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9. ABSTRACT

Symposium held by AID's Office of Science and Technology, where papers were presented on Education, Employment, Rural Housing, Environmental Concerns, Energy, Food, and Employment/Energy. The Working Group on Education discussed needs for both formal and nonformal means for improving educational opportunities for the poor, providing educational institutions which are relevant for development of employment skills as well as general education, and assuring that higher education is not promoted at the expense of rural education. The Working Group on Employment agreed that the rural poor have some technology of their own that needs developing, and need introduction of science and technology. Further, Agricultural development cannot be isolated from industrial development; rural people need to participate in problem identification and planning. The Working Group on Rural Housing concluded that science and technology can increase utilization of local resources for construction, such as local bricks for roofing rather than imported galvanized iron sheets. A.I.D. should undertake demonstration studies to encourage local skills and technologies. The Working Group on Environmental Concerns said science and technology inputs would be related to local conditions. The Working Group on Energy proposed that A.I.D. should support local research group's investigations of appropriate energy technologies, and encourage their ties with similar institutions in the United States. The Working Group on Food proposed explorations of sources of plant nutrients other than chemical fertilizers, studies of inexpensive storage facilities, of inexpensive, energy-efficient transportation, and of efficient cooking stoves, including solar. The Working Group on Employment/Energy said that increasing supplies of energy in rural areas would increase employment and production, and added that community participation in development and design of energy systems would ensure acceptance and use.

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THE PROBLEMS OF SCIENCE AND TECHNOLOGY

Presented at the

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of the

AGENCY FOR INTERNATIONAL DEVELOPMENT
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Table of Contents

Page

Foreword..... i

List of Participants..... iii

THE ROLE OF SCIENCE AND TECHNOLOGY IN ASSISTING THE POOR MAJORITY IN LESS-DEVELOPED COUNTRIES..... 1

Education for the Utilization of Technology by the Poor .....*Manuel S. Alba* 3

Report of Working Group on Education..... 13

Issues in Rural Employment.....*Samuel A. Aluko* 17

Report of Working Group on Employment..... 25

Rural Housing (A Reorientation).....*Balkrishna V. Doshi* 27

Report of Working Group on Rural Housing..... 37

Environmental Problems in Rural Development: Suggested Approaches .....*Leonard Berry* 39

Report of Working Group on Environmental Concerns..... 47

INTERRELATIONSHIP OF ENERGY AND LDC RURAL DEVELOPMENT..... 49

Energy and Rural Development (Keynote Address).....*Roger Revelle* 51

The Implementation of Rural Energy Problems.....*T. A. Lawand* 71

Report of Working Group on Energy: Appropriate Technologies for the Rural Poor..... 83

Food: Role of Energy in Providing Food.....*Ernest T. Smerdon* 87

Report of Working Group on Food..... 95

Employment: Inanimate Energy Sources - An Asset or Liability? .....*Ross W. Hammond* 97

Report of Working Group on Employment/Energy..... 101

ANNEXES..... 103

I. Views on Environmental Problems - in East Africa (reprint from AFRICAN REVIEW)..... 105

II. Summary Report and Recommendations (from Environment and Development Scope Conference, Nairobi)..... 123

Foreword

The Office of Science and Technology of the Agency for International Development periodically holds a symposium on the problems attendant to science and technology in the developing countries. The papers and group discussion summaries in this volume are the product of the third such meeting. The first two meetings were held at Cornell University and the Massachusetts Institute of Technology, respectively. This third meeting was held at the Georgia Institute of Technology, in Atlanta, Georgia.

This meeting brought together a high-level multidisciplinary group of specialists from national and international agencies and institutions concerned with development policies, with the objective of reviewing past and prospective AID programs in science and technology.

It should be noted that a few of the papers presented at this meeting do not appear in these proceedings for various reasons. Samuel Butterfield's fine presentation on "Assisting the Rural Poor" had been previously widely disseminated in the Agency for International Development and each participant at this symposium received a copy of it. The material presented at a luncheon by Dr. Melvin Kranzberg was part of a forthcoming publication and he asked that the material not be published. Hence, it was not taped, nor was the "Background Report on the World Food Conference in Rome" presented by Priscilla Boughton at a dinner meeting.

In general, the position papers on the symposium subject areas are followed by the summary reports prepared by groups of the participants, addressing the same subject areas.

The Georgia Institute of Technology was pleased and honored to provide the facilities for the symposium and extends its thanks to Henry Arnold, Director of the Office of Science and Technology, and his associates for their time and freely given assistance in the design, planning and implementation of the meeting.

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Wednesday, May 7, 1975

THE ROLE OF SCIENCE AND TECHNOLOGY IN ASSISTING THE POOR MAJORITY IN LESS-DEVELOPED COUNTRIES

EDUCATION FOR THE UTILIZATION OF TECHNOLOGY BY THE POOR

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The Development Scenario

The present ferment for rural or nonmetropolitan sector development reflects the failure of past development efforts to recognize the contribution of the rural sector to overall national development. As a consequence, the rural sector has not been a primary developmental focus, nor has it been the recipient of spin-offs of progress in the metropolitan areas. The result is that 70% to 80% of the population of the less-developed world is heavily unemployed, undereducated, and incapable of generating income-promoting opportunities.

An inventory of development plans of most developing countries at the present time will indicate this new or, maybe more accurately, renewed emphasis on the development of the rural sector. The framework is integrated rural development which calls for the mobilization of all inputs to development, the restructuring of social systems focusing primarily on agrarian reform, increased participation in promotion and management of rural enterprises, and formulation of supportive national policies for the stimulation of income-generating and employment-generating economic activities.

Such an inventory will also indicate the strong stress on the objectives of employment and equity in the distribution of income, through the attainment of industrial development and agricultural development, which in the past had not equitably benefited the rural population. Among others, it will emphasize the growth of small-scale and medium-sized industries, labor intensive, of high participation, and compatible with local sociocultural environments.

The past developmental strategy has also resulted in perverse duality characterized by the overdevelopment of the metropolitan centers and the underdevelopment of the nonmetropolitan sectors. No more is this manifested than by the dichotomy of the capital or primal city (around which generally is focused the metropolitan development) and the "rest of the country," still heavily rural

and relying on peasant agriculture. The spin-offs of metropolitan development to the rural sectors have not been as rapid as desired. Primarily, this has been due to the inimical policies of national governments in the past which "pampered" the metropolitan areas -- directing the resources to the cities including the essential manpower, as well as overly centralizing the management and planning of national development. As a consequence, no adequate social and economic institutions have developed to serve the cause of rural or nonmetropolitan development. The more visible result, therefore, is the failure at effecting some intermediation with respect to directing the benefit of growth and progress to the rural sector as well as to promoting a much more effective participation of the rural population in the conduct of development efforts. The absence of such intermediaries or institutions that serve to stimulate resource development -- including human resources -- and its mobilization has stymied even development and accordingly aggravated inequities in income distribution.

A most critical "nondevelopment" or "underdevelopment" in this respect is that of the educational system that recognizes adequately the need to qualify the rural population for participation in developmental activities as well as for the enjoyment of the benefits of progress. Education in most of the developing countries not only has failed in providing the opportunities for income generation as well as employment generation for the nonmetropolitan population, but, in many instances, even failed to attain its basic objective of the delivery of basic or universal education for functional literacy that is essential in realizing the basic understanding of the fundamental functions of society as well as the inculcation of desirable developmental values and attitudes. More so, therefore, it has not succeeded in attaining for the population the requisite of employable skills and awareness of economic opportunities, i.e., the basics of entrepreneurial education.

The New Developmental Strategy

In brief, the new developmental strategy designed to "rectify" the adverse development in the past now consists of promoting labor-intensive agricultural and industrial development, with high participation from the local population in terms of social, economic, and political activities. Specifically, this means:

a. Decentralization of decision-making and administration activities to insure greater local participation. In many countries the policy of "regionalization" (subnational development) is now being implemented.

b. The development and diffusion of appropriate, usable, or intermediate technology for rural development.

c. The stimulation of local enterprises or the overall promotion of entrepreneurial initiatives which in the context of the less-developed economies mean the promotion of small to medium enterprises.

d. The development of institutions in the nonmetropolitan regions to generate capabilities in research, planning, and administration.

e. The formulation of appropriate governmental policies on all aspects of nonmetropolitan or rural development.

f. Social reforms which, among others, should emphasize ownership of land and the promotion of support services. The failure of agricultural development in the past to contribute to rural development is partly traceable to the absence of agrarian reforms and other social development that would have enabled the rural population to share in the benefits of agricultural development.

The Educational Strategy and Implication

Given the problems of rural development and the requirements of implementing an integrated rural development strategy, the need for educational reforms is a requisite. The reforms point to some innovations not only in content, but in institutions and processes as well. Clearly, if rural development presently constitutes the major priority in overall development, education for rural development and specifically for the promotion of technological application should constitute its main instrumentality.

As can be conceived, therefore, the elements for educational strategy towards rural development in general, and in technology application, in particular, should consist of the following:

a. Systemic Reform. Considering the massiveness of the rural sector, both geographically and in terms of population, a national reform of education is certainly called for. A number of countries have indeed undertaken such major reforms of their educational systems. An element of such systems reform

should be the identification of the types of institutions appropriate for rural communities given their agro-industrial profiles -- beyond the basic general education institutions, which in general must be accessible to a large segment of the rural population. In most LDC's, this is hardly the case.

b. Institutional Reform. Given reform of the systems, the institution of appropriate type of educational institutions must be given some attention. In many countries, the Philippines being an example, liberal arts post-secondai institutions, and even secondary institutions, have been set up in rural sectoi emphasizing liberal arts or general education where employment-oriented educational programs are called for, such as trades and craftsmen, agriculture and metallurgy, food processing and management of small enterprises.

c. Reform in Content of Curriculum. As indicated, given the needs for development manpower in the rural sector, curricular programs of educational institutions must integrate components and elements that serve the interest of developmental activities -- particularly in those needs for the development and management of small farm enterprises that, among others, would call for application of simple technology in planting, harvesting, and processing, as well as in the preservation of farm produce. From the rural development standpoint, technology must also mean application of new methods of management -- such as in financing, marketing, and overall management of farm enterprises.

It must be recognized that there are now earnest efforts ongoing in many countries with respect to making education "relevant" for rural development in general and for the utilization of technology appropriate to the setting of the rural development scene. Many of these efforts and experiments are conducted with the assistance of international development assistance agencies -- and taking place not only in terms of formal, but also nonformal education.

For the purpose of articulating our interests and concepts relating to education for the development of the rural sector, it must be noted that in many countries there are in existence a large number of what may be referred to as nonmetropolitan colleges and universities. However, these institutions perform in the traditional sense the basic educational function, heavily academic in orientation, and therefore have not become active agents of development in rural communities. Clearly, one essential reform in concept that needs to be adopted is with respect to the traditional role of educational institutions, particularly those located in nonmetropolitan areas. The basic question

to be raised is: *How do we innovate on the role of nonmetropolitan educational institutions in such a way that they can become active agents of community development?* Concomitantly, what must be the roles -- innovative roles -- of secondary and pre-secondary institutions in the light of the rural environment and the requirements for its development?

Rather than go to a lengthy discourse on concepts, let me attempt to describe two "experiments" at educational innovation specially relevant to technology utilization in the rural sector.

The Concept of the Regional Adaptive Technology Center or RATC

As has been mentioned above, in many countries, there are a large number of post-secondary institutions that have the great potential of playing a major role in the development of local rural communities -- not only in sensitizing the local community population with respect to developmental goals, but also in stimulating the development of income and employment generating opportunities. In the past, these institutions have failed to do this partly because of the traditional role they have been assigned, because of poor administration, and partly because of lack of recognition and support from the national agencies. Yet, these institutions remain the predominant social institutions in the area, of high credibility; they, therefore, can perform high-leverage functions in stimulating interest in developmental affairs for community benefits.

The concept of an *adaptive technology center* venued in such institutions is, therefore, a most appropriate one. The ATC concept is premised on the notion that the institution plays a dominanat role in the community, has recognized leadership, to some extent has some resources at its command to mobilize local participation, and in many instances, some national legitimation that gives it some authority to contribute, in coordination with other agencies, to development activities. But most of all, the ATC concept is fundamentally based on the idea that the university or the college, i.e., the "nonmetropolitan" university as opposed to the center of excellence, can carry on the function of acting as an intermediating institution in the transfer of appropriate technology to the local community through: research in the development of entrepreneurial enterprises, through research and development (simple R & D activities) for application of intermediate technology in the small farm sector, through training of entrepreneurs and small-enterprise managers, through

industrial extension to assist entrepreneurs in the field, and through community involvement designed to mobilize local leadership.

The conduct of these activities to convert the institution into an adaptive technology center -- or to establish an ATC within its premises -- calls for a major restructuring within the university itself, and a reorientation of administration viewpoints, which remain heavily traditional.

Among others, such an experiment, if we call it that, necessitates an integration and participation of various units and disciplinary departments of the university -- engineering, business, sociology and political science, economics, agricultural departments -- to contribute manpower and skills to the venture as called for by the need to understand and get involved in community efforts. In addition, the university administration is called for to participate actively in coordination with other agencies and entities in the area, not only in educational matters, but also in the affairs of planning and administration of community development.

These innovative requirements are indeed new and strange to many of these nonmetropolitan universities. However, the new emphasis of many national governments to decentralize and regionalize efforts has directed some official efforts at giving key importance and recognition to these institutions. They have become more sensitized. The prospect of getting some new resource assistance further encourages the acceptance of these new innovations.

In addition, some efforts are being made to establish a linkage between these nonmetropolitan universities and the so-called centers of excellence located in the cities, not only in providing staff, but also guidance and cooperative input in reorganization and development of programs in the nonmetropolitan universities.

In a more specific sense, the Adaptive Technology Center or ATC (the term "regional" is added to establish the nature of such an institution -- hence the expression "Regional Adaptive Technology Center or RATC) is to carry on activities with respect to:

a. Training for entrepreneurs in as many activity sectors as possible -- whether this be in food processing, small metal handicrafts, local transportation, or others.

b. Research in application of technology for the use of local enterprises. This has been an area of neglect, and is a two-pronged problem. Given that

technologies are available, there have been no channels or intermediating institutions for local users to hear about the technology, much less learn about its application. Manufacturers have not been active in commercializing such technologies, if at all, within reach of small entrepreneurs. The local universities, particularly with subsidies and assistance from the national and international governmental and assistance agencies, potentially are able to function as such intermediating institutions -- which then not only get engaged in modifying and developing such applicable technology, but also in providing the extension service to enable potential users to apply the technology.

In nonfarm technology, there has been no counterpart of the agricultural extension agents. The RATC's are performing such functions.

c. Assistance in research and planning. Up to this time, many of the regionalization efforts have not established viable local efforts in this regard. This leaves the local university still the key institution in performing these functions in coordination with government agencies. Accordingly, a recognition in this respect on the part of the government that the nonmetropolitan university is potentially a major source of local competence in research and planning should be forthcoming. Accordingly, such institutions could plan to develop their capabilities.

d. Training of local leaders. Again, the local university, with appropriate support and encouragement from the national government, can be mobilized to carry on such functions.

It is recognized that local community leadership is an essential requisite for any developmental efforts to be carried on. The dearth of local leadership has been due partly to centralization of developmental efforts and at the same time the outward migration occasioned by search for employment opportunities. The double-pronged approach of regionalization of administrative activities and stimulation of local enterprise will, accordingly, generate a lot of local leverage for stimulating developmental efforts. The role of an educational institution is central in this respect.

The Technology and Development Institute of the East-West Center is a participant in this effort at educational innovation toward the development of local capabilities for the development, utilization, or application of technology for community development. Three regional universities are involved in

this "experimentation": Mindanao State University in the Philippines, Yeungnam University (Taegu) in Korea, and Hasanuddin University (South Sulawesi) in Indonesia; and a fourth one is under consideration: Kohn Kaen University in Thailand. The ATC has been established in each of the three institutions, with national recognition in the case of Mindanao and Hasanuddin. All three institutions have now completed a program package consisting of entrepreneurial training for the local enterprises, industrial extension, and feasibility studies for selected industries to be assisted by the university. Each ATC, as expected, is set up with staff members coming from at least four departments of each university -- itself a new innovation that is now generally accepted.

It is expected that the emphasis on rural development and regionalization strategy will give much wider recognition to such an innovative educational concept as the Adaptive Technology Center (ATC). In a number of Asian countries, such efforts are now ongoing, though not officially called adaptive technology center efforts.

The Village or Barrio Development School

It has been an observation that rural education at the secondary level, and also pre-secondary level, has failed in the past primarily because of the nonrelevance of its content and methods. Among others, it was oriented towards college preparation -- accordingly, it was contributory to migration of qualified manpower from the farm sector to the metropolitan areas. It was also based on the notion that the population going through the secondary school system, particularly in the rural areas, will all go to college. Yet, given the state of development of the many developing countries, this is hardly a correct assumption. National figures indicate that only, at most, 28% of secondary graduates proceed to college -- the figures should be considerably less for nonmetropolitan secondary leavers. In the Philippines, only 18% of those from the rural population are able to go to college.

Thus, it is recognized that high-school leavers, particularly those in the nonmetropolitan areas, must search for employment. The reality of the situation, occasioned by the educational pattern of the past, is that these nonmetropolitan secondary school leavers are unprepared for employment because of the lack of skills. Since education in schools located in the nonmetropolitan areas is

generally inferior, the leavers are therefore unable to find employment anywhere -- except occasionally in the most menial of employment.

The concept of the "barrio development school" as this has been developed in the Philippines is based on the recognition that not all secondary enrollees are able to, or should, proceed to college. This follows from the fact that for the farm communities to develop, adequate educated and skilled manpower must be available.

The concept of the "barrio development school" curriculum revolves around a problem-oriented project -- such as food preservation, poultry and swine marketing, handicraft product development -- as an enterprise initiated by the student while in school and to be continued as a commercial enterprise upon leaving school. Further, during and after the period of schooling, with the assistance of a nearby college of agriculture or government agencies, the school and project students are given contact with such elements as the supplier of farm supplies, the rural banks, the local farm cooperative, local government agencies -- to acquaint them with all aspects of production, marketing, accounting, loan application, and reporting. Accordingly, the training curriculum is evolved with relevant skills programs in management, accounting, marketing, in addition to the basic familiarity with the technical processes of farm production.

Another feature of this barrio school experiment is that the family of the pupil endorses the program and assists in the project activities as if these are legitimate family enterprise activities -- which they are planned to be. In the process, the family members themselves get educated in development orientation and get active in school affairs.

Such project-oriented education is, of course, in addition to the basic general education that must be provided at the secondary level.

In the long run, this experiment is supposed to attain the following: the development of appreciation for local community development, education for employment, development of local enterprises, and retention of qualified manpower in the rural sector.

I have described, rather sketchily, some concepts relevant to the notion of education for utilization of technology by the poor. Two innovative experiments in this respect have been described. These issues, concepts, and innovative experiments of course deserve much more detailed discussion in the future.

REPORT OF WORKING GROUP ON EDUCATION

The panel discussion covered a broad range of concerns and interests with respect to the basic issue of the role of science and technology in education for the poor. A deductive framework may be helpful in summarizing the panel's discussions, i.e., from the very broad *policy* (even philosophical) level concerns to the very specific technical problems.

A. Policy Level Concerns. The panel in this respect raised the fundamental policy questions: What should be the country's *educational* policy? What should the *employment* policy be? What should the *science and technology* policy be that is relevant to the objective of delivering "the quality and quantity of life" to the poor through education? Specifically, the issues raised were:

1. What should be the minimum educational expectation for that lowest 40% of the poor? The need for basic universal education and provision of opportunities for gainful employment? There are other expectations particularly with respect to the need to enable the poor to enjoy an improved quality of life

2. There should be a reexamination of the objectives of education. Fundamentally, the attainment of skills, values, and attitudes compatible with employment opportunities was an expressed concern.

3. A manpower approach to educational policy is helpful if the educational system is generating manpower appropriate for the poor population in the rural areas. Paramedics are more needed than doctors, technicians and craftsmen instead of liberal arts graduates.

4. The development of desirable scientific attitudes and values as reflected in some mandate (e.g., constitutionalization of "scientification" in Korea) is essential in articulating science and technology for solution of development problems.

B. Educational Structure, Processes and Institutions. Recognizing the problem of development for the poor and of the role of education, the panel recognized the needs for:

1. Improving accessibility to educational opportunities for the poor through both *formal* and *nonformal* means.

2. Relating educational programs to the problems of rural or poor communities. Institutionally, the *"regional centers"* or "nonmetropolitan universities" and other educational institutions have the better potential and capabilities for delivering education to the poor, thus attaining some decentralization of development and participation.

3. More relevant types of educational institutions, such as the comprehensive secondary school, that provide not only general education, but skills for employment (inexpensive technical education).

4. Assuring that higher education is not pursued, given constraints of resources, at the expense of rural education.

5. Strengthening of rural institutions as a deliberate national policy.

C. More Specific Concerns Relevant to Appropriate Education and Educational Approaches for the Benefit of the Poor. The concerns of the panel were for:

1. Promotion of programs to encourage metropolitan educated population to consider employment in nonmetropolitan sectors.

2. Continuing improvement in agricultural extension programs for increased farm productivity. Likewise, industrial extension programs to assist in entrepreneurial or job-creating efforts need to be developed adequately and viably.

3. The application of cost-effective educational technology such as: multi-media audiovisual packages (cassettes, video tapes, recorders, etc.), satellite transmission, ETV - wherever appropriate because of greater access to the rural areas where schools cannot be established.

4. Training not only for wage employment, but also self-employment (entrepreneurial activities).

5. Articulation of science and technology, not only in educational curricula and programs, but also in the approach to problems in local communities with assistance from extension agencies and local universities.

6. Rationalization of national expenditures in education. The misallocation of the education budget should be minimized. There is overallocation to higher education relative to secondary, vocational, and technical education.

In brief, the fundamental concern is to relate and articulate educational objectives and programs to the needs and opportunities for development of the large poor majority, and through integration of science and technology in education for the poor.

ISSUES IN RURAL EMPLOYMENT

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Economic growth in many of the less-developed countries seems to have gone pari passu with increased rural poverty and adverse terms of trade between the rural and the urban areas. The main causes can be traced to two opposing forces. First, migrants from the rural areas into the urban areas in search of the benefits of growth cause urban employment as well as rural depopulation and, occasionally, say in Nigeria, cause a shortage of employable labour in the rural areas. Secondly, those who are left in the rural areas are the less economically active, the older elements, the less educated, the less skilled and the less enterprising. The more the growth process creates educational and training facilities, the more the younger and more vigorous people are educated out of the rural areas. Yet, urban industrialization and development depend upon the raw materials and the food produced in the rural areas and the consumption and production capacities of the rural inhabitants who constitute the majority of the population of the country.

As growth proceeds, capital-intensive techniques become more and more dominant. Labour is thus displaced in the urban-based industrial and commercial enterprises, and the number of job-seekers increases faster than the job-creating capacity of capital investment as capital-labour ratio increases.

Attempts are therefore made by politically and socially sensitive governments, not only to limit rural-urban migration, but also to create a reverse migration so that the urban unemployed may return to the rural areas to work and uplift the quality and the standard of life there. It thus becomes obvious that the solution to urban unemployment, rural-urban migration, the alleviation of rural poverty, rural labour shortages, and rural underemployment consists in taking measures to ensure that more and more people are employed in the rural areas in agriculture and in small and medium-scale industries and commercial enterprises than are being currently employed there, and that the rural areas are made sufficiently attractive or less repellent so as to retain the marginal migrants and attract the marginal returnees.

If the rural areas are to perform this employment role and constitute the bedrock and the grassroot of national development strategy, the preconditions that should be created and the issues that must be tackled must be clearly identified.

The Main Issues

1. The most important issue in the solution process is how important the political actors perceive the employment problem in the rural areas, their concept of income distribution, their attitude to rural poverty and to the distribution of political power between the central government, located in the urban areas, and the local authorities charged with uplifting the peripheries.

Where the development process takes place under the leadership of a few merchants, traders, proprietors, foreign interests, and bureaucrats allied with a few and urban-based domestic entrepreneurs, no matter how much the developers want rural transformation, they cannot achieve it, because the enthusiasm and energy of the masses have not been enlisted in the process. For the active participation of the rural areas to be realistic, the local administrative machinery must be organized and strengthened with visionary bureaucrats, technicians, leaders, planners and plan executioners who are not less competent and dedicated than those that direct affairs at headquarters -- for it is easier to give directives from above than to translate them into concrete results in the peripheries. Therefore, the issue of the central-local relationship and the strength of the local administration vis-à-vis the central authority must be resolved and must be right if the development process is to take root in the rural area.

It is only after competent planning, administrative, and executive machineries exist in the local areas that the distribution of investment and, therefore, of employment can meaningfully be fair between the urban and the rural areas. It is then that rural poverty can begin to give way to more balanced development between the rural and the urban areas. It is then that the rigid class structure between the small elite in the urban areas and the often neglected majority in the rural areas can be broken. It is only then that wealth and income can be redistributed in favour of the rural areas, and consumption, savings, investment, and employment in the rual areas raised.

2. The second issue deals with deliberate attempts in the rural areas to encourage a better utilization of the available labour supply, through the adoption of the appropriate input-mix and technology. In theory, labour will be substituted for capital at the margin if the relative price of labour to that of capital were to fall and vice versa, assuming that capital and labour are each homogeneous.

Hence, given that planned output of a commodity, represented by isoquant AB in the diagram, is to be produced with different factor price relatives, then the capital-labour ratio given by the slope of OI (OI passing through G where CD is tangential to AB), where labour is relatively expensive, would be greater than the capital-labour ratio, given by the slope of OJ, where labour is relatively cheap (OJ passing through H where EF is tangential to AB). In an output maximizing equilibrium, the ratio of the marginal products of the two factors is equal to the factor-price ratio, so that G and H represent the respective equilibrium positions for the two production locations, given complete factor mobility, that is, the lower wage level in the rural areas, vis-à-vis the higher-wage level in the urban areas, should give rise to the adoption of more labour-intensive processes in the former instead of the more capital-intensive processes in the latter.

In practice, however, unemployment persists in the rural areas or rural-urban migration continues because few development projects are located in the rural areas and these few are so capital-intensive and sophisticated in technique and factor utilization that they displace rather than generate employment. This contrast between requirements and reality is paradoxical and creates a situation where employment generation is lower in the rural areas than it should be.

The general preference for large-scale, sophisticated, and imported production techniques in the economy as a whole instead of for small, medium-scale, simple and domesticated production techniques consumes so much of the nation's investment resources that far too little surplus remains for rural upgrading and improvement.

3. Thirdly, the deliberate shying away from putting the right emphasis on agricultural improvement and increased agricultural productivity in the rural areas is one of the issues that deserve attention. What is needed is an increase in the necessary capital investment and other inputs in agricultural

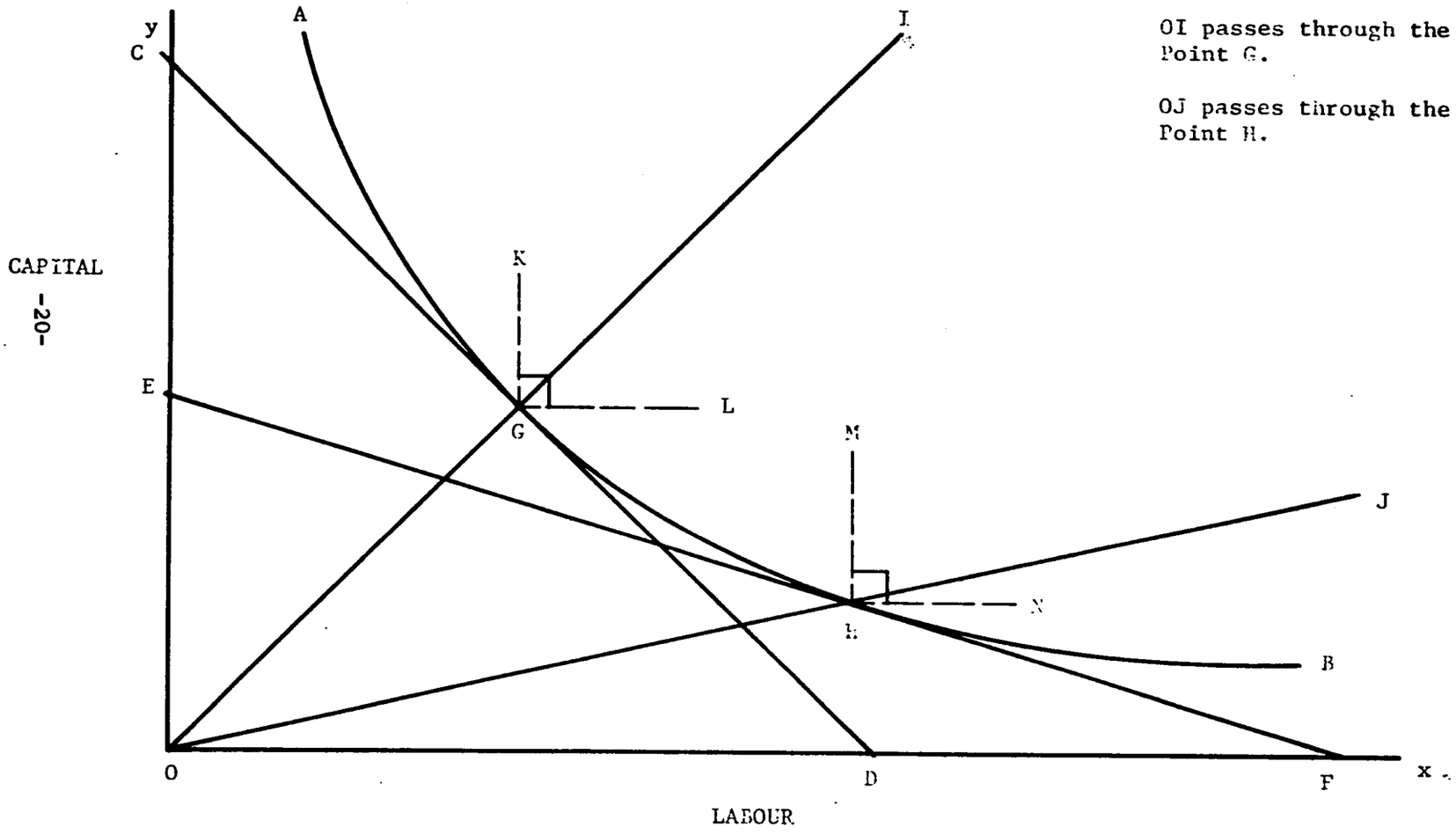
CAPITAL/LABOUR PRICE RELATIVES

NOTE: AB is isoquant: CD is tangential to AB at G.

EF is tangential to AB at H.

OI passes through the tangential Point G.

OJ passes through the tangential Point H.



development and the establishment of agro-based industries all over the rural areas to utilize products from the agricultural sector. The practice whereby the raw materials are produced in the rural areas and the processing plants are located in the urban areas creates a pull away from the rural to the urban areas; this depresses not only the volume of agricultural production and employment, but also removes the acceleration and the multiplier effects of investment and consumption, respectively, both of which cause migration from the rural areas.

4. Fourthly, the issue of reasonable terms of trade between the rural and the urban areas is crucial to employment generation in the former. Unless the terms of trade are steadily and increasingly turned in favour of the producers in the rural areas, through the raising of factor and commodity prices paid by the state for agricultural and industrial labour and output and/or the lowering of prices of many of the industrial and commercial goods and services purchased by the inhabitants of the rural areas, those living or employed there will either migrate or be underemployed, as they will lack the necessary incentives to remain and work hard. That is, rural activities, instead of being penalized, as at present in many rural areas, ought to be compensated in cash and/or kind. Those who work and serve in the rural areas ought to be more highly remunerated and be more quickly promoted than those who work in and enjoy the modern trappings of urban civilization and infrastructure.

In this respect, most of the industries being located in the urban areas should be located in the rural areas, thus deliberately industrializing and modernizing the rural areas through the establishment of rural works programmes, modern infrastructure, the establishment of industries like small refineries, iron and steel, cement and fertilizer plants, as a means of deliberately creating an industrial consciousness among the peasantry, and ameliorating the existing dichotomy and contradictions between the city and the countryside.

5. Fifthly, research and development programmes must be specifically geared to the needs and be relevant to the thought processes of the inhabitants of the rural areas. In spite of the usual admonitions regarding the importance of applied research, there remains a wide gap between the technical analysis and the actual policy decisions being taken. As a result, there is the fallacy of eclecticism, that is the indiscriminate application of techniques and processes that are seen to have worked elsewhere. This is more obvious in the African

countries, where most of the researchers have been, and are being, trained abroad and return home to transplant models and designs learned and applied abroad to the solution of the problems of societies that are primordial and traditional.

This is why most of the efforts to transform the rural areas through policies designed from abroad or by national regimes and foreign-dominated central bureaucracies are more often than not unsuccessful, because the forces that shape and condition the actual performance of rural organizations can most likely be found at the local level, rather than imported lock, stock, and barrel into the locality. Consequently, no solution of the rural unemployment problem would be complete without detailed research and information on the characteristics of social stratification and its linkage to the rest of the social, political, and economic structure of the whole country. The direction of indigenous research which is related to the local resources and the social background of the people is an important issue in rural transformation and employment generation.

These also have implications for the structure of rural development organizations designed to increase output and improve the distribution of income and employment, through cooperatives, credit extension services, and rural work programmes, which must take into cognizance the hopes, fears, aspirations, and optimism of the rural inhabitants.

The essence of rural transformation, however, lies in the constant desire of the political leadership to eliminate the degrading and humiliating sort of peasant misery. Nowhere has rural transformation been as obvious as in mainland China. There, for the first time in the country's history, almost all the Chinese now have decent jobs and a decent standard of living in regard to the basic necessities of food, clothing, housing, health, education, culture, and recreation. They no longer face starvation, infanticide, domestic slavery, cannibalism, illiteracy, pestilence, famine, and disasters. The Chinese in the urban town and in the rural areas have risen together. It is difficult to see anyone that has been left far behind. The rural areas are alive and active with water, electricity, small industries, transportation and communication networks, and with plans for everything else that promises fuller lives for the peasants who, though still relatively poor, are gainfully engaged and optimistic. These transformations which have replaced the precarious position of the Chinese

peasants down the ages and the oppressive conditions under which they laboured, have been brought about through the greater responsiveness of the political, social, and economic plans and policies to the needs of the generality of the population, rather than to those of the elite and the urbanized.

Great lessons of strategy, even if not of wholesale adoption of system, exist in China in any attempts to generate rural employment and reduce rural poverty and misery in the poor countries of the world. Nigeria can and should definitely learn some lessons from this, particularly now that Nigeria's resources are relatively buoyant and the rural areas are crying for attention and for a share in the buoyancy.

REPORT OF WORKING GROUP ON EMPLOYMENT

Three concepts were accepted by the group at the start of the discussion in an attempt to establish a frame of reference.

1. People in the nonmetropolitan areas are unhappy with the present status and are willing to change.

2. People in the nonmetropolitan areas have some technology of their own which could be developed with proper assistance.

3. Projects in nonmetropolitan areas need to focus on where the people are (state of the art) and attempt to improve on what the people have. This will vary from country to country and even from locality to locality within a country. There is a need to determine the state of development of the individual locality when one attempts to introduce science and technology in that locality.

Having accepted these three general concepts, the group discussed the subject topic, and the following ideas, or statements, were presented:

1. We cannot isolate agricultural development from industrial development. There is a strong relationship between the two, and the agricultural development will provide many of the needed raw materials for the industrial development. The concept of "agro-industry" was favored by most of the group as an area where science and technology could contribute greatly and assist in the generation of employment.

2. The concept of two "black boxes" was presented in an attempt to provide services that are required in the nonmetropolitan areas.

   a. The provision of small local research centers to study, research, and identify uses of existing resources, with the research to be very pragmatic and oriented to application. This would be a long-range approach, but in the long run would generate employment as new industries are identified.

   b. Continuing provision of on-site technical assistance and the concept of the extension service.

   c. Research to identify, through sector analysis, those sectors that offer greater potential for industrial development.

3. There is a need to establish a systems approach to ensure the involvement of technology in the whole process of development in the nonmetropolitan areas. The systems approach would enhance what is presently being done.

4. Demonstration-type projects have proven effective, specifically in the area of simple tools being applied to existing conditions, as a means of effective technology transfer.

5. AID might consider changing its priorities; perceptions by LDC's of priorities are often different from those of AID (i.e., education in some LDC's)

6. There is a need to close the gap between the development institutes and the nonmetropolitan people.

7. There is a need for the rural people (local) to participate in the problem identification and planning.

8. Literacy is a significant factor. There is a need to modify the educational systems in order to create indigenous interest. The concept of brief exposure abroad for "doers" vs. government officers was discussed.

9. There is a need to better measure and quantify what is happening in the area of research and development within a location. Possibly, baseline analysis might be used.

RURAL HOUSING (A REORIENTATION)

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Realization has come to us that rural development is essential to improve the condition of life of the majority of our increasing population heading towards further deterioration. The cause of this deterioration lies in our attitude to development and its application. I believe that, unless we consider the so far untouched aspects of development, we will never succeed in solving our problem. Synthesis of cooperation and confidence directed towards self-reliance is an essential part of growth. Unless this aspect is made a part of the strategy, the efforts towards rural development will be without deep convictions. From this point of view, I attach great importance to the philosophy of self-reliance propagated by Gandhijee. In today's context of India's development, I see its significance. I have, therefore, decided to talk on rural housing in the context of the total development as visualised by Gandhijee.

I also feel that this "Indian case" may have some relevance to the rural development in other countries.

House - A Symbol of Life

A traditional house in the rural setting of India had varied significance. It was a symbol of the life-style of the people who lived in it. A house -- or a shelter -- meant a great deal to the villager, for around this shelter he was continuously weaving the web of his and his family's life. It was his universe. It was here that he performed his daily routine which had the dignity of a ritual. His relationships with the elders, with women of the family, with other people, with cattle or other living creatures, were all tied up in this space. To him it was an expression of his life. For him it was not a mechanical service unit which an urban dweller expects in a house. To the villager, house signified continuity of family. It was here that the cycle of birth, growth, and death operated. It was the property which determined the social position, and its growth meant the desired position in the social structure in relation to caste, religion, and region.

Family Extension

When the family grew, the house became extended and eventually developed into a micro community of family members (Khadki or Madha in Gujarati) within the community of a similar trade. In the similarity of trade lay the seed of caste.

Cluster Functions

This cluster of extended houses, to him, was not an addition of units, but an expression of social unity and economic interdependence. The clusters in their formation expressed the extended group activities of the families and became a place of pride and status of the whole community or caste. Here, the specialization of trade employment became apparent. It is in these clusters that one recognised the deep-rooted sociocultural economic ties of the community. Cooperation in trade, marriages, festivals, and social welfare formulated the caste. This was achieved in the central place of this cluster.

The Institutions and the Village

At village level, the clusters become specialized sectors, and towards the "central place of the village" they all merged, forming and focusing into a larger area where annual, monthly, and even weekly activities took place.

In this main square the institutions such as temples, old time sabhas, Panchayat Halls, and weekly markets were located as the principal structures of the villages. This provided the basic contacts for a balanced socioeconomic life. The gradual sequential rapport in form and space between the individual house and the main community can be attributed to this joint participation. The apparently formal expression had profound sense in their locational relationships. For these relationships indicated a socio-cultural-economic interdependence which was the major factor of their survival or growth. Around these institutions there developed a sense of cooperation. Hardships and calamities such as drought, famine, floods, or epidemics were adequately met through the medium of these institutions.

History

"As late as 1830 a British Governor in India, Sir Charles Metcalfe, described the village communities as follows:

> The village communities are little republics having nearly everything they want within themselves and almost independent of foreign relations. They seem to last where nothing else lasts. This union of the village communities, each one forming a separate little State in itself . . . is in a high degree conducive to their happiness, and to the enjoyment of a great portion of freedom and independence.

"This description is very complimentary to the old village system. We have a picture of an almost idyllic state of affairs. Undoubtedly, the great deal of local freedom and independence that the villages had was a good thing, and there were other good features also. . . . The work of rebuilding and rebirth (of Village Republics) still remains to be done by us."

(Pandit Jawaharlal Nehru, Glimpses of World History)

Situation Today

Today the situation of the rural settlement is a negation of what is described above. The house as an element is there, but its total meaning has disappeared. The cluster is existent, but the participation sporadic. The village clusters do exist in physical form, but many have become ghost sectors, since many families are sucked up by the city. Even during the most auspicious occasions, very few now return. As a result, not only the economic balance and cooperation was lost, the settlements which the trades brought for the characteristic pattern also deteriorated. For example, many village communities are dispossessed of their central place where large trees, gardens, and greens used to be. The rainwater storage tank, which was a major element of life, where gatherings and festivals used to take place, is no more traceable. The village temples and the marketplaces where confidence in life used to be reinforced have become ruins. As a consequence, dilapidated houses and insanitary conditions within and around the village are witnessed.

These two descriptions of the village as it was and its present deplorable state of community indicate that the problems of housing cannot be solved in isolation. The house is an integral part of economic and social development. If it is not considered in this perspective, a house, even made of gold, will not carry any meaning. It may, therefore, be noted that the main determinant of a settlement is the socio-cultural-economic aspect around a life-style rather than a mere theory of building.

Village Swaraj

Gandhijee, when he came on the Indian scene after his long sojourn in Britain and South Africa, saw this decay of the village communities and discovered its cause in the mechanical centralization. Having understood the virtue of decentralised developments via self-sufficiency and cooperation, he accordingly propagated rural development. He suggested either a revival or formation of new independent communities based on the earlier pattern suited to the economy of India, which primarily is rural. For this purpose, he insisted on village reform which he called "Village Swaraj," i.e., village autonomy or autarchy. He stressed that development and management in its totality should be achieved through cooperative leadership and enterprises so that the community can achieve the good things necessary for a healthy and moral life. Here he stressed intense use of available local resources so that the community with an idyllic atmosphere can be brought back to life. He propounded simple but practicable ideas for reorganization of villages through maintenance of proper sanitation, hygiene, health, diet, education, industrial growth, transportation and communications systems in relation to personal and social behaviour. He believed that through this simple and natural process the settlement and the house will simultaneously grow, integrating in them the spiritual quality of life and bringing symbolic value to the house as well as to the community.

In his statement about village reconstruction, he expressed his concept of an ideal village. He said, "An ideal Indian village will be so constructed as to lend itself to perfect sanitation. It will have cottages with sufficient light and ventilation built of a material obtainable within a radius of five miles of it. The cottages will have courtyards enabling householders to plant vegetables for domestic use and to house their cattle. The village lanes and streets will be free of all avoidable dust. It will have wells according to its needs and accessible to all. It will have houses of worship for all, also a common meeting place, a village common for grazing its cattle, a cooperative dairy, primary and secondary schools in which industrial education will be the central fact, and it will have Panchayats for settling disputes. It will produce its own grains, vegetables and fruits, and its own Khadi. This roughly is my idea of a model village. . . . I am convinced that the villagers can, under intelligent guidance, double the village income as distinguished from individual income. There are in our villages inexhaustible resources, not for commercial

purposes in every case, but certainly for local purposes in almost every case. The greatest tragedy is the hopeless unwillingness of the villagers to better their lot.

"My ideal village will contain intelligent human beings. They will not live in dirt and darkness as animals. Men and women will be free and able to hold their own against anyone in the world. There will be neither plague, nor cholera, nor smallpox; none will be idle, none will wallow in luxury. Everyone will have to contribute his quota of manual labour. . . . It is possible to envisage railways, posts and telegraphs . . . and the like."

Unfortunately this type of much needed rural community development got very little chance in the new regime and, consequently, the existing village community has further deteriorated.

Suggestions

I believe that if we want to succeed in our objective of developing idyllic settlements or communities, we will have no choice but to go back to the Gandhian principles of self-reliance, cooperation and full use of local resources. We will have to bring about an integrated development with the dictum of "no waste."

Development Strategy - Scope

Since housing cannot be done without the comprehensive study of overall development of the area, maybe a region, or district or a taluka, experts from various disciplines will have to be called upon to discuss the development strategy. At all levels, participation of the user must be sought. The expert's role in such a case will be to project the future trends and indicate the stages of development, including housing. After the initial demonstrations over a period of time, there will develop a local cadre of experts for various needs.

Role of Institutions

For such a program, existing academic institutions or voluntary organisations concerned in the environmental planning and technology should be asked to develop special multi-level programs to suit the immediate, short-, and long-term needs of the community.

The formulation, direction, and variety of such programs must be made on the basis of scientific projections or developments in the region, district, taluka, and other levels so that specialised needs and their timings are assessed and experts trained for the purpose. This way the time lag between the availability of trained personnel and the development is reduced, if not altogether avoided. For example uncoordinated stagewise development of basic infrastructure such as roads and other important services usually creates such problems of time lag and leads to frustrations.

These institutions must be asked to teach these multi-tier programmes in rural areas "in situ," so that live problems become their important case studies, and the direction will be oriented towards particular resources.

To evolve appropriate technologies, even for physical development, the "in situ" institutions should be equipped with tools and technics so that they are able to conduct live experiments to justify modification or change. For example, new ideas on building technology and suggestions for alternative uses of local materials can be advanced through such courses. For example, to establish a small-scale building-component factory to improve building quality, it is necessary to make provisions for demonstration. Hence, new systems of credits for studies in integrated "nature-oriented" industries will have to be provided, e.g., bamboo plantation and the use of bamboos in housing and household industries.

Institution - Location and Participation

To carry out such "tasks-oriented" educational and cultural activities, centres will have to be located in close proximity and in permanent sight of the villagers for their full participation as partners of a company. These centres will, over a period of time, command respect similar to that of a temple.

Based on the nature and scale of developments, larger and more complex building infrastructure-oriented centres can be located amongst a group of villages where special understanding of old and latest developments in ecologically oriented building technology is shown.

With the establishment of such institutions, the main core of rural development will lay the foundation of community development at regional, district, and taluka levels. The gradual socio-economic-technological development, appropriate

to the potentials and needs of the area, will then begin to attract to the village the migrants into the nearby cities.

Impact on Villages

The same philosophy of self-reliance and adequate self-sufficiency will stimulate similar trends of development in the villages. Thus, it is possible to link the existing life-patterns, their cyclic relationships of family, extended family and community, with new development for balanced living and working relationships.

After having located the potentially developable areas, it will be essential to establish a sense of priority in the development of the overall environmental conditions of the villages and their surrounding areas. For this task, full participation of the inhabitants is necessary. Through joint effort, it will be easy to assess the needs of the community at various levels and plan a strategy of development.

The First Act

As a first act of development, the location of basic infrastructure such as water tanks or wells, health, vocational craft and rural industrial centres, demonstration laboratories, etc., will follow. Location of clusters for living and working will be the next step.

Any half-hearted approach to the establishment of the main institutions will be disastrous because I visualise that around these institutions the community must develop.

For example, the villagers must realize that there is much additional wealth besides the bricks in the pit created by the brick kilns. They must know that the pit can be an excellent source for water storage or fish culture or for building a complex of main institutions for the community.

A further demonstration of the use of solar and wind energy for climate control or supply of power also can be developed in the same place. Economically viable harboriculture for industry, fuel, and fodder will be another example which was traditionally followed but now forgotten. For example, the Sindhis who migrated to Kandla from Hyderabad Sindh built wind catchers to replace fans in their houses and shops but did not reach the stage of using the same source for production.

Pattern of Development

This will then lead to a compact yet open-ended development of the community by virtue of the economic and social benefits to the villager. Such an innovative process will invite participation of different skills and trades from within and outside the community and eventually overcome the social barriers of today. Thus, social reforms will imperceptibly take place and the new community will be without any stigma.

The New Village

The new villages thus formed will have an integrated fabric composed of house and work clusters, with the institutions of new faith as the principal focus. To the place, to the climate, and to the life-style they will respond. It will appear that they always were there.

Basic House

On a specific level, I suggest that the standard of a house should not be considered from the point of economy alone nor as a serviceable or replaceable unit, but the house should be seen the way the villagers are used to. Otherwise the house will fail to become what it should be. For example, any house should be designed primarily to provide adequate protection against sun and rain; yet should have ample scope for the residents to derive benefits from nature. With proper guidance and cooperation, they should be able to make full use of solar and wind energy -- to supplement their daily needs to devise climate control and other systems and to curtail their living expenses. Care should be taken to provide adequate open spaces where trees can not only shade the outdoor living spaces, but should provide an additional source of either food supply or revenue. Location of services should have direct linkages with the recycling processes of either the individual or the community. The entire settlements should be so laid that seasonal rainwater can be efficiently stored and used for special purposes.

Technics of Building

Housing is a labour-intensive industry; hence, it should be attached to building-materials research centres where several villages will have the chance to participate and compete on developing locally available, efficient, and integrated technologies -- what we call today eco-systems.

Future

With this approach to planning, the life of the village communities will be enviable. Life will have meaning and a sense of fruitfulness. As a corollary, it will attract people who have migrated to cities to these new places and the process will be like a homecoming.

A house will again give them all the meaning that they were used to. Roots will again be established, and with the new extended family the lost tradition of "continuity" will reemerge.

Finally, I may add that faith, conviction, and examples are necessary to concretize a concept. Hence, it is essential to locate people with such belief even at a cost. Institutions with such programs should be supported and encouraged to march towards this goal of building rural republics of Gandhijee's dream.

REPORT OF WORKING GROUP ON RURAL HOUSING

A rural house expresses the life-style of the inhabitants. Rural housing expresses the basic cultural-economic interdependence of the community. Hence, the development of either the house or the community cannot be seen in isolation. It is a participatory and evolutionary process and should be viewed as such. At the same time the process must be recognized as one which supports the general economic and social-technological development of the rural area.

The primary role of science and technology, therefore, should be to recognize this integrated interdependent process of development and establish mechanisms to create in rural communities an awareness and understanding of this process of simultaneous and interdependent growth. The elements, such as people land, material, and technique, used in this process of development should be taken as part of a system and their virtues and constraints be made known to the user. Once appreciated, the economic, technological, sociocultural, and environmental impact will then establish continuity.

In order to achieve this integrated development, tools for education and communication must be established so that awareness, skills, and participation are created at all levels of planning, from planning a house to planning a community. Also, positive and more effective use of local conditions must be made in terms of geographical conditions for siting and services, climate for orientation, and technology for use of local, but otherwise less useful, materials. For example, the location of growing and producing building materials, such as bamboo, usually disturbs the development pattern and their locations should be planned. For effective results, technology should establish methods for ordering this integrated development based on priority, local needs, and its effective value to the user.

The process of such development should encourage planned nonobsolescence by maximizing the use of the available resources. For example, modern technology can reduce the quantity of materials used in buildings and improve ways of building roads and making wells. This way, local technology can not only be improved, but its multifunctional viability can be appreciated, reducing the temptation to import into rural areas expensive and single functional elements for building use. It will generate developmental patterns for the growth of

natural and man-made building materials and, simultaneously, help establish an ecological balance in the area. For example, the use of local bricks for roofing gives better insulation than imported galvanized iron sheets, and bamboo can be used for reinforcement for earth walls and roofs.

An attitude of recycling of materials will help in establishing an order of priority among materials used for temporary, semipermanent and permanent buildings, reducing the local economic handicaps and improving the environmental conditions. This can lead to avoidance of dilapidated construction and wasted lands, and the unnecessary cutting of trees.

An indigenous built-in system can be developed for building-site development components so that the skills and components can be exported to other communities for economic and sociocultural gain, for example, the use of local fibrous materials for wall panels, roofing, etc. With awareness, this process can establish a new order for improving old or developing new house and community forms which suit local custom and environment.

AID's OST office should undertake a few case studies for demonstration and through the process encourage local skills, technologies, etc., with the aim of stimulating replication of the process within the surrounding region.

ENVIRONMENTAL PROBLEMS IN RURAL DEVELOPMENT
SUGGESTED APPROACHES

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Our task, it seems to me, is to agree on some guidelines, some rules of operation, of an agency approach to rural development. In this exercise we are mainly concerned with questions related to the industrial aspects of rural development. This paper addresses issues of the environment. Thus, part of what we do is alien to the very process we are engaged in; most forms of rural development require a closely interlinked approach, and some of the problems that occur in attempting to promote useful rural change come from continuing divided attitudes to integrated issues.

The opening caveat is that industrial development in rural areas can be seen properly only in the context of the whole system involved, and that the environmental problems likewise can be viewed properly only in this integrated way. Environmental problems are, after all, the result of interaction of man and the natural world. But the word "integrated" has been misused sometimes to mean "consider everything"; more appropriately it should be defined in the sense of "taking care that the major links between various sectors of a development approach are in place." Too many of us have practical experience of the missing link that prejudices the whole operation. It is the lack of a sufficiently flexible attitude or administrative structure that has been a prime cause of both environmental and developmental problems.

Given all this, what kinds of problems can be adequately treated here? I will attempt to deal with five main points which seem basic. In summary, they are:

1. There are many different kinds of environments in that large part of the world occupied by the developing countries. Within these varied natural environments there are many different kinds of developmental and cultural situations; thus, many different kinds of problems.

2. Although we cannot readily transfer our environmental knowledge from North America or Europe to other areas, because both environments and local situations are different, there are useful guidelines which can be applied

widely. Part of our task here is to specify such guidelines. Our technical knowledge is, of course, immensely useful where the problems are of a technical nature. But perception of the pressing environmental problems may differ widely. Politicians, scientists, and others in developing countries may differ among themselves and all may have some different viewpoints from equivalent groups from the developed countries. (See, for example, Berry and Kates, Table 1, Annex I.)

3. In a particular local area there are at least three kinds of environmental knowledge which can be brought to bear on a problem: scientific information, local informal technical knowledge, and local "know-how." Only a small amount of the scientific information and little of the other two categories are used in most projects.

4. Major environmental concerns arise not only at the project level, but from the result of broader trends. The impact of one industry or activity may be locally important; but many small industries plus widespread agricultural development, plus growth in population and rural settlement, plus spread of larger urban areas all may add up to a pattern of ecological change which severely reduces opportunities for the future. These issues need a national-level policy and planning initiative. Clear policies on wildlife conservation, woodland reserves, ecological policies for coastline development and many other topics are still needed in many countries. Such policies often need to be made with a clear idea of the implementation capabilities of agencies and governments concerned.

5. While in each national or regional setting it is important to support policy and planning work and to eliminate obvious environmental hazards related to programs of rural development, rural development is, by definition, a process of change in very complex interrelationships. There is no adequate way of assessing the full outcome of any set of changes, either in their impact on the environment or in their effect on development and local well-being. It is, therefore, important to build in, wherever possible, a hopefully simple feedback process whereby the effects of the first phase of any particular activity can be recognized and the lessons incorporated into later phases.

The rest of this paper tries to spell out more fully some of these suggestions.

Environmental Variety

Many Third World countries are located in the tropics and subtropics, and to the casual visitor, there may appear to be a relative uniformity in the physical environment, at least within the major ecological zones. For example, we use the climatic term "Sahel" to describe a zone which is characterized by a climate transitional between the true desert to the north and the Sudanic zone to the south, with more substantial and prolonged wet season rainfall. To many, the Sahel is a place. But the Sahel includes many different physical environments; the area has a complicated geomorphological history which is important in understanding the mosaic of landforms, soils, and vegetation occurring over this wide area. In addition, the zone is traversed by several major river systems and further diversified by lakeshore environments.

Most other areas which could be chosen as examples display at least this degree of diversity. Spatial diversity of topography, soils, and vegetation, all often subtle, is accompanied in many places by temporal diversity in weather and climate. Much of Africa, for example, is arid or semiarid, these climatic zones being characterized by variability in rainfall and relative uniformity in temperature. Rainfall variation from prolonged drought to torrential downpours, both over the year and over sequences of years, makes it much more difficult to assess quickly what the major environmental problems are likely to be. It is often the big flood or the big drought, or sometimes one rapidly after the other, that creates the most dramatic environmental problems.

The mosaic of human use patterns on the landscape can add new complications. Each agricultural system has its own pattern of environmental use in time and space and we are only now beginning to understand the full range of variation in these systems. A recent study of Tanzania showed that there were at least 230 different agricultural systems in that country, not including the varied, imported plantation systems (Conyers, 1973). There is thus no simple framework for which we might lay down a few simple rules.

Guidelines for Dealing with Environmental Problems

Alongside the diversity of environment and resource use, we need to recognize our comparative lack of knowledge of the natural dynamics of the areas concerned. There is still a tendency to want to apply the guidelines found useful

in the metropolitan countries to the tropics. This has to be done very carefully, if at all.

The development of rural industry is likely to involve water problems, some land pollution problems, some ecological problems, and land-use planning problems. Air pollution is less likely to be a severe problem. For nearly all of industry, except some artisan trades, water is important. The topography and climate of many parts of the tropics greatly limit the number of perennially flowing streams. This means that most water sources are used for several purposes and there will in the future be even more competition in demand. Drinking water, irrigation, power, and industry all compete for the same resource. Pollution problems in such streams thus may have wide ramifications; the problem of water access and water pollution may be a major limiting factor in the development of significant rural enterprises in many parts of Africa.

The variability of stream flow, in both large and small rivers, is a problem which is often met by the construction of storage reservoirs. The unintended side effects of such construction need careful consideration. Problems that have arisen include problems of user rights of the stored water, changes in animal seasonal migration because of changed water supply situations, changes in the pattern of insect life, problems of aquatic plants invading the new habitat, and so on -- the list could be a long one.

A first guideline related to water should recognize that this may be a limiting factor in rural industry and that patterns of water use and disposal may be of prime environmental importance.

Many rural industries are, properly, based on local natural resources. Industries that use local woods or local agricultural products and industries that process locally found minerals are perhaps the most common. In these cases, the environmental problems most frequently neglected are those of the source areas. Even a small-scale wood-using industry can quite rapidly bare important stretches of hillslope, with resultant erosional problems affecting both the slope and nearby agricultural land. Sisal in East Africa is an example of a local industry which, although it is well scattered, has had an important impact on water quality, in this case due to the washing and waste disposal mechanism of the industrial process. Mining wastes are a problem all over the world, and here tropical problems are very similar to those elsewhere except that controls are even more difficult to implement.

Problems of natural resource-using local industry are mainly those of land erosion in the source area and land and water pollution through disposal mechanisms.

Land-use planning problems are closely related to the ecological problems which arise from uncoordinated rural development. Even at a local level, it is easy to identify problems arising from the haphazard growth of industry and agriculture, without consideration of the effects on water systems and plant and animal life.

However, perception of what are the most important environmental problems may vary greatly between different observers. At the time of the 1972 Stockholm conference on the environment, the agenda items deemed most important by Western European and North American delegations were very different from those highlighted by African and Asian members. This is not surprising; the problems are different. In the table (Annex I) we tried to indicate some of the differences that were judged to be important in Tanzania in 1972. External writers interested in East Africa viewed conservation of wild life, soil erosion from cultivated land, unplanned urban land use all as very critical problems. Local priorities went to drought and famine, auto accidents, and biological crop hazards. My coauthor and I added rangeland deterioration and uncoordinated rural land use as important issues. Different regions and different times may well change the focus of attention. For instance, Tanzania has begun to place more emphasis on soil erosion problems in the last few years. Annex II is the conclusion from a recent conference on environment and development. The ideas on industrial problems outlined there may give some view of what Third World academics have recently forwarded.

Any external body will need to recognize and deal with these differing perceptions of environmental issues.

Environmental Information

In rural development projects, it is often difficult to get the necessary data base on which to build a secure assessment of the environmental impacts of the projects. In large river basin development programs and the like, environmental studies are a necessary part of the preliminary work; in smaller projects, the time span for preparatory studies and the cost will frequently allow only cursory special studies. How, then, do we proceed?

There are at least three kinds of environmental information likely to be available for any one locality. All are underused, at least in my experience. The first, formal scientific data, is typically scattered in disciplinary journals not often available in the country concerned. This information, if it was not collected specially for the project, is likely to be only marginally important and may need expert translation to the conditions of the project area. More general books and papers are of little help, as they tend to half inform and sometimes mislead on environmental matters. One important need, therefore, is to have some means of identifying and synthesizing the scientific literature to meet the particular needs of each particular project.

Informal technical knowledge of environment is part of the general knowledge of many people, agriculturalists, engineers, and the experienced administrators, especially those working in an area or who have worked there in the recent past. This knowledge, if tapped, may be a complement to, or a partial substitute for, more formal scientific data. The people concerned often have a sound working knowledge of the most important environmental problems and of previous attempts at solutions. Their knowledge is seldom written down except perhaps in the form of one- or two-copy internal reports. But if questions are asked in the right format, this information may be readily retrievable and of great value.

Informal local knowledge of environment is part of every culture. Local people, farmers and rural artisans, have a close understanding of the complementarities of the familiar landscape and have often adopted good strategies for dealing with any problems. This knowledge is not often organized in such a way that it can be readily applied to new sets of problems, but once more there is a need to fit this information into other data matrices.

Fortunately, it appears that the different sets of knowledge refer to overlapping scales of activity. Local information is often pertinent to the local scale, informal technical knowledge to the somewhat broader regional scale, and scientific knowledge to the regional or national scale. Can our new emphasis on rural development find a use for all of these data? It is necessary to use as much of the different information sets as possible. It will need work and experiment to enable us to do so.

National and Regional Levels of Problem Solution

Environmental problems in rural development result on one hand from the effects of individual projects in isolated areas, on the other from the result of the total impact of many different kinds of developmental change over national or broader regional areas. Thus, project planning needs to be set in the framework of national policies and plans.

Uncoordinated rural growth can, for example, cause far more long-range ecological problems than river pollution. The latter is more easily identified and treated. Clear policies and plans are needed in most countries to guide land use through a period of intense national change. Isolated policies exist on woodland and some areas are set aside for national parks, but few overall plans are available. Many conflicts are involved. Wild animals can be a scourge to farmers in Africa, pests can destroy much of the crop; yet the game reserves are a national and a world heritage. How can the farmers be protected and the wildlife be preserved?

Obviously policy related to land use is a national prerogative, but there may well be many ways in which donors can help to ensure that rural development projects do not build up in ways which result in possible wide-ranging ecological damage to the nation. For example, ERTS photography may well prove a vital tool in monitoring such broad changes.

In concluding, it is important to reemphasize my fifth point. Despite all our technical, environmental, and societal knowledge, we do not yet have effective ways of predicting the specific outcome of projects or programs. Too many factors are at work; there are too many "hidden agendas" which only later become apparent. It is, therefore, most important to build information feedback mechanisms into rural development projects. These can take many forms, but should include information on the environmental issues being encountered. The feedback of information is, however, of little use unless there are ways of modifying the project or program in the light of what has been learned. It all demands a new philosophy which, to be successful, will need to encompass every stage of development planning. Good approaches to rural development should result in better environmental planning.

REPORT OF WORKING GROUP ON ENVIRONMENTAL CONCERNS

The group, consisting of a judicious mixture of AID and university people, was naturally able to discuss a wide range of practical and theoretical issues.

Some general underlying concerns which were expressed included issues related to the possible need for formal Environmental Impact Statements for AID projects; issues related to environmental conservation; and issues related to adequately taking account of impacts of development on environment.

The following main points give a flavor of the discussion:

1. The group was agreed that science and technology are essential to the adequate assessment of environmental change. However, given the wide range of environmental and cultural conditions, the particular S&T input must be related to specific sets of conditions. We were pleased to note that even in the last few years S&T has become much better equipped to deal with some of these problems.

2. We recognized that environmental change is an inevitable part of developmental change, and should be expected. We need to recognize what changes are likely to occur and work towards minimizing harmful aspects of environmental change.

3. We need to be able to assess the environmental changes occurring in an area. Local aspects of environment can be relatively simply monitored, but in the last few years, scientists have become aware of the important implications of climate change. Thus, we have to determine the carrying capacities, crop types, and environmental impact in relation to our knowledge of longer-range climate scenarios.

4. Work is under way to provide a set of guidelines for environmental approaches in arid and semiarid areas. Perhaps this should be considered for the humid tropics also.

5. Guidelines might include sets of broad questions to be asked in the early stages of projects: What is the resource bore, how is that resource bore affected by climatic change, what options are available for future use of the area, etc.?

6. Development involves change in a system. We need to build mechanisms of assessment into the processes of change, and to develop the ability to initiate appropriate corrective actions where necessary. In this context environmental assessment and guidelines should at least highlight key factors deserving special monitoring.

7. We know a good deal about some aspects of environment, hydrology for example; we know less about some others; but we know least about some social and cultural parameters and the particular constraints of political infrastructures.

8. Despite the current concern with environmental problems, and the important need to ensure sustained use of natural resources through good environmental practices, we should recognize that many LDC governments and people currently give environmental problems per se a lower priority.

Thursday, May 8, 1975

INTERRELATIONSHIP OF ENERGY AND LDC RURAL DEVELOPMENT

KEYNOTE ADDRESS

ENERGY AND RURAL DEVELOPMENT

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An old saying has it, "slavery will persist until the loom weaves itself." All ancient civilizations, no matter how enlightened or creative, rested on slavery and on grinding human labor, because human and animal muscle power were the principal forms of energy available for mechanical work. By its discovery of cheaper sources of energy than human muscles, the modern civilization, unlike all others, has been able to make men free. Today, the economic chasm that divides the world also separates two vastly different levels of energy use. More than four fifths of all the energy utilized by human beings is consumed in the rich countries and less than one fifth in all the rest of the world.

Despite this disparity, most "commercial" energy sources and a great variety of "noncommercial" sources are employed in the rural areas of less developed countries. As Table 1 demonstrates, many of the categories of energy use that exist in developed countries can also be applied in these areas. But usable energy has always been in short supply, and the necessity for energy conservation has always been present even though the total amount of energy used is far less than in the developed countries. Modernization of agriculture and improvements in the health and welfare of rural people depend on a considerable increase of total energy use and on substitution of other energy sources for human and animal energy.

Unless and until electrical or other commercial forms of energy are made abundantly and inexpensively available to the rural areas of the poor countries, the growing populations of these areas must depend mainly on energy they can produce themselves. Two principal technical problems are: the development and introduction of improved sources of energy for household and agricultural use, and better ways of energy conservation. The criteria that need to be taken into account in these developments are: low capital and foreign exchange costs, low unit cost of equipment, ease of maintenance and operation, high reliability, easy access, minimum environmental impact, and high cost-effectiveness, that is,

a relatively low ratio of the cost of energy input to the value of energy output. If possible, the materials utilized as a source of energy should not have better alternative uses.

In Table 2, present commercial and noncommercial energy sources are tested against these criteria. We see that no energy sources in their existing state of development are completely satisfactory. The challenge of research and development is to produce energy conversion equipment and processes that more fully meet all criteria. It can be expected, however, that even after considerable improvement has been accomplished, trade-offs between criteria will still be necessary, based on economic, social, and political considerations. All constraints would be significantly relaxed by an order of magnitude increase in total supplies of energy at prices that rural people could afford to pay. Here we are faced with a circular relationship. A much larger supply of energy would raise rural incomes and make it possible for rural people to pay more for their energy supplies.

The low level of energy use and the overwhelming importance, under present conditions, of locally produced "noncommercial" sources of energy in rural areas of the poor countries are illustrated in Table 3, in which estimates are given of the quantities of energy from different sources in rural India. Human energy and the working energy of domestic animals make up 24% of total energy use, while "commercial" sources comprise about 9%. The total energy used -- 7.85 kwh per day per person -- is 5% of the per capita use of energy on United States farms (17). Despite this vast disparity in energy use, the cost per ton of cereals grown in the United States is lower than in India. One of the principal reasons is the high cost of human and animal energy. This is clearly seen in Table 4, which shows comparative pumping costs for low water lifts in Chad. Even though fuel costs in Chad are about twice as high as in the United States, the cost per unit quantity of water pumped by human labor is thirteen times the cost of mechanical pumping with a low-speed diesel engine, and the cost of pumping using animal power is nearly three times as high.

Table 5 gives an approximate energy budget for rural India, showing the estimated allocation of energy for different purposes. The energy used within households for lighting, cooking, space heating, and boiling water is surprisingly high -- over 5 kilowatt hours per person per day. The reason would appear to be that the principal fuels for these purposes -- wood, cow dung, straw,

and other crop wastes -- are very inefficiently used, that is, most of the heat produced by burning is wasted. The energy used directly for agriculture in lifting water for irrigation, production of chemical fertilizers, transportation, operation of farm equipment, and food processing is 2.47 kwh per person per day, or a total for rural India of 3.57×10^{14} kcal per year (397 billion kwh per year). Assuming that 1970-71 food production, expressed in equivalent weight of food grains, was 120 million tons (corresponding to a per capita food intake of 2,100 kcal/person/day), the energy used to grow and process a ton of food grains (containing 3.5×10^6 kcal) was 2.96×10^6 kcal, or about 85% of the human food energy produced. This is considerably higher than the energy use per ton of food grains for modern agriculture, with a technology at the level of that in growing corn in the middle-western United States (10), even when energy use in irrigation and food processing is omitted from the Indian figures.

Table 6 gives a comparison of average energy uses for different purposes in present Indian agriculture with those which might apply in a modernized agriculture, with yields of about 6 tons of cereals per hectare. The energy use for irrigation and for chemical fertilizers per ton of good grains produced would be about twice as high in a modernized agriculture as at present, while that used in constructing, operating, and maintaining farm tools and machinery would be considerably less, as would the energy for cereal milling and other food processing. Economic comparisons between the present Indian food system and that which might be developed, given sufficient additions of capital and skill, are complicated and will not be attempted here (see reference 20). But it is clear that the marginal productivity of additional irrigation water and fertilizer could be very high at present, compared with modernized agriculture.

The large-scale burning of firewood and cereal straw as a source of energy for cooking and space heating has serious implications. Until recent years, forests had completely disappeared from most of China, because the trees had been cut down for fuel. It is likely that a similar process is now occurring in much of India. The total forested area is about 75 million hectares (4), of which 80% is actually or potentially usable. According to Prasad, et al. (11), forest areas contain 50 tons of wood per hectare. Thus, the present reserves, if all were used for firewood, are $7.5 \times 10^7 \times .8 \times 50 = 3 \times 10^9$ tons, or enough to last for 24 years at present annual rates of consumption of 1.26×10^8 tons.

An equally serious problem is the very uneven distribution of the forests, with 50% of the forested area in four states (Madhya Pradesh, Orissa, Andhra Pradesh, and Maharashtra) with less than 20% of the population (9). Intensive reforestation programs will be necessary if India's forests are not to disappear before the end of this century. Actually, reforestation could considerably increase present energy supplies. Parikh (9) estimates potential annual production in forest plantations at 12.5 metric tons per hectare. Thus, the potential annual production under intensive reforestation could be 7.2×10^8 tons -- about six times present annual consumption of firewood.

The use of wheat and rice straw as a source of fuel makes it unavailable for better uses such as feed for domestic animals and mulch to improve soil tilth. Winfield (19) and Scott (14) have estimated that production of wheat straw in north China is about 1,550 kg per hectare. With an average farm area of two hectares, this production is insufficient to provide both food for work animals and pigs, and fuel for cooking, let alone heating during the cold winter months. Jalal (5) has estimated that the total production of rice straw in rural Bangladesh is 350 kg per person per year, or about 1,700 kg per hectare of cultivated area. With the small size of farms in Bangladesh, this is barely sufficient to feed the farmers' bullocks, and its use for fuel means that the animals are as malnourished as the people.

Some of the promising lines of future development to help solve rural energy problems in the poor countries appear to be the technology of biogas production (so-called "gobar" gas), development of rapidly growing trees and leguminous plants for use as fuels (1) or as feed stock for alcohol (12) or biogas production (11), development of inexpensive means for water and space heating from the direct use of solar energy, and development of small hydroelectric generators for areas with perennial streams. Cheaper methods of storing energy would increase the practicality of windmills, at least in coastal regions and on small islands.

Better water management and increased crop yields per unit area would raise the cost-effectiveness of pumping for irrigation and would make it possible to conserve energy by reducing the amount of water pumped per unit area, and perhaps also the total irrigated area. This is graphically illustrated in Table 7, which shows the costs and quantities of energy required in India for pumping different amounts of water from a range of depths to irrigate a cereal

crop. Within the range of water and depths shown in the table, the value of the incremental production in a modernized, market agriculture (13) can greatly exceed the cost of the energy used in pumping, even at energy prices three or four times higher than those assumed in the table. If the amount of water supplied by irrigation is sufficient to meet the evapotranspiration requirement, which depends primarily on climatic conditions, and the soil has adequate water-holding capacity, crop yields are virtually independent of the quantity of water.

In the short term, improved stoves and other means for improving the efficiency of fuels used for cooking, water and space heating, and lighting would appear to be the most promising energy conservation measures, because of the high proportion of total energy consumption used for these purposes.

The technology of biogas production is attractive from several points of view (8, 9, 11). Most of the organic nitrogen in animal manures and human wastes can be conserved for use as fertilizer. Dangerous human fecal materials (19) can, in principle at least, be handled more safely, and the efficiency of energy consumption can be raised, because less of the energy of combusion is wasted when methane or biogas is used as a fuel than when cow dung or crop wastes are burned directly. The technical difficulties that must be overcome include the high cost and "lumpy" nature of the initial capital investment, the sensitivity of biogas production to ambient temperature, the criticality of the "mix" of animal and plant materials that must be used for optimum production of methane, and the difficulties of storing the gas under sufficient pressure.

At present, the direct use of solar energy for water and space heating and cooling (16) is prohibitively expensive for most rural areas in the poor countries. Cheaper materials for capturing and storing solar energy and transporting the energy to the point of use can conceivably be developed.

The high capital cost of efficient windmills and the low and variable wind velocities in most rural areas make wind power relatively unattractive (6, 18). Most existing wind machines produce little or no power when the wind velocity is below 6 to 8 miles per hour. At higher wind speeds the power production increases with the cube of wind velocity. At 15 miles per hour, for example, a windmill costing $2,000 will generate about 1 kilowatt of electrical power, but such velocities occur only in coastal regions where there are relatively steady

land and sea breezes, or on small islands. Even in these regions wind speeds are usually highly variable and wind power has little utility except for pumping and storing water for livestock or human use. The range of uses of wind power might be extended if inexpensive means of energy storage could be developed.

In Nepal, Assam, and other hilly and mountainous regions with abundant precipitation, the force of gravity, expressed in running water of streams and rivers, is a major natural resource. These are often forest regions and watersheds for the great rivers that flow through the lowlands. With the growth of human populations, the forests are being cut down faster than they can grow, partly to make room for new farmlands, and partly for use as fuel. As a consequence, the upland areas are subjected to destructive erosion, while the resulting sediments cause rapid filling of reservoirs and destructive floods in the downstream areas. Substitution of small, run-of-the-river hydroelectric generators (16) might provide a substitute source of energy for the mountain and hill peoples and thereby help to conserve the forests.

In planning a program of research and development to assist in solving the energy problems of poor people in the rural areas of poor countries -- by far the majority of mankind -- systematic analyses of present energy sources and uses, similar to those in Tables 1, 2, and 3, should be undertaken for various climatic regions and for countries in different stages of development. For example, the need for space heating is very real in Korea, northern India, Afghanistan, and Turkey. But it hardly exists, except for high altitude areas, in most of southeast Asia. The reserves and productivity of forested areas differ widely from one country or region to another, as do the intensity and uniformity of incoming solar radiation. Wind power may be a potential energy source in certain regions, but not in others, and similarly, the potentials for water power are widely variable. The difficulties of energy transport and distribution and, conversely, the needs for local supplies of energy will depend on the levels of development and on population densities. These and many other factors need to be taken into account in rational planning for the development and adaptation of energy technology.

Table 1

SOURCES AND USES OF ENERGY IN RURAL AREAS OF LESS DEVELOPED COUNTRIES

	Construction	Irrigation	Fertilizers	Operation of agricultural machinery	Agricultural & other transportation	Domestic water supply	Water sanitation	Cooking	Night lighting	Space heating	Sugar production	Cereal milling	Food storage	Other agro-industry	Communications
Human energy	TM	T		T	T	T	T	T		T	T	T	T	T	
Animal energy	T	T		T	T				T	T		T			
Firewood	T						T	T	T	T				T	
Cow dung							T	T		T					
Straw, bagasse, other crop wastes							T	T		T	TM			T	
"Gobar" gas	M						M	M	M	M				M	M
Solar energy								M		TM					
Windmills		TM				TM						TM		TM	M
Petroleum & natural gas	M	M	M	M	M	M	TM	TM	T	TM		M	M	M	M
Coal			M			M	TM	TM		TM				M	
Electricity: Hydro	M	M	M			M	M	M	M	M	M	M	M	M	M
Thermal	M	M	M			M	M	M	M	M	M	M	M	M	M

T = Traditional Uses M = Modern or Potential Uses

Table 2

SOCIO-ECONOMIC CHARACTERISTICS
OF DIFFERENT ENERGY SOURCES FOR RURAL AREAS

	Capital-output ratio	Foreign exchange costs	"Lumpiness" of capital investment	Difficulty of maintenance & operation	Uncertainty	Difficulty of access	Environmental impact	Better alternative uses	Cost of energy input-value of energy output
Human energy	L	L	L	L	L	L	L	H	H
Animal energy	M	L	M	L	L	L	L	L	H
Wood	L	L	L	L	L	MH	H	H	M
Plant and animal wastes: Cow dung	L	L	L	L	L	L	L	M	L
Straw, bagasse, other crop wastes	L	L	L	L	L	L	L	M	L
"Gobar" gas	H	L	M	M	M	M	L	L	M
Solar energy	H	M	H	L	M	LM	L	L	M
Windmills	M	M	M	M	H	M	L	L	H
Oil	H	H	H	H	M	M	M	M	L
Coal	H	M	H	H	L	M	H	M	L
Electricity: Hydro	M	M	H	M	H	H	M	L	L
Thermal	H	H	H	H	M	H	H	L	M

L = Low M = Moderate H = High

Table 3

TOTAL AND PER CAPITA USES OF ENERGY IN RURAL INDIA, 1970-71

Source	Total Quantity Used: million metric tons	Total Quantity Used: U. N. coal equivalent million metric tons (1)	Total Quantity Used: billion kwh	Per Capita Use: U. N. coal equivalent kg/year	Per Capita Use: kwh/day
Human energy (2)		14.5	120	33	.75
Animal energy (3)		21.5	180	49	1.12
Firewood and charcoal (4)	105	62	515	141	3.20
Cow dung (5)	56	25	205	57	1.30
Straw, bagasse, other crop wastes (6)	32	14.5	120	33	.75
"Gobar" gas (7)	.005	.003	.03	.007	.0002
Solar energy used directly	-	-	-	-	-
Windmills		n. a.	n. a.	n. a.	n. a.
TOTAL "NONCOMMERCIAL" SOURCES	193	138	1,140	313	7.12
Petroleum and natural gas use:					
Fertilizer (8)	3.1	4.7	39	11	.24
Other uses (9)	4.4	6.7	56	15	.35
Coal used directly (10)	2.7	1.8	16	4	0.10
Electricity:					
Hydro (11)	-	2.0	2.9	4.5	.02
Thermal (11)	3.5	2.5	3.5	5.7	.02
TOTAL "COMMERCIAL" SOURCES	13.7	17.7	117.4	40.2	.73
TOTAL ENERGY USE	207	156	1,257	353	7.85

(continued)

Computations for Table 3

(1) United Nations coal equivalent in terms of heat energy = 8.3×10^3 kwh/ton = 7.5×10^6 kcal/ton.

(2) Assume 1/3 of average daily per capita food energy intake of 2080 kilocal (2.3 kwh) was utilized for work-related activities by the rural population of 4.4×10^8 people. $2.08 \times 10^3 \times 3.65 \times 10^2 \times 4.4 \times 10^8 / 9 \times 10^2 \times 3 = 1.2 \times 10^{11}$ kwh. $1.2 \times 10^{11} / 8.3 \times 10^3 = 1.45 \times 10^7$ tons coal equivalent $1.45 \times 10^7 / 4.4 \times 10^8 = 3.3 \times 10^{-2}$ tons coal equivalent per capita = .75 kwh/day.

(3) According to reference 15, the work energy derived from animal power was about 1.1×10^8 tons of "coal replacement" in 1965-66. If animal energy was directly replaceable by the energy in Indian coal (5.8×10^3 kwh/ton), the total quantity of animal energy utilized was $1.1 \times 10^8 \times 5.8 \times 10^3 = 6.4 \times 10^{11}$ kwh or 7.7×10^7 U. N. equivalent tons of coal. If 17% of this was used in urban areas (see reference 4), the total rural use was 5.3×10^{11} kwh or 6.4×10^7 U. N. equivalent tons of coal.

An alternative calculation may be made by assuming that the weight of an average Indian work animal (usually a bullock) and its daily food energy utilization is 10 times as large as that of an average Indian adult male (about 50 kg and 2500 kilocal/day.) According to reference 20, there were 70.4 million bullocks in India in 1972, and the average bullock ate 7.35 tons of fodder, "roughages," and "concentrates" a year. If the average utilizable energy content of this feed was 1.24×10^6 kilocalories per ton, the daily intake would be 25,000 calories, in accordance with our assumption. The total energy utilized would be 6.4×10^{14} kilocal or 7.1×10^{11} kwh. If 30% of this energy were utilized in work-related activities and 83% in rural areas, the total would be 1.8×10^{11} kwh or 2.15×10^7 U. N. equivalent tons of coal. We shall accept this estimate.

(4) According to reference 4, 126×10^6 metric tons of firewood were consumed in 1970-71, of which 83% was burned in rural areas. The energy content/ton of wood is 4.9×10^3 kwh (reference 12), or a total of 5.15×10^{11} kwh for 105×10^6 tons used in rural areas.

(5) According to reference 4, 68×10^6 metric tons of dried cow dung, about one fourth of the amount produced by 247 million cattle (see reference 20), were consumed in 1970-71, of which 83% was burned in rural areas. The energy content/

ton of dried cow dung is 3.7×10^3 kwh/ton (reference 9) or a total of 2.05×10^{11} kwh for 56×10^6 tons used in rural areas. An alternative calculation can be based on results from the National Sample Survey, 18th Round, February 1963-January 1964, which gave a yearly per capita combustion of dung cakes in rural households (corrected for income distribution) of 87 kg, or a total for 440 million rural people in 1970-71 of 38.15×10^6 tons, corresponding to 1.41 kwh. We shall accept the first alternative.

(6) According to reference 4, 39×10^6 metric tons of "vegetable wastes" (on the order of one fifth of the "wastes" produced in Indian agriculture), were burned in 1970-71, of which 83% was consumed in rural areas. Assuming that the energy content of this straw and other plant materials is the same as that of dried cow dung (3.7×10^3 kwh/ton), the total energy obtained from crop "wastes" in rural areas was 1.2×10^{11} kwh, or 14.5 U. N. equivalent tons of coal. This is considerably higher than the household use indicated by the National Sample Survey in 1963-64.

(7) According to reference 11, 8,000 gobar gas plants, each with a capacity of 1.7 m^3 per day of "biogas," were operating in India in 1974. With an energy content of 5.3 kwh/m^3 of biogas, the maximum energy produced would be $5.3 \times 1.7 \times 365 \times 8{,}000 = 2.6 \times 10^7$ kwh/yr. or a daily average for the rural population of $2.6 \times 10^7/4.4 \times 10^8 \times 3.65 \times 10^2 = 1.6 \times 10^{-4}$ kwh/day.

(8) Approximately 2×10^6 tons of nitrogen are consumed in chemical fertilizers, corresponding to an energy use of 3.9×10^{10} kwh (3.5×10^{13} kcal) (reference 10) or 4.7×10^6 tons of U. N. coal equivalent. Since the energy used was derived from naptha and other light petroleum fractions (and from natural gas in most imported fertilizer), with an energy content of 12.7×10^3 kwh/ton, the weight of fossil fuels used in manufacturing 2×10^6 tons of nitrogen was 3.1×10^6 tons.

(9) According to reference 4, 4.5×10^6 million tons of petroleum products in terms of "coal replacement" were used for energy in agriculture in 1970-71, and 27.6 million tons, in terms of "coal replacement" were consumed in households, out of a total for all uses of 97.2 million tons "coal replacement." The actual tonnage consumed (excluding nonenergy products such as naptha for feed stock, lubricating oils and greases, and bitumen) was 16.1×10^6 tons. Thus, the farm usage was $16.1 \times 4.5/97.2 = .75 \times 10^6$ tons, and that for households was $16.1 \times 27.6/97.2 = 4.6 \times 10^6$ tons. Assuming the per capita

domestic usage was the same in the city as in the country, the rural household and village use was $4.6 \times .8 = 3.7 \times 10^6$ tons, and total rural use was $3.7 + .75 = 4.4 \times 10^6$ tons of petroleum products, with an energy content of $12.8 \times 10^3 \times 4.4 \times 10^6 = 56 \times 10^9$ kwh. With the coefficients used in previous paragraphs, we compute the tonnage of U. N. equivalent tons of coal was 6.7×10^6, corresponding to 15 kg of U. N. coal equivalent per capita and .35 kwh per person per day.

(10) According to reference 4, 4.1×10^6 tons of soft coke made from coal were used in households in 1970-71. Consumption per capita was probably at least twice as high in cities as in rural areas. Average per capita coke consumption in rural areas was then 6.2 kg/year, with an energy content of $6.2 \times 5.8/3.65 \times 10^2 = 0.1$ kwh/day, or a U. N. coal equivalent per capita of 4 kg/year.

(11) In 1970-71, according to reference 4, 9.2% of 4.86×10^{10} kwh of electricity consumed was used in agriculture (mainly irrigation), or 4.5×10^9 kwh. In addition, 3.8×10^9 kwh were used in households. Villages containing 36% of the rural population (160×10^6 people) were electrified.

Per capita domestic consumption of electricity is lower in rural than urban areas, but since the urban population was only 110×10^6 people, we may assume that half of the household use occurred in rural areas, or 1.9×10^9 kwh. Hence, the daily per capita consumption of electricity in electrified villages was $(4.5 + 1.9) \times 10^9/1.6 \times 10^8 \times 365 = 0.1$ kwh, and for the rural areas as a whole, 0.04 kwh/day. Hydro power accounted for 45% of electricity generated in 1970-71, and thermal power (including nuclear) accounted for 55%. Applying this ratio to rural areas, we obtain 2.9 and 3.5 billion kwh for the total hydro and thermal electric energy consumed.

Indian coal contains only 5.8×10^3 kwh per ton (5.2 kilocal/ton). The average efficiency of conversion of the heat energy to electricity is 22%. Subtracting transmission losses and electricity used in power generation, the net electricity consumption is 83% of electricity generated. Hence, one ton of Indian coal is burned to generate 1000 kwh of electricity consumed, and the coal required for 3.5 billion kwh is 3.5 million tons. (Actually a large fraction of total electricity was generated from heavy fuel oil and natural gas, but we have been unable to correct for this.) The U. N. coal equivalent at 17% consumptive efficiency is 1430 kwh/ton of coal. Hence the U. N. coal

equivalent of the electricity consumed in rural areas was $(4.5 + 1.9) \times 10^9/1.43 \times 10^3 = 4.5 \times 10^6$ tons.

Table 4

COMPARATIVE PUMPING COSTS FOR LOW-LIFT PUMPS IN CHAD

Type of Pump	Capacity m^3/sec	Irrigated Area Hectares	Hours to Pump 1 Ham	Cost/Ham
Shadoof (2 men 8 hrs./day)	.0008	0.5	3,250	$ 726
Persian wheel with camels (8 hrs./day)	.004	2.5	610	137
Windmill (12 foot multi-vane, 24 hrs./day)	.0002 a/	0.4	13,000	2,400
Gasoline power (5 h.p. engine with sewer pump 12 hrs./day)	.056	48	49	74
High speed diesel (6.5 h.p. engine with sewer pump 12 hrs./day)	.056	48	49	68
Low speed diesel (7 h.p. engine with sewer pump 12 hrs./day)	.056	48	49	54
Electrically powered well system (13 pumps of .056 m^3/sec capacity 12 hrs./day)	.73	400 b/	3.8	67

Assuming 120 day growing season, irrigation required = .60 meters
fuel cost = $.91 per gal. pumping lift = 3 meters

a/ Average wind speed about 6.5 miles/hr. At 15 miles per hour, this windmill has a capacity of .003 m^3/sec, and the irrigated area could be 5 hectares; the cost per hectare meter would be $160. (See reference 6.)

b/ Assumed irrigation requirement = 0.9 meters.

Source: Reference 7.

Table 5

A TENTATIVE ENERGY BUDGET FOR RURAL INDIA, 1970-71

Energy Uses	Quantity Used per Caput Kwh/Day
Construction	0.25
Lifting water for irrigation	0.17
Fertilizer production	0.24
Transportation	0.30
Operation of farm equipment	1.15
Domestic water supply	0.08
Water sanitation	0.15
Lighting	1.05
Cooking	2.30
Space heating	1.55
Sugar production	0.25
Cereal milling	0.10
Crop storage	0.01
Other agro-industry	0.25
Communications	0.002
Total Energy Use per Caput per Day	7.852

Total for Rural India = 1.26×10^9 Mwh/yr.

Source: Author's estimates based on Table 3.

Table 6

COMPARISON OF ENERGY USE IN PRESENT INDIAN AGRICULTURE
WITH FUTURE USE IN MODERNIZED AGRICULTURE
(millions of kilocalories per ton of food grains)

	(1) 1970-71 Agriculture	(2) Future Modernized Agriculture
Irrigation from wells	.20	.59
Chemical Fertilizers	.29	.47
High Yielding Seeds	-	.02
Plant Protection	-	.01
Construction and maintenance of farm tools and machinery	1.38	.16
Fuel for machinery		.31
Fuel for drying crops	-	.05
Transportation	.36	.03
Storage and Marketing	.01	.01
Food Processing	.72	.20
TOTAL	2.96	1.84

Sources: Column (1), Table 5 and text.

Column (2), references 10 and 13. The estimated energy for irrigation is based on using electrified tube wells at 67% pumping efficiency and is taken as the energy content of fossil fuels used to produce electricity in thermal generating plants, with an overall efficiency of 24% for power generation and transmission.

Table 7

ENERGY USE/HECTARE IN IRRIGATION FROM WELLS IN INDIA, USING ELECTRIC POWER

Pumping Lift meters	Consumptive Evapotranspiration Requirements meters	Total Volume Pumped $10^4 m^3$ (a)	Energy Required for Pumping kwh (b)	Cost to Farmers in 1971-72 $ (c)	U. N. Coal Equivalent at 17% Consumptive Efficiency tons (d)	Incremental Crop Yield to Balance Total Energy Use tons (e)
5	0.4	0.6	125	2.50	.09	.19
	0.8	1.2	250	5.00	.18	.39
10	0.4	0.6	250	5.00	.18	.39
	0.8	1.2	500	10.00	.35	.76
40	0.4	0.6	1000	20.00	.70	1.55
	0.8	1.2	2000	40.00	1.40	3.09

(a) Assuming return infiltration plus drainage and nonbeneficial evapotranspiration = 50% of consumptive evapotranspiration requirement.

(b) Assuming 67% efficiency of electric motors and pumps.

(c) Cost of power to farmers in 1971-72 = $.02 per kwh.

(d) United Nations Coal Equivalent = 8.3×10^3 kwh/ton (7.5×10^6 kilocal/ton)
Electricity consumption in India = 79% of gross electricity generation (4)
Average Indian coal contains 5.8×10^3 kwh/ton (5.2×10^6 kilocal/ton)
Average efficiency of electricity generation in India = 22% of heat content of coal

(e) Assuming cereal crops containing 3500 kcal/kg.

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THE IMPLEMENTATION OF RURAL ENERGY PROGRAMS

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Preface

The objective of this meeting is to examine the programs of U. S. AID with respect to the implementation of development strategies for future planning. In this regard, the speaker is at a considerable disadvantage, as his knowledge of the past performance and ongoing program of this Agency are indeed limited. My personal encounters with different AID personnel operating in various parts of the world during the past 15 years have generally been most favourable. This contrasts somewhat with the impression often formulated by my American associates in referring to some of AID's activities and implementation techniques. It is necessary to make this statement, as I felt, and continue to feel, that my total ignorance of your operation is certainly not necessarily an asset. The general comments outlined in this paper result from the experience gained over a number of years not only by the speaker, but by his associates at the Brace Research Institute and elsewhere, and are offered for your consideration. My comments will be far more general than those of the previous two speakers -- leaning more towards a philosophy of approach in order to avoid overlapping.

Background

The problem of energy has been highlighted in recent years as a result of the growing realization on the part of a number of individuals and organizations that man should adopt a more rational course of action in the method in which he exploits both renewable and nonrenewable resources. In reality it received considerable impetus when the control of the price and distribution of petroleum passed out of the hands of the industrialized nations of the West. These surplus petroleum resources make up the balance of the consumption of oil supplies of the importing nations, located primarily by means of volume of consumption in the West. For the most part, the nations exporting petroleum are developing countries. These latter have banded together to form an organization which in itself regulates the price of this valuable commodity upon which the very fiber of the industrialized societies have been based. This simple act has posed the

greatest single challenge to the Western domination of world events in recent time. Obviously the reaction has been bitter and swift in the industrialized nations. The cry has been for autonomy in energy resources. This is an understandable reaction, especially in countries like the United States of America which have, until recent times, grown accustomed to having things go their own way.

Because industrialized nations are developed and well organized, they can indeed allocate resources in the form of manpower, materials, and technology to resolve the problems of energy self-sufficiency at home. Considerable efforts have begun, primarily in the last year, to investigate all manners of energy resources. It must be appreciated that the major effort is going into the exploitation of new sources of petroleum, the development of coal fields, the transformation of coal into usable products, nuclear energy, fusion, etc.

Some effort is being made, particularly in the U.S.A., Japan, and Europe, in the development of renewable energy resources. There are many facets to renewable energy resources, but a quick definition would be those energy resources used, both directly and indirectly, which emanate in a renewable, repetitive format and which have, as their essence, the sun as the driving force. In this category can be grouped the following energy classifications, all characterized by their short time constants. This latter term refers to the period of renewability of the energy source. Long-time constant energy sources, originating as well from the sun (such as coal, oil, gas, peat, etc.), will not be discussed herein. The renewable energy resources to be considered, therefore, are:

hydro energy
direct solar energy
wind energy
biomass energy

There is no need to discuss the technical potentials of these energy forms, which have been more adequately covered by the previous speaker.*

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* However, it must be stressed that to date relatively little research has been done in these fields (except for hydro energy). So I do not think it is entirely fair to do direct comparisons with energies like nuclear, gasoline or diesel engines, etc.

Limitations of Considerations within this Report

It is, of course, possible to discuss at length the potentialities of these renewable resources. This, however, has again been covered by the previous speaker. One must then ask the question, what can we do about it? At the moment these questions are being posed with increasing frequency, both in the developed and developing countries. The latter nations, which concern us more, I hope, in this meeting, increasingly inquire into the potential of these renewable energy forms in resolving their energy demand. This has arisen through the dramatic increase in the cost of conventional fuel sources, which in many cases must be imported, consuming hard-to-come-by foreign exchange.

There is a second reason for this increased interest. The very fact that systems dependent on an imported resource, such as petroleum or other fuels, can be subject to large-scale variations in price and availability, whether justified or unjustified, raises the question as to the development of resources which would be wholly under the control of the local utilizers. In a given country, those energies dependent on the sun become *national* energies. If properly developed, their control becomes purely *national*. They can be used in situ without the need for transportation from one point to another.

Thirdly, if these resources are properly exploited, there should be very little pollution of the environment. Effectively, they are ecologically sound.

Bearing these factors in mind, there is a rush to advise developing countries on the potential of solar energy in their areas. In many instances, both the individuals on these missions and the agencies they represent care little for the real development of these emerging nations. There is a very real danger that the Western aid and international agencies might possibly saddle these developing countries with relatively inappropriate technologies, utilizing renewable energy resources. It would be sad in our history of exploitation of the developing world if we added this nick to our holster. Herein lies the core of the problem. Because of resources shortages, both current and projected, the poorer nations of the world run the increasing danger of being the repositories of inappropriate, inefficient, and often prototype technologies.

Two facts are certain. In the next three decades the population of the world will double. Concurrently, there is an increasing expectancy of demand, particularly in the quality of life as it affects the millions of persons in the rural areas of the Third World. Where will the resources come from to satisfy

the demands for materials and energy resulting from these two conditions? In the competitive marketplace, the smaller, poorer developing country would generally come out second best in securing resources vis-à-vis the industrialized nations. It is all the more essential, therefore, that they embark on logical development schemes such as the utilization of alternative energy sources, encompassed in an overall program of appropriate technology. It might be wise at this stage to define what is meant by an appropriate technology.

An appropriate technology can refer to a tool, process, or system which is essentially compatible with the needs as well as the human, material, economic, and environmental resources of a community or society. These technologies are characterized by their ability to be absorbed within the community infrastructure and their compatibility with it. Often appropriate technologies are small-scale, low-cost, and labour-intensive, but they are not necessarily limited by these considerations. Basically, appropriate technologies tend to utilize local skills and available resources which are important though by no means limiting or even often necessary considerations. The various influencing factors in each different situation determine what is appropriate and what is not. Appropriate technology must be flexible and adaptable. It must be interdisciplinary in approach. Imported technologies can be appropriate if they do not dominate the local scene and if they are basically under local control. Appropriate technologies are owned, operated, and maintained by local populations and create meaningful jobs within a society.

Appropriate technologies can vary from simple hand-powered water pumps to group credit systems to a telephone system -- for each, in its own way, is adequate and appropriate for the society it serves.

Assessment of the Situation in Rural Areas

In order for one to have a proper grasp, within this short time, of the types of implementation programs needed in the assessment of renewable resources in rural developing areas, it would be best for the moment to limit our discussion to the villages and small agricultural holdings of the rural areas. This constitutes a not inconsiderable proportion of the populations of many developing areas. A typical case in point is Bangladesh, where a large proportion of the population lives in the rural areas.

The difficulty with rural development schemes is that one is often very suspicious that few organizations and even local governments are really desirous of improving the lot of the rural poor. The latter have neither the status nor the clout, both politically or economically, to wield much power on their national scene. They are generally ignored by their own ruling elites living in the capital cities, who spare no words in waxing poetic on the virtues of rural development. Unfortunately their actions in the rural areas are hardly commensurate with their platitudes. If the local authorities in most cases only pay lip service to rural development, then one can hardly expect outside agencies to be that much more committed. Frankly, some of the best rural development programs I have seen have come from the private sector, both local and missionary

It seems futile to collectively waste our time in discussing the virtues of the implementation of rural energy programs when we know full well that in many instances there is no real commitment to rural development. Hence, it is a primary prerequisite that we be committed to rural development in order to investigate further courses of action.

The term rural energy programs is a broad one. It is most unfortunate that in our aid programs, and I refer primarily to those of my own country with which I am slightly more familiar, that we are often too busy to attempt to really determine what the problems are. Do we often know what really constitutes the problem? Is it not unrealistic that in order to satisfy the need for a visual effect, we export as part of our aid programs those pieces of equipment, processes, or systems developed to perform in our own society? We often pay little heed to their real appropriateness and adaptability to the local situation.

In an Asian subcontinent country in the last few years, agencies have been parachuting into the villages diesel-powered water pumps which were placed on tube wells drilled at a considerable cost. The technology was adequate in its micro sense. Outside factors, such as the supply of diesel fuel, spare parts, and skilled technicians for their maintenance, limited their potential operating time. Inside factors also limited the output, such as the placing of the pumps on the land of the village "party" representative who operated the pump as a mechanism of controlling dissident factions within the area.

All this is done effectively with the support and approval of the outside aid agency, who feels that they have accomplished something. They have indeed -- they have exported commodities from their country, paid for collectively by the

taxpayers. On the local scene, once the needs of the leading officials have been satisfied, they have distributed these units in different villages. A certain amount of local labour is engaged to prepare the tube wells and install the pumps. Foreign well-drilling equipment and teams are employed as part of further "aid" programs.

Eventually one has installed a series of diesel-powered pumps whose total appropriateness in the overall sense is often questionable. As they lie idle, the local peasantry continues to lift water utilizing his own classical water-lifting systems. At least he is in control of these; no outside or inside factors can affect this operation.

Last month in Sénégal, I saw very similar situations in the dry hinterland. There the ruins of diesel motors put out of commission by the fine desert sand are contrasted with the remains of the water hand pumps whose parachuted presence was unexplained to the local villagers, who subsequently made personal use of any moveable metal parts. Surely, if we really want to have appropriate technologies, we must first:

(a) find out what are the problems;

(b) determine a methodology of approach which will really ensure integration and continuity for the technology within the system.

How would one go about determining a rural energy program for a typical village area? The best way would be to study all the parameters within the particular village or rural area in order to determine the nature and magnitude of the problems. It is a shame that we are often prepared to spend much money, effort, and time to implement a program and little effort or resources to ensure that indeed we really should be undertaking this program.

If one wished to determine a rural energy program for a particular village or area, the following steps would be essential:

(a) Within a given area, assess all the different technological equipment and processes utilized by the local population.

(b) Determine the actual energy demand for all activities, e.g., farming, domestic usage, industrial or commercial requirements, water pumping, housing.

(c) Project what this demand for energy might become with a readily available supply of energy.

(d) Detemine the material resource consumption within the area. It is unfortunately a common fallacy that one should try to rectify the energy problem without examining as well the totality of the problem. Is the energy used effectively or efficiently? What other resources are also used? These invariably affect energy utilization.

(e) In isolated, nonelectrified villages, most of the energy is human, or organic material or animal power, with some occasional assistance from wind or water power. If fossil fuel powered engines have been introduced, what has been the effect on the village life and productivity?

(f) If conventional power systems -- diesel or gasoline engines, or windmills or solar engines -- will be used to replace traditional power forms -- human and animal power -- what effect will this have on the existing village infrastructures?

(g) Investigate the whole question of the village structure, the educational level of its citizens, their behavior patterns, etc., and their acceptance of innovation. If the local community is not ready or cannot perceive the real need for a change, the introduction of even an appropriate technology, for material or energy exploitation, will be only superficial and may eventually fail.

This list is only partial as there is no time to fully develop this theme. All of these pointers seem logical enough, but it is noteworthy that they are not necessarily followed in developing rural energy programs. Why is this? It is essential that we not only introduce appropriate technology equipment and processes, but that they be introduced in an appropriate manner.

There is an appropriate technology process which is dynamic. It examines technology in its socioeconomic, cultural, and political context in order to ensure that all factors have been considered in determining appropriateness.

In the rural areas, these technologies have some hope of successful adoption only if one implicates the local population. Often the leaders or the more progressive elements should be used to provide the social animation to the local populations, explaining not only the need for the energy, but also pointing out the advantages and even the disadvantages. In all cases the participation of the local inhabitants is essential. They must be implicated from the very beginning, in the planning of the facility, where it should be located in the community, whom it will serve, and for what cost. A typical case study might

be the installation of a solar distillation system we undertook in Haiti. A local church organization working with a remote, isolated village provided the lieu and the necessary infrastructure.

Through Haitian animateurs, both social and technical, the local population was informed of the proposed project -- which initially they could barely fathom technically. A Canadian welfare organization provided some funding which partially permitted our own participation. The rest was lots of hard work, effort, and much dedication. Now, six years later, the solar distillation plant still provides water -- apparently for up to 1,000 persons. A windmill pumps water into the saline water reservoirs. The local villagers have got a boost in life; they did something positive in 1969 which permitted them to capitalize on their other ventures and improve their productivity, whether it be in fishing, agriculture, or whatever.

The whole problem of the proper implementation of rural energy programs of this nature is fraught with potential difficulties. In one case, one experiences some measure of success; often even the best intentioned of programs go astray and are partial or total failures. What we should concern ourselves with is not just the program, but its total implementation and acceptability. For it is this final proof of success towards which we must aim our efforts -- the acceptance by man of a truly appropriate technology. To be able to provide some direction enabling these populations to really help themselves, we must see problems from their point of view. We must appreciate their situation and design our technologies not in how they affect us personally, professionally, or nationally, but in how well we involve the local inhabitant in his auto-development. He must even do his own research in time, for who but the local really understands the natural elements in his area. In Sénégal, I recently saw an excellent program called Enseignement Moyenne Pratique which actually is putting this to practice! This pill might be a difficult one to swallow, especially for the national and international academics so often thoroughly divorced from the real problems while still producing magnificent scientific treatises on the subject of rural development.

Implementation of Rural Energy Programs

Not all rural energy development schemes need be on a small scale. The same principles and the same techniques touched upon previously need to be considered in developing the supply/demand relationships for a larger area.

Basically four factors should be taken into account:

(a) the people of the area

(b) the resources available

(c) the technologies for energy exploitation

(d) the structures which function within a given area

A truly appropriate technology results from a harmonious interplay between these four basic factors.

If adequate fossil fuel resources exist, it does no good to introduce an appropriate fuel energy technology into an area if the people cannot assimilate or understand it, or if the structures of the society do not permit the proper benefit from this investment. On the other hand, if the people are not aware of all the technological options, they may not even realize that they have exploitable resources, even though the technology exists and the structures are sound. This was clearly indicated in a recent trip last month that I made to a livestock station at Dahra-Djoloff, in Sénégal. This station is 1,100 hectares in area, with over 1,000 head of cattle on mainly steppe and scrub land. Underground water is available at 30 meters from rainfall sources and at 60 meters from fossil water sources, following the drilling of 200-meter-deep bore holes. A 15 HP water pump powered by a diesel engine supplies water to the complex through 6 km of pipelines to various watering locations. Considerable difficulties were encountered in paying for and transporting the diesel fuel needed to operate the pump. The maintenance costs are excessive, as the location is quite remote from Dakar.

In assessing the water and power problems of this area, it was evident that:

(a) The totality of the water supply and power demand facets of the station needed study.

(b) A dispersed system of water supply would have been better to avoid having the cattle roam such long distances between watering areas. This would have afforded a better management of grazing areas, as those adjacent to the principal pump were obviously denuded.

There were a number of obvious solutions, quite unknown to the excellent Senegalese veterinarians in charge of the station.

(a) The wind, which was fairly constant during the dry season at 15 to 25 km/hour, could be used to pump smaller quantities of water.

(b) The solar-powered pumps offered by SOFRETES-France, a number of which are also in operation in Sénégal and other Sahelian countries, could certainly provide an adequate supply of water. There was no lack of ample solar radiation at all times of the year, even during the rainy months, according to the meteorological records.

(c) The most obvious energy source, never even considered, was the mounds of excrement produced daily by these animals. As the animals tend to leave their droppings near the water holes, collection at least of a large fraction does not seem to present a serious problem. There is no shortage of labour or trucks. The excrement could be gathered and placed in an anaerobic digester for the production of methane gas. The methane could power an engine to run the pump, no doubt with less maintenance than the existing diesel engine. This technology is fairly well known. The residue from the digesters could be plowed back into the fields as fertilizer more easily assimilable by the plants.

Actually, at the moment, the bulk of the volatile components and the moisture are driven off immediately through the action of the intense desert sun and the strong, dry winds. The excrements become hard and bricklike and require thorough soaking before their breaking up and absorption by the soil.

As a result, fossil fuel energy is imported to this remote location when the cattle themselves produce a more than adequate fuel source. Surely we must learn to exploit local resources fully through a proper assessment of the situation. By studying the global problem, it might be possible to satisfy energy needs from within and even possibly create a surplus.

Summary

In conclusion, therefore, the implementation of rural energy programs must necessarily:

(a) meet the real needs of the society;

(b) stem from exact knowledge of what the problems are within the society through an adequate assessment of the area;

(c) implicate at all levels the local people;

(d) utilize systems which are truly appropriate for these developing societies, both in the short term and in the long run.

For, ultimately, it is not just the implementation of a program of energy development that is important. What we must strive for is the development of man himself. We must be particularly careful that we do not implement energy programs based solely on our own experience. An advantage of our society is its flexibility and open-mindedness to change. Unfortunately, in many poorer developing areas, once they are saddled with a system, it is often difficult to re-effect a change. The name of the game is to get local people to help themselves and particularly to assist and influence their own technologists to take an interest in the problems of their country cousins. We must be particularly vigilant, however, that what we offer as technology and the manner of its introduction are equally appropriate.

Finally, and this is so obvious that it need not necessarily be mentioned, we must have the will to want to help develop the rural areas in their own fashion. If this will and the ensuing effort and allocation of resources do not really exist, then talk of meaningful rural development, whether in the field of energy or in other fields, will remain just that -- talk.

REPORT OF WORKING GROUP ON ENERGY: APPROPRIATE TECHNOLOGIES FOR THE RURAL POOR

It is difficult to say that there was general consensus on all the issues that were considered. There were many divergent points of view on the general topic. Following preliminary discussion on the general need to assess the energy problem in the rural areas, the whole question of what constitutes an appropriate technology was raised. There was by no means unanimity in this discussion of definition. Some members felt this implied decentralization, as the rural poor are widely distributed geographically. An attempt was then made to define the limits of the rural areas to be considered in the discussion. The consensus was to look at the problem of energy for populations of under 2,000 inhabitants normally living in towns and villages.

Within the boundary question, the question of scale arose and whether there were merits in going to larger-size energy installations in order to benefit from economies of scale. Again divergent opinions were expressed. On the one hand, it was felt that inexpensive technology costing no more than $15 per family or $500 per village should be used. Another viewpoint stressed that one should graduate from rudimentary technology towards a higher level which would still be under local control. The whole question of the financial limitations of the local populations was put into focus. It was pointed out that not all renewable energy technologies benefit from economies of scale. This depends specifically on the type of technology dealt with. At this stage, they are all somewhat expensive, though it is obvious that some form of decentralization is inherent. Though the question was raised on several occasions that specific technologies be considered, these were never dealt with.

It was pointed out that priority should be given to those energy projects which would:

1. Generate power to increase productivities at the village level.

2. Give priority to alternative energy systems which would replace current energy uses that are causing serious and possibly irreparable damage to the environment (such as the denuding of forests for use as cooking fuel and subsequent effects on climatic conditions).

Much attention was paid to the whole question of the communication of ideas. The relationship between energy needs and how they can be met with

respect to available money and labor was mentioned. This was contrasted with what technologies were available and at what costs. It was pointed out that the NAS survey of alternative energy sources did provide some information in this regard.

The problem of communicating ideas with respect to appropriate energy technologies was discussed in relation to the sources of available information on the manner in which this information is disseminated to the village level. This would necessitate an international system for the communication of ideas emanating from both developed and developing countries in appropriate energy technology. It must be borne in mind that one cannot divorce the village from existing government structures so as to permit the free flow of information.

One positive suggestion was that a compendium of appropriate energy technology, consisting of information gathered in the NAS report, be assembled. It should include work by organizations like the Brace Institute and others in the developing world, and should not neglect the data resulting from rural development programs as long ago as 50 to 100 years in developed countries such as the U. S. This should be made available to organizations in LDC's and elsewhere, though it was recognized that this would require adaptation to be appropriate in specific areas.

Several specific suggestions were made for the consideration of AID. It was suggested that AID:

1. Look at the capability and capacities of research institutes in LDC's which might undertake investigation in appropriate energy technology and research and development.

2. Should intensify funding for research in appropriate energy technology to be carried out in LDC's. It was pointed out that funding of meaningful research programs related to realistic needs of the rural areas would contribute to the reduction of the brain drain from LDC's.

3. Should give greater priority for funding the dissemination of information into the rural areas of LDC's in order to provide stimulus to these programs.

4. Should identify the kinds of research which would benefit the rural poor in these fields.

5. Give consideration to the implementation of projects of a joint nature with LDC's on appropriate energy technology.

6. Should assist in local capability building within these countries.

7. Should encourage, through educational programs, organizations which turn out developmental engineers.

8. Should give priority to the conservation of energy through improved energy effectiveness of different systems.

9. Should pay some attention to the requirements of appropriate energy technology programs coming from local countries and relate them to given experience in this field.

10. Give consideration to the needs for the coupling of indigenous institutions in local countries with U. S. organizations undertaking similar types of appropriate energy technology research programs.

11. Continue to sponsor seminars for representatives of the LDC's on rural development and place the emphasis on appropriate energy technology.

It was also recognized that AID should examine the role of government in providing appropriate energy technology for the rural areas with respect to financing and credit. It is important that the whole question of appropriate energy technology for rural areas be related to national development plans. The right type of organization at the local level would be needed to implement appropriate energy technology programs.

Finally, Dr. Manuel Alba presented a scheme which summarized the whole question of the assessment of energy supply-demand relationships in rural areas, relating this to research financial implications and energy projects, programs, and policies.

FOOD: ROLE OF ENERGY IN PROVIDING FOOD

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I shall try to put the role of energy in providing food in perspective by briefly reviewing the importance of energy in achieving production increases in the United States. I do this not to suggest that the historical pattern in the U. S. should be followed by LDC's, but rather to identify the direct relationships that have existed between yield increases and increases in use and energy -- namely fossil fuel.

When I speak of energy input into agriculture, I am referring only to the external energy input, direct and indirect. The energy input from the sun is not included, since it is free and beyond our control.

Energy in Highly Technological Agriculture

Several comprehensive studies of energy input into U. S. agriculture have been made. Before we discuss specific figures, it is necessary to define just what is meant when one speaks of agriculture. What portion of energy use in the agribusiness chain should be included with agriculture? In addition to direct agricultural production, the indirect inputs such as energy in manufacturing farm equipment, fertilizers, and other production inputs may be included. Transportation of farm products, processing, trade and, finally, household energy used in food storage and preparation are all sometimes included in the energy budget charged against agriculture. A recent study by Eric Hirst at the Oak Ridge National Laboratory showed that the food-related energy requirements for personal consumption of food were broken down as shown in Table 1 (1).

Hirst also showed that while the energy consumption in agriculture increased in the decade of the 60's, the fraction of the total national energy budget devoted to food declined from 13 to 11.9 percent. Note from Table 1 that the proportion of the U. S. energy budget for production in 1970 amounts to only 2.1 percent. Estimates from other sources indicate that the agricultural production sector consumes from 2 to 4 percent of the total U. S. energy budget. All agricultural production, food processing, and transportation of food requires only 6.3 percent of the U. S. national energy budget -- a rather small percentage.

Table 1. Energy budget for the food cycle, including indirect and direct energy uses.

Sector	Energy Use for Food Cycle in Trillion Btu	Percent of Food Cycle Energy Budget	Percent of Total U. S. Energy Budget
Agricultural Production	1,093	17.9	2.1
Food Processing	2,006	32.8	3.9
Transportation	170	2.8	0.3
Wholesale & Retail Trade	982	16.0	1.9
Household Uses Related to Food	1,868	30.5	3.7
	6,119	100.0	11.9

In a similar study, Steinhart and Steinhart report that the U. S. food system accounts for 12.8 percent of the total energy use in the U. S. (2). Again, indirect energy use for manufacturing of production inputs and machines and also to transport, process, store, market, and even refrigerate and cook food in the home are included.

It is important to look at the activities in farm production which are the major users of energy. The best data are available for corn (3). Over one-third of the energy required for corn production is for fertilizer, mostly nitrogen. In fact, the energy for nitrogen fertilizer is the greatest single energy requirement for corn production. Still, there is some evidence that from an energy point of view, more nitrogen fertilizer might be effectively applied (4). The point that cannot be overstressed is that fertilizer has been a key to increases in agricultural productivity in the world. By no means has fertilizer been the only factor, because improved varieties, improved pest control, better water management, and other factors have all been important. Still, increases in yields in this country have paralleled the increased use of fertilizer. According to a recent report submitted by the Council for Agricultural Science and Technology, fertilizer now accounts for one-third to one-half of U. S. agricultural production (5). Grogan and Everett have suggested that external energy applications in the form of fuel, fertilizer, and chemicals have accounted for 60 to 80 percent of the corn productivity increase since 1940 (6).

It is clear to me that energy, like land and water, is an underlying resource crucial to worldwide food production.

Consider arid countries where irrigation is essential for high productivity. If a crop required a total of 30 inches (760 mm) of consumptive use and the water was pumped from a depth of 100 feet (30 m), the energy requirement would range from about 4 million up to 9 million kcal per hectare for the irrigation alone, depending on the kind of irrigation system used (7). This is from 50 to 125 percent of the energy for all other inputs required for production. It illustrates that irrigated agriculture is a truly energy-intensive operation. Except for very high-valued crops, irrigation from deepwater supplies is likely not going to be economical -- unless of course energy is very cheap, a highly improbable situation.

Energy in Low-Technology Agriculture

Low-technology agriculture, such as in LDC's, is much more efficient than high-technology agriculture in terms of digestible food energy produced for each calorie of external energy (usually fossil fuel) used. The LDC's use lower inputs of mechanical and chemical energy into agriculture. Relatively primitive food production systems yield about 16 calories of digestible food energy for each calorie of energy from humans, animals, and fossil fuels (8). The U. S. farmer produces from one to two calories of food energy for each calorie of fossil fuel energy. However, the yield per hectare is vastly higher. In fact, the more primitive agriculture is not sufficiently productive to feed the present population, let alone contribute to a world food reserve.

External energy is essential for high yields. It is necessary even for modest increases in production in the LDC's in the short term. The highest potential payoff is in fertilizer, tillage, water pumping, and transport. Energy for fertilizer manufacture, particularly nitrogen, must remain a critical concern. However, machines to substitute for human labor or even animal labor are not of major importance when labor is plentiful.

Energy for Food Processing

In the U. S., the food processing sector of the food cycle uses more energy than any other sector (see Table 1). In fact, it uses nearly twice as much as the production sector, even including all the indirect energy inputs such as fertilizer. However, the highly technological and energy-intensive

food processing industry in the U. S. could improve its energy efficiency markedly. The industry does provide nutritious and safe food with little loss in foods which are processed and, thereby, preserved. The industry has ample storage space for foodstuffs, protecting them from pests and harmful organisms.

If the often-quoted high figures concerning losses and wastage of food between the producer and ultimate consumer in LDC's are correct, then a major effort is needed to provide safe storage and good methods of processing and preservation. I have heard that in many LDC's in the tropics in excess of 25 percent of the food grains produced is lost without reaching the human consumer. The figures are higher for vegetables. If these figures are true, then a major effort needs to be mounted to prevent this loss.

More emphasis needs to be given to food processing. And food processing requires external energy sources in most cases. Still, there is potential for more use of solar dryers for various commodities, and this should be encouraged. Other low-energy-requiring preservation methods should be used as well.

An example relates to double or triple cropping, which is often possible in the tropics. Frequently, one crop may have to be harvested at a high moisture content and must be artificially dried. This usually requires an external energy source.

The Future Potential from Research

How far can we go in increasing food production? The May 9, 1975, issue of Science, which arrived on my desk day before yesterday, is totally devoted to the food problem. It has a wealth of information, particularly related to the world food situation, potential problems, and solutions. Each person should study it carefully. It is clear that the potential for increased production is great (9), but there are also real risks (10). There will be some breakthroughs by science that will help in the fight for more food production. Some, such as a biological nitrogen fixation breakthrough in grasses, could have impact on world food production almost beyond dreams (11). But there are many problems to be solved, and a prudent strategy is not to count heavily on such breakthroughs until more data are in.

A Strategy for Governmental Leaders in LDC's

As of the moment, I do not believe that we can increase production per hectare in LDC's without increasing the external energy input -- at least not

on a short-term basis. Therefore, I think it is essential that governmental leaders in LDC's take this fact into account in their planning and policymaking. This is particularly true for the fertilizer and other chemical production inputs and for irrigation. AID should continue to assist in promoting low-technology packages for agricultural production in LDC's, but at the same time clearly make known the fact that agricultural production increases per hectare will require some increase in energy input to agriculture. This must be considered in planning the energy budget for each nation.

A Remark on Net Energy Flow

There is a school of thought which argues that we can do little with technology unless there is a massive flow of energy into the system, regardless of what the system might be.[1/] The argument is that all significant increases in agricultural production in the past in the developed world have been due to the subsidization of the system with external energy, usually fossil fuels. These fuels are used to manufacture fertilizer, pesticides, and machines and even to support a society that could afford significant research programs in agriculture to develop such things as better crop varieties. I do not agree with all aspects of the above concept. Still, it has enough truth in it to clearly show that low-energy technology packages which will increase production are not easy to come by. The fixation of nitrogen by certain organisms in the soils is a good example of what science can do to provide a resource through natural processes, as opposed to using external energy means.

1/ The leader of this school of thought is Dr. H. T. Odum, distinguished ecologist and author of the book, Environment, Power and Society, and the forthcoming book, Energy: Crisis to Steady State, to be published by McGraw-Hill.

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REPORT OF WORKING GROUP ON FOOD

The working group first reviewed the highlights of the position paper prepared by the group chairman. It was the consensus that certain energy inputs had been essential to crop yield increases in developed countries and this should be helpful in appraising certain energy-related factors in increasing food production in LDC's. Fertilizer has been one key factor in productivity increases in the developed countries, and it was judged of great importance in possible production increases in LDC's. Proper irrigation in water-short areas was also highlighted as an energy-intensive operation essential for good production.

The group decided to look at the four sectors of production, post-harvest handling and processing (dealing with losses), transportation and marketing, and, finally, home use. We realized that this arbitrary division represented a continuum from the producer to the ultimate consumer and not all the identified problems would fall under the aegis of AID/OST. The problems are highlighted by areas.

Production Problems

The whole production process has to be viewed as a system. It is essential to understand the host of inputs essential to high yields. These include adequate plant nutrient supply (fertilizer), adequate water (often meaning irrigation), good seeds (meaning properly adapted crop varieties), adequate tillage, good pest control, efficient harvesting, and other factors. It was recognized that the failure of any one input could cause the whole production system to fail. The most energy-intensive of the above factors are fertilizer, water (irrigation), and tillage.

Fertilizer does not have to come totally from commercial sources such as chemical fertilizer. We suggest that all potential sources of plant nutrients, including wastes, be explored. Particular attention should be given to the anaerobic digestion of animal, human, and other organic wastes, with the digester gas being used for fuel and the residual material used as fertilizer. Properly inoculated legumes providing biological nitrogen fixation should be used in crop rotations. Legumes can provide high-protein food sources and conserve soil fertility.

Processing and Storage

Losses of food between production and ultimate consumption are judged to be serious. There is a need for adapted technology providing inexpensive storage facilities using local materials for construction so that any surplus produced over the farmers' own needs can be stored until proper time to market the product for best profit. Cooperatives may be helpful. Also, proper institutions for low-cost credit to the farmers are essential. Above all, the loss of food must be prevented -- it is an energy loss *and* a food loss.

Food processing must be increased to prevent spoilage and to make food safer. Better low-cost packaging for foods is desirable. Solar dryers offer promise, and we encourage their use. Solar refrigerators (coolers) are also needed. Even food irradiation may have application. AID/OST should look at the problems and opportunities for greater use of solar dryers for agricultural crops and solar coolers.

Transportation and Marketing

The problem of high cost of transportation, or even the total lack of it, was noted by several in the working group. The group supported the need for inexpensive, energy-efficient transportation. A complete transportation technology analysis, including roads, vehicles, ropeways, and all other energy-efficient transportation schemes, is needed. The transportation network of every LDC must be analyzed as a system, but we recognize that good transportation usually requires a high energy input.

In marketing, there is a need for cheap and energy-efficient packaging. This could help reduce food losses.

Home Use

Cooking of food accounts for more external energy than producing the food. Dr. Revelle suggested that in rural India cooking may amount to over one-fifth of the energy used by each person. We strongly suggest that work by AID/OST is needed on increasing efficiency of cooking stoves, as well as on solar cookers.

EMPLOYMENT: INANIMATE ENERGY SOURCES - AN ASSET OR LIABILITY?

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Employment generation in the rural areas of developing nations, despite its new-found popularity, is not a sudden panacea for ailing economies. It is a long, slow, difficult process, with relatively few successes to point to.

The existing or incipient energy shortage has not greatly hindered the rural development process to date, probably because of the fact that rural sectors in developing countries have generally been energy-deprived areas. The extension of energy sources to the rural areas of developing countries has been fragmented, haphazard, and a low-priority activity in many countries.

Most of the 15 developing countries with which Georgia Tech is reasonably familiar do not have well-developed energy infrastructures in rural areas. Of these countries, South Korea has done a fair job of rural electrification despite a costly oil and gasoline situation. Nigeria, sixth largest oil producer, has critical gasoline (petrol) shortages and an unreliable and overloaded rural electrical system, created in part, as Professor Aluko can attest, by lack of governmental planning and organization. The Philippines has a large-scale rural electrification effort under way, but it affects only a few areas of the 7,000 islands in that country. In Venezuela, which has allocated a great deal of effort to its energy infrastructure, I recall how very frequent were the system outages in urban and rural areas.

In general, rural electrification schemes are not part of strong interconnected systems, with resultant frequent power outages which require a multitude of standby and emergency motor-generator sets by industries which cannot afford production shutdowns. These standby systems are costly to buy and to run and increase the cost of doing business.

Indeed, the paucity of adequate, reliable electricity, regardless of the energy source of that electricity (water, gas, oil, geothermal, solar, wind, nuclear), is an important consideration in the labor/capital relationship, introducing a major bias toward labor-intensive activities in rural areas where energy deficiencies are more pronounced.

Moreover, it has sometimes been frustrating to developing countries to plan and build rural energy systems, to find that load-building through industrialization does not automatically follow, and consequently, employment generation does not occur. This was the case in the Philippines, where new efforts had to be mounted to stimulate employment generation in rural electrification areas through industrial development programs, primarily cooperatives of various kinds.

In general, rural areas of developing countries were energy-deprived before the energy crisis was generally recognized, and this factor has slowed rural employment generation by making the rural scene less attractive to potential residents, to industries, to retail trade establishments, and to other economic sectors which generate jobs.

Should the energy crunch continue to deprive the rural areas of adequate energy resources, intuitively one expects a retardation of balanced rural development which will continue to affect the rural way of life as well as employment opportunities.

What, then, can be done relative to energy if balanced rural development is to occur? Recognizing that generalized answers are difficult since situations vary from country to country, what are the issues? Here are six issues, selected from many, which may merit consideration.

1. To what extent should or can developing country governments focus on rural development programs when, with limited national resources, this almost certainly means reducing the effort to solve urban problems?

2. To what extent should governments allocate resources for rural energy systems development?

3. What are the most appropriate systems for bringing energy to rural areas?

4. Would easy access to energy in rural areas be counter-productive as far as employment generation is concerned, in terms of changing the labor and capital factors and relationships?

5. How can rural delivery systems for energy be best designed and implemented?

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Indeed, the paucity of adequate, reliable electricity, regardless of the energy source of that electricity (water, gas, oil, geothermal, solar, wind, nuclear), is an important consideration in the labor/capital relationship, introducing a major bias toward labor-intensive activities in rural areas where energy deficiencies are more pronounced.

6. What should be the role of international development organizations in rural energy systems promotion and how can this best be done, considering limited resource endowments?

REPORT OF WORKING GROUP ON EMPLOYMENT/ENERGY

1. Agricultural and industrial development go hand in hand and should be considered together.

2. Increased supplies of energy in rural areas are a good thing and should lead to employment generation, increased agricultural production, and agro-industry processing. Larger energy supplies will benefit both the small traditional producer with limited markets and the modern industry with more extensive markets.

3. The extension of energy systems to rural areas will not, by itself, lead to development. Other programs are needed to achieve development objectives (a systems approach which considers all elements is essential).

4. There is a need for appropriate decentralized energy sources in local areas as well as for larger energy systems.

5. There is a clear need for assessment of local energy problems. The rural energy problem is large and complex, and more information is required, based on a survey of selected location specific needs. There is a need to test assumptions in the light of results of existing rural energy programs to determine their validity.

6. AID should consider encouraging developing-country governments to focus on rural energy programs and allocate resources to their development.

7. Community participation in development and design of energy systems will insure acceptance and utilization of these systems. Rural people are rational and can accept change where the benefits of change are made apparent to them. Community participation in the extension of energy systems to rural areas and the development of the systems are incentives to retain rural people in their areas.

ANNEXES

THE AFRICAN REVIEW

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Views on Enviromental Problems—in East Africa

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Environment is the ambience that surrounds us. Environmental problems are those of men, posed to us by a variegated and variable world of nature, created by us through our interaction with the natural world, intensified for us by our growth in numbers, our desire to live together and our quest for technological ease and excellence.

AN OVERVIEW

Environmental problems are nowhere more important than in Africa, but they little resemble the problems that served to initiate the 1972 United Nations Conference on the Human Environment. For in Africa, as in much of the developing world, and despite the inroads of technology, environmental problems for most men are those of the world of nature. In an era in which even the woes of mankind are bedecked in a certain glamour, it seems quaintly old-fashioned to remind our readers that the problems of Africa are still those of the rains that fail or wash the soil away, of the wildlife that destroys the harvest or of disease so endemic as to mock the very concept of being healthy.

To illustrate this we have compiled Table 1, a listing of environmental problems focusing on the resources to which they are related.

The perspective we adopt is that of professionals who are sympathetic with the national aspirations of the East African peoples. We interpret these aspirations as including: (a) an attitude for development broader than a desire for economic growth and one that considers that the ways in which development takes place may be as important as the ends it serves; (b) an emphasis on the overwhelming majority of the people of East Africa who live in rural areas, while recognizing the particular problems of the urban sector and the inevitable increasing significance of these problems; and (c) a strong tradition of ties to the land that emphasize the pragmatic use of land for human betterment but with close affinity and respect for the natural world.

Thus, the personal views that we espouse in this paper are our attempt to combine our best professional judgement with our perception of national aspirations. To this judgement, we bring a combined Eastern Africa experience and knowledge encompassing work in the Sudan, Uganda, Kenya,

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Tanzania and Zambia. For each problem listed in the table, we have provided qualitative estimates of various parameters: the importance of the problem, change in its direction and intensity, concern with it, and man's potential to affect or alter the problem.

In the table we suggest that the importance of a problem can be estimated as a function of the severity of its impact, the frequency of its recurrence and the extent to which the population is involved in effects of the problem. These estimates are crude but, nevertheless, revealing. One major problem, population growth appears to be a moderately severe, increasingly widespread problem, but in predominantly rural Eastern Africa, affects at most, but 5 per cent of the total population.[1] In contrast, endemic diseases such as chronic malnutrition, intestinal infections or malaria are severe, particularly to children, occur frequently, and the population at risk is most of the area's inhabitants.[2] Automobile accidents which average 50 times greater than American rates affect few, with a pernicious severity and selectivity of victims: mainly from the leaders, the educated and the skilled.[3] In further contrast, bird and insect damage, while widespread and frequent, is relatively light in the severity of individual losses.[4]

The direction and rate of change in the intensity of the problem is shown symbolically in the table. Certain problems grow rapidly (10 to 15 per cent per annum), natural hazards are periodic and relatively stable, and some land use changes are slow, but steadily worsen. Somewhat surprisingly, we conclude that a technological hazard such as auto accidents may show little or no change. While the frequency and severity continue at a high rate, improvements in roads and vehicles offset the increase in traffic and vehicle ownership.

Concern is expressed from several points of view. The form of concern external to Africa is reflected in both popular and scientific publications and this concern is often the highest as those who bother to write about African problems from a European or North American perspective are by definition[5] generally concerned. For evidence of internal concern we draw heavily on governmental actions and pronouncements. In these, African nations, pressed by the exigencies of development problems, evidence concern publicly mainly over the dramatic effects of nature or the growing edges of modern life which often personally involve the policy-maker.

In our evaluation we share the vision or myopia of official Africa in devaluing many world-view problems in the light of more pressing needs. At

1 I. D. Thomas and C. J. Thomas, "Comparative Population Data for the Divisions of Tanzania", BRALUP Research Notes No. 10 (University of Dar es Salaam, 1971).

2 H. Page, "Health Services and the Incidence of Disease", in *Tanzania in Maps*, edited by L. Berry (University of London Press, 1970), p. 118.

3 Local newspapers in Kampala, Nairobi and Dar es Salaam, almost monthly report the death or severe injury of senior government personnel in car accidents.

4 A. C. Mascarenhas, personal communication; also see note 34

5 We also have available one of the few studies existing in East Africa of farmer perception of various environmental crop hazards, a comparative evaluation by 219 Sukumaland farmers of 13 potential crop hazards. See L. Berry *et al.*, "Pilot studies in Human Adjustment to Agricultural Drought in Tanzania", BRALUP Research Paper No. 13 (University of Dar es Salaam, 1971).

the same time our own experiences and those of colleagues lead us to serious concern with the soil erosion problem, but concern more related to overgrazing than erosion from cultivation of steep slopes.[6] Our preoccupation with rural development is manifest in a high concern for more co-ordinated rural land use. Such a concern arises from our applied research, where we have found failure to achieve expected benefit from water supply and/or irrigation schemes because they were designed and built as alien intrusions on existing land use with no attention to soils, farmer interests, or markets.[7] But we would disagree with the emphasis on urban land use that so frequently embodies physical planning in the European sense, which in Africa leads to urban districts segregated by class or colour, with workers often isolated from their places of work, and all manner of *bidonvilles* tolerated if mostly out of sight to all but their inhabitants.

On the wildlife issue, international concern is often expressed about the need for preservation of wildlife ecosystems, coming often from countries which have destroyed much of their own wildlife.[8] While recognizing the global need we also recognize that the world as a whole should take on the cost of this exercise. We would rate the preservation of wildlife as a *national* objective fairly low in priority unless means can be found of benefiting local people much more than at present.

Finally, some problems attract our interest not because of their urgency but because of the relative ease by which they can be changed. Thus urban land use may be more easily controlled than rural land use, or agricultural chemicals regulated far more easily than ubiquitous bird or insect pests. Conversely our reading of the work of Bradley[9] or Kreysler[10] makes us pessimistic on the prospect of radical reduction in endemic and water related diseases.

The table serves to set in overview what we think are the more distinctive Eastern African environmental problems, but it oversimplifies them as well. Indeed its tabular classification does an injustice to the major theme of this paper; that environmental problems are in a major way the result of interaction of man and the natural world. Each major ecological zone has its particular set of problems and in the area studied we pick out the desert, the semi-arid lands, the wet and dry savannah and the tropical highlands as having distinctive sub-sets of important man-land problems. To these we add

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6 R. Wilson, forthcoming publication, *The Soils of Tanzania* (FAO, Rome).
A. Kasseba and L. Berry, eds., *Land Use in Tanzania*. Proc. Conference, OUP. (in Press).

7 L. Berry and R. W. Kates, "Planned Irrigated Settlement: A study of four villages in Dodoma and Singida Regions Tanzania", BRALUP Research Paper No. 110 (University of Dar es Salaam, 1970).

8 Considerable international pressure has been brought to bear on East African governments when quite small decisions on land use changes affecting game parks have been announced. The general East African record on preservation of game ecosystems and development of game parks is good.

9 D. Bradley, in G. F. White, D. J. Bradley and A. U. White, "Drawers of Water; Domestic Water Use in East Africa" (Draft).

10 J. Kreysler, "Uhuru na Maji: Health, Water Supply and Self-Reliance in Mayo Village", BRALUP Research Paper No. 3 (University of Dar es Salaam, 1968).

Table 1—SOME PARAMETERS OF RESOURCES AND RELATED ENVIRONMENTAL PROBLEMS IN EAST AFRICA

Resources and Related Environmental Problems	Importance			Rate of Change	Potential to Affect or Alter the Problem	Concern		
	Severity	Frequency	Population at Risk			External	Internal	Author
Human Resources								
Population Growth:								
Urban Congestion	+	+	−		+	+++	++	++
Rural Involution	−	−	+	↑	++	+	+	++
Quasi-Natural Hazards:				→				
Drought	+++	++	++	↔	+	++	+++	++
Flood	++	+	+	↔	+	−	++	+
Endemic Disease	++	++++	+++	←	+	+++	+	+
Fire	+	−	−	↔	+	−	−	−
Technical Hazards:								
Auto and Related Transport	+++	+	−	↔	+	+	+++	+++
Industrial Accidents	+	−	−		+	−	−	−
Occupational Diseases	−	−	−		−	−	−	−
Land Resources:								
Soil Erosion From Cultivated Land	−	−	++	↔	+	++++	+	++
Rangeland Deterioration	++	++	+	→	−	+++	+	+++
Forest Destruction	−	−	−	→	+	+++	+	−
Unplanned Urban Land Use	−	+	−	↑	++	++++	+	+
Uncoordinated Rural Land Use	−	+	+	←	+	−	+	+++
Water Resources:								
Industrial	−	−	−	→	++	+	+	+
Sewage and Human Waste	+	+	+	→	−	+	+	+
Water Related Diseases	++	++	+++	↔	−	+++	+	+
Air:								
Pollution	−	−	−	↔	+	+	+	+
Other Risks:								
Conservation of Wildlife	+	−	−	↔	−	++++	+	+
Marine Pollution	−	−	−	→	+	++	+	+
Agricultural Chemicals	−	−	−	→	++	+++	+	+
Biological Crop Hazards								
Birds, Insects, Vermin	−	++	+++	↔	−	+	+++	+++
Wildlife and Livestock	+	−	−	↔	−	+	++	+
Micro-parasites	+	++	++	↔	+	++	+	+

Key Not Significant − Moderate ++ Very High ++++ Increasing → Decreasing ←
Low + High +++ Rapidly Increasing ↑ Stable ↔ Rapidly Decreasing ↓

two distinctive urban environments; the concrete, European-type colonial city and the traditional African urban complex.

The zoned complexity is matched by dynamic changes partly induced by population-based growth and partly by the disruptive impact of development inputs. Recent studies of population pressure, soil erosion, natural hazards, water development and international trade illuminate these changes, confounding some conventional expectations while confirming others.

A ZONAL VIEW

The Traditional City

The traditional city in Africa is difficult to define; it may be epitomized by Omdurman or Ibadan or by the fringes of many modern African cities like Nairobi or Dar es Salaam. Among its characteristics are: closely spaced single, rarely double, storied buildings, largely of traditional materials, using traditional kinds of services for the large part; the Arab *suk* or the African market place as the focus of retail activity, small workshops and trading firms as the industrial backing and standpipes and latrines as the major water and drainage services.[11]

These cities fulfil many functions very well. Their very lack of services means that they absorb a less disproportionate amount of the nation's wealth than the Western modern city; the intermixture of small industry and dwelling cuts down the needs for transport and inter-city communication may be a limited problem. However, rapid growth brings a whole set of environmental and social hazards unless accompanied by a thoughtful adjustment of living styles to the new scale.

Even in the tropics fuel is a major requirement and most traditional cities use charcoal as the cheapest cooking fuel. A city of 20,000 to 30,000 may in the right ecological setting obtain enough charcoal for its daily purposes from the surrounding areas without endangering the habitat; 250,000 or over 1,000,000 people present a new hazard to environment in most ecological zones. It is difficult to compute the total needs but whatever the detailed figures the results are evident. The almost complete deforestation of the Nile Valley from Khartoum to Malakal well documented from historical records, the totally bare zone around Omdurman and the growing range reached by charcoal buyers around Dar es Salaam, all highlight the ecological effects of urban growth.[12] In the same way the mixture of animals and agriculture within the traditional city is a rational adaptation of rural life. But when the city is large, grazing for goats and space for agriculture disappears leaving a nutritional gap to be filled.

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11 See R. J. Horvath, "Von Thünen's Isolated State and the area around Addis Ababa, Ethiopia", *Association of American Geographers*, Vol. 59, No. 2 (1969), p. 308, for a discussion of the role of forests in an African city.

12 J. H. G. Lebon, "Land Use in Sudan", *World Land Use Survey*, Regional Memoir 4 (1965).

In many ways the traditional city may be important for Africa in the future, one important function being the preservation of many elements of local life within an urban setting. But in order for it to fulfil its functions, a careful look needs to be taken at the problems of growth. The dangers are of major economic, ecological and social deterioration. How can we have single story homes with plots for cultivation and yet prevent impossible strains on the transport and service network?[13] How can fuel needs be met cheaply without ecological danger? And as the city presses even closer together the disposal of waste and sewage becomes a more pressing problem: can it be solved cheaply and wisely?[14]

The Modern City

The modern city in Africa began as an administrative structure—typically with well separated (segregated) areas—the administration block and the widely spaced suburban-type dwellings, the local town, etc. Later, planned additions learning European lessons provided industrial areas and the varying grades of residential areas. This city now shows the splendour and misery of its European counterpart, together with, for most of the poorer sections of the community the problems of poverty and lack of public facilities. The journey to work on foot or in infrequent and overcrowded buses adds greatly to the working day. Improved services exist but are strongly differentiated; the urban poor of Nairobi pay as much as $1.23 per cubic metre for water compared to $0.10 per cubic metre for the rich, without the convenience of taps.[15] A recent urban plan for Dar es Salaam, forecasting a modest, constrained growth rate of 6 per cent per annum, would, nevertheless, absorb a high percentage of the local development funds of the country in order to carry out the recommended "needed" projects.[16] Planning the European way is in our view not the answer. Rather than repeat the errors of current urban development, should not the aim for a planned city be one which will have a good public transport system in a comparatively classless society; that has integrated district, integrated in function as well as in race and income, so that communication problems are reduced but with industry well controlled in its environmental effects?

The Desert

Of all ecological zones perhaps only the semi-desert can be more affected by man than the desert and of all ecological zones the desert is perhaps the most apt to spring surprises. Deserts in Africa are usually so because of lack

13 The document "Arusha Master Plan Tanzania" contains a discussion of these problems (Tanzanian Government, 1971)
14 Some interesting possibilities of cheap self-igniting waste disposal units are currently under experiment by Swedish scientists.
15 G. F. White, D. J. Bradley and A. U. White. "Drawers of Water, Domestic Water Use in East Africa" (Draft)
16 Dar es Salaam Master Plan.

of water and one of man's dreams has been of "making the desert bloom". The recipe seemed to be "add water for instant success". One ambitious attempt at desert transformation has been in the Aswan High Dam, the formation of Lake Nasser and the vast consequent increase in the irrigable land and electric power supply of Egypt. It is too early to trace the full costs and benefits of this achievement but the project is beginning to reveal once more the hazards of such large modifications of any environment.[17] Despite the popular statements to the contrary, some anticipation had been made of problems such as the loss of natural fertilizer from the Nile silt in the irrigation waters, the problems of silting and evaporation in the reservoirs, the effects on fisheries off the delta, the erosion of the delta shoreline and increased erosion downstream of the dam. But these were not thought through and the needed research undertaken and their extent will only be apparent in the future. The greatest hazard from competitive plant and animal life may yet be to come. Provide water in a hot desert environment and ecological conditions are perfect for the rapid multiplication of a host of plants and animals. The development of whole new ecosystems may appear catastrophic, with rapidly multiplying plant and animal life. The intrusion of the water hyacinth into the Nile south of Khartoum in the fifties was one such major event. Lake Nasser is very vulnerable to such events. The modification of environment has also had wide ranging social effects. Some of these like the evacuation of Nubians from the area were foreseen and to some extent planned. Less clear are the effects on the south Egyptian peasant. How has he reacted to the new siltless waters? How is fertilizer distributed to replace the silt? We do not have data to follow up these questions, but it seems clear that the social and political ramifications, good and bad, will continue to unfold for some time to come.

The Dry Savannah

Most of Africa is semi-arid, and dry seasonal vegetation covers perhaps 40 per cent of the continent. Past fluctuations of climates have meant that this zone has at various times been both drier and wetter than it is at present. For this reason its soils have been formed at least in part in different climates and are vulnerable.

A wide zone exists south of the Sahara which contains large areas of loosely compacted sandy soils and the North Central Sudan may be typical. In this area where present cultivation is hampered by the irregular and uncertain

17 The degree to which the *Saad El Aali* (Aswan High Dam) is cited as a prime example of environmental problems appears almost inversely related to the literature available on the actual environmental effects. For the problem of evaluating costs and benefits see C. S Russell and H. A. Landsberg, "International Environmental Problems—A Taxonomy", *Science*, 172, pp. 1309-1310.
See also, C. S. George, "The Role of the Saad El Aali (Aswan High Dam) in the Fisheries of the Southeastern Mediterranean", in *The Careless Technology; Ecology and International Development*, M. T. Fravar and J. M. Milton (eds.) (New York: The Natural History Press, 1971).

rainfall, grazing has traditionally been the means of livelihood. Cattle, goats and camels are the main source of income. Growth and development have produced a steady rise in the stock numbers and major government and private programmes for provision of water points have been in operation for 25 years. The Dixey/Aubert FAO team in 1959 emphasized the scale of the resulting problem—a major deterioration of a whole ecological zone.[18] Thus, in this zone, provision of water must be linked with its uses. Water for irrigation and gardens and water for human consumption may be encouraged but water for stock must be mainly related to the potentiality of environment and coupled with central land use planning.

Environmental problems here relate to the whole planning of rural land use and the future economy of the area. Grazing is an effective use of this zone but if future generations are also to use it, major national and possibly international steps, including the setting up of proper standards of land use, optimum stocking rates and long-term education and organization on environmental problems, will need to be taken.

Wet Savannah

Much of East Africa falls into the wet Savannah climo-vegetational zone. It is the zone of seasonal drought but good vegetation cover, of smallholder agriculture with maize and millet the staples. Here problems of growth and change tend generally to be less traumatic than elsewhere but have grave potential for the future. Peasant cultivation in many areas has not been such as to make for any major deterioration, overgrazing is locally a problem but land pressure is not yet high.[19] Environmental problems are related to the natural environment, with birds and other pests,[20] including tsetse and wild game figuring high. A major need is to match people and crops to markets and land capability so as to increase rural incomes.

Highlands

Tropical uplands with their unique range of temperature and insolation conditions and their generally adequate rainfall make attractive and productive environments. They have been preferentially sought out by the East African peoples and some of the densest populations occur on the uplands of Kenya, Uganda and Tanzania. Also, some of the most intensive land use systems have developed in these areas often accompanied by well organized water control and use. But such systems have been confronted with problems

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18 For detailed investigation of the area and the problems see *Doxiades, Associates 1963-1966*, and UN Special Fund, *Land and Water Use Survey in Kordofan Province of the Republic of the Sudan*, 60 Reports and Final Report 1966. J. H. G. Lebon, "The Land and Water Use Survey of North Central Kordofan (1961-66)", *Geog. Journal*, Vol. 134 (1968), pp. 546-549.

19 I. D. Thomas and C. J. Thomas, 1971, op. cit.

20 A. C. Mascarenhas, in S. Ominde (ed.), *Essays in Honour of Professor Baker* (Oxford: OUP, 1970).

of steady population growth and low rates of increase of prices and yields in the cash crops. Population growth and resultant land pressure may in some areas be endangering the whole viability of these favoured ecological niches.[21] Yet few data are available on this process and its effects. The studies by Thomas[22] (Uluguru and Pares) provide some beginning to the co-ordinated study of the land use and population in mountain areas, and work by Datoo[23] underway looks at the whole response, or lack of response to traditional systems under steady pressure through changing population parameters. The thesis of Boserup[24] that the steady pressure serves to stimulate re-adjustment strikes us as an optimistic view of a serious problem. To avoid rural involution, new and much more productive combinations of resource use will have to be found in these areas.

AN HISTORIC VIEW

Soil Erosion: A Chronic Environmental Problem

Soil in any part of the world is a vulnerable resource, in the tropics with high rainfall intensities, particularly so. Since the 1920s the misuse of the land has concerned the governments in East Africa.[25] Such fears were based on concrete evidence in some areas but in others on imported ideas of what was good and not good agricultural practice.

A number of schemes in Tanzania were initiated in the 40s and 50s mostly to deal with conservation problems in the mountain areas, but some others in lowland and plateau areas. They all raised peasant resistance, were poorly thought out, in some cases did not improve the agricultural conditions and were in the final analysis failures.[26] As some of the land conservation schemes were firmly associated with colonial government and with some of the more repressive aspects of their agricultural policy it is not surprising that such ideas dropped out of general discussion after independence.

Recently in East Africa a number of studies of mountain areas, by

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21 S. H. Ominde, *Land and Population Movements in Kenya* (London: Heinemann, 1968).
R. S. Ondingo, "Land Settlement in the Kenya Highlands" in *Education, Employment and Rural Development* (Nairobi: East African Publishing House, 1967).
J. N. S. Carey, "The Decolonization of the 'White Highlands' of Kenya", *Geog. Journal*, 131 (1965), pp. 186-207.

22 I. D. Thomas, "Some Notes on Population and Land Use in the North Pare Mountains", BRALUP Research Notes No. 9 (University of Dar es Salaam, 1970).

23 B. Datoo, personal communication.

24 E. Boserup, *The Conditions of Agricultural Growth, the Economics of Agricultural Change Under Population Pressure* (Chicago: Aldine, 1966).

25 Somewhat to our surprise we found that soil erosion became a serious concern in East Africa before it was a worldwide issue. (G. Gillman's personal papers, Tanzania National Archives.)

26 L. R. Cliffe, "Nationalism and the Reaction to Forced, Agricultural Change in Tanganyika During the Colonial Period", *Taamuli*, Vol. I, No. 1 (July, 1970), pp. 3-15.

EAAFRO[27] and later by co-operation between Uppsala University and the University of Dar es Salaam[28] point to the conclusion that deforestation and even cultivation of steep mountain slopes in the tropics on particular kinds of soils is less hazardous than was formerly supposed though dangers exist in terms of *bare* ground and in some localities. Continuous cropping on steep slopes in the Ulugurus has certainly been practiced through the last 50 years without catastrophic changes in yields.

Equally there is growing evidence of the soil erosion problem on a variety of soils in East Africa, particularly those under grazing. In grazing areas the social value of cattle is often weighed in numbers, large numbers are also thought of as good drought insurance. With improved veterinary facilities and water supplies, grazing and the availability of palatable grasses become the constraints on stock numbers.[29] With grazing land not controlled by rigid land tenure provisions overgrazing is all too high a probability. Murray-Rust[30], in a detailed study of one catchment in Arusha region Tanzania, traces the effects of improved water supplies through an increase in stock, in stock movement, a major increase in soil erosion, and a 55 per cent infilling of the reservoir, all in a decade. If one accepts the high economic potential of Africa's grazing areas such processes bode ill for the economic and environmental future of these areas.

The Introduction of Water: An Acute Environmental Problem

Most environments in Africa are water deficient, at least for part of the year and deficiency in water provides the main barrier to a wide variety of biotic developments when sunshine, suitable temperatures and suitable soils are often available. Water control constitutes an interference in the hydrological cycles, makes major modifications in the soil biotic cycle, and drastically alters inputs into the local ecosystems. All of these systems interact with each other and react on man in several ways. Thus we can regard water control as being, in most cases, an acute disruptive change in the environment often for the real benefit of man but just as often accompanied by a poorly understood, long chain of sequential events sometimes harmful both to man and the environment.[31]

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27 L. Berry and J. Townshend, "Soil Erosion in Tanzania", in preparation for *Geografiska Annaler* (Special Publ. on Tanzania, 1972). H. C. Pereira *et al.*, *East African Agriculture and Forestry Journal* (1962), special issue. Also M. Dagg and J. R. Blackie, *Bulletin of the I.A.S.H.*, Annee No. 4 (1965), pp. 63-75.

28 A. Rapp and L. Berry, "Soil Erosion and Sedimentation Studies in Tanzania", in *Proceedings of Conference on Land Use* (Dar es Salaam: Tanzanian Publishing House, 1971).

29 M. N. Harrison, "Report on a grazing survey of the Sudan Khartoum", mimeo. (1955).
J. R. Peberdy, "Rangeland", in W. T. W. Morgan, *East Africa, its Peoples and its Resources* (Oxford: Oxford University Press, 1969).

30 H. Murray-Rust, "Soil Erosion in Kisongo Catchment Area, Arusha", BRALUP Research Paper No. 15 (University of Dar es Salaam, 1971).

31 For a detailed explanation of the complexity of events, see the report of the Working Group on Man-Made Lakes of the Special Committee on Problems of the Environment, of the International Council of Scientific Unions, *Man-Made Lakes as Modified Ecosystems* (in Press).

We have studied a small irrigation scheme at Mangoni in Tanzania[32] where the construction of a small dam to regulate flow resulted in there being permanent water in the stream below the dam. Game which used to travel elsewhere for water in the dry season, flocked to the area and elephant and wild pig particularly were a major disruption to the scheme and its crops.

On larger irrigation schemes, including the largest in Africa in the Sudan Gezira, the irrigation water brings with it the bilharzia snail which is a constant scourge to the people of the Gezira, lowering their will to work and their resistance to other diseases and creating major social problems.[33]

Drought: A Periodic Environmental Problem

Current research now permits us for the first time to broadly, albeit crudely, sketch the extent and effect of drought hazard.[34] For example, six times in the past thirty-two years over half of the population of Tanzania was affected by a major shortage of rainfall. These major events, occurring on average once in five years, affect national income by about 4 per cent and require a commensurate effort from the labour of smallholders, generate migration movements that increase urban problems, accelerate existing malnutrition, and create widespread, if unmeasurable psychic stress. As governments strain to cope with the hazard and accept increasing responsibility for coping with it, large amounts are expended for famine relief and development effort is sidetracked into what is at best a maintenance effort. The assumption of such responsibility by national governments and their increasing capability to do so has led to a genuine reduction over time in the more terrifying impacts of drought-death and disease from famine. But in line with observations from many other parts of the world, commercialization of agriculture, regional specialization, centralized marketing, and an urban demand independent of production have increased the economic effects of drought losses and the resultant loss of development effort. Thus, a recent drought occurrence in Tanzania, a minor one by its climatological extent, required the import of 43,000 tons of food grains in contrast with minimal imports in the more serious drought year of 1965. The perspective for the future is also depressing as the *Uhuru* decade for Tanzania appears by contrast with previous eras more favoured climatically than that experienced in the past or to be experienced in the future.

32 L. Berry and R. W. Kates, 1970, op. cit.

33 W. A. Hance, *African Economic Development* (New York: Praeger, 1967).
A. T. Sharaf, "The Sudan", in S. P. Chatterjee, *Developing Countries of the World* (Calcutta, 1968).

34 A major manifestation of drought is food shortage and famine. This is now documented in Berry *et al.*, op. cit.; C. Brooke, "The Heritage of Famine in Central Tanzania", *Tanzania Notes and Records* No. 67 (1967), pp. 15-22; C. Brooke, "Types of Food Shortage in Tanzania", *Geographical Review*, Vol. 57 (1967), pp. 333-357; A. Mascarenhas, "Aspects of Food Shortages in Tanganyika (1925-46), Geog. Dept., University College, Dar es Salaam, Research Paper No. 3 (1966), mimeo, M. Patton, "Dodoma Region 1929-1959, A history of famine", BRALUP Research Report No. 44 (University of Dar es Salaam, 1971). More recent work is described in R. W. Kates and B. Wisner, "The Impact of Agricultural Drought in Tanzania and Kenya" (in preparation).

More can be done at the level of farm management to reduce drought vulnerability: planting at optimal times, using short season maize varieties and millet for drought prone areas, and improved local marketing and storage policies. Adoption of these depend in part on general improvement in agricultural practice, on utilizing potential in co-operative activity, on development of improved varieties and methods, and on complex environmental change. For example, the adoption of drought sensitive maize in preference to drought resistant millet has come about in part, because bird depredations, greater in millet, have increased with the concentration of crops and the loss of bird chasers as more small children attend school. But the historic way of coping with food shortages has been to spread the risk and share between places of shortage and places of plenty. In tribal Africa the family and tribe served this purpose. Increasingly national government takes on the task. But the rising costs suggest that both national and regional planning are required for periodic variation in rainfall.

Pollution: An Exogenous Environmental Problem

The response of developing countries to the environmental problems of developed countries ranges from hostility to at best, mild sympathy. Considerable fear has been expressed that the environmental preoccupations of developed countries will detract from the already meagre interest and development aid available;[35] that environmental standards based on developed nation standards will be imposed on developing countries already burdened by inappropriate technology transfers and forced purchases of tied aid; that environmental standards will be used to further reduce imports from developing countries;[36] and that overall, environment is just one of the growing list of issues which the rich countries of the world use to evade the true crisis of mankind, the great global inequalities of rich and poor. Hamilton Shirley Amerasinghe, Ambassador of Ceylon to the UN, gave recent voice to these and similar views.[37]

> The government of developing countries, their economists, and planners must not and will not allow themselves to be distracted from the imperatives of economic development and growth by the illusory dream of an atmosphere free from smoke or a landscape innocent of chimney stacks. We must not, generally speaking, allow our concern for the environment to develop into a hysteria.

That these fears are well based can be readily understood by East Africans long accustomed to international concern with its wildlife resource, at times bordering on hysteria, and deeply revealing of values that seemed to express

35 See, for example, "African Lands taking first small steps to preserve environment", *New York Times*, December 28, 1971, p. 2.
Also, discussions at preparatory conference for UN Conference on the Environment 1972 (at Addis Ababa, September, 1971).

36 C. S. Russell and H. H. Landsberg, "International Environmental Problems—A Taxonomy", *Science* (June, 1971), pp. 1307-1314.

37 Quoted in M. T. Farvar *et al.*, "The Pollution of Asia", *Environment*, 13 (October, 1971), p. 10.

greater concern over poaching than the malnutrition of children.[38]. But certain aspects of the environmental crisis might be used to further the needs of developing countries. Some African nations might choose to become "pollution havens". In the words of Amerasinghe:

> All developing countries are aware of the risks, but they would be quite prepared to accept from the developed countries even 100 per cent of their gross national pollution if thereby they could diversify their economies through industrialization.

Fortunately such rhetorical choices may not be necessary. Rather, in developing regions where the present levels of pollution are already low, with careful locational and technological planning, natural processes of air, water and soil can be used to dispose of residual waste with minimal environmental disruption. This potential comparative advantage may shift the balance of locational decision as to where to process primary materials that serve as the major exports of so many developing countries.[39]

Another key production decision may shift to the favour of developing countries. Synthetic manufacturers are major polluters. Commoner recently contrasted the disruptive qualities of synthetic fabric production compared to the virtues of natural production of cotton:

> Nylon, for example, is produced in a series of from six to ten chemical reactions ranging from 200° F. to 700° F. This means a considerable combustion of fuel —and resulting air pollution. In addition, such chemical reaction may release waste chemicals into the air or water, again polluting. One environmental input not included in the natural production of fibre... (and) because the synthetic fibre is man-made it cannot be disposed of without putting a stress on the environment... every bit of synthetic fibre or polyester that has been produced on the earth is destroyed by burning—and thereby pollutes the air—or accumulates as rubbish.[40]

It makes good ecological sense to buy East African cotton and sisal.

Finally, the more radical environmentalists in developing countries have raised substantial issues as to the rapacious nature of a system, predominantly capitalist, that involves employment in the U.S.A., for example, of 40 to 50 per cent of the world's natural resources for the direct consumption of about 6 per cent of its people. Depending on overviews of the finite nature of the resource base, the problem is more or less serious. But it helps little to note as some have done, that African and other developing countries vie with each other for such exports. Clearly, the international terms of trade for primary production makes a mockery of the notion of comparative advantage unless it means that poor countries will have the comparative advantage of remaining poor.[41] By focusing on the true social costs of production in both developed and developing countries, the environmental crisis can be made to

38 See note 9 and *New York Times*, op. cit. (note 35) on both these points.
39 See Russell and Landsberg, op. cit., for a discussion on trade, aid and environment
40 B. Commoner, "The Closing Circle", *Nature, Man and Technology* (New York: Knapf, 1971).
41 J. F. Rweyemamu, "International Trade and the Developing Countries", *Journal of Modern Africa Studies*, 7, 2 (1969), pp. 203-19.

serve as emphasis to the exploitative nature of the present world market in agricultural and industrial materials.

CONCLUSIONS

African environmental problems still relate strongly to the difficulties of the African environment, and are not an exotic import of the anxieties that concern the developed world. Natural hazards, although their effect is being altered with changing technology and parameters of population are still of paramount importance. Maintaining the viability of both town and country in the face of change; permitting radical developmental change while preventing the deterioration of land and other natural resources and doing this in the face of successive accretions of population in fragile ecosystems—these are the problems.

The major remedy both for internal self-reliance and for outside support seems to be encouragement to develop existing knowledge of the unique qualities of major environmental zones and appropriate governmental infrastructures for each. Within countries and between countries in Africa every encouragement should be given to develop co-operative measures to "spread the risk" of natural hazards at any one time. The traditional wisdom of the small farmer needs to be institutionalized into a system of regional complementarities and specialization. Africa-wide co-operation in natural disaster prevention, now mainly in locust control, should be broadened to cover a range of natural hazards, with planning for inter-regional food storage and distribution given a high priority.

The tide of global environmentalism does not necessarily auger well for developing countries. But new opportunities for common cause should be exploited in practical ways. Environmentalists in developed countries should be encouraged to raise demands for tariff-free entry of natural products competitive with synthetics, for greater processing in the country-of-origin, for non-exploitative price and profit remission policies and for redistribution of the world's wealth rather than the continued gluttonous growth of environmentally disruptive consumption in the developed world.

In the East African context, many of the difficult choices facing policy-makers are genuine questions of balancing development and conservation, but none should be made by omission or out of ignorance. Major development projects should routinely provide for environmental impact assessment (see Appendix A). On a regional basis specialized personnel should be available, charged with reviewing imports of industrial and other machinery to encourage pollution control and to prevent the dumping of "dirty" technology. The regional monitoring and quarantine of agricultural plant imports currently carried out in East Africa, should be broadened to include related imports of fertilizer, herbicides and pesticides. Modest amounts of directed research similar to the type described in this paper can serve to identify and focus energies on the most pressing environmental problems, energies which are

now dispersed by the varying perception of external observers, resident scientists, and local policy-makers.

Finally, the legal systems of many countries are still in their early formative years and may be amenable to incorporating environmental quality as a public right. What Africa does not need now is another bureaucracy charged with monitoring or protecting such a right. Rather an assertion of public domain over environmental resources with provision for stand-by controls seems a more appropriate arrangement.

The two strands of thought running through this paper: the concern with the "traditional" environmental problem and the growing awareness of the new set of problems brought on by technology reflect the basic nature of development. While the complexity and multiplicity of the problems seem daunting, our own view is one of optimism. Africa has time, and if that time can be used wisely, an exemplary model may yet be achieved.

APPENDIX A

An example of the kind of guidelines for environmental assessment that are currently being discussed.

QUESTIONS ON ENVIRONMENT AND DEVELOPMENT

The following are some queries which might be made when drawing up and reviewing plans or projections either on a project, sector, country, regional or inter-regional scale. Answers to these questions, along with social and economic considerations, could help both governments and assistance agencies in appraising more fully development programmes and projects.

1. *Goals*

   (a) Is there an environmental component of the national development policy and how does the programme relate to it? Are short-term programme objectives consonant with long-term goals?
   (b) Do the objectives include an enhancement of the environment, or of its maintenance?
   (c) Is the implementation of objectives feasible under existing legislation and existing administrative and supervisory machinery? How realistic is it to expect that qualified personnel will be available to administer and supervise?

2. *Preparation*

   Have relevant and interested groups (including the scientific community) been consulted on possible environmental effects?

3. *Environmental Consequences*

(a) What kind of environmental changes are foreseen? How far are these irreversible? What alternative choices remain open for the future? Is there a "balance sheet" of estimated environmental costs and benefits?
(b) Have possible alternative arrangements for achieving comparable goals with more favourable impact on the environment been explored?
(c) Has adequate provision been made for the recovery of environmental quality and the avoidance of a deleterious effect on society? If so, what will be the difference in
 (i) direct investment costs; and
 (ii) maintenance costs?

4. *Evaluation*

What arrangements have been made for keeping the programmes under continuing review and—if required—subsequent reassessment of objectives and approaches?

5. *International Environmental Implications*

In the interest of the rational use of resources as well as the protection of the environment, how does the programme relate to such environmental standards, global criteria or priorities which may have been generally adopted or recognized?

Annex II

(From ENVIRONMENT AND DEVELOPMENT SCOPE conference, February 11-23, 1974, Nairobi)

SUMMARY REPORT AND RECOMMENDATIONS

Scope

Most developing countries have, at one time or another, considered industrialization as the panacea for problems of economic development. They believed that industrialization would reduce their dependence on the highly industrialized countries of the world and that their claim to political independence would be fully realized only when they had established a self-sufficient economy. It was also thought that a self-sufficient economy would become a reality when manufacturing industries complemented the merely extractive and domestic industries. Thus industrialization was seen as the basis of development and the hope of developing countries. This attitude accounts for the considerable attention which developing countries have given to industrialization in recent decades. Although developing countries are at varying levels of industrial development, it is true that all of them are still very eager to modernize the industrial sector of their economies and to reinforce the base of a self-sustaining economy.

Most developing countries are also still actively engaged in the task of changing the pattern which their industrialization assumed during the colonial era. The character of industrialization during the early colonial period was basically that of extracting raw materials (many of them non-renewable) for the markets of developed countries where the manufacturing processes took place. Although industrialization has made some progress in the developing countries, extractive industries are still of paramount importance. In a few of these countries, geography and history have conspired with politics to keep extractive industries dominant. A case in point can be found in the industrial experience of the Latin American countries. Despite some noticeable advances in industrialization, a considerable proportion of the industrial activities of these countries consists of the exploitation and export of non-renewable raw minerals (silver, tin, copper, iron, zinc, lead, tungsten, molybdenum, antimony, iodine, and crude oil) and in land and sea primary products. It is worth noting that most of the mining and petroleum exploitation in these countries has been carried out by foreign countries which are often unconcerned about the effects of such extraction on the economic life of the countries involved and on the quality of the environment. It is no exaggeration to claim that other developing countries shared this experience in broad detail.

In recent years, especially during the United Nations' Development Decade, industrialization in the developing countries has been rapidly transformed. Apart from domestic industries or handicrafts and the extractive industries, numerous small-scale and medium-scale industries have been established. A few large-scale industries, especially iron, steel, and petrochemical, have been established, although they are still few and far apart. More important, they are unevenly distributed, and some developing countries are without any of these heavy industries, in spite of the fact that they are recognized as the real hallmarks of full industrial development.

The low level of heavy industrial development explains why few, if any, of the developing countries have become exporters of industrial goods. This situation illustrates clearly

Summary

the economic gap yet to be filled by the developing countries if they are to become highly industrialized. It also points to the fact that the gathering momentum of industrialization in the developing countries will have an increasing and decisive impact on the environment.

The necessity for environmental orientation in industrial planning is therefore obvious. Until recently, the impact of industrialization on the environment was minimal, and the self-control mechanism of nature could have handled whatever damage might have occurred. The story is now different. The technologically operated industrialization of recent decades has had increased adverse effects on the environment, and the breakdown of the self-adjusting mechanism of the environment is imminent. In order to avert some of the numerous problems of unguided and uncontrolled industrial development, more attention must be given to making industrial planning environmentally oriented.

Options

It is a foregone conclusion that developing countries must industrialize. The question that provokes debate is how they can industrialize to aid their economies and at the same time support the welfare of the environment. Obviously, certain options or alternatives are available, some more profitable than others. In general, the available options will depend mainly on the types of industries to be established and their locations.

As to the types of industries, it is desirable for every country or region to establish, as far as practicable, a whole range of light to heavy industries and in such sequence as the economy permits. This is easier said than done, but nothing less ambitious will meet with the economic aspirations of the inhabitants of the different countries. Each country will, of course, determine its own priorites.

The Republic of Korea may be cited as an illustration of the ordering of priorities. During the First Five-Year Plan Period (1962-1966), the Republic of Korea concentrated on developing its agriculture mainly for food crop production; its energy industries (coal mining, power generation, oil refineries); and its basic industries such as fertilizers and cement. During the Second Five-Year Plan Period (1967-1971), the emphasis was on developing the iron and steel industry, machinery, electronics, petrochemicals, etc., while much importance was attached to social overhead capital (e.g., highways, ports, and industrial estates). During the Third Five-Year Plan Period (1972-1976), efforts will be exerted to develop heavy industry, including ship building and precision machinery, to the further development of the petrochemical industry. Many other countries have similar plans, but not many have attached proper importance to the spatial and regional planning of these industries. Neither have they weighed carefully the effects of the projected industrial expansion on the environment and on the quality of life of the people. How best to approach this inevitable expansion of industrialization is suggested under the section on guidelines.

Just as there are options regarding the types of industries to be established, there are also options concerning their location. Most of the industries established in developing countries in recent decades are normally located in or near cities, or later gravitate to them. As a matter of fact, industrialization and urbanization normally occur in the same place and have a mutual attraction. This trend, if uncontrolled, may cause or aggravate environmental problems (air pollution, water contamination, excessive noise) and result

in the inadequacy of public facilities such as water, housing, sewage, schools, hospitals, markets, and transport.

Although industrialization and urbanization have a common location in economically developed countries, it is still possible to keep them at some distance in the developing countries, especially by encouraging rural industries *per se* (handicrafts, agro-based industries, and other small-scale industries) and by locating medium-scale industries in the rural areas. This point is developed further under guidelines.

Since most of the industries in the developing countries have not yet been established, industrial planners have the choice of concentrating or dispersing them. In most developing countries, the lack of firm regulations for industrial planning has resulted in an anarchic pattern of industrial growth and areal spread. In some cases, the few regulations which have been suggested deal only with the inner arrangement of the industry, its sanitary aspects, and, to a lesser extent, with controlling the harmful effects of haphazard growth. By opting for a reasonable degree of concentration and dispersion, little or no damage would be done to the environment. It is mainly by environmentally oriented industrial planning that a balance could be achieved between concentration and dispersion, which may result in dispersed concentration or concentrated dispersion. Until recently, basic factors considered in the process of determining the location of industries did not include those which recognized the interests of the environment. Such traditional factors are:

(1) Space requirements, including building costs and other physical facilities.
(2) Availability of raw materials and other inputs and parts.
(3) Availability of machinery and equipment.
(4) Availability and cost of energy (e.g., electricity, coal, fuel, and gas).
(5) Availability of labor.
(6) General infrastructure, especially of transport and communications.
(7) General relationship with other aspects of the economy (especially in terms of financial sources, providers, customers, and general service).
(8) Overall national security and national strategy.

These factors are not at all exhaustive; in fact, their flexibility depends to a great extent on the range of options that a country is willing to consider.

In recent years, because of an increasing awareness of the environmental dimension of industrialization, the following factors have increased in importance: the effects of industry on environment and vice versa; the possibilities for the elimination of wastes, unusable residuals, and effluents; and the possibilities of recycling. These factors weigh heavily in determining some of the guidelines and research priorities which are suggested below. The developing countries have the option of according them the importance which they deserve.

Guidelines

Aiming for total welfare. In developing countries, environmentally oriented industrial planning must be geared to the total welfare of the inhabitants. The planning must cater to the welfare of individuals and of the community at large. In many developing countries, the colonial heritage has led to the stratification of society into elites; skilled workers; and laborers, most of whom are illiterate. Industrial development, in terms of

its diversity, must cater to the interests of the different classes and aim to bridge the gaps among them.

Efforts should be made to ensure the growth of the total economy so that polarization into urban and rural economies, in terms of industrialized and non-industrialized economies, respectively, would be prevented. The current trend for urban areas to become exclusively industrialized and for rural areas to depend mainly on primary or extractive industries should be vigorously counteracted. Whatever the economic advantages of the concentration of industries in cities where infrastructural facilities are currently available, determined efforts should be made to disperse them as much as possible. Industries should be seen as a means of attracting to rural areas the facilities usually associated with urban areas. Planning which is sufficiently forward-looking should ensure that some of the infrastructural facilities are provided in rural areas before full-scale industrialization begins. In general, industrial planning in developing countries must attach more importance to regional than to local development.

In order to provide for the total-welfare of the people, the concept of industrialization should be broadened to include not only the manufacturing facilities, but also facilities for the educational, recreational, social, and health needs of the workers. The conditions suitable for maximum production should be considered along with those which would ensure the maximum efficiency, comfort, and satisfaction of the workers.

In certain situations, increasing economic productivity leads towards decreasing social welfare. Attempts should be made to reverse such situations by according social welfare a premium over economic productivity. To do otherwise is to overlook the fact that increasing economic productivity does not necessarily contribute to total welfare.

In a special way, industrial planning in developing countries must demonstrate a sharp awareness of the traditional life of the people, and must ensure that whatever is compatible in their backgrounds with modern attitudes to industrial development is jealously guarded and preserved. The tempo of industrial development must be controlled as much as possible to avoid abrupt and disruptive changes in the life-systems of the people. What is being suggested here is that rather than bending the people to industry, every effort should be made to find ways and means of adjusting industry to the lives of the people.

Educating the people for industrial life. It should not be assumed that some of the inhabitants of the developing countries are, by the nature of their present occupations (such as shifting cultivation and nomadism), averse to becoming industrialized. Aversion and resistance to change become manifest when people are not prepared for change. A systematic process of education for industrial life is needed in many developing countries. Such an education should include technical training for those who can become skilled workers or managers and should aim at improving the quality of manpower for industry.

Exploiting non-renewable resources. Any form of exploitation and utilization of non-renewable resources which does not consider future prospects could result in sub-optimal output and a low standard of environmental quality. Resources must be exploited and managed by necessary compromises. In addition, adequate provisions must be made for their conservation, and any irrational exploitation based on the attitude of conquering the environment must be avoided.

In previous years, especially before independence, most exploitation of resources in

developing countries overlooked local or domestic interests, both economic and environmental. The reaction to this has been the nationalization of some industries in some countries. The so-called "principle of comparative advantage" used to justify the exploitation of these resources for the use of manufacturing industries in "mother countries" is no longer tenable. Current exploitation should be undertaken first for domestic industries and then, where there is an adequate surplus, for export.

In addition, exploitation should be carried on in relation to known or proven reserves, and long-term implications should be kept in mind. It is important to realize that unbridled exploitation can lead to serious ecological imbalances, even in the short run.

Guaranteeing the stability of the environment. Environmentally oriented industrial planning must guarantee the stability of the environment in the near and far future. The effects of industry on the environment, and vice versa, must be carefully assessed at all stages, and a course of action leading to a stable state at particular times must be followed. The environment must also be preserved from contamination and other harmful effects, especially those that are irreversible.

Governments must enact laws for the preservation, conservation, and restoration of the environment. Many Latin American countries, especially Argentina, Brazil, Chile, Mexico, and Peru, have commissions and other bodies which act on behalf of their governments to cater to the interests of the environment in many ways.

Fostering an integrated approach to industrial development. The spatial allocation of resources would help to balance the inter-regional inequalities which normally develop at the early stages of industrialization, especially where economic considerations are paramount in the decision-making process. There is a tendency for countries with wide inter-regional disparities to fall apart. The spatial element of development would, if noted, help to reduce such disparities and should not be underestimated in development strategy.

In recent years the need for the integrated utilization of natural resources has become evident. Yet, more often than not, the practice has been to seek the integrated development of only one resource at a time, e.g., that of water development schemes within the physiographic basin of each developed river. Since various resources are indivisibly integrated in their occurrence, their exploitation and utilization should be based on the concept of total integration or unity which is characteristic of the total environment itself.

In many of the developing countries, national boundaries do not accord with physiographic units so that it becomes necessary for many nations to work together if they are to achieve maximum utilization of the integrated resources provided by nature. Some countries are so small in size and population that they must cooperate with others in industrial planning and development if they are to make any progress at all. No country can develop its industrial activities in isolation: each country is linked with others in a matrix of world relationships and is kept in a perpetual state of dynamism by the complex interactions of geographical, economic, social, and political systems. It must be added, however, that any attempts made jointly by many countries to plan their industrial development in reference to a commonly shared environmental resource does not absolve each of the countries from responsibility in the execution of its own particular objectives of industrialization.

The integrated approach to environmentally oriented industrial planning makes it possible to adopt the concept of growth centers which can exist at a variety of levels,

namely, local, regional, national, and international. It is now generally agreed that particularly in developing countries the development of growth centers for industrialization also permits the development of a spatial strategy for an urban-rural continuum. This strategy may in the long run reduce the migration pressure which has caused the creation of slum quarters in and around cities and the revolting sanitary, economic, and social conditions which accompany unplanned city development.

Recycling of resources and their products. Recycling should be the watchword in most developing countries. For too long a time, many agricultural, forest, and mineral resources were exported more or less in raw form to industrially developed countries so that their by-products were never available to the countries of extraction for purposes of industrial production. Today, even though the industrially advanced countries are understandably concerned with recycling their wastes, developing countries have yet to use in full the different by-products of their resources. Initial efforts should be concentrated on ensuring that every by-product of any industrial project is extracted and used locally instead of being exported. Although the exportation of timber and petroleum, virtually in their raw forms, illustrates convincingly this point of under-industrialization, almost every industry can go at least one step further in maximizing the use of raw materials.

The intensive processing of resources at the local level will not only generate more industry, but will also guarantee a higher price for the various industrial products and by-products. The traditional policy of keeping market prices under the control of the highly industrialized countries has long been due for a change. Developing countries must be able to enter world markets subject to the laws of supply and demand, and not to price controls exercised by the developed countries.

Research program

Natural resource survey. Institutional arrangements for natural resource surveys have not always been accorded the importance which they deserve. The inventory of mineral resources in particular must be accelerated in most countries and completed in others. Comprehensive surveys leading to thoroughly documented inventories of resources, especially in terms of their potential reserves, should form a major area of research activity in the countries of the developing world. In regard to certain raw materials, such as trees, research should be geared to finding effective methods of regeneration and replanting in order to ensure a steady and continuous supply.

Some countries have produced national atlases which are compendia of information on natural resources both physical and human, but by and large, there are many gaps in these atlases. Relevant departments of the universities and of the government should collaborate on forming the institutions which will undertake the natural resource surveys. There is a great need to collect well-documented and frequently up-dated information on natural resources.

Relevant and appropriate industries. A general classification of industries includes the following types: handicrafts or domestic industries, large-scale industries, and international industrial complexes. Not all types are relevant or appropriate at all levels of development; some cannot be effectively sustained at particular levels. In order to promote productive and environmentally oriented industries, it is necessary to establish relevant and appropriate types of industries at each level of economic development.

Researchers should therefore attempt to assess the types of industries that would fit into the particular level of socio-economic development in developing countries. Such research activities should include a continuous survey of the space requirements for industries, the types of appropriate machinery and other physical equipment, the quality and quantity of the available labor force, the cost of various inputs, and an estimate of the size of the market. The necessity of research in this field is underscored by the bitter fact that the developing countries have experienced the failure of many industrial projects caused by a lack of awareness of environmental, human, and cultural variables which interact with economic and technological variables. It is an obvious fact that the adoption or rejection of a new form of technology or industry — where there is a choice — is as much a function of the social and economic variables as it is of the physical environmental variables.

Adaptation of industries to the life-styles of the people. Research should be undertaken to find out ways of adapting industries to the life-styles of the inhabitants of developing countries. All too often industrial projects are imported from industrially developed countries into the developing countries without any change in the structure of the industries and in the life-styles which the industries demand. Such a situation could disrupt the socio-cultural life-styles of the inhabitants with the consequence that industrial development would generate socio-cultural degeneration. As far as is practicable, ways and means should be found to preserve the socio-cultural values which the people continue to cherish. Therefore, systematized research into the social and cultural characteristics of the inhabitants of developing countries is necessary in order to know how to adapt the industries in the area to the people. Such an adaptation would in the long run make possible a healthy and viable relationship between the people, their industries, and the environment.

Effects of misuse and abuse. Research should be geared to monitoring the misuse and abuse of the environment for industrial purposes. It goes without saying that most forms of exploitation for industry create problems of pollution, contamination, degradation, exhaustion, and so on. Particularly in mining, certain damaging effects result from concentrating plants for the washing, melting, and refining of ore. The rate of accumulation of these wastes and other forms of pollution should be studied so that effective means of waste disposal can be devised. Furthermore, inventories and studies of environmental and ecological problems produced by each industry should be made with a view to providing effective solutions, preferably those which can solve the problems speedily.

Personnel. One of the tasks of research should be to train the type of personnel who can translate guidelines into practice. Appropriate training programs should be provided for producing trained personnel in the field of environmentally oriented industrial planning. Such trainees are expected to form a new breed of planners, and to be aware of the role of the environment in the determination of planning objectives in developing nations (economic growth, economic independence, and integrated socio-economic welfare). Such personnel could operate within a National Environment Resource Institute in each country.