, only three: Schistosoma haematobium, S. mansoni and S. japonicum are significantly pathogenic and prevalent. S. haematobium is found in Africa, the Middle East, and a small focus in India. S. mansoni occurs in Africa, the Arabian Peninsula, northeastern and eastern South America and the Caribbean area. S. japonicum occurs in China, Japan, the Philippines, Indonesia, Laos, and Thailand.

3. S. mansoni and S. japonicum eggs leave the human body through feces; S. haematobium eggs exit through urination. A mature egg which reaches water, within a month hatches almost immediately, releasing a number of first-stage larvae, miracidia.

^{1/} See Jordan, P., and G. Webbe (1969); and Ansari, N., (ed.) (1973) for Transmission, Disease, Control and Public Health and Economic Significance of Schistosomiasis. Prescott, N.M., (1975) provides an excellent survey of the literature on the economic impact of schistosomiasis.

4. A miracidium has a free-swimming life span of approximately only one day; within that time, it must seek out and penetrate an appropriate snail host/vector. The most efficient vectors belong to the genera Biomphalaria for S. mansoni, Bulinus for S. haematobium, and Oncomelania for S. japonicum.

5. Except for the vector snails in the genus Oncomelania, which are amphibious, the other vector snails are strictly aquatic. The amphibious vectors are dioecious, i.e., reproduce sexually, while the aquatic vectors are hermaphroditic, i.e., are capable of asexual reproduction. Depending on environmental conditions, a vector snail may have a life span of several weeks to several years.

6. After successful penetration, miracidia asexually multiply into hundreds of thousands of second-stage larvae, or cercariae. Within four to seven weeks of initial penetration, cercariae emerge from their intermediate host as a cloud of free-swimming, infective agents. Cercariae have life spans of approximately 48 hours in their free-swimming state; it is during this brief time that they are capable of penetrating the skin of man as well as a few other mammals.

7. The role of nonhuman mammalian reservoirs in transmission is very important in S. japonicum. "Domestic animals--dogs, cats, cattle, water buffalo, pigs, horses, sheep and goats--wild mice and rats are all reservoir hosts..." (Jordan and Webbe, 1969, p. 160). The relative efficiency of some of these animals, dogs and cows in particular, in transmitting the infection is so high that a check on their population is often warranted in a control program. The role of nonhuman reservoirs in the transmission of S. mansoni is believed to be more important in the Caribbean Islands and South America than in Africa. Monkeys, baboons, rodents, cattle and dogs have been found with natural infections in both regions; but with less frequency and lower prevalence of infection in Africa. Exactly how much these reservoir hosts contribute to transmission of infection is not clear. Some of them are found to be incapable of excreting viable (hatchable) eggs. S. haematobium infection is rarely found in wild animals. On very rare occasions, baboons, monkeys, rats, the domestic pig, and the chimpanzee have been found infected with S. haematobium. It is generally held that these rare occurrences of natural infection are merely incidental and have no significance in the transmission of the infection.

8. Once inside the skin, cercariae develop into young worms, schistosomules, and migrate through the circulatory system to the lungs and from there to the liver where they mature and mate. Mated worms of S. mansoni and S. japonicum species then migrate to the veins of the bowel; S. haematobium couples to the bladder. Within the bowel or bladder, the worms spend the rest of their lives, which average three to five years. Each female worm is capable of producing hundreds of eggs a day throughout her mated life. A few of the eggs are carried in the bloodstream to the liver, lungs, and other

parts of the body. Some become trapped and die in the surrounding tissues of veins in the process of being transported. Others manage to enter the bowel and bladder and leave the body of the host in the feces or urine. Excreted eggs hatch upon reaching water within a period no longer than a month and thus, commence another cycle in the perpetuation of their species.

Schistosomal Disease

9. Disease due to schistosomal infection is a consequence of the incomplete excretion of eggs. The mere presence of adult worms is not known to cause major illness or complication in the host. Eggs that lodge in tissue surrounding the organ that harbors mated worms eventually die and decompose. As the body reacts to invasion by this foreign matter, it develops fibrosis and granuloma. This is the principal cause of schistosomal disease. The second important cause is that portion of eggs which is carried to the liver, lungs, and other parts of the body. Thirdly, on rare occasions, adult worms may induce schistosomal complications by migrating to or lodging themselves into the liver, lungs, the nervous system and other parts of the body. Migration of adult worms to such locations is induced by several factors including use of schistosomicidal drugs--a fact that has rendered unsupervised mass administration of chemotherapy still impractical.

10. Pathologically, S. mansoni and S. japonicum share the same pattern--except that the latter is more virulent (faster in causing morbidity and mortality), and is harder to treat. Both are recognized as intestinal forms of the disease due to the fact that the mature infectious agents dwell in the bowel and cause major damage to the surrounding tissues of the intestine and liver. During the early phase of these two infections (penetration to maturation in the liver), symptoms can include skin rash, diarrhea, liver enlargement, and tenderness, variable fever, and sometimes lung disturbances. The egg-laying phase is characterized by dysentery, with frequent bloody stools, liver and spleen enlargement and tenderness, rectal lesions, and other serious complications. In the final stage (tissue reaction and repair), intestinal lesions, ulcerations and fistulae may develop. Concurrently, spleen and liver enlargement, serious diarrhea, ascites (dropsy) and other major disturbances may also develop. In its advanced stages, S. japonicum may cause brain complications which more often than not result in death.

11. The early phase of infection with S. haematobium shares practically the same pattern of symptoms as the other two major forms of human schistosomiasis. In the egg-laying phase, haematouria (blood in the urine) commonly appears. In the final stages of this infection, urinary tract diseases such as calcified bladders, nonfunctioning kidneys, and ureteric deformity progressively develop. Hence, its popular name, urinary schistosomiasis.

12. The onset of the symptoms of the acute stage of schistosomal infection is slow. In S. mansoni, it occurs between 3 and 12 weeks after cercarial penetration. In S. japonicum, the symptoms of the acute stage are observable between 2 and 12 weeks after infection. In S. haematobium, symptoms may not be visible until the eighth week after infection. The intensity, duration, and frequency of symptoms of the acute and subsequent stages depend on a number of factors but most importantly on: a) the intensity of infection (the worm load); b) concurrent infections; and c) nutritional status of the human host. However important the above factors are, they do not completely explain the pathology of schistosomiasis. Schistosomal disease due to irreparable damages to vital tissues may be sustained long after adult worms have been drastically reduced in number or even completely eliminated in the human host. Other things being equal, higher levels of egg output are associated with higher numbers of paired adult worms. Hence, some researchers have tried to associate egg output with intensity of infection and therefore, morbidity.

13. Morbidity due to schistosomal causes is hard to define. Its symptoms, other than the presence of eggs in excreta, are not specific enough to isolate schistosomal infection as cause of morbidity. The problem is compounded by synergistic relations of the infection with malnutrition. Furthermore, egg output is a poor index of intensity of disease. Disease is a function of the accumulation of eggs in tissue, and the location of adult worms. It is plausible that as an increasing number of eggs get lodged in tissue surrounding the location of paired worms the passage of eggs could be blocked, thereby reducing the number of eggs that reach excreta. Morbidity control is thus an elusive objective. Whereas potential morbidity can be averted through the elimination of adult worms, damage done to tissue by decomposing eggs is virtually irreparable through drug treatment. Surgical removal of scars caused by decomposing eggs, and haemofiltration methods to remove adult worms from sensitive locations in the body such as the liver, have been successfully accomplished. These methods, however, are too costly to be implemented as control measures.

Schistosomiasis Control

14. There are two viable objectives of schistosomiasis control: transmission control and control of spread of the infection. The former objective aims at reducing the intensity and growth of prevalence of the infection in an endemic area; the latter aspires to restrict the introduction of the infection to a potentially endemic area.

15. Control may be realized by disrupting the life cycle of the parasite at one or more points through one or a combination of measures. By destroying adult worms through drug treatment (chemotherapy), transmission as well as control of potential morbidity may be achieved. Toxic side effects of the currently available drugs notwithstanding, chemotherapy is believed to be the most effective control measure. Contamination of water by egg-carrying excreta may be prevented through the use of water-sealed

toilets. Snails may be destroyed chemically by molluscicides; biologically, through the introduction of competitor species, predators, or parasites; or by altering their habitat through engineering measures. Human contact with infected waters may be prevented by providing sanitary water for drinking, bathing, swimming and laundering. Fences and footbridges may also curtail the frequency of contact. Health education is an indispensable ingredient of any control program, for in the final analysis, the success of such activity depends on the active participation of the community being protected.

Economic Significance of Schistosomiasis

16. While the existence of economic losses due to sickness and cost of treatment is generally accepted, the lack of consistent methods of estimation and reliable data bases have led to widely different financial estimates, and hence, to some controversy over the general cost of the infection. Estimates range from \$560 million annually for Egypt alone, according to one expert, to \$450 million annually for the whole of Africa, and a mere \$650 million for the world, according to another expert. One recent study could not discover statistically significant losses in productivity due to schistosomal infection. Beyond absence from work, reduced productivity, and cost of medical care which most estimates have tried to include, there are economic losses that are hard to quantify or express in monetary terms. There is the disutility of discomfort due to illness; the increase in the dependency ratio due to morbidity; the grief and anguish caused by death in the family or community; the apathetic and fatalistic attitude toward life and work caused by chronic illness; loss of productive resources such as domestic animals due to the zoonotic form of the infection; and the underutilization of potentially arable land due to fear of infection. These and other losses are less than adequately accounted for even by the most thorough estimates currently available. Even those estimates which deal with the direct cost of the disease only understate the problem by failing to include payments made to traditional doctors and healers; and studies that have attempted to measure the indirect costs of the disease have yet to resolve the problem of measuring "reduced work output due to illness" where continuous industrial employment is not available and/or is not the norm.

17. There is yet another aspect of its economic significance. Schistosomiasis is one of the classic examples of economic development-related diseases. The growth in the number of water resource-related (hydroelectric and irrigation) projects has greatly increased the habitat of the vector snails, and hence the prevalence of schistosomiasis. For this reason alone, the Aswan Dam project in Egypt and the Volta Dam project in Ghana have been described as ecological horrors by some experts. In some projects, the emergence of this problem has impeded the realization of sound economic returns. An irrigation scheme in Rhodesia had to be abandoned due to an alarming increase in prevalence of schistosomiasis after ten years of construction and a cost of \$10 million. It has thus become imperative that such external diseconomies as may result from water-related development efforts be taken into consideration in project appraisals, and appropriate control measures be implemented to curtail negative consequences.

SCHISTOSOMIASIS CONTROL IN WORLD BANK-FINANCEDDEVELOPMENT PROJECTS

1. The World Bank's direct involvement in schistosomiasis control began in late 1970 with the appointment of an Environmental Adviser in Projects Advisory Staff, Central Projects. It was the Environmental Adviser's responsibility, among other things, to review all Bank-assisted projects which would likely have important environmental effects, to advise on appropriate investigations and remedial measures, to establish appropriate links between the Bank and other agencies of similar environmental concerns, and to prepare guidelines on Environmental issues. As the work load increased, an Assistant to the Environmental Adviser was appointed in early 1973. In 1975, the Office of Environmental and Health Affairs (OEHA) was established within PAS/CPS and under the direction of the same Environmental Adviser. The staff of the Office was immediately increased by the addition of a chemical engineer and two health economists. A tropical medicine specialist was appointed in late 1976. The Office reviews and advises on environment- and health-related issues of the Bank's projects, maintains liaison with other organizations, and undertakes research and development of guidelines relevant to Bank operations.

2. Due largely to the recent increase in the number of the Bank's agricultural and rural development projects, one of the major activities of the OEHA has become the control of schistosomiasis. The Bank's objective is not to eradicate schistosomiasis--which, though highly desirable, is still an elusive ambition, particularly in view of the limitations of the current state-of-the-art of control--but rather to eliminate the risk of spread and transmission of the infection in the development projects it helps finance.

3. Since 1971, the number of Bank projects in which the schistosomiasis problem has been addressed has grown markedly. Starting with only three in 1971, the number grew to eight by 1973, nineteen by 1975, and thirty by mid-1977. The 30 projects cover a total area of 37,774,224 hectares and touch the lives of some 13,260,300 people. Eighteen of these projects have budgets allotted to schistosomiasis control totalling \$63,360,000 and constitutes 4.13% of the total cost of the projects.

4. The Bank's project approach to schistosomiasis control can be roughly categorized into three groups. In the first group are 12 projects with specific schistosomiasis control components. The second group consists of nine projects in which schistosomiasis control is provided as part of general health care services. The third group consists of nine other projects for which the borrower countries have given assurances to undertake control activities as warranted.

Schistosomiasis Control Components

5. Specific schistosomiasis control components are necessitated by prevailing high levels of the disease in the project areas, the institutional and financial limitations of the borrower countries to undertake major control efforts, and by the likelihood of the incidence of infection frustrating the realization of a project's economic objectives. Thus, in Egypt, Liberia, Malawi, Mali, Morocco, Philippines, Syria, and Yemen Arab Republic, 12 projects have included specific schistosomiasis control components. Chemotherapy and the use of molluscicides, the two most effective methods of control, are the most popular methods used. Health education, water supply, sanitation and engineering methods of control are included in more than half the number of control components. To generate successful implementation, the control strategies are tailored to fit local conditions and institutional arrangements. As a result, the design of these control components varies by country as well as by project.

6. These 12 projects cover a total area of 2,239,400 hectares with a total population of 9,986,200. The cost of the control components of 10 of these projects for which data are available amounts to \$53,360,000 (or 4.91% of the total cost of the same 10 projects). On an annual basis, allowing for the average of five years of disbursement of cost, the cost of the control components in the 10 projects is \$4.87 per hectare covered and \$1.07 per person protected. The high yearly cost per hectare of control is due to three projects in Egypt and two in the Philippines, which have relatively high population densities. The annual cost of control in the two countries is \$6.35 per hectare but only \$0.98 per person protected. Egypt and the Philippines alone account for 88% of the cost of control components in this group. This is probably only fair since the five projects in the two countries are in the most endemic parts of the world, and account for 91% of the project population in this group of projects.

Schistosomiasis Control as Part of Health Care Services

7. Projects in which schistosomiasis control is provided as part of health care services components are found in areas where schistosomiasis is only one in a myriad of health and environmental problems. In such instances, the Bank provides schistosomiasis control along with other health care needs. In addition to schistosomiasis control, these components can include health education, mother and child health care, primary health care, sanitation, vector control and, in some instances, nutrition. These components, once again, are tailored to fit local conditions, and aspire to meet health and environmental needs of the population they serve.

8. The nine projects in this second group are found in Brazil, Ethiopia, Kenya, Malagasy Republic, Malawi and Sudan. They cover an area of 19,058,600 hectares with a population of 1,699,100. The health care services components of seven of this group of projects, for which data are available, cost

\$9.5 million (or 3.85% of the total cost of the same seven projects). On an annual basis, the cost of the health care services amounts to \$0.10 per hectare and \$1.19 per person.

Assurances for Schistosomiasis Control

9. The third category of implementation of control consists of nine projects for which assurances to control schistosomiasis have been obtained from the borrowing countries. The nature of the assurances have ranged from promises to study and monitor the problem to implementation of control programs as warranted. Generally, there is no financial allowance made for the control of schistosomiasis in these projects. The only exception in this group of projects is Liberia--Bong County Agricultural Development Project, which has \$0.5 million allocated for surveillance and monitoring activities. The agreements are for the borrowing country to undertake control where the infection is known to be endemic and to maintain monitoring activities where there are risks that the infection might spread.

Research Trends

10. Tropical Diseases Research. The World Health Organization (WHO) is currently launching a Special Programme for Research and Training in Tropical Diseases. The major objective of this multifaceted program is to coordinate worldwide research and control of the six most important tropical diseases--malaria, schistosomiasis, filariasis, trypanosomiasis, leishmaniasis (kala azar) and leprosy. The OEHA of the World Bank is collaborating with the WHO and other agencies in development of this program. The research objectives of the schistosomiasis program include development of drugs, epidemiology and control, including snail biology, public health and socioeconomic effects of the disease, immunology (including development of vaccines) and other fundamental biological studies. Research priorities for funding will be determined by Scientific Working Groups (SWGs) composed of leading scientists selected on a worldwide basis for their competence in the fields of disease and research. Research is to be performed in the most appropriate facilities with special preference to be given to tropical countries. The training and institution strengthening activities are also to be based as much as possible on existing institutions in tropical countries. The Special Programme, by pooling worldwide resources and expertise for research and training, aspires to accelerate the pace of progress toward the control and eventual eradication of these diseases.

11. The active participation of OEHA in this Special Programme is in fulfillment of its terms of reference (Administrative Circular, February 20, 1975): to "Maintain an active liaison with the WHO and its regional organizations". The experience OEHA gains from active participation in the development and implementation of the Programme and the realization of the research and training objectives of the Programme will complement and significantly improve the efficiency of the World Bank's activity in the area of disease control.

12. Research on the Cost-Effectiveness of Schistosomiasis Control Activities. The OEHA is also charged with the responsibility to "plan and oversee appropriate Bank-related research in the health area", and "develop, test, and refine health guidelines for use of Regional Offices and Operating Departments analogous to the environmental guidelines". The proposed research study of the economics of schistosomiasis control activities is an initial modest attempt to fulfill these responsibilities of the Office. The major objectives of this research include the identification of the most cost-effective combination and scheduling of control strategies given resource limitations and the economic and epidemiological risks associated with selected optimal and efficient strategies. The analytical framework of the study reflects the Bank's approach and objectives in schistosomiasis control. The results of this study will be useful in the development of guidelines for schistosomiasis control. More importantly, the implementation of control programs--following the results obtained from qualitative as well as quantitative analyses of the study--would enable the Bank and other institutions involved in control activities to realize both significant savings and improved results. In an analytical optimization framework, the study would investigate two issues central to most control programs: a) the highest benefit (i.e., reduction in prevalence of infection) for given budget constraints, and b) the least cost delivery of control activities for given target levels of prevalence of infection. A side issue complementary to either one of the above two issues is the epidemiological and economic risks (robustness) associated with a chosen optimal and efficient strategy of control.

13. The cost of the first and second phases of this study is estimated at under \$100,000. This amounts to less than 0.4% of the cost of control components in Egypt, less than 0.6% of control components in Philippines, or less than 0.2% of the total cost of the 10 direct schistosomiasis control components for which data are available. A conservatively pessimistic estimate of an expected 1% savings in the cost of control amounts to \$287,000 from Egypt alone, \$181,500 from Philippines, or \$533,600 from the total cost of the 10 direct schistosomiasis control components. Irrespective of the transmission model and the optimization framework, use of the cost model in financial planning and implementation of control programs alone is likely to yield more than 1% savings in the cost of control programs. Thus, the cost of undertaking the research will in the long run constitute an insignificant fraction of the benefits generated by proper utilization of the results of the research.

SCHISTOSOMIASIS TRANSMISSION MODELS AND
COST-EFFECTIVENESS STUDIES

A. Introduction

1. This Annex reviews the major features of existing models of schistosomiasis transmission and studies of the cost-effectiveness of control activities, and presents the rationale for the analytic approach being proposed. The Annex by no means pretends to treat exhaustively all published and unpublished studies in this area of research; a number of transmission models and practically all of "the economic impact of schistosomiasis" studies are excluded.^{1/} The selection of models for review is based entirely on their significance to the proposed research. Economic impact studies are excluded as the objective of the proposed research is restricted to cost-effectiveness evaluation as contrasted with assessment of the economic loss due to schistosomiasis or economic benefits due to its control.

B. Schistosomiasis Transmission Models

2. There are two broad groups of schistosomiasis transmission models. The first group consists of models constructed on the basis of a posteriori reasoning. These models predict the transmission process as a function of two forces--the force of infection and the force of deinfection. The magnitudes of these forces are estimated by fitting a curve, known as "a catalytic curve" through a distribution of age prevalence of infection [Muench, 1959]. The second group consists of models that attempt to explain the life cycle of the parasite on the basis of a priori reasoning. The life cycle of the parasite in these models is partitioned into a set of distinguishable stages.

^{1/} A more exhaustive discussion of models is given by Cohen (1977). The major theoretical and empirical issues of mathematical modeling of schistosomiasis is found in Fine (1976) and Fine and Lehman (1977). Rosenfield (1975, pp. 15-18) gives a tabular presentation of important features and limitations of the most well known transmission models. The mathematical theory of infectious diseases is contained in an authoritative text by Bailey (1975). Bailey's text concentrates on what may be referred to as "contact diseases" and treats helminthic infections (to which schistosomiasis belongs) rather tersely in a couple of pages. Control theoretic works more relevant to "contact diseases" than to schistosomiasis are exhaustively treated by Wickwire (1977). The literature on the economic impact of schistosomiasis is surveyed by Prescott (1975). Mathematical models of applied ecology are reviewed by Conway (1977).

Each stage is modeled separately with appropriate links with the preceding stage. The two categories of models are referred to as catalytic and life cycle models, respectively.

Catalytic Models

3. Catalytic models of epidemiology may be understood by analogies to catalytic processes in chemistry. Among the many possible forms of catalytic processes the two that are relevant in describing the epidemiology of schistosomiasis are the "Reversible Catalytic Curve: Two-Way Reaction" model and the "Two-Stage Catalytic Curve: Successive Reactions" model. The former model describes the process of a substance A changing to substance B at some rate, while B reverts to A at a rate which may be the same, but is generally different. In the latter model, substance A changes to substance B which in turn changes to substance C at rates which are generally different.

4. Analogously, in the case of schistosomiasis transmission, if a population in an endemic area is: a) in a steady state, b) entirely susceptible to infection, and c) exposed to a constant force of infection, \underline{a} , and a constant force of deinfection, \underline{b} , the rate of change of the proportion of the population at age t infected, $y(t)$, may be expressed as:

$$\frac{dy}{dt} = \underline{a} (1 - y) - \underline{b}y \quad y(0) = 0 \quad (1)$$

whose general solution is

$$y(t) = \frac{\underline{a}}{\underline{a} + \underline{b}} \left(1 - e^{-(\underline{a} + \underline{b})t} \right) \quad (2)$$

This equation may be fit to age prevalence data either by the method of moments or maximum likelihood to obtain values for parameters \underline{a} and \underline{b} . Contrary to observation in the case of schistosomiasis, equation (2) implies reversible loss of infection and hence, monotonically increasing prevalence with age for $\underline{a} > \underline{b}$. Better fit to observed age prevalence data is obtained with the form Muench identified as "The Two-Stage Catalytic Curve" [Muench, 1959]. Assuming that loss of infection is irreversible, the population may be partitioned into three subgroups: $x(t)$ (proportion never infected), $y(t)$ (proportion currently infected), and $z(t)$ (proportion currently deinfected and not at risk of reinfection). Death and emigration occur at equal rates in all three. The rates of change in the proportion of the population infected of the three partitions may be expressed as:

$$\frac{dx}{dt} = -ax \quad x(0) = 1 \quad (3)$$

$$\frac{dy}{dt} = ax - by \quad y(0) = 0 \quad (4)$$

$$\frac{dz}{dt} = by \quad z(0) = 0 \quad (5)$$

whose general solution is

$$y(t) = \frac{a}{a-b} \left(e^{-bt} - e^{-at} \right) \quad (6)$$

if $a \neq b$

or

$$y(t) = ate^{-at} \quad \text{if } a = b \quad (6')$$

Hairston (1965b) obtained reasonably good fits of equation (6) using age prevalence data from Egypt, the Philippines, and Syria. Sturrock and Webbe (1971) applied equation (6) to analysis of age prevalence of infection of eight samples of field snails. At $n - 1$ degrees of freedom, where n is the number of age groups, seven curves fitted the data satisfactorily ($p > 0.05$). With $n - 3$ degrees of freedom to allow for the two parameters being estimated, four of the curves fit the data satisfactorily.

5. Cohen (1973) modified the Two-Stage Catalytic Curve to permit analysis of the mortality or emigration rate, m , of individuals not infected and individuals deinfected, and m' , the increased mortality or emigration rate of individuals currently infected; m' is the selective host mortality rate of schistosomiasis infection. The model may now be expressed as:

$$\frac{dx}{dt} = -ax - mx \quad x(0) = 1 \quad (7)$$

$$\frac{dy}{dt} = ax - by - (m')y \quad y(0) = 0 \quad (8)$$

$$\frac{dz}{dt} = by - mz \quad z(0) = 0 \quad (9)$$

Since selective host mortality is observed in schistosomiasis infections, the introduction of m and m' would remove some of the bias in the estimates of a and b . Cohen applied his modified version of the "Two-Stage Catalytic Curve" to the data obtained by Hairston's (1965b) and Sturrock and Webbe's (1971).

In both instances it was found that exclusion of selective host mortality underestimates \underline{a} and overestimates \underline{b} . Some bias remains due to the assumption of constant mortality and emigration rates over all age groups.

6. The foregoing models assume permanent immunity. Lewis (1975) relaxes this assumption by introducing a constant, r , the loss of immunity rate. His model

$$\frac{dx}{dt} = rz - \underline{ax} \quad x(0) = 1 \quad (10)$$

$$\frac{dy}{dt} = \underline{ax} - \underline{by} \quad y(0) = 0 \quad (11)$$

$$\frac{dz}{dt} = \underline{by} - rz \quad z(0) = 0 \quad (12)$$

yields three general solutions depending on whether $(\underline{a} + \underline{b} + r) \leq 4(\underline{ab} + \underline{ar} + \underline{br})$. Setting $r = 0$ reduces this model to Muench's Two-Stage Catalytic Model. These two models, one with $r > 0$ and the other with $r = 0$, are deterministic. Lewis makes these models stochastic by incorporating the fact that infection becomes manifest when at least one male and one female worm infect a susceptible individual. Male and female worms have an equal probability of penetrating the individual; thus the frequency distribution of paired worms is poisson distributed with a constant parameter. The general solution of the model with $r > 0$ is a function of \underline{a} , r , and the distinct real roots $\frac{-A + (A^2 - 4B)^{1/2}}{2}$,

where $A = (\underline{a} + \underline{b} + r)$ and $B = (\underline{ab} + \underline{ar} + \underline{br})$. Setting $r = 0$ to represent permanent immunity yields a general solution which is a function of two parameters--the rate of penetration μ , and \underline{b} .^{2/}

7. Nasell uses a catalytic curve model to explore the implications of latency of infection in snails in the snail component of one version of his life cycle model [Nasell, 1976].^{3/} He partitions the snail population into susceptible $x(t)$, exposed but latent $u(t)$, shedding cercariae $y(t)$, and recovered $z(t)$, with each partition having a characteristic death rate. The rate of conversion from one state to the next in this model is implied to be instantaneous. This obscures the true meaning of latency which is the delay or time lag between two successive states.

^{2/} Lewis calls the general solution to the deterministic model with $r = 0$ Model A, and with $r > 0$ Model B. He refers to the general solution to the stochastic model with $r = 0$ Model C, and with $r > 0$ Model D. Models B and D fit Hairston's S. haematobium and S. mansoni data better than Model A. Models C and D fit the S. japonicum data better than Models A and B.

^{3/} See the following section for review of life cycle models.

8. Rosenfield (1975) is the first to employ a catalytic model to predict transmission. Using the model of equations (1) and (2), she develops the recursive relation:

$$y_{t+1} = I(1 - y_t) - by_t + y_t \quad (13)$$

where

$$I = \frac{\underline{a}}{\underline{a} + \underline{b}} \left(1 - e^{-(\underline{a} + \underline{b})} \right) \quad (14)$$

I is interpreted as the rate of incidence. The values of the parameter \underline{a} , estimated from a cross-section of endemic localities are regressed on the environmental factors--H(meters of accessible snail habitats) and P(number of people passing eggs). The resulting regression equation

$$\underline{a} = \beta_0 H^{\beta_1} P^{\beta_2} \quad (15)$$

where $\beta_0, \beta_1, \beta_2$ are constants;

is substituted in equation (13) to predict prevalence of infection as a function of H and P. The model was successfully verified on data on an irrigation project in Iran. The study thus converts an a posteriori static (steady state) model of two unexplained parameters \underline{a} and \underline{b} into a dynamic predictive model which is a function of observable environmental factors H and P.

9. An alternative recursive relation based on the same reversible catalytic model of equation (1) is given in Rosenfield, et. al, (1977). The new model with the recursive relation

$$Y_{t+\Delta t} = \left(Y_t - \frac{\underline{a}}{\underline{a} + \underline{b}} \right) e^{-(\underline{a} + \underline{b}) \Delta t} + \frac{\underline{a}}{\underline{a} + \underline{b}} \quad (16)$$

yielded identical empirical results when applied to the same data.^{4/}

^{4/} An alternative to the reversible catalytic model for use in Rosenfield's (1975) model has been suggested at a conference on Mathematical Models of Schistosomiasis, Bellagio, Italy, May 9-14, 1976. The theoretical foundation of the alternative model $\frac{dy}{dt} = \underline{a} (\sqrt{y} - y) - \underline{b} (\sqrt{y} - y) \log\left(\frac{1}{1 - \sqrt{y}}\right)$, where \underline{b} is twice the death rate of the worm in the human host, is not given in the proceedings of the Conference [Fine, 1976, p. 10].

Life Cycle Models

10. Hairston [1962; 1965a; 1973] is the first to attempt modeling the life cycle of the schistosome parasite. Hairston postulates that the parasite would attain a stable population in the absence of changes in both the definitive and intermediate host populations, and the other important transmission components. A stable population means that the net reproductive rate (NRR) of the parasite is equal to unity. This may be expressed as:

$$Q \times f \times h \times d \times p \times i \times T \times c \times m = 1.0 \quad (17)$$

where Q is total output of female eggs by one female,
 f is the probability that an egg will reach the feces,
 h is the probability of being able to hatch,
 d is the probability of being deposited near snails,
 p is the probability of penetrating a snail,
 i is the probability of establishing an infection in the snail after penetration,
 T is total cercariae produced by an infected snail,
 c is the probability of reaching mammal, and
 m is the probability of maturing in mammal.

Applying this approach to data from the Philippines and Egypt, Hairston obtained 0.6 as the estimate of the NRR of S. japonicum, and 1.9 and 2.8 as the estimates of NRR for S. mansoni and S. haematobium respectively. Given that these infections were shown to be stable in their respective endemic areas, the deviation of the estimated values from the expected value of NRR is attributed to the poor quality of the data. Quite obviously if the data were perfect, a value for NRR less than unity would imply a declining parasite population while a value greater than unity would mean a growing parasite population.

11. Hairston points out that over a range of transmission rates "compensatory mechanisms" would be at work such as to maintain the NRR close to one. Hence, if a decrease in the value of one of the components of NRR were to be effected as through a control measure, there would be a compensatory increase in the product of the other components to keep the parasite population in equilibrium. This equilibrium may be established at different levels of transmission. There would, however, be a critical minimum below which the parasite could not maintain its population. This failure of compensatory mechanisms would come about at low transmission rates where there would be increasing probability that single parasites which succeed in entering the definitive host would remain unmated.

12. According to the life table model, a control measure need not be one hundred percent effective to interrupt transmission. All that would be necessary would be to disrupt the compensatory mechanism. "For example, if snail control were being attempted and the critical level of transmission were known in terms of miracidial survival, it would be a simple matter to

estimate the number of snails necessary to maintain the critical amount of success of miracidia. Any significantly lower number would then be known to represent satisfactory snail control, with the dynamics of the parasite population operating in favor of the control effort". [Hairston, 1965a, p. 61].

13. Hairston, thus introduces two important concepts that recurrently appear in life cycle models of the schistosome parasite--the stationary state value of the parasite population (where NRR is equal to one) and the threshold value of the parasite population (where compensatory mechanisms would fail). The first is explicitly stated. The second is implicit in Hairston's exposition of the dynamics of the parasite population.

14. Macdonald (1965) breaks the transmission process into four stages and develops a dynamic nonlinear model in which the explained variable is the mean worm load, m . The first stage in Macdonald's model is the inoculation rate to which snails are subject which depends on the number of people in the endemic area, their mean worm load and the proportion, (α) , of these which are fertile, the proportion of eggs passed which reach water (the "contamination factor"), the probability, $(1 - e^{-0.15})$, which the average miracidium has of coming into effective contact with a snail, the density of snails per linear meter of bank, and the total length of habitat. In a given endemic area only m and α will be variables while the rest will remain constant parameters. Letting B represent the product of the parameters and of the probability of an infected snail living till cercariae develop, and p represent the probability of a snail surviving through one day, the infection rate in snails is given by:

$$\frac{Bm\alpha}{Bm\alpha - \log_e p} \quad (18)$$

15. The second stage, multiplication of larvae in snails (the "snail factor"), depends on the number of snails; their infection rate; the mean daily cercarial output; and the time for which they remain infected. Letting A stand for the product of the "snail factor", the biological efficiency of cercariae in penetrating a potential host and the frequency and extent of human contact (the "exposure factor"), the third stage, the inoculation rate h , to which man is subject is expressed as:

$$h = \frac{ABm\alpha}{Bm\alpha - \log_e p} \quad (19)$$

16. The fourth stage, the growth of infection in man, may now be expressed as the difference between the inoculation rate h and rm where r is the death rate of the worm or what Macdonald refers to as the "longevity factor". Hence:

$$\begin{aligned} \frac{dm}{dt} &= h - rm \\ &= \frac{ABm\alpha}{Bm\alpha - \log_e p} - rm \end{aligned} \quad (20)$$

17. Macdonald indicates that an approximate value for the upper limit of the integral would be:

$$\frac{A}{r} - \frac{(-\log_e p)}{B} \quad (21)$$

and the point of inflection is passed when

$$\frac{a \approx r(-\log_e p)}{AB} \quad (22)$$

This point of inflection is what Macdonald calls the "breakpoint" or the critical worm load above which transmission would continue but below which the parasite would be unable to maintain its population and hence be eradicated.^{4/}

^{4/} It appears that the existence of the "breakpoint" (which corresponds to the critical worm population below which compensatory mechanisms fail to operate according to Hairston) depends on the assumption of a poisson distribution of worms and their pairing process in the definitive host. The issues involved in this are: "the sex ratios of worm populations in their hosts; the efficiency of mate location within hosts; sex specific mortality rates of mated and of unmated worms; their tendency to monogamy or polygamy; and the behavior of mated worms upon death of their partners". Autopsy studies and egg output data indicate that worms are not randomly distributed but rather tend to be clumped together, i.e., they are negative binomially distributed rather than poisson distributed in the human host. Substitution of the negative binomial distribution of worms in Macdonald's model tends to eliminate the "breakpoint". [Bellagio, pp. 13-15; and private communications with David J. Bradley of the London School of Hygiene and Tropical Medicine].

18. To qualitatively evaluate the effects of known control measures, Macdonald simulated 20 years of control activity. He reports that:

"The effect of reduced contamination to 1/15,000 of excreta reaching water, which represents a very high standard of sanitation, is virtually negligible over the entire period. The effects of snail control and control of exposure in the form of entry to water are virtually identical during most of the period of fall, though during the later stages control of exposure is somewhat more effective, resulting in a slightly earlier disappearance of the infection. Ultimate disappearance following either of these methods is delayed for over 20 years, throughout all of which effective measures would have to be carried out, and even improvement to a level approaching perfection would only slightly reduce the time involved to 14 or 15 years, owing to the long mean lengths of life postulated for the worms, three years. By contrast, the combination of systematic treatment with either reduction of exposure or snail control produces a rapid result, the final effects of which are visible between four and five years after the start".

19. Although Macdonald's conclusions are based on computer simulations, with a single set of arbitrarily chosen parameter values, all except his conclusion that "the effect of reduced contamination...is virtually negligible" have been corroborated by a more detailed analytical model [Nasell and Hirsch, 1973]. "It is possible that Macdonald may have been led to this conclusion by a fortuitous selection of parameter values upon which to base his simulation" [Fine, 1976, p. 18]. Another possibility is that, "this conclusion results from Macdonald's implicit assumption, not generally true, that the waters in which snails live is saturated with miracidia and that nearly all snails are infected" [Cohen, 1977].^{5/}

20. The most elaborate analytical model of schistosomiasis is that of Nasell and Hirsch (1973). The model's mathematical structure has stochastic as well as deterministic elements. The model is algebraically complex and difficult to follow. Its basic assumptions and the set of eight parameters which characterize the transmission dynamics are, however, intuitively appealing. The model may be summarized as follows:

^{5/} Macdonald died before publishing the data he used in his simulation model. The data is now being retrieved from his laboratory notes at the London School of Hygiene and Tropical Medicine, London, England. This information is likely to clarify the implicit assumptions of the model. [Private communications with Dr. David J. Bradley of the London School of Hygiene and Tropical Medicine].

$$\frac{dW}{dt} = -\mu_1 W + P_1 \lambda_2 Y \quad (23)$$

$$\frac{dY}{dt} = P_2 \lambda_1 X(N_2 - Y) - \mu_2 Y \quad (24)$$

with two transmission factors

$$T_1 = \frac{P_1 \lambda_2 N_2}{\mu_1} \quad (25)$$

and

$$T_2 = \frac{P_2 \lambda_1 N_1}{\mu_2} \quad (26)$$

where W is the expected number of worms alive in each person,
 X is the expected number of mated worms in all people added together and is expressible in terms of W,
 Y is the expected number of infected snails,
 T₁ is the capacity of the snail population to deliver infection to a person,
 T₂ is the capacity of the human population to deliver infection to an uninfected snail,
 N₁ is the number of humans at risk,
 N₂ is the number of snails,
 λ₁ is the rate of egg laying,
 λ₂ is the number of cercariae shed by an infected snail per unit time,
 P₁ is the probability a given cercariae will infect a given human,
 P₂ is the probability a given egg will infect a given snail,
 μ₁ is the death rate of schistosomes in the human host, and
 μ₂ is the death rate of snails.

21. The model demonstrates that the epidemiological situation at any time will depend on initial conditions and the two transmission factors. Eradication would result from a threshold function $F(T_1, T_2) < 0$; while the infection would reach the asymptotic prevalence values of Q_∞ and Y_∞ in man and snails, respectively for $F(T_1, T_2) \geq 0$, given a sufficient initial worm load. Finally, expressing Q_∞ and Y_∞ as functions of T_1 and T_2 :

$$Q_{\infty} = Q_{\infty}(T_1, T_2) \quad (27)$$

and

$$Y_{\infty} = Y_{\infty}(T_1, T_2) \quad (28)$$

it is shown that

$$T_1 \frac{\partial Q_{\infty}}{\partial T_1} > T_2 \frac{\partial Q_{\infty}}{\partial T_2} \quad (29)$$

and

$$T_1 \frac{\partial Y_{\infty}}{\partial T_1} > T_2 \frac{\partial Y_{\infty}}{\partial T_2} \quad (30)$$

"These inequalities imply that the reduction in Q_{∞} and Y_{∞} accompanying a small decrease in T_1 are larger than the respective reduction in Q_{∞} and Y_{∞} accompanying a proportionately equal decrease in T_2 . Thus control is more efficient through T_1 , than through T_2 ". This qualitative conclusion remains unchanged in versions of the model which a) incorporate a catalytic model approach to the snail component (Nasell, 1976), b) explicitly examine the issues of eradication (Nasell, 1976a), and c) examine the ramifications of the introduction of external sources of contamination and infection (Nasell, 1975). The conclusion that reduction of T_1 is more efficient than reduction of T_2 is similar to Macdonald's simulation result that snail control is more efficient than control of contamination of snail habitats. Not surprisingly, these conditions derive from the fact that the assumptions in both models are similar.

22. Lewis (1975, 1976) models the growth of the three populations, humans, snails, and the parasite as immigration-death processes with the snail population partitioned into susceptible and infected. The analytical approaches and the results obtained in Lewis' models are similar to Nasell and Hirsch's. Lewis' models are, however, algebraically simpler and are based on empirically better founded assumptions than either of Macdonald's or Nasell and Hirsch's. For example, Lewis assumes a negative exponential age distribution of the human population which permits reduction in the parasite population due to death of infected humans. Macdonald and Nasell and Hirsch ignore host mortality. Lewis assumes differential mortality rate between infected and uninfected snails. Nasell considers differential mortality in one version of his model [Nasell, 1976]. Lewis provides for an external source of infection either through infected immigrants or animal reservoirs. Nasell [1975] also models external sources of infection. Lewis' models predict an age prevalence of infection curve similar to those observed in epidemiological survey data.

23. Lewis addresses the issue of equilibrium value of the parasite population (Lewis, 1975) and threshold values (Lewis, 1976). Both models have deterministic as well as stochastic versions. Their application to analysis of the impact of a continuous mollusciciding program (which would increase the death rate of susceptible and infected snails to 10% and 15%, respectively) reveals that the stochastic model closely approximates the results of the average of ten deterministic simulation runs. Thus proving that the more tractable stochastic approach is more efficient than deterministic simulation for modeling schistosomiasis transmission.

23a. Among the published models, only Lee and Lewis (1976) explicitly considers the two most important time delays in the life cycle of the worm--the time delay between miracidial penetration and the development of cercariae (t_1), and the time delay between cercarial penetration and maturation of the worm in humans (t_2). The first is seasonal (being short in warm months and long in cold months), the second is constant. Using steady-state rate constants from Hairston's (1965a) calculations and the nonlinear stochastic pairing process of Macdonald (1965), Lee and Lewis developed a combination of "rate-variable" and "integral-variable" transmission models in which the two time delays are explicitly entered.

24. The central hypothesis in Lee and Lewis' model is that knowledge of time delays will permit planning of efficient and optimal control strategies. To test their hypothesis they simulate the effectiveness of chemotherapy and mollusciciding activities implemented at different times in the year in the Akisha section of the Egypt 49 project area. It appears that 90% effective chemotherapy in May followed by 100% effective (for two months) mollusciciding in June (t_1 in June = 1 month, $1 \text{ month} \leq t_1 \leq 5 \text{ months}$) or mollusciciding in July followed by chemotherapy in September give the most effective control. In this model, neither the threshold value nor the stationary state parasite population can be analytically derived. Consequently, the search for the most effective control is a matter of trial and error and good intuition.

25. In the life cycle models reviewed above, the mean worm load in the definitive host and/or prevalence of infection are computed as functions of the human, snail, and parasite populations. The models take into account the complete life cycle of the parasite. Holford and Hardy (1976), on the other hand, predict both the mean worm burden and age prevalence of infection in a "partial" life cycle model based on two critical parameters--the immigration and death rates of worms. Their model may be summarized as follows:

$$P(t) = \left[1 - e^{M(0, t)} \right]^2 \quad (31)$$

where

$$M(0, t) = \int_{t_0}^{t_0 + t} \lambda(r) \exp \left(- \int_r^{t_0 + t} \delta(x) dx \right) dr \quad (32)$$

$$\lambda(t) = A \left[\exp(-Bt) + C \right] \quad (33)$$

where $P(t)$ = prevalence of infection at age t ,
 $M(0, t)$ = the mean worm burden at age t ,
 λ = the immigration rate of the worm, and
 δ = the death rate of the worm

$A, B, C > 0$

Substituting and rearranging terms, the mean worm burden may be expressed as:

$$M(0, t) = A \left[t e^{-\delta t} f(t; \gamma) + C' (1 - e^{-\delta t}) \right] \quad (34)$$

where

$$\begin{aligned} C' &= C/\delta \\ \gamma &= B - \delta \\ f(t; \gamma) &= 1 \quad \text{if } \gamma = 0 \\ &= \frac{1 - e^{-\gamma t}}{\gamma t} \quad \text{if } \gamma \neq 0 \end{aligned} \quad (35)$$

Both the immigration and death rates of the worm are assumed to be poisson distributed.

26. Using methods of maximum likelihood, equation (31) was fitted to observed age prevalence of infection distribution in order to estimate the parameters γ , A , C' and δ . Substitution of the values of these parameters into equation (33) renders the value of $\lambda(t)$. An essential assumption of this model is that the immigration rate of worms declines with age of the human host. This may be due to reduced contact and/or due to a build up of immunity. The assumption adequately takes into account the observed (but not yet conclusively explained) phenomenon of age prevalence of infection peaking up in young age groups and declining to a positive asymptote in older age groups.^{6/}

^{6/} Holford and Hardy's work thus proves that one need not know the complete life cycle of the worm in order to estimate the two most important epidemiological bits of information--prevalence of infection and intensity of infection. Furthermore, the model proves that the most important parameters explaining prevalence and intensity of infection can be estimated by a simple curve-fitting technique. The model in effect is a hybrid life cycle and curve-fitting technique and as such, it constitutes an analytical link between the two modeling approaches. In recent private communications, Holford has suggested to us the idea of estimating the immigration term, $\lambda(t)$, in a regression equation in which the independent variables are H and P as in Rosenfield's model.

C. Cost-Effectiveness

27. So far, only three cost-effectiveness related studies of schistosomiasis control activities [Jobin, 1972; Paulini, 1974; and Rosenfield, 1975 and also Rosenfield, et. al., 1977] are reported in the literature. These three studies are pioneering in their: a) empirical implementation of transmission models to predict transmission and to evaluate the effectiveness of control activities; b) use of simple cost functions; and c) use of simulation techniques to evaluate cost-effectiveness of control activities. The first of these studies [Jobin, 1972] is strictly a benefit cost analysis of a single control activity--chemotherapy. The other two are cost-effectiveness studies of multiple control activities--chemotherapy, mollusciciding and engineering methods of snail control.
28. Jobin's study is based on a life table simulation model of schistosome transmission. The study is an extension of Jobin's earlier studies of the dynamics of snail populations, and Hairston's life table model [Jobin and Michelson, 1967; and Hairston, 1965a]. The data on the human population component of the model is taken from the World Health Organization's (WHO) study of the Egypt 49 Pilot Control Project [Bull. WHO, 1966, Vol. 35, No. 3]. The endemic area studied is within the pilot control project region. In the model, the human, snail and worm populations are subdivided into discrete age groups. Each age group is advanced monthly to the next age group after appropriate adjustments for deaths and emigration, following the methodology of life table calculations. In addition, the human population is subdivided into epidemiologically similar units. In the summary phase of simulation of the model, age specific prevalence of infection, worm burden and the resultant economic impact of the disease are calculated.
29. Jobin's transmission model predicted an overall prevalence of infection of 49% compared to observed prevalence of infection of 46%. In order to evaluate the impact of a control program of chemotherapy, a one year treatment program curing all males and females, ages 5-19 years (the group with the highest worm burden), is simulated. Overall prevalence of infection fell from 49% to 38% and total egg output declined by 50% during the first year. Summing over five years beginning the first day of the one year drug treatment program, the benefit to cost ratio was almost 8:1.^{7/}
30. Paulini's study (1974) is based on a modified form of Macdonald's transmission model. This model is used to simulate the growth of the mean worm burden in a hypothetical community of N people. Per capita costs of chemotherapy and mollusciciding are estimated as:

^{7/} Economic impact of the disease is calculated as the sum of the annual medical cost and the annual wage lost. The cost of the one year chemotherapy program is said to cost 40,000 Egyptian pounds.

$$C_1 = A \frac{P}{N} + B \quad (36)$$

and

$$C_2 = A' \frac{V}{N} + B' \quad (37)$$

where C_1 and C_2 are the costs of chemotherapy and mollusciciding respectively, P is the number of infected people, V is the volume of water treated, A is the cost of treating one person, B is the overhead cost of chemotherapy, A' is the cost of treating one unit of volume of water, and B' is the overhead cost of mollusciciding.

Benefit is measured as the percent reduction in the mean worm burden.

31. Two types of chemotherapy are considered. The first is to treat about 30% of the infected, always choosing the most parasitized. The program yields about 67% reduction in the mean worm burden after five years. The second is to treat 60-70% of the infected (once again choosing the most parasitized). With continued surveillance to maintain it, this program yields 99% benefit. Mollusciciding all transmission sites at 5 to 8 week intervals over a period of 20 years renders 99% benefit. When the two activities are combined, chemotherapy needs to concentrate on only 15-20% of the infected to yield a 99% benefit in five years.

32. Using the above information, Paulini addresses the following questions:

- (a) "which of the control measures, alone or in combination, will give the greatest benefit in the shortest time"? and
- (b) "which of the control measures, alone or in combination, will cost less at the same level of benefit"?

To answer the above questions, Paulini distinguishes between a high prevalence area (40% prevalence with $10m^3$ of water to be treated per inhabitant) and a low prevalence area (10% prevalence with $1m^3$ of water to be treated per inhabitant). The relative cost-effectiveness of the three different approaches to control--chemotherapy, mollusciciding, and mollusciciding plus chemotherapy--are illustrated diagrammatically by first plotting the cumulative per capita costs against time and then plotting the cumulative per capita costs as functions of benefits obtained in high and low prevalence conditions.

33. Rosenfield (1975) used her schistosomiasis transmission model^{8/} to evaluate the cost-effectiveness of chemotherapy, mollusciciding, engineering, and combinations of the three. Using data on a control program of an irrigation project in Iran, she simulated the reduction in prevalence resulting from

^{8/} See section on Catalytic Models.

a given control activity subject to the annual budget of the program. In this model, the sum of all expenditures (investment plus recurrent) on a given activity is divided by the volume of the activity such as meters of habitat treated or number of infected people treated to obtain a constant average cost of the activity. The budget is then divided by this constant average cost of activity in order to determine the amount of chemotherapy, mollusciciding or engineering activity that could be undertaken during the budget year. Budgetary surpluses are used for repeated treatments within the same year so as to minimize the failure rate of control activities. Failure rates of chemotherapy and mollusciciding are assumed to be 0.25 and 0.33 per treatment, respectively. For instance, the budget for chemotherapy in one of the villages in the control area in 1967 was large enough to permit 5.7 rounds of treatment. For cost-effectiveness analysis, the failure rate of chemotherapy, 0.25, is then raised to the power of 5.7 which gives a corrected failure rate of 0.0004 for that year.

34. Rosenfield, et. al, (1977), use the same model to introduce a new concept--case-years prevented--to evaluate cost-effectiveness. Case-years prevented is computed as the difference of case-years of no controls and case-years resulting from control activities summed over the period of analysis. Over a period of six years of control activities and ten years of post-control, the combined chemotherapy-mollusciciding-engineering approach gives the highest number of case-years of infection prevented. Mollusciciding rendered the lowest number of case-years of infection prevented.

D. Rationale for the Approach Taken
in the Proposed Research Study

35. The central objective of the proposed study is evaluation of the cost-effectiveness of schistosomiasis control activities, in particular, mollusciciding and chemotherapy. The proposed analytical model is composed of three subunits: a transmission model, a cost model, and an optimization framework. The transmission model provides information on the status of infection expressed as a function of variables that can be changed by control activities. The cost model portrays the costs of control activities and expresses these costs as functions of the nature and extent of control activities. The optimization framework enables the use of various forms of objective functions and constraints in identifying efficient strategies and produces analytical as well as numerical results.

36. As is evident from the discussion of cost-effectiveness studies in the previous section, none of the three earlier studies is wholly satisfactory. The major shortcomings of these studies are found in their modeling of costs of control activities, and in their use of simulation procedures to examine cost-effectiveness. Simulation procedures do not explicitly consider all possible

combinations of feasible control activities. Hence, Jobin examined the benefits and costs of only one level of chemotherapy. Rosenfield compared the effectiveness of chemotherapy, mollusciciding, engineering and combinations of the three activities at levels actually undertaken by the Iranian Control Project. Paulini selected two different levels of chemotherapy, one level of mollusciciding and one combination of chemotherapy and mollusciciding. Evidence of the optimality of the levels and combinations of activities selected is offered in none of these three studies.

37. The most difficult task of the study is the selection of a theoretically sound and empirically implementable transmission model. In Section B of this annex, the most recurrently cited epidemiological models of schistosomiasis transmission were reviewed. It is evident from the review of these models that the life cycle models are theoretically sound. Yet, their empirical implementation is severely limited by the present lack of detailed knowledge of the life cycle of the schistosome parasite. Besides being mathematically too complex, most of the life cycle models that are praised for their theoretical soundness require an exorbitant amount of data.^{9/}

38. Catalytic models, in contrast, are mathematically simple and relatively modest in their data requirements. One only needs the distribution of age-specific prevalence to estimate the parameters of a catalytic model. The major objections to use of catalytic models in the study of the epidemiology of schistosomiasis have been that: a) they can only be applied to steady-state epidemiological conditions, and b) they describe only the proportion of humans infected and completely ignore the worm population and the snail population. Catalytic models are meant to explain steady-state age prevalence of infection conditions. Rosenfield (1975) is the only one to have used a catalytic model in a nonsteady-state situation, i.e., an irrigation project where environmental factors were variables (see equations 1, 2, 13, 14, and 15 of this annex). Rosenfield's use of a recursive equation (equation 13) and regression analysis of the impact of accessible snail habitats and the number of people passing eggs (equation 15), on the force of infection parameter accomplishes two important objectives simultaneously. First, it converts a basically static steady-state model to a dynamic predictive model which is a function of measurable environmental factors H and P. Second, it portrays cost-effectiveness

^{9/} The only exception is the "partial" life cycle model of Holford and Hardy (1976). Its parameters can be estimated by fitting a curve through age-prevalence of infection data. The rest of the life cycle models require data on survival and reproduction of the worm in its free living state, in snails and in humans. Quite obviously, such information can only be gathered by a team composed of highly trained epidemiologists, biologists, a biometrician and a number of first-rate technicians. Hairston (1965a, p. 61) estimates that such a large team may require up to two and a half years to collect the required data. Hairston (1973, p. 279) gives a list of the data required.

analysis in terms of the values of H and P and hence, the value of the force of infection a, which may be revised periodically as functions of the extent of mollusciciding, chemotherapy, and engineering activities:

$$H_t = H_{t-1} - (1-h)\tilde{H}_{t-1} + H't \quad (38)$$

and

$$P_t = P_{t-1} - (1-p)\tilde{P}_{t-1} + P't \quad (39)$$

where \tilde{H} is meters of habitat molluscicided;
 H' is meters of new habitat,
 \tilde{P} is number of infected humans treated,
 P' is number of infected immigrants,
 h is failure rate of mollusciciding, and
 p is failure rate of chemotherapy.

It should also be observed that this is one of the only two schistosomiasis transmission models that have been empirically implemented. The other is Jobin's life table simulation model which is partly based on arbitrary parameters. The second objection--that catalytic models only describe prevalence of infection in humans--is not significant unless disease control (i.e., morbidity and/or mortality control) is envisaged. In the proposed research, control of prevalence of infection is the objective of the control program. Rosenfield's schistosomiasis transmission model is therefore the best candidate for adoption in this study. It has most of the basic requirements of a transmission model for use in cost-effectiveness study; and as a transmission model it has been successfully verified on data on an irrigation project.

39. Rosenfield's model will be modified in two ways. First, a search will be conducted for that catalytic model which gives the best statistical fit to data on age prevalence of infection. Rosenfield used the Reversible Catalytic Curve to estimate parameters a and b. The Two-Stage Catalytic Curve, Cohen's improved Two-Stage Curve which includes a term for selective host mortality, and Lewis' Two-Stage Curve with a term for loss of immunity will be compared for best fit. The curve that gives the best fit will then be converted to the form of equation (13) to simulate growth of the prevalence of infection. Second, Rosenfield's regression equation will be respecified to include analysis of the impact of water contact, W, on the force of infection:

$$a = \beta_0 H^{\beta_1} P^{\beta_2} W^{\beta_3} \quad (40)$$

where $\beta_0, \beta_1, \beta_2, \beta_3$ are constants.

Where necessary, a variable, Q, for nonhuman definitive hosts involved in transmission will be included in like manner in the regression equation. Nonhuman definitive hosts are important only in *S. japonicum*. H, P, and W can be partitioned depending on available information. H can be partitioned according to distinguishable types of habitat, degree of accessibility and/or density of infected snails. P can be partitioned according to classes of egg output; and W according to patterns of water contact.

40. Respecification of the regression equation has theoretical and empirical virtues. As the independent variables in the equation are surrogate variables--H for number or density of infected snails, P for egg-output, and W for success of cercarial penetration--their partition into distinguishable classes will sharpen analysis of the contribution of each partition to the force of infection. Omission of water contact in Rosenfield's study is a serious mis-specification of the transmission model. H and P are only necessary conditions for transmission. Given the two variables, W provides the sufficient condition for transmission to take place. Empirically, the use of these surrogate variables permits analysis of cost-effectiveness of control activities. The effectiveness of snail control activities can be evaluated on their impact on H, and hence on the force of infection; the impact of chemotherapy on P, and sanitation and water supply programs on W can be evaluated in like manner. Partitioning of the variables is necessitated by the fact that different methods of mollusciciding, for instance, are required for different types of H, different approaches of chemotherapy for different characteristics of P, and likewise, different sanitation and water supply measures for different patterns of W. Different methods of mollusciciding will have different cost structures. The same is true for different approaches of chemotherapy, and sanitation and water supply programs. The next logical step is hence to estimate the appropriate cost functions corresponding to the different approaches of control activities.

41. In the proposed research study, the cost-effectiveness of only the two most frequently applied control activities, mollusciciding and chemotherapy will be considered. Since the transmission model is flexible enough to permit evaluation of virtually all known methods of control including control through the engineering design of irrigation, control activities omitted in the initial phase of the study could be considered in subsequent phases.

42. In this study, costs of each activity will be partitioned into investment and recurrent costs and modeled as flows. These costs will be estimated econometrically. Hence, there will be an investment cost of mollusciciding and a recurrent cost of mollusciciding; and similarly for chemotherapy. These costs will be estimated as functions of size, type, and characteristics (such as PH, turbidity, temperature, rainfall, vegetation and velocity of flow) of habitat. Other characteristics of the habitat will also be investigated if data are available or field research indicated their importance. Similarly, costs of chemotherapy will be assumed to depend on the size of the population treated, the intensity of infection, nutritional status, and accessibility. In the estimation procedure, binary variables

will be used to characterize the qualitative aspects of both habitat molluscicided and infected humans treated. This study will be the first to employ econometric procedures to estimate cost functions for schistosomiasis control activities.

43. Cost-effectiveness will be assessed in an optimization framework. The optimization procedure envisaged is dynamic programming. Analytical as well as numerical results will be sought. Benefit of control--reduction in prevalence of infection will be optimized subjects to budget constraints and capacity restrictions. The model will be specified such that the budget for a given year may be increased by transferring unspent monies from previous years, and by adding revenues from the sale of scrapped capital. Capacity restrictions--available facility and equipment-- will be expressed in terms of size of habitat that can be molluscicided, and number of infected people that can be treated in each period. Additional constraints will be included to characterize major institutional or physical features of the control program being investigated. The dynamic programming procedure is sufficiently flexible to permit analysis of various forms of objective functions subject to appropriate constraints.

44. The objective function in this study, reflecting the objective of minimizing prevalence of infection may be expressed as:

$$\text{Min } \sum_{t=1}^T Y_t R_t$$

where Y is prevalence of infection,
R is a discounting factor expressing subjective trade-offs
in the timing of program benefits, and
T is terminal time.

To penalize larger values of prevalence of infection disproportionately more than smaller values, the objective function may be expressed as:

$$\text{Min } \sum_{t=1}^T Y_t^2 R_t$$

Where the goal of the control program is specified as being to minimize deviations from target levels of prevalence of infection, the objective function may be expressed as:

$$\text{Min } \sum_{t=1}^T \left(Y_t - A_t \right) R_t$$

where A is target level of prevalence of infection.

Once again, squaring the deviation will penalize larger deviations disproportionately more than smaller deviations. To avoid evenhandedly penalizing below and above target deviations, the targets may be assigned values which are unachievably high. Formulated as the sum of squared deviations as in

$$\text{Min} \sum_{t=1}^T \left(Y_t - A_t \right)^2 R_t$$

it permits derivation of feedback equations in the optimization of the corresponding Lagrangian expression. Furthermore, by virtue of the dynamic programming solution algorithm which works backwards from terminal time $t = T$ to $t = 1$, it is possible to set $Y_T = A_T$ in the feedback equation and solve the rest of the period of analysis accordingly. Hence there will be no need for additional statements to express desired terminal time state conditions.

45. Conversely, one could solve for "minimum effort"; in which case the objective will be to minimize costs as in

$$\text{Min} \sum_{t=1}^T \left(C_t^M + C_t^P + K_t^M + K_t^P \right) V_t$$

where C_t^M is recurrent cost of mollusciciding,
 C_t^P is recurrent cost of chemotherapy,
 K_t^M is investment cost of mollusciciding,
 K_t^P is investment cost of chemotherapy, and
 V is a discounting factor

subject to the state trajectory and capacity restrictions in each period.

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OFFICE MEMORANDUM

TO: Files

DATE: December 28, 1977

FROM: Benjamin B. King, VPD *BBK*SUBJECT: Research in South Asia

1. I attended a meeting with Messrs. Blobel, Waide, Alisbah, Grawe and Wall of the South Asia Region on the questions raised in Mr. Wall's memo of December 15 about the number of research projects in India. Mr. Stern's earlier memo of June 2, 1977 was written because of a fear that if we have too high a profile it could increase the likelihood of attacks on the Bank for intellectual imperialism and the like; in fact there was one such attack in the press shortly after.

2. The list of projects attached to Mr. Wall's memo (Attachment I), which have something to do with India, is a very mixed lot. They have a variety of different characteristics (not necessarily mutually exclusive):

- (a) Initiated or supported by the Region itself (e.g., Buffer Stocks, Agricultural Growth).
- (b) Generally agreed with the Indian Government (Capital-Labor Substitution).
- (c) Part of a multi-country comparative effort (ICP, Income Distribution, Irrigation Management, Urban Public Finance).
- (d) Largely carried out within India (Employment Models, Labor-Force Participation).
- (e) Primarily study in Washington of existing material (major, Narangwal; minor, Rural Employment).
- (f) Finished (Foodgrains, Ability Characteristics).
- (g) Use of a technique developed outside India (Programming in the Manufacturing Sector).

Depending on its characteristics, a project should have more or less susceptibility to private and public objection in India. Subsequent lists ought to make some sort of distinction.

3. It appeared to be the general consensus that there was a trade-off between the need to carry out research, and the cost of potential criticism. In several cases the priority attached to research projects, by the Region, was low. It was agreed to have an "early warning" system to notify the Region's Chief Economist (Mr. Waide), whenever any project involving research in the country, whether or not by Bank staff members, was being considered--well before any commitments are made. He would arrange for Regional views to be made known to the project's sponsors. This applies to all countries in South Asia, not just India. I undertook to make this known.

Attachment

Distribution

<u>South Asia Region</u>	<u>CPS</u>	<u>DPS</u>
Messrs. Hopper (o/a)	van der Tak	Karaosmanoglu
Picciotto	Yudelman/Donaldson	Duloy
Blobel	Habte/Jallade	Stoutjesdijk
Kraske	Gordon/Moore	Mrs. Hughes
Waide	Willoughby	Choksi (o/r)
Alisbah	Jaycox/Churchill	
Clements		
Dunn		
D. Lee		
Parsons		
Pranich		
Rowat		
Shibusawa		
Shields		
Tibor		
E. Williams		
Street		

Ongoing and Proposed Research Studies in India

Code No.

Ongoing Studies

670-26	Substitution of Labor and Equipment in Civil Works
670-45	Labor Force Participation, Income and Unemployment
670-68	International Comparison Project
670-70	Urban Public Finance and Administration
671-02	Population Growth and Rural Poverty
671-06	Employment Models and Projections
671-30	Structure of Rural Employment, Income and Labor Markets
671-08	Income Distribution in Asian Countries (A Case Study on India)
671-15	Effects of Health and Nutrition Standards on Worker Productivity
671-33	Ability Characteristics as Factors of Production
671-19	Educational Reform (A Case Study on India)
671-21	Foodgrain Production in Asia
671-34	Management and Organization of Irrigation Projects
671-38	Narangwal Population and Nutrition
670-24	Programming in the Manufacturing Sector
671-24	Simulation of Buffer Stocks
671-25	Commercial Bank Behavior
	Agricultural Growth Strategy and the Rural Poor
	Small Scale Enterprise Studies

Proposed Studies

Case Studies of Determinants of Recent Fertility Decline
in Sri Lanka and South India

Basic Needs in Punjab and Kerala

Managerial Structures on Public Sector Manufacturing
Enterprises

December 15, 1977

JVoigt/JWall:ggb

Mr. S. Burki, EPRPP

December 19, 1977

Orville F. Grimes, Jr., VPD

"Research Project Outline: Political Economy of Basic Needs"

1. My quick reaction to this draft, in response to your request, is that the basis is established for what could eventually be a useful and relevant piece of research. However, a substantial effort at confining the scope to manageable bounds will be required for confidence to be placed in this outcome.

2. Part of the problem (a small part, I believe) is the use of phrases like "generative processes," "productive participation," and "institutional integration," the obscurity of whose meanings raises a question whether they are in fact adequately defined in the mind of the writer. The proposal should be directed to the unenlightened reader, rather than to the initiate.

3. Once such concepts are clarified, the larger problem will emerge more sharply: overdesign and overambitiousness in terms of any conceivable criteria of efficient management, organization, and supervision, if not also in terms of resource requirements. In the enumeration of objectives (p. 2) the proposal appears to strike in too many directions. Each of the topics listed could in its own right be shaped into a useful, though ambitious, study. To my mind, however, the heart of what this research aims to achieve is an analysis of institutional constraints on access to basic services and methods of mitigating these constraints--the second of the objectives listed. I would therefore urge greater attention to this topic in a revised proposal, for two reasons. First, popular participation and management (the third objective), as one among several competing ways of organizing access to basic services, would most usefully be analyzed as part of a broader matrix of institutional constraints on service provision, not as a separate exercise. Second, there would appear to be enormous difficulties in deriving practical guidance from anything as broad as an examination of "...the political economy of different production systems for basic needs and therefore questions of political conditions and choices." (objective one).

4. I feel we should thus encourage the authors to be more specific about the sorts of issues and concerns they feel most in need of research in this more narrowly defined area. Two additional points might be relevant in this regard. Given that the content and scope of the proposed country case studies are most hazily sketched out, one would expect

that much of what is now mentioned (p. 14) as the first phase, that of describing "specific research designs and hypotheses for the country case studies," would be done as part and parcel of elaboration of the proposed study, not after the research gets underway. In addition, the repeated assertion that "received or dominant models of public allocation" must be thrown out leaves me uneasy. What are these dominant models? Why have they failed? Surely, if we are interested in the affordability of consumption packages to meet basic needs, we will not wish to scrap existing distribution networks and set up entirely new ones, but instead to make relatively small, measurable improvements in the efficiency of existing systems. To do so, we will need to know much more about the principal features of such systems.

cc: Mr. Simmons

OFGrimes:gm *df*

Mr. M. Weiner, OED

December 19, 1977

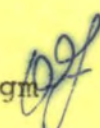
Orville F. Grimes, Jr., VPD

Research Projects Evaluated During 1977

Please find attached a set of memoranda resulting from the evaluation during 1977 of an additional seven research projects. A report on the eighth project evaluated this year ("Labor Market in a Rapidly Growing Economy," No. 670-90) will be available soon.

cc: Mr. B. King (w/o attachments)

Attachments

OFGrimes:gm 

RESEARCH PROJECTS EVALUATED DURING 1977

<u>Identification Code</u>	<u>Project Title</u>	<u>Evaluation Supervisor</u>
670-08	Project Appraisal and Shadow Prices	I.M.D. Little
670-14	Agriculture Mechanization Study in India	R. Picciotto
670-44	Education Finance and Income Distribution	B. de Vries
670-69	Growth and Income Distribution in Brazil	E. B. Waide
670-90*	Labor Market in a Rapidly Growing Economy	E.V.K. Jaycox
670-99	Economic Aspects of Household Fertility Behavior and Labor Supply in Northeast Brazil	E. Lerdaу
671-11	Public Utility Pricing and Investment	C. Willoughby
671-16	Standards for Site and Services Projects	H. van der Tak

*Report to be submitted soon.

Mr. T. Goering, AGR

December 15, 1977

Orville F. Grimes, Jr., VPD

Proposed Study of Post-Harvest Food Losses in Bangladesh

1. While this topic is of considerable interest, its embodiment in the Greeley proposal exhibits, first of all, an ambiguity in objectives. Only by sacrificing thoroughness and depth of coverage could a study of this kind attempt to cover both the determinants of post-harvest foodgrain losses and factors governing adoption of appropriate post-harvest technologies. A clearer choice should be made, and my preference is for the former. The rationale for such a choice emerges principally from the diversity of reactions among recent reviewers: despite what we "know" about the magnitude of prevailing losses, this issue is far from settled.
2. Acceptance of the above premise implies that the research could be cast very much as the "first objective" is described (p. 13): "...to establish reliably the prevailing loss patterns. This in itself is a complex task, and the project will have made an important contribution if just this is established together with an understanding of the socio-economic relations within the post-harvest system; this achieved, there would then be concrete grounds for determining the direction of further research....." If the research does little more than relate losses to the socio-economic structure of rural production and distribution in zones of given physical and socio-economic characteristics, it will have made a valuable contribution. The question then arises whether a more sharply focused study would need resources of the magnitude proposed. It would not be surprising if the sponsors found they could get by with much less.
3. Reformulation along these lines would leave the technology issue as one among many, whose precise nature is unknowable at present, to be addressed at a later stage. It may eventually prove useful, as one illustration, to examine the pattern of losses against a broader matrix of post-harvest activities (with storage and transport explicit) and impacts (production/income, employment, role of women). Since results from the initial study will have a significant bearing on the directions further work should take, options should not at this time be foreclosed.

4. Whatever the chances at present of a close association with BARC, a good deal of attention needs to be given to liaison with government. What mechanisms would be suitable for ^{promoting} awareness of the results, and opportunities for implementation, within government circles? On this matter the proposal is largely silent.

5. May I suggest that we invite Professor Greeley to give a seminar in the near future on the experience in Andhra Pradesh, lessons from which should be in hand before it is decided how the study may be extended elsewhere. Since the main purpose would be retrospective, a summary of relevant strands of the literature, concentrating perhaps on what the scientific literature omits in terms of socioeconomic considerations and vice versa, would also be quite useful, if one is available. Both elements would contribute to the second purpose of the seminar, to obtain reactions to the program of research proposed for collaboration with the Bank.

OFGrimes:tqr *1977*

Mr. E. Rodriguez, PAB

December 14, 1977

Benjamin B. King, VPD Signed B. B. King

Cost of Research

1. Your memo of December 9 provides most of what we wanted to know in the first instance. I trust that, in the future, we can keep in better step with each other by full exchange of information on the data and the methods we use.

2. Let me now, however, make one point about the method of calculating the cost of an effective man-year for staff and consultants as though they were the same. It appears to me to be wrong to attribute the cost of supervisory staff to consultants. They supervise the "effective" staff, who in turn devote part of their time to working with consultants; in the case of research, this time is already included under research. In many cases, this may be a very cost-effective way of using the staff's time, since it extends the number of effective man-years at comparatively low marginal cost.

3. This point is illustrated in the accompanying table, which uses the DPS figures for FY76 in your memo of November 22. I have had to make some guesstimates about a few things; if wrong, the numbers would be changed, but not the principle. They are:

- (i) Effective man-years are 100 staff and 15 consultants.
- (ii) Salaries of the "effective" man-years are two-thirds of the total professional staff (not an essential element).
- (iii) Bank overhead costs are distributed equally among staff and consultants.

4. The critical point is that certain costs are not charged to consultants at all: other salaries, staff benefits, travel etc. Maybe this is going a little too far, but on the other hand attributing an equal share of Bank overheads may go too far the other way.

5. In the present case, I doubt that a correction of this kind would make too much difference, since the proportions of staff to consultants may be about the same for research as for the total and in any case the number of consultants is small. But the principle is there.

cc: Messrs. Karaosmanoglu, Vergin, Mrs. Cleave, Mrs. Hazzah (o/r)

BBKing:gm

Table of DPS Expenditure (FY76)
 (\$'000 FY77)

	<u>Staff</u>	<u>Total</u>		<u>Per effective man-year</u>	
			<u>Consultants</u>	<u>Staff</u>	<u>Consultants</u>
"Effective" salaries	2,573	398	25.7	26.5	
Other prof. salaries	1,286	-	12.9	-	
Other dept. expense	2,992	-	29.9	-	
Benefits	<u>2,996</u>	<u>-</u>	<u>30.0</u>	<u>-</u>	
	9,847	398	98.5	26.5	
Overhead	<u>1,424</u>	<u>214</u>	<u>14.2</u>	<u>14.2</u>	
	11,271	612	112.7	40.7	

Mr. John Duloy, DRC

December 14, 1977

Abraham Bekele and Fredrick Golladay, CPSEH

Research Proposal - The Economics of Schistosomiasis Control Activities

1. Attached is a copy of the final draft of the research proposal. It contains most of the suggestions for amendment we received from model-builders and experts in the field. We are already in contact with Dr. Kendrick regarding optimal control programming packages. We have also solicited his comments on the proposed analytical model.
2. We would appreciate your reaction to the proposal before it is submitted to the research panel. Thank you for your assistance.

cc: Dr. James A. Lee

ABekele:br

THE ECONOMICS OF SCHISTOSOMIASIS CONTROL ACTIVITIES

The World Bank

November 29, 1977

THE ECONOMICS OF SCHISTOSOMIASIS CONTROL ACTIVITIES

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Mr. B. B. King, Research Advisor

December 13, 1977

John A. Holsen, Panel Chairman

Report of Panel on "Research Support for World Development Report"

1. The subject research proposal was reviewed on December 9 by a panel consisting of Messrs. Goering, Keesing, Meo, Pyatt and Holsen. The proposal was reviewed with Ms. Hughes and Messrs. Waelbroeck, Cheetham and Gupta. Messrs. King, Grimes and Candler also participated. The proposed project requests \$804,000 to finance a three-year program of research support for the World Development Report. The main components of the work and the approximate financing requested are:

- | | |
|---|-----------|
| 1. Assistance to Bank staff in development of the core model for global framework/WDR studies (Waelbroeck/Brussels) | \$281,000 |
| 2. Support for program to prepare national and regional models for the study of the world food situation (Tims/Amsterdam) | \$213,000 |
| 3. Studies of problems related to LDC manufactured goods' penetration of European markets (Waelbroeck/Brussels) | \$300,000 |

The project proposal combines the budgets for the two Brussels components (#1 and #3); the distribution shown above is based upon Mr. Waelbroeck's statements at the Panel Review. There are a number of other components mentioned in the original project proposal, but these are either relatively minor items or are being dropped. The minor items, which were not discussed by the Panel, include funding the continuation of Mr. Waelbroeck's consulting service for EPD's commodity modeling efforts and "low budget" studies by the Brussels team of shifts in the pattern of comparative advantage and of the elasticity of demand for manufactured exports of the LDCs. The item which has been dropped is the construction of a disaggregated projection model for LDC exports of manufactured goods.

2. Component #1, assistance with the core model, is essentially a contract for consulting services, with the detailed work program to be determined as the activity progresses. Mr. Pyatt stated, and Mr. Waelbroeck agreed, that the approach to be taken would be considered first by Mr. Pyatt's own working group on the future direction of the Bank's global modeling and then discussed more broadly within the Bank and with the Brussels team. After this initial stage (lasting about six months) the work would be managed by EPD as part of its on-going global framework activities. The Panel was satisfied with these arrangements, but believes they should be clarified in the project proposal. Members of the Panel noted that general models, such

as the proposed core model, were not likely to be very helpful in exploring a number of the issues with which the Bank is now concerned (such as employment and income distribution). Ms. Hughes agreed that the core model would be basically concerned with trade and capital flows, but stressed the importance of continuing improvements in this aspect of the Bank's work. The Panel agreed to the general approach that, while the core model would be kept flexible in the hope that a range of policy considerations might be introduced, it was expected that satellite modules and separate studies would prove to be the more useful way of handling most issues other than trade, capital flows and their interrelationships with aggregate growth. The Panel welcomed the personal and professional qualifications of Mr. Waelbroeck who would be directing this aspect of the work.

3. The agriculture component of the project would finance work which is already underway; this work seems certain to go forward whether or not Bank support is made available. Bank support would permit the studies to be completed somewhat earlier (1980 instead of 1981). Except for this acceleration and the fact that the "residual" regional models would certainly follow the classification adopted for the WDR, it is not clear what specific gains to the Bank in general and the WDR work in particular would result from the proposed financial support. If the Bank's agricultural staff were to give anything more than the most general sort of judgment, it would be necessary to know more about what the Amsterdam group proposed to do and how they would go about it. This component of the proposal appears to have only limited relevance to the Bank's lending program for the rural sector. If the Bank were to participate in financing this work, the Panel thought it would be necessary to agree upon procedures for interaction between the agricultural specialists at the Bank (including relevant regional staff) and those working on the project and to provide opportunities to review the progress of the study.

4. Planning for the third component of the project -- market penetration of developing countries' manufactures in Western Europe -- is at an early stage. The discussion on page 12 of Annex IV was, however, supplemented by Mr. Waelbroeck's memorandum of December 9 and his comments at the Panel's meeting. He advised the Panel that the study would involve about \$100,000 in consultants' fees for country studies plus about 1.5 man-years annually of professional work in Brussels. (Total cost about \$300,000.) He stressed the value of having this work done in Brussels, the center of EEC trade policy. Panel members noted that the relationship of the proposed studies of manufactured exports to the WDR and the global framework was somewhat tenuous, especially since the projections part of the proposal was now being dropped. Mr. Waelbroeck said the main purposes of the work would be to (1) inform planners in developing countries of the problems in penetrating the European market and thus provide needed background for LDC policy makers and negotiators and (2) help deflate fears in Europe by improving understanding of what is involved in such imports from LDCs. It would also help in the design of adjustment measures.

5. The proposed project has a general objective which goes well beyond those of the particular studies involved. It is "also intended to serve as a focus for the Bank's dialogue with the academic and international agencies communities in Europe". This link with European research interests is to be

welcomed. The Panel believes that Messrs. Tims and Waelbroeck, because of their past association with the Bank, are good choices for such a beachhead in Western Europe. The three components of the proposal provide a basis for this cooperation since they reflect the research interests of these two investigators. The Panel believes that these three logically distinct components are included in this single research proposal mainly for this reason.

6. The somewhat special nature of this project proposal has made it particularly difficult to evaluate; we are better able to suggest questions than make recommendations. The Panel believes the Research Committee should consider whether it is appropriate to use research funds for component #1 since the activities concerned are not really distinguishable from what might ordinarily be done with a department's consultants' budget. In the case of component #2, the work is likely to be done whether or not the Bank is involved; consequently a basic concern must be whether or not having the work completed in 1980 rather than 1981 is a sufficient basis for financing under the research program. In the case of component #3, the work program is at present too general to be evaluated; a positive decision at this time would have to be based mainly upon the importance of the general subject and the competence of the principal investigator. Even as judgments were reached regarding individual components, the Panel's understanding was that components #1 and #3 were to be considered a package for purposes of funding; it was not certain whether the work associated with Mr. Tims (component #2) could be considered separately. Finally, one must ask whether the general considerations mentioned in paragraph 5 are sufficiently strong to override doubts which may exist regarding the justification of the individual components; the Panel was conscious of the importance attached to these general considerations.

7. Assuming a positive decision is to be made with respect to the basic thrust of this request, the Panel recommends that specific changes in project management be introduced to insure coordination with those in the Bank most concerned with one or another of the specific components. As now proposed, the project would be supervised by EPD with the help of "a steering committee that would determine, jointly with Tims and Waelbroeck, the work program on an annual basis, and monitor progress." Component #1 is consulting support for EPD's global framework and the presently proposed arrangement seems appropriate. However, the Panel believes that component #2 is in large measure an agricultural study and component #3 is primarily a study of LDC exports of manufactures. In these cases it is suggested that the working level coordination and project monitoring be managed by the Bank staff most closely associated with the particular subject matter; global framework personnel would, of course, participate and some overall coordination might be desirable at a senior level. It is desirable to give this clear role to the subject matter specialists for at least two reasons -- to maximize the two-way flow of knowledge and ideas between specialists within and outside the Bank and to avoid the danger of the global framework developing in isolation from the Bank's own subject matter specialists. In the case of component #3, the problem is one of preparing a work program as well as of subsequent monitoring; funding should not be made effective until agreement on the work program has been reached.

JAHolsen/ddm

cc: Messrs. Goering, Keesing, Meo, Pyatt
Ms. Hughes, Mr. Cheetham

Mr. Hollis B. Chenery

December 13, 1977

Benjamin B. King Signed B. B. King

The Amsterdam-Brussels Proposal

1. I think I should tell you in advance that it is my present intention to vote against this proposal. My reasons are ones of principle rather than substance, although I have some reservations on the latter score.

2. In the first place, there is the issue of the use of Research funds. All departments of the Bank are being squeezed by budgetary stringency. This proposal looks like general support for ongoing work in DPS (and, within DPS, in EPD) and, in my opinion, there is a lot of truth in that. In short, it appears that DPS is doing an end run around the budgetary process. I think that is wrong.

3. If a prior management decision has already been made that the proposal should go through and be financed on an exceptional basis from Research funds, then this fact should be stated. The Research Committee could then be informed of the precise constraints under which they are operating and the function they are supposed to be performing in commenting on this proposal. Otherwise, the integrity of the process is going to be harmed.

cc: Mr. Karaosmanoglu
Mr. Holsen
Mr. Grimes

BBKing:gm

Mr. B. B. King, Research Adviser

December 12, 1977

John A. Holsen

Future Research Areas in Country Economic Analysis
(Background for FY79 Research Budget Recommendations)

1. This note responds to Mr. Chenery's memorandum of November 10, in which he requested a review of prospective research activities in the field of "country analysis" and an indication of important areas of research which might justify an increase in external research funds or internal staff time. I have discussed this topic with the suggested interviewees (except Mr. Duloy, who has been out of Washington) and also with other DPS staff members. I have not tried to adjudicate the well known differences of opinion among the principal interviewees, partly because there is no budget constraint in the present exercise and partly because I believe their main suggestions all merit some budgetary support.
2. Two important projects in the country analysis area have been "Prototype" and "SAM". There now is a general agreement with respect to both projects that the time has come to move from the development of analytical methods to the "extension" of the results to Bank country economists. (A Panel of the Research Committee is currently recommending some additional support to complete these projects on the condition that this work include the preparation needed to enter the extension stage.)
3. In the case of the SAM work, what is needed is a DPS mission support capability which would help country economists prepare SAMs or mini-SAMs for their countries. This approach has a considerable potential for organizing data in a useful format for "new style" Bank economic analysis as well as being a useful technique for organizing the consistent data base that is needed for improved country modeling efforts. The aim should be to develop SAMs and mini-SAMs as a "production line" technique that complements the basic economic tables now used in country economic work (national accounts, balance of payments, budget, etc.)
4. In the case of Prototype, the proposed extension would be on a more modest scale. This is partly because it is now generally agreed that Prototype is not suitable as a production line tool; for the foreseeable future it will be too demanding in data requirements, in staff time and in computer resources. It should, however, be possible to adapt the Prototype approach for use on important basic economic missions; more extensive use may be possible when appropriate simplifications are made. Subject to the satisfactory conclusion of the present work program (which includes testing the technique on one country in addition to Korea), it is proposed that at least three or four "field trials" be conducted in the following two years. This round of applications of Prototype would be aimed at both useful results for the regional offices concerned and further refinement of the Prototype approach.
5. The budgetary resources needed in the case of both SAM and Prototype are internal staff time rather than external funds. The requirement might be 3 man-years annually in the case of DPS support for SAM applica-

tions and 2.5 man-years annually for extension of Prototype. The gains from techniques such as SAM and Prototype are in the form of improved analysis rather than labor savings. (Their effective application will involve a contribution from regional country economists in addition to that from DPS support staff.) To pursue the agricultural analogy, the research has been done and we are now ready to move to field trials (if not routine application); however, the higher yields will only be obtained if we are prepared to pay for the additional inputs the better techniques require. While one might for a while continue to support "field trials" from the research program, it must be recognized that the introduction of SAM and Prototype will call for a permanent increase in DPS support for regional work (or an equivalent increase in regional economic staff once they have a good grasp of the technologies).

6. Another high priority area for improving the techniques for country economic analysis is in the up-grading of the RMSM ("revised minimum standard model"). A major effort in this direction has been postponed in part because we wished to see whether the next generation of production line country economic models would be best developed by "working down" from Prototype or "building up" from RMSM. With the recognition that, during the next few years, the Prototype approach is likely to be used mainly for a limited number of basic reports, we can no longer delay improvements in our "production line" country economic models. Prototype may be a source of ideas for the successor to RMSM. There are substantial complementarities with the proposed mini-SAM work, since the latter could result in relatively widespread improvements in the country data bases. There are also complementarities with the work being done on the global framework. (It would be desirable to add models for major countries to the regional models now being used in the global framework; at the same time these regional models, based on mini-SAMs, are suggestive of how one might approach the successor to RMSM.)

7. The idea behind the MSM and RMSM was that of a "minimum standard output" which could, if a more sophisticated model were not available, be generated by the "minimum standard model". The objective was to have models designed for country analysis that would also provide outputs suitable for intercountry comparisons and aggregation. As one moves to upgraded RMSMs, it would be desirable to maintain the concept of a "minimum standard output", but encourage a diversity in country models that reflected data availability, varying economic structures and differing Bank needs. It would probably be desirable to develop rather different types of models for medium-term and long-term analysis. It is not clear whether the requirements of the increasingly complex global framework will permit a single model to serve both country economist and global framework requirements; this question can only be answered as the work proceeds. As the work program would emphasize practical application of existing methodology rather than methodology itself, this effort would have to be carried out in close cooperation with both country economists and the DPS staff concerned with mini-SAMs. A DPS input of about

3 man-years might be desirable.

8. Extension of SAM and Prototype along with work on an upgraded RMSM appear to be the three work programs in the area of country analysis which might have substantial impact upon the DPS budget in FY79. (This assumes that the proposed Brussels-Amsterdam project would be classified under other headings -- e.g., global framework, agriculture and international trade.) A number of other activities were mentioned during the interviews, but are not discussed in any detail because they would be comparatively low budget activities. Some of them, although related to improving country economic models, might also be classified under headings other than "country analysis". The other suggested activities included (1) work on improving the production function, including technological progress as well as capital and labor; (2) work on savings and investment decisions in the private sector (including role of financial intermediaries); (3) development of a software package to reconcile data inconsistencies; and (4) historical quantitative studies of country development (aimed at hypothesis testing rather than projecting) involving detailed work on a few countries.

JAHolsen/ddm

cc: Messrs. Duloy, Pyatt, Norton
Mrs. Hughes, Mr. Cheetham

Research Committee Members

December 12, 1977

Orville F. Grimes, Jr., VPD

Meetings on December 16 and December 20, 1977

This volume contains material for the meeting of the Research Committee on Friday, December 16, 1977 at 3 p.m. in Room E1208. With the agenda outlined below, we will no doubt find it necessary to reconvene on Tuesday, December 20, 1977, at 3 p.m. in Room C1006.

Not all the materials pertaining to each agenda item can be provided at this time. In particular, review panel memoranda on many of the submissions will be distributed to you as soon as they are available.

The agenda for these meetings is:

Proposals

1. Research Support for World Development Report
2. Short-Cut Methodology - International Comparisons
3. Small Enterprise Financing: Role of Informal Credit Markets
4. Capital Market Imperfections and Economic Development
5. Key Institutions and Expansion of Manufactured Exports
6. Industry and Regional Effects of Increased Imports of Manufactured Goods from Developing Countries
7. Projections on the Extent of Food Deficits of Target Groups Under Alternative Policy Programs
8. Labor Migration and Manpower in the Middle East and North Africa
9. Case Studies of Determinants of Recent Fertility Decline in Sri Lanka and South India

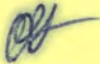
Requests for Supplemental Funding

1. "Labor Force Participation, Income, and Unemployment" (670-45)
2. "Prototype Models for Country Analysis" (670-86)
3. "Social Accounts and Development Models" (671-27)
4. "Linkage of Commodity and Country Models" (671-28)
5. "Narangwal Population and Nutrition" (671-38)
6. "Textbook Availability and Educational Quality" (671-60)

It is likely that proposals one, three, seven, and eight in the above list, plus the supplementary requests, will be considered on Friday, December 16.

The papers for the meetings are in the following sections:

- i) Budget Information - tables showing budgetary positions for FY78 and FY79, and the proposals to be considered at these meetings.
- ii) Proposals - the research proposals, panel recommendations where available, and related documents
- iii) Supplementary Requests - requests for additional funding under existing research projects
- iv) Forthcoming Proposals
- v) Completion Reports



Distribution

Messrs. Chenery, Balassa, Ode Vries, Dubey, Holsen, Jaycox, B. King, Lerdau, Little, Picciotto, van der Tak, Vergin, Waide

Those listed below

December 9, 1977

Orville F. Grimes, Jr., VPD

Panel to Review Research Proposal

1. A panel consisting of Messrs. B. B. King (Chairman), F. Colaco, J. Edelman, C. Lluch, and G. Tidrick has been established to review the attached research proposal on Wednesday, December 14 at 3 p.m. in Room A520.


- | <u>Proposal</u> | <u>Staff Responsible</u> |
|--|--------------------------|
| Short-Cut Methodology -
International Comparisons | R. McPheeters |
2. As is customary, the panel should seek answers to questions like (a) Are the issues raised by the proposed research of interest to the Bank? and (b) Is the study so designed as to deal meaningfully with these issues? To aid in considering the quality and relevance of the proposed research, panel members may find useful the attached guidelines for preparation of research proposals.
3. The recommendations of the panel should be sent to me as soon as possible after the meeting.

Attachments

Distribution:

Messrs. B. King, Colaco, Edelman, Lluch, Tidrick, Kamarck

cc: Mrs. Hughes, Messrs. Cheetham, McPheeters, A. Schwartz, S. Ahmad, Mrs. Sachse

OFGrimes:gm 

Mr. Hollis B. Chenery, Vice President, Development
Policy

December 9, 1977

H. G. van der Tak, Director, Projects Advisory Staff

Major Research Budget Needs in Population, Health and Nutrition

In accordance with your memorandum of November 10, 1977, Mr. Stoutjesdijk and I held a panel meeting on the research needs in the above areas as perceived by both producers and users. The meeting was attended by Messrs. Berg, Basta, Bekele, Chernichovsky, H. Jones, Lucas, T. King, Lethem and Schebeck; several other knowledgeable people were unfortunately not in town. My general conclusions may be summarized as follows:

1. There appears to be general agreement that greater efforts should be made to exploit the research possibilities, and research components, in the Bank's population, health and nutrition projects or components included in other projects.

2. The main constraint on research in these areas is staff to generate and direct studies rather than a shortage of funds.

3. A priority area is research on the cost effectiveness of alternative delivery mechanisms in the sector concerned.

4. There are large biomedical/nutritional research needs which I ruled out from consideration for the purpose of this inquiry (but cf. the Bank's role with regard to the tropical diseases research program, etc.).

5. With regard to population, the Population Department staff sees no need at this time for expanded research and suggests that we await the results of Carmen Miro's international review group on research and population development which are expected to be available next summer. Tim King disagrees with this view and argues for more population research, as suggested by the Berelson Panel, but his immediate proposals do not suggest any increase beyond the current level of some two to three staff man-years (plus appropriate external funding). The major need appears to be for identification of reasonably specific research needs.

6. With regard to health, which is likely to become a rapidly expanding area of Bank operations, two broad research themes have been identified as the socio/economic causes and effects of health problems, in particular communicable diseases, and the cost effective mode of intervention, including delivery of services. Preparation of some more specific proposals is well advanced. The scale envisaged for the immediate future is one staff man-year and up to \$200,000.

7. Substantial work has been done on the preparation of a nutrition research program. Its main focus would be on what are the nutritional, health and functional performance results of government food and related health programs (institutional feeding, consumer subsidies, nutrition education, fortification and home food production) and what are the nutritional effects of agriculture and other government policies and regulatory actions? It is proposed to carry out these studies primarily in the context of on-going or revolving Bank nutrition projects, and to be funded largely through Bank loans. In addition, it is proposed to support analyses of existing data or pulling together of diverse sets of data to learn more about the effects of providing, for example, 70 - 85 or 100% of recommended nutrition standards, for different periods and at different ages. This would help in formulating cost effective nutrition programs. The sponsors of the research program suggest that the minimum of three full-time professional staff would be necessary as well as \$150,000 per annum for the next two years. I would think that a useful start for FY79 could be made with, say, one staff man-year and \$150,000.

8. My tentative general conclusion is that at this time it should be possible to accommodate the identified research needs in population, health and nutrition largely within the existing staff resources of the Development Economics Department, assisted by the DRC and the CPS units concerned. A full-time coordinator for health and nutrition research would be useful to generate a program and proposals, act as a focal point and get things started. Would it be possible to find him/her within DPS? The associated demands for external research funds would not unduly strain the research budget for FY79. If the research programs develop we might think for FY80 and beyond in terms of 5-7 man-years and \$500,000 for population, health and nutrition combined.

9. I attach various informal memoranda prepared in connection with this inquiry.

Attachments

HGvanderTak; lfb

cc and cleared with: Mr. Stoutjesdijk
cc: Messrs. Avramovic
Duloy
Kanagaratnam
Berg
Lee
T. King
B.B. King/Grimes

Mr. Attila Karaosmanoglu

December 5, 1977

Benjamin B. King *Signed B. B. King*

Scenario 1987

1. Operation "Shrinkback" is virtually completed. The Bank is now not much more than half its size ten years earlier. This has been accomplished by attrition; the spinning off of some consulting subsidiaries 1/; the moral and financial support (for a limited time) of some independent consultants; and a number of goldplated handshakes.

Regional Offices

2. Once it was realized that economic reports hardly served any purpose any longer and that practically nobody read them except reviewers of the published ones, the job was devolved to the countries themselves, as a condition of borrowing. Assistance in preparation of reports is given as needed: in most cases, limited to one or two staff members; in a few, to a larger team. The gain in self-esteem and self-understanding among member countries from having the responsibility of reporting to the Board and to other donors appears to be considerable.

3. Each Regional Office has an economic consulting adviser deputed on a rotating basis from the relevant Division in the R&D staff (see below). This division is responsible for recommending to member countries consultants from whom they may wish advice on such matters as taxes, tariffs, agricultural pricing, model-building, surveys, etc. Thus the main function of Regional Offices, from an economic point of view, is to give limited assistance in economic reporting, to comment on the validity of reports submitted and to facilitate advice in problem areas and specialized subjects (including project analysis).

4. The Bank Group now makes very few loans and credits for traditional infrastructure projects. In addition to the Regional Offices, the Chairman of the Loan Committee has a central infrastructure staff, which can be called on to review sectoral policy and programs, whenever there appears

1/ These are profit centers, selling services to the Bank and outside in competition. The first experiment was with software (CAD); if this is successful, a DRC division will be spun off.

to be a problem; he also has central advisers on procurement etc. When a loan or credit for an infrastructure sector is made, a part of the annual funds set aside for the country in question is segregated and allocated to that sector, conditional on whatever remedial steps appear to be in order. The thrust of project lending is in integrated rural and urban programs; Projects Departments now have two main divisions, rural and urban.

R&D Staff

5. Some of the greatest economies were obtained by collapsing CPS and DPS into a Research and Development Staff. Since several departments (Industry, E.W.T., Transport) have been replaced by the small central regional staff, insofar as heavy infrastructure is concerned, and since population and tourism projects have been discontinued, the main function of R&D in respect of regional programs is to support general country analysis and the preparation of urban and rural projects and programs.

6. Before describing how this is done, it is as well to mention one element of the R&D staff, less directly connected. This is the World Development Department, which is concerned with annual development report preparation. It also has divisions for industry and trade, commodities and world modelling (current application).

7. A separate Statistics Department has been created with four divisions. Data bank; centrally maintained country statistics (for regional use in country-recognizable form) 1/; external debt; statistical methods.

8. Though the Development Research Center has much the same role as it did earlier (tool-building; quantitative analysis), it now consists of four divisions: two for applied analysis (one for project/sector analysis; one for analysis of policy instruments at the macro level) and two research units (one to be spun off).

9. The other department dealing with the regions is the Regional Service Department (RSD). The functions of the latter are:

- (i) Central supervision of monitoring and evaluation (setting up systems; liaison with countries on these; collection of results; arranging for analysis and dissemination).
- (ii) Collection, evaluation and dissemination of comparative experience. It had finally dawned

1/ These are now published in a loose-leaf service.

on the Bank that it never systematically took advantage of what it could learn from the variety of experience in the field. The division responsible debriefs missions, arranges for compilation of experience on different subjects and arranges frequent international conferences. 1/ This activity replaced the EDI, which was gradually phased out, the final three years' courses being devoted to training of institute managers.

- (iii) Consultancy services. A central service for providing countries with information on advisers on a variety of subjects (see para. 3).
- (iv) Human resources (education, population and health).
- (v) Urban support unit (including employment and environmental issues).
- (vi) Rural support unit.

10. In addition, there is a special task force available for any special initiative attached to the front office. It has a small permanent staff and draws ad hoc on other departments.

1/ Ranging over a fairly wide area, including public administration.

Mr. E. Rodriguez, PAB

December 1, 1977

Benjamin B. King, VPD

Cost of Research

Your memo of November 22nd tells us how you calculated the DPS coefficient of expenditure per professional man-year. As a way of calculating costs of research in DPS, I have no quarrel with it except for refinements which are hardly worth it in a rough-and-ready exercise of this kind. 1/ However, there is much missing data which I would like to have to understand exactly how you arrived at the figures on page 22 of the 5/16/77 paper on the FY78 budget. We are now coming to the final stages of our report and it is rather important that we have this information quickly. All that follows is concerned with FY77 expenditure.

DPS

- (i) What was the expense component per effective MY for FY77 in FY77 \$?
- (ii) How many effective man-years were there in DPS -
 - (a) in total
 - (b) spent on RPO research
 - (c) spent on Non-RPO research
- (iii) What was the contribution of DPS to joint research (Bank staff) and in-house research. Presumably these should be the product of (i) and (ii) b and c respectively.

CPS

- (i) What were the respective contributions to joint and in-house research?
- (ii) How were they calculated (percentages of budget, same method as DPS or what?)

1/ For example, it is wrong to attribute a share of consultant fees and contractual services to RPO research, since this is already paid for out of the Research Budget.

December 1, 1977

Regions and YP's

- (i) Same as (i) for CPS.
- (ii) Same as (ii) for CPS.
- (iii) As regard YP's, is it possible to identify where they were, at least in broad jurisdictions (CPS, DPS, Regions), if no finer distinction possible.

Consultants

- (i) Non-RPO consultant man-years are estimated at 10. How was this done? What is the division between CPS and DPS?
- (ii) Presumably there was no additional cost for these consultants, since they are subsumed under the "expense component" per effective man-year". Right or wrong?

cc: Messrs. Chenery, Karaosmanoglu, Vergin, Grimes
Mrs. Cleave

BBKing:tr

Messrs. H. van der Tak, A. Berg, H. Jones,
and J. Wall/Charles Taylor
Orville F. Grimes, Jr., VPD

December 1, 1977

Progress Review of Narangwal Research Project, Monday, December 5

1. In addition to the materials already distributed, you may find pertinent the attached record of issues discussed and understandings reached at the time this research project was presented to the Research Committee. A subsequent progress report (December 22, 1976) is also included.

2. Among the questions which may arise at the meeting, the following are suggested as of sufficient interest to form a tentative outline for discussion:

- a. What is the extent of progress in addressing the broad policy questions described, when the study was approved, as amenable to analysis? What further steps are proposed in forthcoming work to advance the study toward operationally useful results?
- b. Would modifications be desirable in the way supervision is exercised and work organized?
- c. In what form(s) will the final report and other results be disseminated to audiences in the Bank, in India, and in the wider development community?

3. As mentioned earlier, we will meet at 2:15 p.m. in Room E 1026 on Monday, December 5, for an hour at the most.

Attachments

cc (w/att.): Messrs. Baldwin (o/r), T. King, Faruqee,
Chernichovsky, B. King

OFGGrimes:tqr *of*

Those listed below

December 1, 1977

Orville F. Grimes, Jr., VPD

Panel to Review Research Proposal

1. A panel consisting of Messrs. H. Vergin (Chairman), R. Headworth, G. Hyde, and C. Taylor* has been established to review the attached research proposal on Thursday, December 8 at 2:30 p.m. in Room D860.

<u>Proposal</u>	<u>Staff Responsible</u>
Small Enterprise Financing: Role of Informal Credit Markets	V. V. Bhatt

2. As is customary, the panel should seek answers to questions like (a) Are the issues raised by the proposed research of interest to the Bank? and (b) Is the study so designed as to deal meaningfully with these issues? To aid in considering the quality and relevance of the proposed research, panel members may find useful the attached guidelines for preparation of research proposals.

3. The recommendations of the panel should be sent to me as soon as possible after the meeting.

* Or other staff member from India Division.


Attachments

Distribution:

Messrs. Vergin, Headworth, Hyde, C. Taylor, B. King

cc: Messrs. Stoutjesdijk, Bhatt, Nankani

Those listed below

December 1, 1977

Orville F. Grimes, Jr., VPD

Panel to Review Research Proposal

1. A panel consisting of Messrs. B. de Vries (Chairman), G. Kalu, K. Laursen, F. Moore, and G. Pfeffermann has been established to review the attached research proposal on Monday, December 12 at 3 p.m. in Room D556.

Proposal

Staff Responsible

Key Institutions and Expansion
of Manufactured Exports

D. Keesing/K. Dervis

2. As is customary, the panel should seek answers to questions like (a) Are the issues raised by the proposed research of interest to the Bank? and (b) Is the study so designed as to deal meaningfully with these issues? To aid in considering the quality and relevance of the proposed research, panel members may find useful the attached guidelines for preparation of research proposals.

3. The recommendations of the panel should be sent to me as soon as possible after the meeting.

Attachments

Distribution:

Messrs. B. de Vries, Kalu, Laursen, F. Moore, Pfeffermann, B. King

cc: Messrs. Keesing, Dervis, Weigel, Dubey, Stoutjesdijk, Westphal (o/r)

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Class of Service: **TELEX**

Date: **NOVEMBER 29³⁰, 1977**

Telex No.:

Originators Ext: **5469**

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PRELIMINARY STAFF VIEWS SUBJECT TO POSSIBLE CHANGE AS THE RESULT

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OF ANY NEW INFORMATION FROM DECEMBER MEETING. IN PARTICULAR OUR

CONCERN RE EXPANSION INTO POPULATION SHOULD BE MENTIONED. BBB

FOR YOUR INFORMATION, WE MET LAST WEEK WITH DR. MOSLEY AND

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H. GRAVES, CONSULTANT, IN WASHINGTON. FOLLOWING IS A SUMMARY OF

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THIS MEETING. (A) MOSLEY INDICATED THAT NEW CENTER WOULD EMPHASIZE

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THE ESTABLISHMENT OF CLINICAL FIELD TRIALS BUT BASIC BIOMEDICAL

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RESEARCH WOULD BE MINIMALLY CARRIED OUT IN BANGLADESH. HE

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ACKNOWLEDGED NEED TO ESTABLISH PROPER COOPERATIVE ARRANGEMENT WITH

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RESEARCH INSTITUTIONS ABROAD; HOWEVER THESE ARRANGEMENTS HAVE STILL

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TO BE WORKED OUT. HE ALSO EXPLAINED THAT CENTER WOULD NOT COVER

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POPULATION AS SUCH, ONLY INDIRECTLY, WHEN FERTILITY, ETC. ARE

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AFFECTED BY HEALTH OR NUTRITION. ACCORDING TO MOSLEY, DR. IBRAHIM

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IS NOW IN FAVOR OF CENTER PROPOSAL. MOSLEY STRESSED THAT

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COMMUNICATIONS SECTION

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 FOR YOUR INFORMATION. WE MET LAST WEEK WITH DR. MOSLEY AND
 CONCERN RE EXPANSION INTO POPULATION SHOULD BE MENTIONED. BUT
 OF VIA NEW INFORMATION FROM DECEMBER MEETING. IN PARTICULAR OUR
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 ALSO COMPLEX NATURE OF OUR WORK BUT INFORMATION AS REPRESENTING
 FOR WHICH WE ARE SEND (MOGHEA RESEARCH LABORATORY). AND PLEASE

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DUSCA BANGLADESH

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Class of Service: TELEX page 2 Date: NOVEMBER 29³⁰, 1977

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COOPERATIVE ARRANGEMENTS BEING WORKED OUT WITH OTHER BANGLADESH INSTITUTIONS. (B) CENTER'S RELATIONSHIP WITH WHO NOT CLEAR AT THIS STAGE. MOSLEY IS TRYING TO ENLIST AN INTERNATIONAL ORGANIZATION LIKE BANK TO BE CONVENER OF QUOTE INFORMAL MEETINGS OF DONORS UNQUOTE AND TO SPONSOR CENTER, PRIMARILY BECAUSE THIS WOULD ESTABLISH PROPER FRAMEWORK FROM OTHER DONORS TO PROVIDE FINANCIAL SUPPORT. MOSLEY IS PRESENTLY CONCENTRATING EFFORTS IN TRYING TO OBTAIN SUPPORT FROM UNDP (HE REALIZED THAT WHO AND BANK MAY HAVE PROCEDURAL PROBLEMS IN TERMS OF ACTING AS CONVENER). (C) MEETING OF INTERNATIONAL SCIENTISTS DID NOT TAKE PLACE IN DACCA OCTOBER/ NOVEMBER AS SCHEDULED AND EXPECTED TO TAKE PLACE IN FEBRUARY 1978. (D) MOSLEY EXPLAINED THAT RESEARCH NEEDS IN BANGLADESH WOULD BE BETTER TAKEN INTO ACCOUNT WITH THE INTERNATIONALIZATION OF CHOLERA RESEARCH LAB (SO FAR THE U.S. NIH HAS HAD MAJOR SAY IN DEFINING CRL'S RESEARCH PROGRAM). CENTER'S BOARD OF DIRECTORS WOULD COME LARGELY FROM DEVELOPING COUNTRIES. (E) CONCERNING DANGER OF HAVING CENTER ATTRACTING SCIENTISTS FROM OTHER BANGLADESH INSTITUTIONS, MOSLEY SAID THAT THE REAL PROBLEM IS THE FANTASTIC BRAIN DRAIN CURRENTLY OF SCIENTIFIC PERSONNEL TAKING PLACE FROM BANGLADESH, IN PARTICULAR TOWARD THE MIDDLE EAST. (F) WE INFORMED MOSLEY THAT

K [TELETYPE TRANSMISSION] [RECEIVED] [NOV 29 1977] [WORLD BANK] [COMMUNICATIONS SECTION] [WASHINGTON, D.C.]

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SUBJECT:	DRAFTED BY: LPlesch:va
CLEARANCES AND COPY DISTRIBUTION: Cleared & cc: Dr. Lee cc: Dr. Kanagaratnam (o/r), Messrs. Blobel, Rajagopalan, L. Weiss, A. Berg, Chernichovsky, Pisharoti.	AUTHORIZED BY (Name and Signature): L. Plesch <i>Luis A. Plesch</i>
	DEPARTMENT: S. Asia Program
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Class of Service: TELEX Page 3 Date: NOVEMBER 29, 1977
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PISHAROTI WOULD REPRESENT BANK AS OBSERVER AT DECEMBER MEETING IN
DACCA. REGARDS PLESCH.

NOT TO BE TRANSMITTED

SUBJECT:	DRAFTED BY:
Health	LPlesch:ya
CLEARANCES AND COPY DISTRIBUTION:	AUTHORIZED BY (Name and Signature):
Cleared & cc: Dr. Lee	L. Plesch <i>Luis A. Plesch</i>
cc: Dr. Kanagaratnam (o/r),	DEPARTMENT:
Messrs. Blobel, Rajagopalan,	S. Asia Programs
L. Weiss, A. Berg, Chernichovsky,	SECTION BELOW FOR USE OF CABLE SECTION
Pisharoti.	CHECKED FOR DISPATCH

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Mr. Purviz N. Damry, SEC

November 30, 1977

Attila Karaosmanoglu, VPD

Date of Board Discussion of Research Program

As we discussed yesterday, I see some merit in postponing the Board discussion of the Annual Report on Research to make the report of the Advisory Panel on Income Distribution and Employment (RAPIDE) available to the Executive Directors before the discussion takes place. As an independent body, RAPIDE cannot be held to a strict deadline. Panel members are of course fully aware of the established timetable for Board discussion of the Annual Report on Research in mid-February, and will make every effort to produce their own report for circulation to the Board about four weeks earlier. However, based on the latest information at our disposal, we should realistically anticipate that Board circulation of the RAPIDE report may well not occur until late January, with a fair chance of its occurring somewhat later. We shall have a better feel for the timing of the report after the Panel meeting scheduled for December 13. In the present circumstances, we feel it advisable to request a two-week postponement of the Board research date, from February 14 to February 28, 1978.

AKaraosmanoglu/OFGrimes:nf

cc: Messrs. Chenery
B. King
Grimes

Those Listed Below

November 30, 1977

Orville F. Grimes, Jr., VPD

Panel to Review Research Proposal

1. A panel consisting of Messrs. J. Holsen (Chairman), T. Goering, D. Keesing, P. Meo and G. Pyatt has been established to review the attached research proposal on Wednesday, December 7 at 3:00 p.m. in Room A-907.

Proposal

Staff Responsible

Research Support for World
Development Report

R. Cheetham/J. Waelbroeck,
W. Tims

2. To aid in considering the quality and relevance of the proposed research, panel members may find useful the attached guidelines for preparation of research proposals.

3. The recommendations of the panel should be sent to me as soon as possible after the meeting.

Attachments

OFGrimes:nf

Distribution:

Messrs. Holsen*, Goering, Keesing, Meo, Pyatt, S. Gupta, B. King

(*without proposal; distributed earlier)

cc: (for information)

- Messrs. Chenery
- Karaosmanoglu
- Duloy (o/r)
- Avramovic
- Mrs. Hughes
- Messrs. Cheetham, D. C. Rao

Mr. Barend A. de Vries, IDF

November 30, 1977

Orville F. Grimes, Jr., VPD

Education Research

1. Enclosed herewith are the materials we have assembled so far on education research projects. First is a table showing budgetary resources and staff time devoted to all current and completed studies. Proposals, review panel memoranda, and completion reports for many of these projects are also included. Four projects (670-44, 670-46, 670-51 and 670-91) have been evaluated to date; evaluation reports for these projects have been appended. We have also added "abstracts" of the studies recently approved, for which disbursements are just beginning.

2. If we can assist further, please let us know.

OFGrimes:nf

Enclosures

cc: Mr. B. King

Those Listed Below

November 29, 1977

Orville F. Grimes, Jr., VPD

Panel to Review Research Proposal

1. A panel consisting of Messrs. R. Picciotto (Chairman), S. J. Burki, O. Price and M. Selowsky has been established to review the research proposals listed below on Thursday, December 1 at 3:00 p.m. in Room D-860.

<u>Proposals</u>	<u>Staff Responsible</u>
(a) Projections on the Extent of Food Deficits of Target Groups Under Alternative Policy Programs	B. Abbai/G. Donaldson
(b) Sector Planning for Agricultural and Rural Development: Implications for Bank Sector Work	G. Donaldson/B. Abbai, A. Egbert

2. Professors Knudsen and David, Brookings Fellows affiliated with the Agriculture and Rural Development Department (AGR) for the academic year 1977-78, would carry out the bulk of the proposed research. Research Committee approval of these proposals thus entails a shift in the financial charge of their tenure from AGR to the research budget, in addition to their commitment to the specific work programs outlined. With this background, panel members should, in the usual manner, make their recommendations on the basis of the intrinsic merits of the proposals. A general updating with details on the budgets will be provided at the meeting by the research sponsors.

3. The recommendations of the panel should be sent to me by Thursday, December 8.

OFGrimes:nf

Attachments

Distribution:

Messrs. Picciotto*, Burki, O. Price*, Selowsky*, B. King
(* memorandum only; proposals distributed earlier)

cc: Messrs. Donaldson (w/att.), Abbai, Egbert, David, Knudsen

Files

November 28, 1977

Benjamin B. King, VPD

FY79 Research Budget (Interview with E. Stern)

1. There is a lack of communication of research results, with no mechanism for dissemination on either side (researchers or user). South Asia Region is trying a new experiment. One or two economists will be taken off their regular duties for a period of 3-6 months each and attached to the Chief Economists' Office to carry out approved work of their choosing. This would include work which would be the basis of a further research proposal.

2. Resources for dissemination and state-of-the-art papers (as in para. 4, November 10) are a high priority. At present, research results reach one or two people in a region at most. For example, if 2-3 day workshops like the one proposed by DRC on income distribution and poverty were to be instituted, Mr. Stern said that, unquestionably, South Asia would make 3 economists completely free to attend it; he thought that every region should do this.

3. Subjects of possible interest for research are:

- (i) The whole question of revenue-raising. Comparative performance of different levels of government and of countries at different income levels. This is important in relation to charges in specific projects (lending rates, prices for utilities and other services). This should not be considered solely on a project basis. If a government has a good revenue-raising record, it should be less constrained in its freedom to subsidize target groups.
- (ii) We really know next to nothing about employment generation, particularly indirect effects. Present guidelines are inadequate.
- (iii) Large country models are a low priority, at least for Bank work. They cannot be very useful, unless actually adopted by countries themselves.
- (iv) How far should processing of raw materials in the country of origin go (in terms of efficiency,

levels of production, employment consequences) and how do you get it started? Maybe, this is too product and country specific, but perhaps some lessons can be drawn from experience.

- (v) The size and management of country buffer stocks, in food particularly, is an important policy question. While some research is going on, perhaps increased resources are required to speed up and broaden this investigation.

BBKing:nf

November 28, 1977

Mr. R. H. G. Bos
Netherlands Universities Foundation
for International Cooperation
Badhuisweg 251
Postbus 90734
2509 LS 's-Gravenhage
Netherlands

Dear Mr. Bos:

I am now in a position to send you the package of documents I referred to in my letter of September 29. Enclosed you will find:

- (a) Guidelines for Submission of Research Proposals;
- (b) Status Report;
- (c) Completion Report;
- (d) Guidelines for Evaluation of Completed Research Projects.

Research proposals are initiated within the Bank, though the original idea may come from outside and much of the subsequent research may be done outside. The point is that proposals should finally reflect the needs of the Bank, as well as the interests of the researcher. Document (a) represents therefore the guidelines for sponsors of research proposals in the Bank.

Once a proposal is put forward, it is submitted for appraisal to a review panel of about five staff members, chosen from various parts of the Bank. We try to include those with relevant methodological expertise on the one hand and potential users on the other. The Chairman of the panel is a member of the Research Committee.

The panel's recommendations are submitted by the Chairman to the Research Committee, which has 12 senior members of the Bank's staff (again with varied representation); the Chairman is the Vice President, Development Policy Staff (Hollis Chenery). The Research Committee approves it (with or without modification), sends it back for further work or rejects it.

November 28, 1977

Once a proposal is approved, the project receives appropriations each year, which cannot in total exceed an authorized limit, except marginally, without further recourse to the Research Committee. Status reports (document (b)), describing the project's progress, are sent to us three times a year by the project's supervisor, who is usually the original sponsor.

When a project has been completed, the supervisor is asked to evaluate the project himself. This is done on document (c) (recently revised). An evaluation panel, chosen in much the same way as those for the original proposal, is then selected to make an independent evaluation. Guidelines for this process are in document (d). When completed, this report is placed on file with the Bank's Director-General, Operations Evaluation, where it may be examined by the Bank's Executive Directors.

The above are official documents. Some very informal notes of our own (not for circulation or quotation) on how well or badly the system works are enclosed as (e). They are rather cryptic, but I could enlarge on any of the points, if you wish. I do now expect to be in England during the week of April 17-21. If you would like me to come to Holland at about that time, please let me know.

Yours sincerely,

Benjamin B. King
Research Adviser
Development Policy

Enclosures

BBKing:nf

Distribution List

November 23, 1977

H. G. van der Tak

Research Needs in Population, Health and Nutrition

The attached memorandum of Hollis Chenery refers and is, I believe, self-explanatory. Dragoslav Avramovic has kindly accepted to join me as a panel member. I should like to meet with you to discuss research requirements in the area of population, health and nutrition on Friday, December 2, at 3:00 P.M., in Room E-1026. Any written reactions would also be most welcome.

Attachment

HGvanderTak:lfb

Distribution List

Messrs. Kanagaratnam/Baldwin
Messrs. Berg/Schebeck/Basta
Messrs. Lee/Liese/Golladay
Messrs. T.King/Reutlinger/Selowsky
Mr. Sharpston
Mr. Wright

cc: Mr. Avramovic
Mr. B.B. King

OFFICE MEMORANDUM

TO: Distribution List

DATE: November 23, 1977

FROM: H. G. van der Tak

SUBJECT: Research Needs in Population, Health and Nutrition

The attached memorandum of Hollis Chenery refers and is, I believe, self-explanatory. Dragoslav Avramovic has kindly accepted to join me as a panel member. I should like to meet with you to discuss research requirements in the area of population, health and nutrition on Friday, December 2, at 3:00 P.M., in Room E-1026. Any written reactions would also be most welcome.

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Mr. Sharpston
Mr. Wright

cc: Mr. Avramovic
Mr. B.B. King

OFFICE MEMORANDUM

TO: The Research Committee

FROM: Hollis B. Chenery *ABC*

SUBJECT: FY79 Research Budget Recommendations

DATE: Nov. 10, 1977

1. In order to make recommendations to Mr. McNamara for next year's research budget, I have decided that we should make a limited internal survey of the various research areas to see whether it would make sense to suggest any significant change in the budget or any marked shift in priorities within it. This will be a stopgap measure, pending the completion of a series of panels on the lines of RAPIDE, a process which may take a couple of years. I am asking for your cooperation in this survey.
2. Procedure. At a meeting with Messrs. Balassa, Duloy, B. King and van der Tak, a procedure for carrying out this survey was agreed as the most promising in the circumstances. Each Research Committee member will chair a small panel-- one or two staff members in addition to himself, with adequate user representation. The additional members may be of his own choosing, or Messrs. King and Grimes will assist in picking them, if so desired. The panels will be of two kinds. One will review subjects mainly with producing departments; the other will discuss research requirements with regional offices. A tentative list of assignments is attached (Table 1). The panel will have one or (in exceptional cases) two meetings, at which plans, priorities or requirements will be discussed, and will then report back to the Research Adviser, much as other panels do.
3. Substance. We would like to ascertain broad answers to the following questions:
 - (i) Are there any uncovered areas of research which the Bank ought to be doing, which cannot be covered under existing fiscal constraints by phasing out "softer" areas within the sector?
 - (ii) If so, is the constraint on external funds, internal staff time, or both?
 - (iii) If constraints were removed, how much would it cost roughly (in \$100,000 of external funds and man-years of staff time)? A table of recent expenditures is appended (Table 2).

4. It is to be noted that included in this survey would be dissemination of existing tools or knowledge (mainly requiring internal resources) and state-of-the-art papers to bring people up to date (external resources could readily be used here with little impact on staff time).

5. Timing. I would hope that the panels could meet and deliver their reports (2 or 3 pages) by December 9. King and I will then prepare a consolidated report to McNamara indicating the nature of the budgetary alternatives.

Attachments - 2

cc: Mr. Baum
CPS Directors
DPS Directors
Chief Economists
Mr. Grimes

BBKing:HBChenery:di

Table 1

Tentative Assignment List

<u>Assignment Subjects</u>	<u>Assignee</u>	<u>Interviewees 2/</u>
a) Income distribution/employment <u>1/</u> b) Public finance	Little	a) Ahluwalia, Leiserson b) Bhatt
Country analysis	Holsen	Duloy, Pyatt, Norton, Cheetham
Industry and Trade	Balassa	Westphal, Laursen, Moore
Agriculture & Rural Development	Picciotto	Yudelman, Duloy, Leiserson
Transportation	Jaycox	Willoughby, Harral
Public Utilities	Vergin	Rovani, Warford
Urbanization	Waide	Jaycox, Keare
Education	de Vries	Hultin, Jallade, T. King
Population, Health & Nutrition	✓ <u>van der Tak</u>	Kanagaratnam, T. King, Schebeck, Basta
<u>Regions</u>		
S. Asia, E. Asia	B. King	Waide, Hasan
LAC, E. Africa	Lerdau	Holsen, Gulhati
EMENA, W. Africa	Dubey	Dubey, de Azcarate

1/ Can clearly not say too much, pending RAPIDE report.

2/ Indicative list.

BBKing:di
November 10, 1977

Table 2

Research: Comparative Expenditure Data (RPO's only)

<u>Category</u>	<u>Exp. (\$000)^{a/}</u> <u>(Av. 1975/77)</u>	<u>Author. (\$000)</u> <u>(1978)</u>	<u>Man-years FY76</u>	
			<u>Prof.</u>	<u>Res. Ass</u>
IB Income Distribution	337	69	5	2
II.C Country Analysis	337	154 <u>c/</u>	3	2
II. Trade	160	167	2	1
III. Agriculture	394	517	2	1
IV. Industry	141	217	5	2
V. Transportation	317	148	4	3
VI. Public Utilities	125	401	3	2
VII. Urbanization	182	317	<u>b/</u>	<u>b/</u>
VIIIA Education	70	236	2	1
VIIIB Employment	188	149	1	-
VIIIC Pop. & Health	108	83	1	1
Other	<u>11</u>	<u>56</u>	<u>-</u>	<u>-</u>
Total	2,370	2,514	28	15

a/ \$ of FY78.

b/ Under 0.5.

c/ Will very likely be increased.

Note: The figures for man-years are all that are available so far and are not terribly reliable. They should be interpreted as giving a ball-park order of magnitude of the resources used.

BBKing:nf
November 8, 1977

RES. - GEN.

November 23, 1977

Mr. Clell G. Harral
c/o Mr. Jochen Kraske
Chief, World Bank Resident Mission
P. O. Box 416
New Delhi, India

Dear Clell:

Please find enclosed a complete draft of the SOL case study. In this version I have tried to reflect your comments on sections A and B, transmitted to me by Basil Coukis. Aside from some minor editorial suggestions which there has not yet been time to consider, Basil Coukis' comments on all sections have also been incorporated. Basil also offered to give a copy to Phil Green, whose suggestions should prove most valuable.

The enclosed draft is simultaneously being sent to the wider circle of those having participated in the study (Carnemark, Leon Miller, Willoughby, Jaycox, etc.), along with selected Regional staff, the Research Committee, and Peter Thormann (USAID). I hope to have comments from many of them by the time you return. We should then be able to put the chapter in final on or about Friday, December 16.

We much appreciate your willingness to review the draft prior to your return, and look forward to receiving your reactions.

With best regards.

Sincerely,

Orville F. Grimes, Jr.
Secretary to the
Research Committee
Development Policy

Enclosure

OFGrimes:nf

OFFICE MEMORANDUM

TO: Those Listed Below

FROM: Orville F. Grimes, Jr., VPD *OF*

SUBJECT: Forthcoming Research Committee Meeting

DATE: November 23, 1977

1. It is likely that following its meeting in mid-December, the Research Committee will next meet in the latter half of February. To be considered at this meeting, proposals in final form should consequently reach this office no later than Friday, January 13.

2. I would appreciate it if those planning to submit proposals for the February meeting would confirm, by the end of December, their intention of doing so. Even more than usual, submission of proposals in draft form prior to the January 13 deadline will greatly facilitate the review process.

OFGrimes:nf

Distribution:

Research Committee Members
DPS, CPS Directors and Division Chiefs
Regional Chief Economists
Mr. Lowther
Ms. Stout
Miss Hidalgo-Gato
Miss Peter
Mrs. Cleave
Mrs. Hazzah

OFFICE MEMORANDUM

yellow

TO: Mr. Hollis B. Chenery
FROM: Benjamin B. King *BBK*
SUBJECT: Annual Report (Chapter I)

DATE: November 21, 1977
REG. GEN.

1. You will receive drafts of Chapters II and III this week, so it is time to think about Chapter I. The following suggestions are based on the assumption that we want to gradually streamline the report, a process started with the preparation of Appendix A, which you already have.

2. The chapter would consist of three main parts:

- (a) Very brief introductory section with some restatement of "objectives". The E. D.'s have already expressed the view that the original statement (footnote p. 5 in last year's report) is on the vague side. What more or less can we say? Perhaps some ideas will come out of the R. C. review.
- (b) Financial evolution and resources employed. This would pull together the counterparts of para. 1.6 and chart (pp. 2 and 3) and paras. 2.1-2.3 and tables 2.1 and 2.2 (pp. 14-16), plus truncated guidelines table (not in last year; p. 8 in previous year). Maybe we should have new guidelines or say that new ones are being put together.
- (c) Evaluation. We have some notes to go on (copy attached) for RAPIDE. Also reference to RAPIDE, but no attempt to "scoop" its results.

3. This omits any discussion of dissemination, which I think is still an issue. But there isn't much positive to say.

4. Can we discuss?

BBKing:nf

Attachment

Annual Report/RAPIDE Notes

- (i) The Bank should be quite specific in the objectives of work entrusted to consultants, rather than sending them off with vague terms of reference. Payment should be by completion of specified tasks.
- (ii) This implies that adequate staff time is a necessary condition.
- (iii) Long projects should be phased as far as possible.
- (iv) Open-ended projects, where the researcher is embarking on a voyage into unknown territory, should have a preliminary phase, the object of which is to define the project more narrowly.
- (v) It may not be enough to have general agreement among all interested parties in the Bank at the beginning of a project. Steering committees or advisory groups should always be considered for substantial projects, if only to prevent the "interested parties" saying at the end that they were not informed of progress.
- (vi) Host country approval is vital. It must be more than the tacit agreement of a few officials.
- (vii) Researchers always overstate their case. One should beat down their claims to a realistic level.

- (viii) Data collecting always takes far more processing time (cleaning) than anybody thinks.
- (ix) Except for data processing, overruns are more in time than in money. Reasons not fully understood, but include (a) overcommitment of consultants; (b) exogenous demands on Bank staff time; (c) side-tracking, which, even if interesting and sometimes important, is not strictly part of the original proposal.
- (x) Ultimate dissemination gradually loses steam, possibly because of exhaustion or managerial imperative to begin new cycles of work. How to deal with this is not clear.
- (xi) Research Committee does not function well as an "ideas" group. It is better suited to considering specific projects.
- (xii) Mid-term reviews may be required whenever a project (of whatever size) changes objectives or direction.
- (xiii) No matter how well lessons are learned and are seen by project sponsors stark and clear in other people's projects, mistakes have a habit of persisting, at least at preliminary stages. In other words, vigilance is a must.

Mr. John M. Kalbermatten

November 22, 1977

Richard W. Middleton

INDIA - Follow-up to World Water Conference

1. On November 4 I accompanied Mr. Williams (Chief ASPWS) and Mr. van Nimmen (Resident Mission, Delhi) to a meeting with Mr. N. Nasrullah, Joint Secretary, Ministry of Works of Housing, Government of India. Also present from the Ministry were Messrs. K. Biswas (Director, Urban Development) and C. R. Nagabhushana Rao (Deputy Adviser, Public Health Engineering).

2. Mr. Nasrullah emphasized his Government's commitment to the 1990 goals set by HABITAT and endorsed by the World Water Conference ^{1/}. However, given the magnitude of the problem (80 percent of the urban population receive water service - admittedly often of poor quality - but only 10 percent of the rural population), the Government is somewhat at a loss to know how to proceed.

3. He outlined a program of extending water supply to priority rural areas. These areas were identified in 1974 on the basis of distant (more than one mile) sources, endemic waterborne diseases, or objectionable (F, Fe, Mn) water constituents, and contained about 153,000 of India's estimated 587,000 villages. So far, however, water supply has been extended to only about 40,000 of the original 153,000. The reasons for the slow progress included diversion of funds by the states (which are responsible for water supply) to other projects and the inability of these poor areas to produce the required 30 percent of project costs. It had now been decided to make this a central government program, with the objective of serving the remaining villages by 1983. Rs. 40 crores had been allocated for the balance of the current year.

4. His aim in describing this program was, it appeared, to demonstrate the Government's serious attention to the sector. He did not request IDA assistance for this program (and, given its "worst first" nature, the lack of any consumer participation, its geographical dispersion and the uncertain support of the state agencies, it would almost certainly be difficult to develop a "Bankable" project). What his ministry now wants is assistance in sector planning and in coordinating and directing the efforts of the individual states. To this end Mr. Nasrullah would like the WB/WHO CP to complete sector studies in the states not already covered, then produce a synthesis in a master planning document which would examine not only the overall investment priorities and policy issues but also deal in depth with sector industries and materials requirements, manpower development, etc.

5. Such a massive undertaking is clearly beyond the resources of the CP. We explained to Mr. Nasrullah that we were endeavouring to assist sector development by CP decentralization, but nevertheless the input we could envisage from the SEARO CP would be limited to about two sector reviews each year, together with the work on the "rapid assessment" which is already under way. However; I consider it most important that we try to support the Government in this endeavour. One possibility appears to be to develop the proposals being discussed prior to the

^{1/} See, for example, the speech by the Satish Chand Agaswal, Union Minister of Finance, in Jaipur on November 6, when he pledged drinking water supply to all villages within the next 10 years, for which Rs. 2,000 crores would be

November 23, 1977

November meetings of the ACC and the Ad Hoc Group: to bring together the resources available from UNDP, UNICEF and other institutions for such a project under the direction of a small central executive group. Mr. Nasrullah promised the full support of his ministry staff in any such exercise.

6. As soon as the draft results of the "rapid assessment" for India are available, I recommend that we convene a meeting to discuss what further action can be undertaken.

cc: Messrs. Williams (ASPEW), Alisbah (ASA), Kraske (New Delhi)

RNMiddleton:jbe

Mr. John M. Kalbermatten

November 22, 1977

Richard N. Middleton

INDIA - Liaison with SEARO CP
Back-to-Office and Full Report

1. In accordance with my terms of reference dated October 6, 1977 I visited New Delhi from November 3 through 7 to participate in the above meetings. A list of those attending the meetings is attached as Attachment 1.

Summary

2. The agreements reached during the meetings, including the revised memorandum establishing the SEARO CP, the work plan for 1978 and the provisional work schedule for 1978, are in Attachment 2 and its Annexes 1-3. The attachment details the follow-up actions required on the part of SEARO, WHO HQ and the Bank (ASPWS). No follow-up is required by this department 1/.

Work Plan

3. The CP work plan for the countries which fall within the Bank's South Asia Region was agreed by Mr. Williams. That for the countries in the Bank's East Asia and Pacific Region was agreed by me, based on my briefing sessions with AEPWE prior to departure. The two highest priority items in this region's assistance in developing provincial cities water supply projects, were included in the work plan for 1978. Not included were assistance to Bangkok in reducing unaccounted-for water (for which SEARO considered they lacked the expertise) and a water supply tariff study for Jakarta (which SEARO stated was already in hand, through consultants). Part of the 15 percent "fire fighting" allowance could be devoted to assistance in preparing consultants' terms of reference for a sewerage study for Bangkok, if the government approaches the Bank for assistance. A telex reporting progress on the AEPWE work plan and proposing a liaison meeting in Jakarta between Messrs. Bruestle and Unakul was sent to HQ on November 4 (Attachment 3).

4. The Reserve Activities for AEPWE countries are all those suggested by SEARO. In addition, SEARO mentioned that in Thailand a UNDP-financed country-wide environmental health project which is expected to start in 1978 would include planning for the water supply and waste disposal sector.

5. The least well-defined elements of the work plan are those related to Country Health Programming; it was not clear exactly what was intended in each case, but the activities were allowed to remain since this is an important part of SEARO's current work. Detailed terms of reference for these activities will in any event be sent to the Bank for approval prior to commencement of work.

1/ Since the memorandum, as agreed, differed only marginally from the earlier Dieterich/Rovani draft, I approved it on behalf of the Bank; no formal confirmation is necessary.

Staffing

6. Dr. Gunaratne, WHO's Regional Director, expressed his interest in providing more than the stipulated 12 man-months of SEARO engineer support to the decentralized CP activities. An extra P5 sanitary engineering position will be created in 1978, partly to assist in CP work. SEARO requested that the Bank provide the names and CVs of suitable candidates, and a telex to this effect was sent to you on November 4 (Attachment 4).

7. Subsequently, Mr. Unakul reinterpreted Dr. Gunaratne's remarks, in the sense that additional support might be given from field staff rather than from SEARO, and he provided a list of all the sanitary engineering staff currently working in the region (Attachment 5). While there will be some circumstances in which it is more efficient and economical to use field staff than those from Regional HQ, the Bank should, in my view, make this the exception rather than the rule. In general, the CP should use the SEARO staff with whose competence we are satisfied and who are familiar with the Bank's requirements. Paragraph 2 of Attachment 2 reflects this position.

8. During the first year of SEARO CP activities, we will need to pay particular attention to the allocation of staff to particular activities. Apart from the field vs. HQ staff issue, of the four (soon to be five) SEARO staff only two (Messrs. Roy and Acheson) have direct experience of working with the Bank, and there may be some initial "orientation" problems with the remaining staff.

Budget

9. The agreed budget provisions are set out in Attachment 2, paragraph 9. It should be noted that it was agreed that the CP should cover travel costs of all staff except when they are engaged in activities which are clearly associated with SEARO's ongoing programs (that is, Country Health Programming and the Rapid Assessment). I believe that this is necessary (a) because of SEARO's apparently limited travel budget; and (b) because the travel costs of field staff would be subject to clearance by the governments of the countries in which they work unless met by CP. WHO HQ will be carefully monitoring these costs during FY 78, to ensure that they remain within the overall CP budget.

Reporting

10. The provision for monthly reporting during 1978 (Attachment 2, para 8) is expected to be superseded by quarterly reporting in 1979, once the SEARO CP is firmly established.

World Water Conference Follow-Up

11. At the end of our meetings Mr. Bachmann arrived from CP (Geneva) to begin work on the "Rapid Assessment". It is too early to judge how successful his work will be, or whether the amount of effort provided in the draft work plan is adequate. Meanwhile, the Indian government has expressed its interest in a far more ambitious country-wide analysis of the sector, which I recommend the Bank should support (see my memorandum to you dated November 22, 1977).

Attachments

cc: Messrs. Rovani, Bharier (EWTDR), Rajagopalan, (ASP), Beach (AEPEW), Heyland Williams (ASPEW), Blobel (ASA), Votaw (AEA), Ms. Boskey (IRD),
Ms. Peter (EWTDR)

WRNMiddleton:jbe

Messrs. Hollis B. Chenery & Orville Grimes

November 17, 1977

Benjamin B. King

Research Expenditure

1. I attach a couple of tables which may be of interest. The first shows expenditure in each subject category, divided by the "class" in which projects were initiated--in effect the year in which funds were committed (including any overruns or additions later). This table is in current dollars (as opposed to constant ones as in my table of November 10). It shows a very uneven level of commitment in a number of sectors.

2. The second table compares percentages of various concepts of expenditure with the guidelines in our earlier reports:

- (i) All expenditure and outstanding authorizations from 1972 to date;
- (ii) Actual expenditure 75/77, plus authorizations in 78 (this was the original basis for comparison);
- (iii) Actual expenditure, plus authorizations of the classes of 75 to 78 only (this gives an idea of the distribution of expenditure committed since 75).

BBKing:nf

Attachments

Sectoral Expenditure Plus Authorization by "Classes"

(\$m.)

	-----C L A S S-----							<u>Total</u>
	<u>72</u>	<u>73</u>	<u>74</u>	<u>75</u>	<u>76</u>	<u>77</u>	<u>78</u>	
IA	.19	--	--	--	--	--	--	.19
IB	.18	.15	.80	.17	.06	--	--	1.35
IC	1.10	.07	--	.24	.21	--	.09	1.71
II	.04	.02	.08	.26	.28	--	.03	.71
III	.33	.54	.12	.35	.26	.59	.20	2.39
IV	.37	.02	.25	.06	.15	.03	.17	1.04
V	1.76	.02	--	.14	--	.03	--	1.95
VI	.28	.02	.16	.05	--	.58	--	1.09
VII	.06	.08	.04	.38	.03	.59	--	1.18
VIIIA	.30	.04	.13	.04	.01	.21	.11	.85
VIIIB	--	.41	.03	.20	.19	.04	--	.87
VIIIC	--	.01	.04	.12	.13	--	.14	.44
Other	<u>.09</u>	<u>.01</u>	<u>.02</u>	<u>.01</u>	<u>--</u>	<u>.02</u>	<u>.06</u>	<u>.20</u>
Total	4.71	1.37	1.66	2.01	1.33	2.09	.80	13.97

November 16, 1977

Guidelines Compared

(%)

<u>Category</u>	<u>Guidelines 75/78</u>	<u>Exp. & Auth. 72 to date</u>	<u>Exp. & Auth. 75/78</u>	<u>Commitments 75 to 78 Classes</u>
IA	1.0	1.4	--	--
IB	14.0	9.7	10.5	3.7
IC	10.0	12.2	12.0	8.7
II	4.0	5.1	6.7	9.1
III	20.0	17.1	18.1	22.5
IV	10.0	7.4	6.7	6.6
V	10.0	14.0 ^{1/}	11.0 ^{1/}	2.7
VI	5.0	7.8	8.8	10.1
VII	10.0	8.4	8.9	16.1
VIIIA	5.0	6.1	4.8	5.9
VIIIB	5.0	6.2	7.2	6.9
VIIIC	5.0	3.1	4.2	4.3
Other	<u>1.0</u>	<u>1.4</u>	<u>1.0</u>	<u>1.4</u>
	100.0	100.0	100.0	100.0

1/ Of which 6.1 and 6.3, respectively, is capital-labor substitution.

November 16, 1977

Mr. Michael C. Beenstock

November 17, 1977

Benjamin B. King

RAPIDE

I attach for Al Fishlow, when he comes:

- (a) a set of four forms relating to research projects (submission guidelines, status report, completion report, evaluation guidelines);
- (b) some notes put together by Orville Grimes and myself on lessons learnt; and
- (c) my remarks to the Board last February (not supposed to be for direct quotation).

BBKing:nf

Attachments

Mr. Jeremy J. Warford, EWT

November 11, 1977

H. Reitze, CPSEN

IIED's Request for Names and Comments on a Study Proposal

1. As per our telephone conversation of this morning, I am hereby attaching a copy of IIED's draft proposal entitled, Project Appraisal Methodology for Environmental Aspects of Development. Thank you for providing me the names of Messrs. A. Kneese, W. Spofford, C. Howe and Prof. R. Haveman. I further appreciate your accepting my suggestion that I give the IIED your name also as a possible panel member for this study. Perhaps you may wish to give us your personal comments on the draft proposal at your convenience.

2. At your request I am also sending you a copy of IIED's interim report, Multilateral Aid and the Environment - A Study of the Environmental Procedures and Practices of Nine Development Financing Agencies. We would appreciate your comments on it.

Attachments

R.
HR/fb

cc: Dr. J.A. Lee
Mr. G.B. Baldwin

✓ NRIC
a Brazil-NE Development Program

RES. - GEN. - 2

Messrs. Yudelman, Merriam and Duloy

November 7, 1977

E. Lerdauf

BRAZIL : Clearance of two papers by Mr. Scandizzo

I attach the memo of Mr. Earwaker to Mr. Skillings (November 4), a copy of which has already been supplied to Mr. Scandizzo.

My own conclusions are:

1. There is no objection to publishing the paper Risk Attitudes of Subsistence Farmers in Northeast Brazil : A Sampling Approach, by Dillon and Scandizzo.
2. I do not think that the paper on Land Distribution, Tenancy Systems and Target Population in NE Brazil, by Scandizzo can be cleared for publication in its present form. Whether the problem is one of imperfect explanation of the research and reasoning underlying certain conclusions, or whether in fact these conclusions are - as they appear to the outside reader - non sequiturs, I am not prepared to say. But certainly conclusions that have a strong political flavor, or that rely on words with a high emotive value - such as exploitation - cannot be presented unless their basis is crystal clear.^{1/}
3. Aside from the comments of Mr. Earwaker, I have some particular questions. As he notes, the parameter values of Table 3.1 are of critical importance. But the institutional back-up for them is simply absent. Thus the relation between p_j and \bar{p}_j is simply stated to "... symbolize the higher price the landlord is able to obtain for his crop (because of his superior bargaining power in comparison to sharecroppers) ..." It is not clear whether this means that both sell to third parties but that landlords get a better price, or whether the sharecropper sells to the (monopsonistic) landlord, or what. In a paper published last year Mr. Scandizzo described the typical fazenda share contract as follows:

"... the landowner allows the sharecropper to produce enough subsistence crops to supply his family's consumption of basic foodstuffs; his other consumption is met from his retained share of the cash crop proceeds and from credit extended to him by the landowner. If the sharecroppers produce more than their subsistence, the landowner gets a 30% share, whereas he gets 50% of the cash crop, cotton. ... The shares of the crops retained by the sharecroppers are marketed through the landowner's facilities, who retains 25% of the proceeds for this service."^{2/}

^{1/} Personally, I would argue that this is true for research conclusions of any kind, but I don't view my own clearance function as going that far. I assume that the author or his editors will take care of such technical slip-ups as those noted by Mr. Earwaker in his para. 10-11.

^{2/} G.P. Kutcher and P.L. Scandizzo, A Partial Analysis of Sharetenancy Relationships in Northeast Brazil, Journal of Development Economics 3 (1976).

November 7, 1977

4. I do not see how the parameter values of Table 3.1 are consistent with this, but I may be wrong. The point is that the reader has to take them on faith.

5. I endorse Mr. Earwaker's para. 13, but I find myself much more concerned with his paras. 12 and 14, which go to the heart of the problems posed by the present version of this paper. I cannot find in it a satisfactory explanation of how the main conclusions are arrived at. I interpret these conclusions, in summary, to be that landlords, on average, appropriate an important share of the output produced by others, and would do the same at the margin if output were to increase as a result of various public initiatives (credit, etc.). The conceptual, analytical and statistical bases for these conclusions are simply not presented adequately.

6. Nor can I find a basis in the paper for the assertions quoted by Mr. Earwaker in his para. 15. These are generalizations often found in elementary textbooks on development, but in what way do this paper's results prove that a great part of land in the NE is "... held as a speculative asset and/or tool for privileges, social rank and power ... etc."?

7. Finally, I cannot understand the virtual exclusion of laborers from the analysis. They are numerically as important as sharecroppers, landlords and owner-operators.

cc: Messrs. Skilling
Pfeffermann
Donaldson
Earwaker
Scandizzo

ELerdau:jd

November 7, 1977

Mr. Neville Bulman
Deputy Head of Overseas Unit
Transport & Road Research Laboratory
Department of the Environment
Crowthorne, Berks RG 11 6AU
England

Dear Neville:

For sometime I have been meaning to ask you if you would care to offer an updated version of footnote 2 on the enclosed page which will go into the monograph we ultimately hope to issue on the "Economics of Highway Design and Maintenance Standards".

We are having a computing tape of the HDM run off to your specifications and I will be bringing also a copy of the (rough draft) User's Manual and Program Documentation volumes with me -- as well as the Accra paper -- when I call in at TRRL next week.

Incidentally I hope to spend three days in Nairobi prior to the Accra meeting. I hope John Rolt can spare me an hour or two to bring me up to date on his work with the RARP.

Sincerely yours,

C.G.H.

Clell G. Harral
Highway Design & Maintenance Adviser
Transportation Department

CGHarral:phm

Enclosure

November 7, 1977

Professor R. Vaitheswaran
Department of Economics
Coe College
Cedar Rapids, Iowa 52402

Dear Professor Vaitheswaran:

In reply to your letter of October 24, the titles in which you are interested are of research projects currently under way. There is no presumption that such projects will produce a single final report of the same title. We have consequently tried to list, at the end of each narrative, any published reports having arisen in the course of the study. Where none are listed or to obtain other information about the project, we ask that inquiries be addressed to the responsible project supervisor whose name appears following each narrative.

In the event, none of the projects that you list has issued a final report. In one case, that of the project on "Labor Force Participation, Income, and Unemployment" (No. 670-45), a draft study of the urban labor market in Peninsular Malaysia is currently undergoing final revision and is scheduled to be available within a few months' time. You might then wish to inquire as to its availability of Mr. Mazumdar, the principal researcher. It is further doubtful that materials prepared under the study of Agricultural Mechanization in India (No. 670-14) will in fact be assembled in a final report. However, a somewhat similar study of mechanization in Pakistan was undertaken at about the same time, and on the premise that you might find it of interest I am enclosing a copy of the final report. For the other projects you would again wish to contact the principal supervisors listed, noting that in the case of the Employment Models and Projections project (No. 671-06) your inquiry should be addressed to the current monitor, Mr. Ardy Stoutjesdijk, of the Development Economics Department.

Thank you for your inquiry.

Yours sincerely,

Orville F. Grimes, Jr.
Secretary to the
Research Committee
Development Policy

Enclosure
OFGrimes:nf
cc: Mr. Mazumdar

✓ NRCC
cc Brazil - NE Development Program
RES. - GEN.

Mr. Robert F. Skillings, LC2

November 4, 1977

Frank J. Earwaker, LC2

Clearance for Publication of Papers by Scandizzo, and by Dillon and Scandizzo

1. This memo responds to your request to read and comment upon two papers entitled "Land Distribution, Tenancy Systems and Target Population in Northeast Brazil" and "Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach".
2. The first paper is based on census data from the IBGE and INCRA as well as from the IBRD-SUDENE farm survey. The second paper is based on data from a field survey conducted by the Federal University of Ceara. As far as I can see, neither paper reveals material of a confidential nature. Nor does either paper purport to represent the Bank in any way.
3. I do not know whether the quality and propriety of papers written for publication by staff members is considered a proper matter for Bank scrutiny or whether that judgement is left to the publisher. The two papers differ quite substantially in this respect.
4. In their paper "Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach", Dillon and Scandizzo analyze the response of 130 sharecroppers and small farmers when faced with a choice between risky and secure production patterns posed to them hypothetically by interviewers. The paper examines the influence of socio-economic characteristics upon the risk-preference revealed by the respondents. It concludes that risk aversion is more a characteristic of small farmers than of sharecroppers. It suggests that a special paternalistic relationship between landowner and sharecropper may protect the latter from production risks to some extent. The independent small farmer, on the other hand, must bear all production risks himself and is therefore more risk conscious. Attitudes to risk appear to be influenced by level of income and also by other socio-economic variables, however.
5. With respect to the substance of the paper I have two reservations. First, the respondent's choice between risk alternatives in a hypothetical "game" setting may be quite different from their choice between risks in the real world. In the former situation the respondent has nothing of substance to lose or to gain. He is quite free to project an image of cautious deliberation or of energetic entrepreneurship as he may think appropriate. Second, the sample of 130 farmers was quite small and fully 20% of the respondents were excluded from the analysis because they gave unsatisfactory answers. The statistical tests of significance computed by the authors do not take into account adequately the 20% non-response rate, and this may distort their findings.
6. Notwithstanding these reservations I think the paper has merit as an interesting piece of research. It is written in a sober and scholarly manner. I see no reason why the Bank should object to its publication.

7. Mr. Scandizzo's paper "Land Distribution, Tenancy Systems and Target Populations in Northeast Brazil" is a much more broad ranging document. First, it examines the distribution of land in Northeast Brazil and finds it to be highly skewed. After making due allowance for differences in land quality the paper concludes also that the distribution of wealth (incorporated in land) is no less skewed than is the distribution of land itself. Second, the paper considers the relationship between the distribution of land and the distribution of income. Although the distribution of agricultural income in the Northeast has quite a low Gini coefficient (between 0.3 and 0.4), Scandizzo argues that there exists, nevertheless, a "peculiar type of inequality" which is characterized by an almost uniform distribution except for the top five percentile. He suggests a different measure of skewness to bring out this "peculiar type of inequality". Third, the paper examines the land tenure system and calculates the share of agricultural production attributable to various population groups (laborers, sharecroppers, owner-operators, landlords etc.). In this section it is concluded that whereas the landlords constitute only one percent of the labor force and produce none of the agricultural output, fully 11.4% of the output accrues to them by way of transfers from other groups. "The sharecroppers for example, are producing a share of gross output larger than their share in the populations, but a large part of it is appropriated by landlords" (p. 31).

8. Developing this latter point the paper then examines the distributional effect of productivity increases with special reference to the landlord-sharecropper relationship. In this section, Scandizzo concludes that, for each of the three major crops (cotton, corn and beans) explicitly considered, the benefits of increasing productivity would accrue "almost completely" to the landlords. Indeed, the benefits accruing to sharecroppers and small farmers are so small, claims Scandizzo, that when due account is taken of the risks (due to drought, etc.) associated with expanding output, the rational sharecropper will eschew any suggestion of increasing productivity.

9. The paper then examines "the credit problem" as a final issue. It assumes that most of the credit received by sharecroppers is channeled through the landlord. It calculates that the landlord receives the greater part of the increased productivity which results from the sharecropper having access to credit. It calculates, furthermore, that the landlord, by virtue of his role as financial intermediary, will benefit directly from high interest rates at the expense of the sharecropper and small farmer.

10. As it stands the paper has a number of shortcomings. There are many signs of hasty writing and sloppy workmanship. Some sentences are blatantly self-contradictory; e.g. "An increase in productivity of beans and/or cotton would benefit sharecroppers and small farmers more than landlords, whereas increase in the field of beans would benefit the landlords more." (p.42). In several instances the text is at variance with the tables. The sentence quoted above provides a case in point. No matter how the internal contradiction within the sentence may be resolved, table 3.2 indicates that landlords

would benefit from productivity increases in any crop (cotton, corn or beans) more than sharecroppers and/or small farmers.

11. More seriously, the methodology behind many of the computations is unclear and inadequately explained. The estimates of output attributable to different population groups (table 2.6), and the estimated impact of interest rates on income (table 3.10) appear as though pulled out of a hat. Even the algebra is wrong in places. Equation (4) on page 39 seems to have been obscured by typographic errors but there is also a term missing in the reduced form. Were the results in the subsequent table 3.2 calculated on the basis of the correct algebra or the incorrect algebra?

12. In common with all quantitative research work, the conclusions reached by this paper stem directly from the parameters put into the underlying model. Yet there is no detailed definition or explicit assessment of these parameters. "All values are simple averages calculated from survey data" (p. 40). The unit cost of production for each crop and the sharecroppers share of the unit cost are crucial concepts that need elucidation before a meaningful interpretation can be placed upon the conclusions of the analysis. Everything hinges upon the parameters specified in table 3.1.

13. In addition to these shortcomings the paper makes a number of unsupported assertions by way of gratuitous elaboration of its general theme. It asserts, for example, that the minifundio class is the main victim of inflation (p. 9). That is the first and last mention of inflation in the paper. It asserts also that "progress measures would be successful only if agrarian reform plans could be directed towards augmenting the small farm populations" (p. 50). Nowhere else in the paper is agrarian reform examined.

14. In general, the paper lacks those searching qualities of critical appraisal that one normally associates with good research work. It is written from a very partial point of view. Thus, in developing the material on income distribution set out in table 2.6 (p. 31), it makes a big point that landlords apparently get more than they produce (they produce nothing). It completely ignores the parallel conclusion that temporary laborers also appear to get more than they produce. Could it be that the latter conclusion is less in keeping with Mr. Scandizzo's political predispositions and is therefore to be ignored? In fact, both conclusions seem far-fetched yet the reader looks in vain for some critical assessment of them.

15. At times, indeed, the paper reads more as a political polemic than as a research paper. For example "the results tend to support the contention that a great part of the land in the Northeast is held as a speculative asset and/or tool for privileges, social rank and power rather than as a factor of production" (p. 7). Or, again, "sharecroppers would be at a disadvantage with such a development strategy since it provides them no means to escape exploitation, imposed by the landlord" (p. 59).

Mr. Robert F. Skillings

- 4 -

November 4, 1977

16. These observations by no means exhaust my misgivings concerning the quality and propriety of Mr. Scandizzo's paper. I do not know whether the prospective publishers (IICA-OAS) share my misgivings. I believe, however, that for Bank staff to publish this sort of paper could detract from the reputation of the Bank itself even if a standard disclaimer is printed at the head of the article.

cc: Mr. Scandizzo, DRC

FJE:smn

FJE

November 3, 1977

Professor Robert E. Baldwin
Department of Economics
Social Science Building
University of Wisconsin
Madison, Wisconsin 53706

Dear Professor Baldwin:

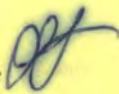
At the request of Helen Hughes, I am enclosing copies of two successful submissions to the Bank's Research Committee, which you might find of use in drafting your own proposal. Length and content, you will note, vary according to the research agenda proposed and the amount of preparatory work already undertaken. The enclosed guidelines, prepared several months ago, are an attempt to move toward a more standardized format.

I hope you find this material helpful.

Yours sincerely,

Orville F. Grimes, Jr.
Secretary to the
Research Committee
Development Policy

Enclosures

OFGrimes:nf 

cc: Mrs. Hughes (w/o enclosures)

Enclosures: Proposal 671-56 ("Marketing Manufactured Exports",
Morawetz)
Proposal 671-35 ("Export Incentives in Developing
Countries", Balassa & Westphal)
Guidelines for Submission of Research Proposals

Mrs. Helen Hughes

November 2, 1977

Benjamin B. King

The Baldwin Project

1. While I have no doubt that there is much in the Baldwin proposal that will prove useful for us to quote to each other, I have a sneaking question whether it will butter any more parsnips. Isaiah Frank, in his note, believes "that it is extremely important to get across to the public that not all market disruption is due to 'unfair' trade practices, etc., etc."... How much more evidence do we need to get this across to the public, if that is possible? Will this project provide the smoking revolver? There is, surely, a fair amount of circumstantial evidence that lower wages per se are popularly used as evidence of unfair practice ("Look for the Union Label"). Refuting this is not a research problem.

2. The difficulty is that the subject is as much political as economic. It is no use being righteously right on the merits of fair competition if one is politically wet. What is the political tolerance in industrialized countries to fair and unfair competition? What characteristics of the competing product or the affected industry differentiate the level of tolerance? Have measures of adjustment assistance really affected it (cf. Frank's Department of Defense analogy)? Does the existence of some consumer's advocate (official or private) make a material difference? In essence, what we are after is not only a good argument for liberalized trade, but a telling one.

BBKing:nf

cc: Messrs. Karaosmanoglu
Balassa
Frank
Keesing

Mr. Clive L. G. Bell

November 2, 1977

Benjamin B. King

Muda

1. I gather from what you have said that:
 - (i) Both farm households and landless households have rice-related incomes $Y(R)$ and non-rice-related incomes $Y(N)$.
 - (ii) For landless households $Y(R)$ is a larger proportion of the total Y than for farm households.
 - (iii) Ergo, if you double $Y(R)$ in each case, landless households' income will go up more percentage-wise than farm households.
 - (iv) If wage rates go up in real terms (as Lyn Squire maintains in this case), then (iii) applies a fortiori.

2. The above is true when rice prices are unchanged. If they rise, then the way in which wages are determined is crucial:
 - (v) First, suppose there is a share-cropping arrangement in which each type of household gets a fixed share of the rice, which exceeds their consumption by what we will call the "surplus".
 - (vi) Then, if the price rises, the family whose (post project) surplus is larger as a percentage of income will benefit more percentage-wise.
 - (vii) Since landless families have a larger proportion both of income from rice and consumption of rice, the answer is indeterminate in principle, though presumably determinate in any given case.
 - (viii) To the extent that "wages" go up less (or not at all), the landless families will be relatively that much worse off. 1/

1/ If wages rise to exactly compensate for the increased cost of their consumption of rice, they will be absolutely no worse off. All the gain will go to the farm households.

(ix) And vice-versa, if the price falls.

3. I would assume that most of the changes in real income for agricultural households are due to the primary effects of the project. If this true, isn't it possible to extract a simple explanation of the Adelman-Bell-Hazell-Robinson phenomenon, based on whatever assumptions are made, from the black box?

BBKing:nf

cc: Messrs. Duloy
Balassa
Hazell
S. Robinson
Squire

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 PRESIDENT, COLOMBO CAMPUS
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REGARDS

ZACHARIAH

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