

Reflections and Expectations  
on  
Development and  
Development Research

**53.**

Reflections and Expectations on Development Research

REFLECTIONS AND EXPECTATIONS ON DEVELOPMENT  
AND DEVELOPMENT RESEARCH

by

ANAT ARBHABHIRAMA  
Asian Institute of Technology

YONGYUTH YUTHAVONG  
Mahidol University

and

AROONSI JITJANG  
National Education Commission

SIPPANONDHA KETUDAT  
Chulalongkorn University

The views expressed in this document are those of the consultant. They do not necessarily represent the views of IDRC.

September 1983.

This background paper was prepared for and forms part of the main report entitled "Development Research Issues and Possible Future Directions for IDRC: An OPE-ASRO Supported Study".

## TABLE OF CONTENTS

1. Concept of Development	1
2. Major Issues : Basic Root Causes Hindering Development	3
3. Characteristics of Development Research	8
4. State-of-the-Art and Priority Areas : Human Resources	10
Education	10
Population	13
Health and Nutrition	14
Unemployment	17
5. State-of-the-Art and Priority Areas : Natural Resources	19
Water Resources	19
Resources for Agriculture and Forestry	21
Tropical Agriculture of Food and Industrial Crops	21
Soil Quality	23
Animal Husbandry	23
Sea and Inland Fisheries : Mariculture and Aquaculture	24
Forestry and Forest Products	25
Mineral and Energy Resources	26
Increase in Value of Resources through Industry	28
Food Industry	29
Engineering Industry	30
6. Urban and Rural Development	31
Urban Development	31
Rural Development	33

7. Science and Technology Development	34
Science and Technology Policy and Management	35
Technology Transfer : Adaptation and Diffusion	36
Technology Forecast and Assessment	37
Acquisition of Capability in Emerging Areas of Science and Technology	38
Development of Manpower and Institutions in Science and Technology	40
Scientific and Technical Services	41
8. Organization of Research System and the Roles of External Agencies	42
Universities	43
Planning Agencies	44
Government Operating Agencies	44
External Agencies	44
Information Centres	45
9. Strategies for Development Research Support : Future Orientations	45
Programme vs. Project Support	46
Network Support	49
A New Orientation	51
10. Conclusion	51
11. Acknowledgements	52
12. Reference	53

## 1. CONCEPT OF DEVELOPMENT<sup>(1)</sup>

Development is not the creation of a physical product, nor is it purely economic growth. It is not a thing, not an end goal, but a process of change. Development as we understand it today, is an individual and social process aimed at a better, fuller, more contented and harmonious life. Development requires the wise utilization of natural resources for the benefit of the population as a whole. In order for this condition to be satisfied, scientific knowledge is one of the necessary ingredients.

Although science is universal and, therefore, relatively easily transferrable from one society to another, technology which is its application is not. Technology is the application of knowledge, usually from as many fields as necessary, to solve a certain problem or to achieve a predetermined desired goal, by utilizing available resources as input to a process consistent, in most cases, with economic, social, political, cultural, and environmental contexts. A problem always arises whenever technology is not consistent with these contexts. Consequently, technology must be developed or modified and nurtured indigenously, otherwise inadvertent undesirable side-effects will occur, and the benefits will not reach the mass.

Natural resources, the necessary components of development, are part and parcel of the ecosystem of our biosphere. For over three billions years all living organisms have instinctively learned to adjust and utilize the natural environment. Natural evolution has maintained the balance of nature until man appeared on the scene several million years ago. Since the beginning of the agricultural revolution close to ten thousand years ago, man has increasingly learned to utilize nature and the natural resources upto a point where he many times has lost touch with nature. On the dark side, the industrial revolution has blindfolded man from contentedness and left him exposed to his greed in the exploitation of nature. Ignorance and unwise exploitation of these resources could produce damaging irreversible effects to the biosphere,

threatening the existence of man himself. Development, therefore, implies wisdom in harnessing and proper utilizing of natural resources for the ever-continuing ecological balance of the biosphere and man.

Development implies an individual and a social desired change from one state of affairs to another. In order for this dynamic change to be smooth and non-disruptive, it must be generally accepted by the people. This acceptance is not passive but must be actively participated in by those involved in the development process. A unilateral decision taken by political leaders or even a benevolent dictator on a development project without proper understanding, appreciation, sufficient support and participation by the people involved may lead to an unexpected outcome, and the benefit derived thereby may not reach the planned target group at all. The success of development, therefore, requires new attitudes and new skills necessary for the process of change. This is why education, scientific and technological literacy are believed to be the key to success in development.

In order to provide an atmosphere conducive to development, modern means of communication of information can assist in creating appreciation and understanding of common social issues. Whether the information is spoken, hand written, printed, film, message on radio, telex, magnetic tape, television, cabled television or radiated subscription television utilizing computer and satellite technology, the purpose has always been the same. That is, to take information and convey it to someone for social, entertainment, educational, cultural, commercial, financial, political, developmental, peaceful or military ends. Such information and communication resources are indeed powerful and are showing a recent boom as a new economic sector.<sup>(2)</sup> Properly utilized, and consistent with culture and environment, these new resources can be advantageous for development. Exploitation of it for the benefit of a few greedy and selfish groups may have adverse effects on development.

We must ask, and always ask ourselves, the question for what purposes are we utilizing the resources.

Throughout history, we observe that development proceeds sometimes slowly at a snail's pace and at other times quite rapidly as seen in some newly industrialized countries (NIC). Development is the conjunction process of many factors. Significant among them are the four basic ingredients: the mobilization of financial resources, the wise utilization of natural resources, the proper application of science and technology and man himself. Although there are some similarities and common problems confronting development, there is no one single general formula giving a general path for development. Development is a process that is location, temporal and cultural specific.

## 2. MAJOR ISSUES : BASIC ROOT CAUSES HINDERING DEVELOPMENT

There are eight interrelated basic issues faced by developing countries. Some of these issues have existed over the past few decades and will still be with us over the next decade, while some are emerging. They all affect development. They are the main basic root causes of most problems to be discussed in Sections 3 through 7. Research properly addressed to these issues and related problems would help prepare developing countries to face them and alleviate major problems.

First and foremost is still the rapid population growth. Although achievements over the past decade have been noteworthy, regrettably, it is too soon to cross the population explosion off the list of worries. The problem is not yet fully arrested. The proportion of children population is still higher than that of the working adults, thus each family has a high dependency ratio. The rapid rate of population increase does not only place a heavy financial burden on governments in the provision of social services such as health and education, but has brought with it other social problems such as

poverty, the widening gap of income distribution, the shortage of land for cultivation, rural to urban migration, urban problems, unemployment and the deterioration of physical and mental well-being of the people as a whole.

Second is the model - the model of human resources development and the associated models for social services provision. Faced with the monumental task of human resources development, the governments of developing countries look for assistance and cooperation from various industrially developed countries and international agencies. Although both parties are, to a certain degree, aware of the problems involved, western models and their adaptations have been utilized. For example in health care, a heavy emphasis and the associated financial allocation have been placed on the curative aspects of care in hospitals, rather than on primary health care with emphasis on the preventive aspect aimed towards the rural population. In western societies, the education levels of the population are relatively high and the general knowledge of the preventive aspects of health care are extensive, but such is not the case in developing countries. The western models, be they health, education or urbanization, tend to favor those in the urban areas. When these models are applied to developing countries, they tend to create wider disparities between the urban and the rural, the rich and the poor, the educated and the uneducated, and those who have information and those who have not. We must remind ourselves that the models developed in the West to cope with education, health and urbanization provision have evolved over a long period of time, utilizing scientific and technological knowledge which has been slowly blended into the way of living and culture. The indiscriminate application and adaptation of these models over a short time span have not allowed them to be fully integrated with the developing countries ways of living. Many problems are thereby emerging such as the materialistic outlook at the expense of the indigenous spiritual values and over-exploitation of natural resources instead of effective utilization of resources while keeping the ecological balance.



Even though the model is indigenously developed, there are still problems associated with development that we must be prepared to cope with. Since the development process brings with it a new way of life, a new society and a different physical and social environment, there are new problems requiring attention. As most developing countries are agricultural and rural in nature, as soon as development starts various types of industries emerge in cities and nearby. In addition to occupational health and accidents, labour relations and welfare need to be coped with. As transportation networks are being built, there are more traffic and road accidents. Entertainment facilities in a new urban centre bring with it cultures foreign to the local rural surroundings. All these new happenings are acquired in a relatively short period of time and many have no genetic compatibility with the traditional way of life. Those who are not able to adjust and cope with such development do not at all gain from the overall thrust. Consequently, they feel left out, alienated and do not participate in the development process.

Third is the issue generated by unmet expectations. As the development process starts, new physical changes in the environment appear on the scene-dams, roads, electricity poles, schools and hospitals. The poor see these new physical construction right next to them but at the same time no water comes to their fields. They have no electricity. They can not afford to attend secondary schools. What children learn in primary schools or hear on the radio and see on television at the corner stores are not familiar to them, but excite them giving them, hopes and expectations. This rising expectation has permeated all through the population over the past three decades since the end of the second world war. The momentum of expectation causing social demands has been so strong that the social services provided by the government are not adequate to cope with them, due to limited financial and human resources as well as the fact that these provisions are often poorly managed. The symptom of unmet expectations are manifold: rising crime rate, youth protests, drug addictions, etc.

The fourth major issue involves what might be called the "gold rush" phenomenon. Many developing countries have stocks of natural resources which, after centuries of being neglected, are suddenly over-exploited in a short time period, without proper linkage with other sectors of development. This distorts the pattern of national development, and creates further problems as discussed below. Over-exploitation of petroleum resources, and the resulting over-dependence on them, is but one example; exploitation and mismanagement in tin mining is another. Proper mechanisms are needed for regulation of utilization of particular natural resources, and prevention of their exploitation.

The fifth major issue results directly from the over-exploitation problem, or in many cases simply from well-intended development efforts. Adverse environmental effects, e.g., forest depletion, soil erosion, pollution, easily arise from intense or unusual human activities, occurring at a pace greater than can be accommodated by the environment. Some adverse effects are quite unexpected, arising from a chain of events generated by the introduction of a new element in the environment. For example, increased incidence of malaria in some parts of Thailand was traced to gem mining activities, resulting in trapping of rain water suitable for breeding of anopheline mosquitoes. Environmental concern must, therefore, be a major part of any human activity if harmony with nature is to be achieved.

The sixth major issue concerns poor distribution of income and benefit generated from the resources among the various sectors of the population. The small farmers, producing the bulk of agricultural output, receive far less income than the entrepreneurs serving as processors or simply middle men. On the macro-level, the urban sector derives disproportionately high benefit at the expense of the rural sector. The imbalance is created amid rising expectation of every sector of the population. In a real sense, many people would have been better off if that dam had never been built, or that oil well had never been struck.

Corruption and inefficiency, our seventh major issue, stem from injustices in the reward system described above, as well as from the general state of under-development. The problem of corruption and efficiency is both cause and effect of other hindrances to development. It is disturbing that in Southeast Asia this problem is most rampant in the bureaucracy, virtually the controller of government mechanism. A major reform of the bureaucracy is long overdue in many countries.

We come to the eighth and last major issue, namely, an inadequate legal and enforcement system to ensure against the foregoing problems and to promote effective development. To be sure, all Southeast Asian countries have a long legal history, and there is quite effective maintenance of law and order in general. Yet with regard to development activities, or activities which pose a threat to development, the legal system has not caught up with rapid changes. For example, laws on many aspects of environmental conservation and pollution remain to be written, let alone enforced. Laws and regulations are needed, which would ensure a more equitable distribution of income derived from, say, agricultural activity. Some good examples exist, such as Law for Support of Rubber Plantations in Thailand, but these are still rare.

These major issues affect development and need to be tackled, but we must remember that the developing countries are not homogeneous. Each country, as well as the subregions within a country, is at a particular stage of development; each has a different historical perspective under a varying cultural environment. One general formula does not work. Moreover, for each of all these development issues, there are two levels of questions. The first level of questions are technical, e.g. how to teach arithmetic effectively, what prevalent diseases are around the new lake areas. One developing country can learn to answer this type of questions from others and with some adaptations from developed countries. The other level of questions is more fundamental and more philosophical. Why do we need to teach modern

mathematics? What should be the relative weight in the curriculum of mathematics or the indigenous language? At this stage of development, do we need cabled television or radiated subscription television? What are they for? These questions are cultural and temporal specific and need to be answered indigenously. Analysis, research and experimentation are needed to suit various issues and local conditions.

To sum up, we must learn how to cut shoes to fit our feet rather than import shoes and adjust our feet into them. Above all we must ask : do we need shoes at all? For some places at sometimes, we do; but at other places at other times, we do not.

### 3. CHARACTERISTICS OF DEVELOPMENT RESEARCH

Just as the developing countries have their unique characters and are at various stages of development, so has development research in each country at a particular time been a unique experience, which may not easily yield to generalization. However, since the countries in Southeast Asia have been cooperating with each other for the past two decades, and have comparable levels of development, the experiences from previous research may be drawn upon to provide lessons for the future.

Development research might roughly be classified into two categories. The first category includes research conducted specifically in connection with some development projects or activities. In most developing countries most major development projects and activities would fall under the responsibility of government agencies. Any accompanying research would also normally be done by, or under supervision of, these government agencies, although there is a growing tendency to farm out the research to outside people, normally in universities. The second category comprises research taken under the initiative of individuals or groups of researchers, or research undertaken by policy and planning offices mostly with the purpose of

finding new or appropriate technologies, providing data and analysis for policy makers, or achieving other means towards promotion of the development in question. Most of the research in this category is undertaken by people in universities or research institutions, relatively independent of development implementation agencies of the government.

It might at first glance be assumed that extensive research is as a rule conducted as a prerequisite and as a monitor of major development projects and activities in developing countries. After all, this is development research where it is immediately needed, and not just something deemed important by the researcher and the funding agency. On closer look, however, although the importance of detailed research is generally accepted, in all too many cases this is not actually done, or done only in a superficial manner. Policy research, technology impact studies, feasibility studies and case studies are some of the admittedly important yet often neglected, aspects of research for major development projects and activities in the past. Consequently the so-called major "development" projects and activities often turned out to be of little benefit, or of some benefit for one group of people at the expense of others, or downright catastrophic. Many examples can be recalled ranging from health care delivery, to land reform, irrigation and construction of power stations. There are a number of reasons for this neglect, the important ones include fear of jeopardy of the intended plans, lack of capability for or familiarity with the needed research, and unsuitability of the bureaucratic system to support such research. While little can be done to correct the first, the latter two situations can and should be improved in the future. Agencies such as IDRC can have an important role in these regards.

The value of development research conducted by individuals, groups, or policy offices independent of the development implementation agencies is that it can be relatively objective and impartial in nature. Hence, issues which give rise to conflicts of interest among various

groups, which may have various options for the course of action or which require long-term planning are often best tackled by the independent researchers. Furthermore, the atmosphere and the flexibility of operation of the universities and research or policy research institutions are more conducive to productive research than government agencies mainly occupied with routine work and bound by bureaucratic regulations. However, there is a danger that the research may be far removed from the actual developmental activities, the majority of which are planned and executed under the responsibility of government agencies. Past experiences have shown that many researches only led to publications and "know how" which, though of value by themselves, often did not lead to further action of developmental value. This is admittedly difficult where research of a rather basic nature is concerned; for example, a study on methods to limit male reproductive capacity need not lead to a change in strategy of population planning, even if new methods are found. It is nevertheless clear that increasing awareness of actual developmental activities of the independent researchers should be a welcome trend for the future.

#### 4. STATE-OF-THE-ART AND PRIORITY AREAS : HUMAN RESOURCES

##### 4.1 Education

Education is central to development. It serves to bring about national cohesion and unity. It is one of the basic needs necessary to lead a decent life in the modern world as well as being the base upon which other basic needs could be achieved. It also serves an individual to attain his intellectual, attitudinal, moral and ethical, and physical development. The governments of developing countries, therefore, are politically, developmentally and morally committed to provide education to the populace. Moreover, from the point of view of an individual, education also serves as a ladder for social mobility. Based upon those reasons and with limited resources, the priority areas for development and for research are as follows:

First is the quantitative expansion with quality and equity in compulsory primary education. The applications of the Coleman type research relating student achievements with socio-economic variables have been instrumental in bringing about expansion with equity in many Southeast Asian countries. The results and recommendations drawn from such research have stimulated education reforms both system-wide and specific reforms in primary education.<sup>(3,4)</sup> Moreover, the result of research on resources allocation in budgeting for greater equity in primary education in Thailand has been implemented by the government.<sup>(5)</sup> In the area of quality and relevance, the IDRC supported projects on Reduced Instruction Time (RIT) and Instruction Managed by Parents, Community, and Teachers (IMPACT) have been adopted and implemented in many countries in Asia. More research and development experimentation in primary education stressing quality, equity and relevance are needed.

Second is the linking of formal and non-formal education. Although this topic has been talked about for sometime in various seminars, there need to be case studies in depth and comparative case studies, so that general conclusions on guidelines could be drawn up regarding factors encouraging and inhibiting the link. If such guidelines could be drawn, functional and permanent literacy could be achieved in the foreseeable future. Furthermore, the guidelines would also help in improving employment opportunities.

The third priority area is relating education with work, particularly at the second level of education and for out-of-school youth. The problem will be more serious in the decades to come because the demographic increase for the age group of 15-25 will rise over the next decades, in addition to the normal increase in the enrollment ratios at the second level of education. This problem is quite complex particularly in developing countries, where there is no tradition of formal apprenticeship in factories, since the study would require in depth research regarding factors inhibiting the tripartite relations, namely, schools, government and enterprises, both private and public.

Fourth priority is higher education planning. This problem is related to the rising social demand created by the demographic increase as well as the rising expectation of the young generation to be educated. At present there are various types of higher education institutions in Southeast Asia. Only in the Philippines and Thailand, are there open universities. There is only a scant number of research efforts on graduate unemployment,<sup>(6)</sup> costs, internal efficiency, external efficiency, condition encouraging and discouraging innovations. Higher education institutions are usually organized in traditional disciplinary-oriented faculties and departments. Only a few interdisciplinary problems and natural resources development institutions exist. The results of such research could be utilized for planning. We are even more discouraged when we look at teacher education and science education; since top students tend to study medicine and only poor ones are left in teacher education and science. If such conditions prevail continuously in the future, development could really be affected.

Fifth is the problem in inculcating ethical and moral values. In the present curriculum with the prevailing practice in the teaching and learning process as well as the overall social context, it has been said many times that we are now teaching a book and not teaching a man. Few studies have been made as to the reasons why and how to correct this.

Sixth is the financing, planning and management of education. Headways have been made in research on education costs<sup>(7)</sup> and financing,<sup>(8)</sup> planning and implementation.<sup>(9)</sup> In addition, linking the planning at the local level with that at the national level is a key factor in development.

The key to the external efficiency aspect of education is research related to policy issues. In this regard the impacts and interaction of social sciences and education are extremely relevant for policy guidelines in education. Examples of the topics are, the effects of economic, social and political environment on educational philosophy



and policy, a study of the disadvantageded groups in access to all levels of education, significant indicators of educational quality, problems on technology and management, interdisciplinary research on children's growth and development, improvement of teacher training and retraining systems at primary and secondary levels, a study of factors within the present educational system which obstruct self-reliance development, evaluation of efficiency and effectiveness of agencies in charge of management of education for disadvantageded groups, etc.

#### 4.2 Population

As the human resource is one of the most important resources, population conditions and problems play significant roles in the failure or success of development of any nations. The rapid population growth rate does not only constitute a problem in itself, it also leads either directly or indirectly, to other social problems such as unemployment, housing, drug addiction, migration, social disorder, environment exploitation, etc. Thus, population problems must be arrested in a timely manner for they generate long run and rather negative effects. The population explosion which most developing countries have been facing during the 70's has impeded the effective development of those countries. In spite of the declining growth rate, representing success in some countries to some extent, the priority areas for development and for research are still identified as follows:

First, realization that the rapid population rise is not proportionate to the existing economic and financial status of the country. Attempts to reduce the population growth rate have been done continuously for the past decade. Evidence has shown that in some cases the growth rate has been reduced in the urban area rather than the rural one. Family planning programmes especially in remote areas have been inadequately effective due to the shortage of medical personnel, appropriate approaches to the local people, funding, statistical data, research and suitable evaluation procedures. Studies to find various measures and implementation appropriate to certain target groups ensuring the success of family planning should be supported.

Another area is the quality of the population. Developing countries such as Thailand have experienced a substantial difference and unequal development of the quality of people residing in remote areas and those living in urban areas in terms of intellectual background and physical well-being. The cause of this phenomenon is the emphasis on economic development under limited financial resources ignoring the consideration of all related social aspects. Hence, extensive attempts should be drawn to reduce and minimize the inequity in public health and educational services. In addition, occupational training activities for the population need support to accord with manpower requirements.

#### 4.3 Health and Nutrition

Health and nutrition are two major components conducive to a good life and living. Without good physical and mental health, a man or a woman will not be able to study, to work and to live happily in harmony with nature and to be a useful member of one's family and community. Self-confidence, adaptability, self-control, financial independence, physical fitness, and moral principles, all these factors will enable a man or a woman to live a normal life contributory to the society. For developing countries which face economic constraints and population explosion, the problems concerning health and nutrition have arisen as follows:

First is the inadequate medical care provided by the government to cope with the rising demand and expectation of the people. In spite of substantial supportive implementation from private organizations and charitable foundations complimentary to government funding, public health and nutrition services have been relatively limited. Besides quantitative aspects, quality of the services differs between urban and rural areas. Hence, the expansion of development and research for accelerating basic health services for certain target groups should be stimulated. In addition studies on how to mobilize and maximize funding for health and nutrition services are necessary.

Second is the distribution of medical services to the rural poor against the improvement of professional capacity. There are differences between services provided by the government for city dwellers and rural poor in terms of number and size of hospitals, ratio of patients per physician and other related facilities. While the government takes full responsibility for improving rural services, it is also necessary for it to emphasize the production of high level medical personnel including physicians, the supply of which has been very limited. Moreover, incentives have to be offered to attract capable physicians to the remote areas. The training of village health communicators and village health volunteers under the primary health care programme in Thailand has been quite a successful supporting means, contributing to improving medical services for the rural poor. Measures applying technology to accelerate provision of medical and nutritional services to the rural poor as well as the strengthening of professional capacity need greater funding so as to achieve the objectives of health services for all the people by the year 2000.

Another problem is the unconstant policy on preventive and curative approaches in health services. The past two decades of public health development indicated that morbidity rates of preventable common diseases such as gastro-intestinal diseases and diarrhea are still high despite the success on the eradication of certain communicable diseases such as plague, cholera, etc. Illnesses and deaths from accidents, poisoning and violence have increased annually. In addition, there are still diseases transmitted by poor family health practices such as those among infants which can be prevented by immunization, maternal and child diseases, malnutrition, etc.<sup>(10)</sup> Most expenditures have been utilized for curative purposes. Thus preventive measures for basic health development should be raised to a higher priority for support.

Parasitic diseases such as those occurring in tropical developing countries remain the world's great neglected diseases, compared, for example, with cancer or heart diseases. The amount of fundamental information available on malaria, schistosomiasis, filariasis and other tropical diseases is so scanty and, unless more is known, attempts at their control and eradication will remain unrealistic. The problem of drug resistance, for example, chloroquine resistance of falciparum malaria in Southeast Asia, needs research both in the laboratory and in the field. Some local remedies for parasitic and other diseases are worth investigating in a systematic manner. Results from this research might refute, support or suggest means for further improvement of these remedies. The research will often involve identification, isolation, purification and study of pharmacological properties of natural products, and require a combination of efforts in the various sciences.

Protein-calorie malnutrition and vitamin deficiencies are prevalent in most developing countries, many of which are, paradoxically enough, exporters of food and other agricultural commodities. Much basic information is lacking on the pathophysiology of malnutrition, and on the interaction between malnutrition and infection. Priority should be given to research in these areas.

Finally, the building up of people's participation in health service and care is essential. In practice, the majority of the people do not have an adequate sense of responsibility with respect to community health problems. There is still the need for collective efforts in the exchange of community health knowledge and information and the organization of a body for the neutral solution of health problems. Therefore, attempts to bring in people's self-reliance and collective participation in basic health services and nutrition is a strong recommendation.

#### 4.4 Unemployment

The oil price explosion and international monetary crisis in the early 70's have greatly disturbed the world economy by causing high inflation, economic recession, and particularly unemployment all over the world. These problems are more severe in the developing countries than in the developed ones. As far as unemployment is concerned, it will lead to other relevant problems such as crime, lack of safety of life and property, poverty, mental illness, etc. In developing countries in general, unemployment is becoming increasingly more severe. There has been some exchange of ideas in order to find the causes, conditions and curative means of the problems. Unfortunately, concrete action has not been taken. The priority areas for development and for research are as follows:

The first area is youth unemployment. In developing countries, e.g. Thailand and Indonesia, there are many more young people outside the school system than inside, and most of them have reached only primary education. Most of them work in agriculture, industry, or business, generally as unskilled labor. A large number of them are unemployed. As a result of the disproportion between increase in the youth population and the increase in employment opportunities, the problem of unemployed and unskilled youth keeps growing. Besides the unemployment problem, there is also the problem of underemployment.<sup>(11)</sup> The creation of more jobs in the provinces by the government in cooperation with private business will help reduce the problems. In addition informal education should be strengthened to provide training for the kind of jobs consistent with certain target groups.

Another area is graduate unemployment. Thailand and the Philippines have experienced this problem for the past decade. A higher rate of graduates in the fields of social sciences has been either unemployed or underemployed. The recognition of the problem is quite obvious, but only a very small number of studies seeking for a solution

have been done. Nowadays, this problem has begun to be critical in Thailand. The principal rationale for this problem is the rapid expansion of higher education to cope with social demand and political pressure. As a result of this problem, demand for more local graduate studies has arisen, regardless of the graduate studies abroad. In solving this problem, research on factors inhibiting ability in self-employment of graduates at all levels of education need prior support. In addition cooperative attempts between the government and the private sector in accurate manpower forecasting has to be promoted. A reliable information system concerning graduates and manpower in various fields is indispensable.

The next problem is the migration from the rural to urban areas because of poor income from agriculture. A good example for dealing with this problem is the village job creation programme in Thailand. Measures to build up collective efforts of villages to be self-reliant in term of agriculture and other occupations may help reduce migration. Moreover, research to find new technology to improve agricultural plantation is needed. This will be elaborated on in section 5.

Finally, the change from agriculture to industrialization orientation has generated unemployment. The capital intensive industry which invests heavily on machinery and equipment tends to lay off much of its labour force. Thus, labour intensive industries e.g. agro-industry, weaving, integrated circuit assembly, etc. should be promoted. However, there should be apprenticeship training so that not only physical labour, but skill and knowledge will also be utilized. Studies should be done for the improvement of curriculum and of the teaching and learning process, so as to inculcate entrepreneurship and self-employment ability in each individual. This measure is applicable to all of the afore-mentioned unemployment problems.

## 5. STATE-OF-THE-ART AND PRIORITY AREAS : NATURAL RESOURCES

### 5.1 Water Resources

In view of the importance of water both as a natural resource and hazard, there has been too little attention on many aspects of its development in the developing countries. While relatively large-scale projects, such as construction of large dams for hydroelectric power or irrigation, have been given prominence in many countries, the small-scale projects for water management have only recently been seriously considered. Furthermore, the one-dimensional outlook of those responsible for the large-scale projects have often created negative impacts which could have been avoided or minimized. By now however, most governments are aware of adverse environmental impacts that unavoidably accompany such large-scale projects, including deforestation, ecological disturbances and consequences on public health due to increase in water-borne diseases, etc. The problems of human resettlement and its effect on the livelihood of those depending directly or indirectly on a water resource which has been modified are also now more clearly understood, if only from the bitter lessons of actual experiences. It is to be hoped that these lessons will be valuable for planning future projects, not only in the same countries but for any countries which may come across similar situations.

It is convenient to classify development works on water under two different but related aspects : water as an economic resource, and water as basic human need. The former includes work on large-scale irrigation systems, transportation, industrial utilization and harnessing of hydropower. There are a few examples of successful projects based on well researched plans; for examples water resources development in Taiwan and irrigation systems in Indonesia. The latter aspect includes works on procurements, use and conservation of water in rural communities. Understandably, because of lack of immediate economic effect of the latter, there has been relatively little research

on this aspect except under the realm of "appropriate technology". Recent trends have, however, been encouraging, with greater emphasis being put on small-scale self-help systems for water management. Some new technologies and systems developed for use in desert areas can also be transferred and adapted for appropriate use in the Southeast Asian region.

Development of water resources should be stressed in both quality and quantity aspects. For water as an economic resource, emphasis should be made on operation research on water management, in order to increase the efficiency of water usage. For example, the present low efficiency of water usage for irrigation (13% for Thailand) could be greatly improved. In order to obtain optimum benefit from the large-scale irrigation or hydroelectric schemes as well as to minimize the adverse effects of flooding and salination, research is needed not only in construction of dams and channels, but also on optimum methods of management and maintenance. Small-scale schemes may be more appropriate, or even the only alternative, under many circumstances. For water as a human need, research is needed for development of self-help systems in rural communities, including organization of water management in the farm. Appropriate technology for procurement of groundwater or water from other sources needs to be developed. The water needs to be free from pathogens and pollutants. Efficiency in use and conservation techniques are important in areas where water is a scarce resource. Both endogenous research and adaptation of transferred technology should be encouraged, so as to contribute to the development of water resources in both aspects.

Attention needs to be paid also to water as a hazard. Hence to problems of flood control and management deserve mention, and so do the problems of wastewater treatment, both from household and industrial use. Although the technologies are known for the solution of most of these problems, they are not always appropriate and in any case require adaptation.



## 5.2 Resources for Agriculture and Forestry

### 5.2.1. Tropical Agriculture of Food and Industrial Crops

For most developing countries the bioresources will continue to provide the major means for subsistence and earning in the foreseeable future. The so-called "Green Revolution" resulting from research on new varieties of cereals and other crops has been beneficial to a large number of farmers, although the dramatic increase in productivity obtained more than a decade ago has not kept momentum in recent years. The main drawback of the past approach in increasing productivity is reliance on energy-intensive input, viz. chemical fertilizer, pesticides, water supply, farming machinery. With the passing of the age of cheap energy (which incidentally has never been cheap to non-oil-producing countries), new research approaches should attach far more importance to the question of energy input versus productivity. This conclusion has far-reaching implications on existing technologies and management systems, ranging from choice of crop varieties, land and water management to post-harvest technology. Recent results from rice research in the Philippines may serve to demonstrate encouraging trends for the future. Another good example may be found in Malaysia, where research and development on rubber and palm oil, covering integrated aspects from plantations, through processing plants to the market, has contributed tremendously to the country's productivity.

In view of the lack of water supply through irrigation in major parts of cultivated areas, research on rain-fed agriculture should be given high importance. Development of new crop varieties through genetic improvement should take as a major consideration the fact that most of the agriculture in developing countries will continue to depend on rain as the major water supply.

Genetic improvement of such food crops as legumes, cereals and tubers, and such industrial crops as rubber, oil palms and fibre plants should be a major topic for future research, making use of new advances in genetic engineering as well as classical approaches. Searches for high productivity and improvement in product quality, such as increase in nutritional value, are expected to still depend on classical approaches in agricultural research. However, improvement of other characteristics, such as resistance to salinity, plant diseases and pesticides can be effectively achieved through genetic selection from tissue culture.

In the attempt to improve tropical agriculture of food crops and industrial crops, a main criterion must be minimization of the energy requirement. Dependence of crops on artificial fertilizer can be minimized both by genetic improvement and development of organic fertilizer from waste and by-products. Multi-cropping techniques can yield beneficial results and should be further explored, and so should soil enrichment through naturally occurring micro-organisms. Dependence on chemical pesticides and herbicides, which pose a hazard to the environment and a health risk as well as being expensive to the small farmers, can be minimized through integrated methods of pest and weed control and search for more effective biological controls. Reduction of environmental and health hazards of pesticides and herbicides is a matter of great concern and should be studied. Introduction of new and more efficient post-harvest technology should contribute substantially to reduction in loss and deterioration in quality of the product on the way from the farm to the market place or the processing plant.

To ensure that the farmers actually obtain the benefit from development of improved crops, an efficient system is required for distribution of seeds and fertilizer and for extension of new farming techniques involved. Research is needed to define the optimum methods, the role of the government and private sector, pricing policy, and other mechanisms to achieve this aim.

It may also be pointed out that at present only a tiny fraction of the world's plants are being substantially utilized in the service of man. A search for more varieties as well as development of known varieties, should yield natural products of medicinal or economic value, especially in view of the accumulated wisdom of traditional medicine which relies heavily on utilization of plant products.

#### 5.2.2. Soil Quality

With increasing intensity of agriculture, the problem of preservation and improvement of soil quality becomes even more urgent than in the past. While there has been steady progress in the development of technology for prevention of soil erosion and improvement of soil quality, the same cannot be said of management of land use. Roughly the same situation exists on the problem of control of deforestation and management of existing forests. Perhaps more than any other problems, these problems highlight the major stumbling blocks to development as discussed above.

Preservation and improvement of soil quality, including protection of soil from desertification should be emphasized both in the technological aspects, and in the aspects involving management of land use. Agricultural techniques which do not deplete the quality of top soil, especially the content of trace minerals, should be carefully examined and balanced carefully with those techniques which may well yield greater productivity but leave the soil exhausted. An area of great importance for further work concerns the optimal utilization of marginal lands. This should involve an integrated approach.

#### 5.2.3 Animal Husbandry

Recent rapid development in the commercialization of animal products in some Southeast Asian countries demonstrates the potential of animal husbandry in the generation of food and wealth. This development

was brought about by a combination of effective management and use of new technology. Outstanding problems, however, still remain in some areas, especially in the improvement of utilization of local food resources, including prevention from, and removal of toxic contaminants. Prevention and treatment of infectious animal diseases are important problems, the solution to which are expected to arise from both adaptation and use of research advances from the developed countries, and endogenous research activities. It is important to bear in mind that the new generation of vaccines, antibiotics, etc., is likely to depend increasingly on new advances in biotechnology. Genetic improvement of animal stocks is expected to rely on the conventional breeding technology, in the production of hybrids between imported and local stocks, which would have a combination of required characters.

With the emergence of large-scale animal husbandry, the direction of small-scale activities, which provide occupations for the majority of the rural communities, needs to be elucidated. Management and interaction of animal farms at different scales, therefore, should be studied in order to provide analysis for future policy decisions. The effectiveness of small-scale animal husbandry can be increased through "integrated" farming, utilizing existing knowledge on food chain and ecological factors.

#### 5.2.4. Sea and Inland Fisheries : Mariculture and Aquaculture

While the agricultural potentials of the land have been well explored, the same cannot be said of the sea and inland waters. On the one hand, the sea has been over-exploited in many places through over-fishing, but on the other hand aquaculture and mariculture are still very primitive sciences compared with agriculture. Recent researches have yielded some dramatic results, as demonstrated, for example, by research on milk fish breeding in the Philippines<sup>(12)</sup> or lobster farming in Thailand. Southeast Asia appears to be capable of developing shoreline and inland aquaculture to a much higher degree in the near future, given the right incentives and enough research combined with adaptation of technology from more advanced countries.

It has been pointed out that with regard to harnessing of aquatic bioresources, the situation in developing countries, or indeed in many developed countries, is equivalent to the dawn of the agricultural age on the land thousands of years ago : gathering and hunting in the wild. The main difference is that, in the modern age, change will be more rapid by many orders of magnitude. While fishery without cultivation will continue for some time into the future, the problem of preservation of existing resources will become increasingly pressing. Optimum methods for harvesting and optimum use of catches require integrated research, employing knowledge from marine science to economics. Efforts in aquaculture must, however, take precedence over hunting in the waters. New and simple technologies have recently emerged, and shown every sign of promise that they will combine to transform the face of aquaculture in the near future. New aquaculture techniques should be developed, not only for fresh and seawater animals, but also for seaweeds and other edible plants from water.

Underlying the success of any agricultural and aquacultural undertakings discussed above must be the ability of the farmers to sell their products with good profit. The scale sensitivity of marketing tends to favour the large entrepreneurs over the small farmers. Research is needed to find more effective ways to help the small farmers in obtaining good prices at the market or at the processing plants. Legal as well as financial and economic measures will be needed, and the research should provide various options for policy decisions.

#### 5.2.5 Forestry and Forest Products

Important areas for research involve integrated approaches to the control of deforestation and management of existing forests as well as optimum utilization of forest products. The relative advantages and disadvantages of clear cutting versus selective cutting of tropical forests, including issues of soil erosion, population pressure, legal enforcement, corruption, etc., need to be carefully weighed. Methods for reforestation through mass planting of fast growing trees and other means, and management of reclaimed forests deserve special attention.

The genetic pool of the forests need to be preserved, while searches for improved forest species and evaluation of their aptitude should be made. Concurrently with these efforts, judicious utilization of tropical forest products both for material and energy needs requires careful study both in terms of technology and management. The specialized ecosystem of the mangrove deserves a special mention in these respects in view of its importance in many developing countries.

### 5.3 Mineral and Energy Resources

There have in the past been very few development researches on mineral resources, and although there have been a number of endogenous studies on energy resources, these are mostly on "alternative energy". The reasons for this are not difficult to find. While these resources are of course vital for the economy and well-being of developing countries, a number of important aspects unfortunately require high technology presently beyond the control of developing countries. Development of these resources are to a large extent tied to the production system in the North through multinational corporations, international markets and consultants, and major capital. Oil prospecting and rare minerals processing are but some of the exclusive areas requiring almost completely superimposed technologies. While one cannot expect this pattern to be significantly changed in the future, the need to broaden the capability of the developing countries in developing their own mineral and energy resources is very clear. There have been some positive signs in the recent past, as witnessed by activities organized by an association of international geoscientists concerned with development of the Third World, i.e. the Association of Geoscientists for International Development, Caracas, Venezuela.

Development of alternative energy resources has received considerable attention in Southeast Asia, both at household and industrial levels. Some researches have given rise to encouraging results, for examples, new designs for biogas fermenters, wind-powered

pumps, solar refrigerators, etc. It remains to be seen, however, whether these inventions will make any significant impact in the rural communities, for which they are mostly intended. It is perhaps regrettable that the impetus for development of alternative energy may be weakened, at least temporarily, by the current world oil situation. This impetus need to be maintained because of the importance of alternative energy resources in the long run.

Many developing countries are blessed with rich deposits of mineral and hydrocarbon resources. Since the level of technological sophistication and local demand is not yet very high, these resources are simply mainly exported as raw materials for industrial processing and use in the developed countries. The prices of these commodities are relatively low compared with finished products, and the market continuously fluctuates. It makes sense, therefore, for the developing countries to acquire capability for processing of their mineral and energy resources. However, even if such capability is achieved, it is uncertain whether their products will find use in the local industry or will be competitive in the world market. A recent failure of the soda ash project to get started in Thailand is an example to demonstrate this point. It is worthwhile to make case studies and feasibility studies on processing various types of resources, in order to form the basis for further policy decisions.

It is unrealistic for agencies like IDRC to assist developing countries in acquiring many high technologies for prospecting and processing of mineral resources. However, in addition to this issue, another issue of no less importance to which IDRC may be able to contribute substantially involves the role of small-scale mining and processing. The livelihood and environment of substantial part of the local population are dependent on these activities, for example, tin mining in Thailand and Malaysia. The socioeconomic and environmental impacts of different scales and technologies of mining should be studied in detail. The technologies of small-scale mining and processing should themselves be the subject of research for improvement in efficiency as

well as reduction of environmental impacts. Interaction between these activities and agriculture and industry also deserves exploration; for example, the potential utilization of rock phosphate as fertilizer should be studied in this context.

The energy needs and alternative energy sources of the rural developing areas need to be studied in depth. The study should be dynamic, taking into account the development of future technologies in the developed countries as well as changing needs of the rural areas. Bioenergy sources should continue to play a dominant role, and better methods for bioenergy conversion should be actively searched for, ranging from increase in biomass production through conversion into convenient energy forms. Direct solar energy conversion can be improved, and so can indirect conversion through wind and hydropower. It is important to bear in mind that those dependent on alternative energy sources are mainly in the rural areas. The technologies developed should therefore be simple and adaptable and should realistically serve the needs in farming and household activities.

#### 5.4 Increase in Value of Resources through Industry

This topic has not been a fertile ground for development research supported by international agencies, a fact which prompted many people in the South to believe that the North may want it to become developed too — but not too much. While it may be true that the least developed countries have more pressing needs, and deserve more attention than the newly industrialized countries, it is also true that increases in value of natural resources through industry should be encouraged no matter what level of development a country may have. Some development researches in the past have focused on small-scale, labour-intensive and agro-based industries. More attention has been paid on the economic than on the technological side of the issue.



A crucial question is whether the developing countries should do "research and development" in the sense that advanced industrialized countries are doing, or whether it is better to aim at indigenization of industrial products through "reverse engineering". This question is fraught with difficulties concerning restrictive practices of the transnational corporations, protection of intellectual properties and international transfer of technology. There have been some policy studies<sup>(13)</sup> which suggested that, in addition to research and development, the role of technological dynamism at the micro-level, i.e., "backyard workshops" and small rural production sectors can significantly contribute to a country's scientific and technological capacity. The significance of this contribution is, however, inevitably limited by the level of technological sophistication of a particular industry, and each developing country needs its own appropriate policy on the relative importances of innovative research and development and technological transfer and adaptation.

Priority areas for research on increase in value of resources through industries should be as follows:

#### 5.4.1 Food Industry

To complete the chain of activities in agricultural development, development of the food industry must be promoted. Processing of food depends on technologies of varying complexity, a large proportion of which can be acquired by the developing countries without much difficulty. Again the major determining factor for success is the market, and the policy for food industry must take this into account, in addition to availability of supply of raw materials, technology and manpower.

Traditional practices in food processing can be studied with view of improving the efficiency of the process and utilizing the 'waste' products. An example is improvement of the present fermentation processes for production of fish sauce, soy sauce, tempeh, etc. Utilization of waste products serves not only to economize the process but also to lessen environmental pollution. However, the profit incentive is often not strong enough, and this combined with the weakness of environmental regulations lead to the entrepreneur's neglect of adequate waste treatment. Simple and efficient technologies, many of which can be adapted from those already existing in developed countries, can help greatly to strengthen the traditional food industry in Southeast Asia.

Many Southeast Asian countries are blessed with an abundant supply of agricultural products, the excess of which can earn substantial export income. However, problems on quality control and improvement abound for both processed and fresh products. The importance of post-harvest technology has been emphasized, and likewise should the importance of processing technology, which will enhance the value of the products. For example, improvement of the value of cassava starch can be made, not only on minimizing the toxic cyanide content, but also on upgrading the nutritional quality, pelletizing process, etc. Methods to preserve and process tropical fruits, should be developed. This problem is all the more important, considering that many fruits are available only during short periods of the year.

#### 5.4.2 Engineering Industry

In order for the developing countries to be able to increase the value of their natural resources through industrial conversion, it is important that the engineering industry, especially at the medium and small-scale level needs to be developed. The engineering industry provides electrical and general machineries and basic metal products which in turn are needed for all other types of industry. Furthermore, it provides farm machinery required for extensive development of agriculture, and transport machinery required for infrastructural

development. In many instances, advantage can be taken of the highly developed status of the engineering industries in industrial countries, and the developing countries may aim at "reverse engineering" rather than novel "research and development". This however should not be viewed as simple copying, but as inventive process of adaptation for particular local needs. Appropriate tractors for rice farming, motorboats for rural waterways ("long-tailed" boats in Thailand), pumps and compressors, etc., can be manufactured using primarily local components. Forging and casting technologies need to be adapted to meet the unique character of the raw materials available, and the type of use required. Careful economic assessment is also needed for making the optimum choice between direct import and endogenous production.

## 6. URBAN AND RURAL DEVELOPMENT

As the government starts the process of development, existing city and town centres normally become focal points for economic and management of development activities. People from the rural areas begin to move to these centres to seek employment, since the opportunity to find jobs and their pay are usually higher than farming. This rural to urban movement creates problems and issues which must be tackled.

### 6.1 Urban Development

In general, existing urban centres in developing countries do not have a sufficiently strong base to absorb the expanding economic activities and the labour force. This is because the production structure is not diversified, and most industries and business are on a small scale. Existing investment incentives are not attractive enough to successfully disperse industries to various planned locations. The creation of industrial estates with positive attractive incentives is one of the measures used to overcome this problem. Research on factors encouraging or inhibiting investment in industries in these estates is among one of the most important topics for study. Furthermore, feasibility studies for all these industries are necessary.

Basic urban infrastructural facilities are usually inadequate for the development of an economic base for the growth of industries and other economic activities in these urban centres. The shortcomings of facilities extend also to ineffective flood prevention control systems, inadequate water drainage, and the lack of provision of clean water for human consumption and industries. Furthermore, the telecommunication system, particularly the telephone and telex services necessary for modern industries, trade and services is far from satisfactory. The transportation network is another major issue that can help or hinder a planned land use system. All these issues need research and development activities to assist effective and efficient urban planning.

The urban land use system in many cases depends on effective legislation and enforcement. In some municipalities boundaries have not been updated or redrawn in accordance with the growth of the community and the expanding economic activities. The municipality, therefore, is incapable of increasing its local tax revenues which are necessary to improve basic urban infrastructures.

Housing policy in developing countries needs unprecedented attention. Unless the policy and its implementation are effective, urban slums may grow overnight as the rural people migrate to urban centres to find employment. When such a situation occurs, professional people often are deterred from moving to these towns to participate in industries.

All these issues together with the provision of social services namely, education, health and other recreational and cultural activities need effective planning. Research and development in integrated planning consistent with the local social and cultural context are the necessary first step in order to alleviate major problems associated with haphazard and unplanned growth.

## 6.2 Rural Development

Like many other developing countries, Southeast Asian countries have the majority of employment in the agricultural sector. Although the manufacturing sector has been expanding rapidly in some countries, it still accounts for only a small fraction of the total employment. It is imperative, therefore, that rural development be given primary importance, with emphasis being put on agricultural and agro-industrial technology development.

A large proportion of the labour force in the rural areas is mobile and fluctuates with season. Because agro-industry and other industries have grown and because of improved means of transport, there is considerable movement of labour to urban areas where the industries are located, especially during off-planting periods. The service and other sectors of the economy in the urban areas also absorb a huge amount of labour from the countryside. In recent years, another very important factor emerged in the labour situation in some countries is drainage of skilled and semi-skilled workers to the Middle East. The implications of labour force fluctuations to development of the rural areas deserve intensive study, as do various means to prevent both temporary and permanent drainage of the labour force.

The success of rural development depends on three main elements : infrastructure; raw materials and factors needed for increased production of them; and people's organization. Without these elements, it is difficult to promote any sustainable development. It is imperative, therefore, if they still do not exist, to promote conditions which will bring about these elements. Many topics concerning the first two elements have been separately discussed above. It is also important to promote the third element, people's organization, for economic and social purposes, and not just for political purpose as has been usual in the past. IDRC should promote studies on this aspect. More study is also needed on how to promote sustainable development, given limited amounts of external resources. The merits and demerits of external

change agents or facilitators deserve close scrutiny, be they extension officers or well-meaning volunteers. Sustainable development implies self-reliance and should mainly involve people at the grassroot level. It is important to find out the optimum interaction between the local people and external agents. While it is generally accepted that an integrated approach should be adopted in rural development, strategies need to be mapped out for both short and long term efforts. In the short term, given the present weak infrastructure of the rural areas, is it feasible to stress development of small and medium-scale industries which require concentration of labour in small towns, not too far from the homes and, therefore, not enforcing migration? What industries can meet this criterion, and how can they be promoted? How can raw materials, e.g., agricultural products be used locally in a profitable way? What are the types of people's organizations needed? In the long term, strategies may be needed for self-development of villages based on low-cost agricultural and cottage technologies. Prerequisites for this would include the existence of an effective irrigation system, supply of energy and other inputs, an extensive credit system, and other components of a healthy infrastructure. What are the factors and criteria which make these strategies successful?

## 7. SCIENCE AND TECHNOLOGY DEVELOPMENT

A constantly recurring issue in discussion on new directions for development research is acquisition of new knowledge and technical expertise, or transfer and adaptation of technology from abroad. In order to be able to do so, there must be an endogenous capability in science and technology and in applying them for development. Strengthening of scientific and technological capability is a long-term process requiring continuous commitment from the government, yet yielding little immediate political benefit. It is not surprising therefore that, with the exception of only a few countries like South Korea, science and technology development has been relatively neglected in the developing countries.

Adding to this drawback are the popular notions that science and technology are alien to the cultures of the South, and that because of their complexity they are best left to the scientists and technologists themselves. Recent trends have, however, indicated an increasing understanding in Southeast Asia of the primary role of science and technology in the development process. The Fifth National Plan for Economic and Social Development of Thailand, for example, devoted a chapter to this issue. Restructuring of science and technology in the Philippines, resulting in the formation of a National Science and Technology Authority is another example. It is important that the support for science and technology development gathers momentum, and that it does so in an appropriate direction. Agencies like IDRC can support some of the crucial efforts which are needed.

#### 7.1 Science and Technology Policy and Management

The role of policy and management is all the more important for developing countries, which have limited resources in science and technology and cannot afford to build and use them in a haphazard fashion. Most developing countries have National Research Councils, Ministries of Science and Technology, or similar authorities which deal with such important issues as budgets for research and development, running science and technology information systems, regulating technology transfer, and planning of scientific and technical manpower. Yet very few of those in charge are well versed in policy and management in science and technology. As a result, inappropriate or non-existent policy, accompanied by mismanagement, ruins what little support is obtained for science and technology. Training in policy and management for those concerned appears to be very important in ensuring that resources for science and technology are appropriately allocated and used, and that development of science and technology proceeds in appropriate directions. The developed countries can have a large role to play in this effort, although it must be realized that their preoccupation with "big science" means that developing countries can learn from them only in a discriminate fashion.

## 7.2 Technology Transfer : Adaptation and Diffusion

- Large payments are made by developing countries to transnational and other corporations as royalty fees, licensing fees and fees for various forms of technology transfer. Many Southeast Asian countries have no policy for regulation of technology transfer, nor an agency to advise the buyers against unfair restrictive practices, or to ensure that the buyers obtain the most suitable technology at the appropriate prices. Technology Transfer Centres have been set up in some Southeast Asian countries, but they still lack the expertise and, more importantly, relevant information on the technologies to be transferred under their supervision. IDRC, with its original interest in information systems, can help these countries with the setting up of technology data banks in particular, and of technology transfer centres in general.

Technology transfer cannot be viewed as a complete process, but one which should normally be followed by adaptation to suit the particular conditions and needs within the country. Large private companies can go through this process by themselves, but small and medium companies lack the capability to do so. There is a need for selected research institutions or universities to become centres for digestion and adaptation of imported technologies of benefit primarily to the small and medium companies. Examples for such technologies vary from food extrusion technology to processing of precious stones. The centres can enter into contract with private firms, or develop the technologies on a joint venture basis. Support from the government and external sources may be needed, especially at the beginning of the programme, in order to acquire the machineries and build up the expertise needed.



### 7.3 Technology Forecast and Assessment

This important area is virtually unknown in many developing countries. Yet their future is very much dependent on the technologies which will assume significance in the future, both in satisfying the local market and in successfully competing in the export market. Many developing countries still have no patent laws, and those which do have only just started. Forecast and assessment of technology of importance to the developing countries based on patents analysis within the countries themselves is, therefore, virtually impossible, and multiple indicators as yet poorly defined need to be developed. This area can benefit greatly from the contribution of international experts with experience of forecast and assessment from OECD countries or others, who can turn their interest on this problem to the developing countries. More importantly, the developing countries themselves must build up an expertise in this area, so that future planning will not be entirely based on guesswork.

Even in the absence of detailed analysis, it is possible to identify broad priority areas of science and technology for the future based on development implications relevant to and appropriate for the Southeast Asian countries. There are many criteria to consider. Is the priority area consistent with the existing and future natural resources that could be developed? Do we have the human resources capacity to initiate and start the programme going? Will we have a critical size of scientists, technologists and engineers? Will the priority area so developed raise the quality of life for the poorest of the poor? Can we form a network of cooperation among developing countries in Southeast Asia and, as well as with other technologically developed countries? Does the benefit of such a technologically developed priority area reach the mass? Do we have a cutting-edge advantage over some other countries in choosing the priority areas? Do we have economic and social pay-off enough to undertake research and development in these particular areas? Is such development consistent with our culture and in harmony with our environment? We can ask a hundred more relevant questions.

These questions have to be answered in very simple terms but on a sound scientific and technical basis. In addition, some of the development projects would have to be both economically feasible and commercially viable and competitive to the world market. Only when these answers are clear and easily understandable, will political leaders, policy and decision makers make decisions. Then the planners and managers can play their roles in the implementation of the application of science and technology for development.

#### 7.4 Acquisition of Capability in Emerging Areas of Science and Technology

Science and technology are not static activities, but continuously progressive, building on past achievements so that new advances tend to be made in an accelerated manner. New areas are emerging, with their applications gaining ever wider scope, while old areas become "classical", serving mainly as foundation stones while their applications become outmoded. It is important for the developing countries to realize the significance of emerging areas, and build up their capabilities so as to gain optimum benefit from them, while making sure not to repeat the mistakes made by the early pioneers in the North. At least the acquisition of this capability will ensure against overwhelming technological dependency so familiar in the past. The opportunity cost for neglecting some emerging areas in science and technology may well be too high to afford.

In the decision to choose certain emerging areas of science and technology for building up of capability, the developing countries should apply appropriate criteria as discussed in Section 7.3 above.

With these above-mentioned criteria in mind, we can now try to choose emerging priority areas for science and technology that have relevance for development. A few examples will be given as an illustration.

First, the countries of Southeast Asia have long coast lines and with great experience in utilizing marine resources both physical and biological up to a point where in some cases over-exploitation has overtaken the natural ecology. Marine resources development and management would, therefore, be a most appropriate first priority. In this particular area of priority for biological resources, the entire chain of studies and research from marine biology, ecology, farming, etc. to the packaging and delivery of products to the consumers should be considered. Similar studies could be considered for physical non-renewable resources.

Second, the Southeast Asian region has been blessed with tropical humid climate where there are plethora of biological species. These species do breed and crossbreed naturally over billions of years under various conditions. With recent advances in science in molecular biology and genetic engineering, biotechnology could be a flourishing field of studies. The implications and the application of biotechnology for agriculture and food production, and health and medicine are unimaginable.

Third, like it or not, wherever one lives in the present age and the future world, one is confronted with a myriad bits of information. We must acquire them, digest or process them and utilize them for our own benefit to adjust ourselves so that we can lead happy and contented lives. In Alvin Toffler's articulate presentation,<sup>(14)</sup> he said our present civilization is now confronted with the third wave of global revolution, the information revolution. Those who have more information and who can process, retrieve and utilize information are in a better and more advantageous position than those who have less. Information is a kind of resource, but quite a unique resource.<sup>(15)</sup> Information is expandable, compressible, substitutable, transportable, diffusive, sharable. Timely information is worth a million, but just a few seconds late, it is worthless.

A machine that acquires, accumulates, stores and processes information according to our instruction is a computer. It can perform many fast miracles. The applications of a computer are manifold. Remote sensing of electromagnetic waves emitted or reflected from the earth by an artificial satellite, utilizing a computer for processing this electromagnetic information can yield information such as earth-map pictures of different colors about cropping, forest depletion, mineral resources, etc. Such an application, as well as many many more can yield information about ecology or ocean current flow.

#### 7.5 Development of Manpower and Institutions in Science and Technology

Although a part of the overall programme in development of manpower discussed in Sections 3 and 4, this area deserves additional mention in view of the special importance in development of science and technology. Building up scientific and technical manpower is costly and time-consuming, hence requiring careful planning and a long-term commitment. Projections of manpower supply and requirement are fraught with gross assumptions and uncertainties, but the need for making these projections to the best accuracy, with alternative models for policy decision, still has to be fulfilled. Action plans for scientific and technical manpower development can then be elaborated.

Building up of scientific and technological institutions should consist in strengthening of both education and research and development aspects. The support can range from giving grants-in-aid to specific research proposals to infrastructural strengthening, such as support of graduate programmes in specific fields, workshops, symposia and other activities contributing to the "atmosphere" of the institutions. Great care should be taken, however, not to spread the support over too many areas, so that the momentum is lost by the sheer scope of the programme. A most important criterion is that there must be at least a core group of capable personnel to carry out the programme successfully.

## 7.6 Scientific and Technical Services

Any scientific and technological activities cannot be successful unless they have adequate supporting services. These range from routine maintenance of instruments, to analytical services and supply of scientific and technological information. At present, few people with budgetary control in the developing countries appreciate the importance of these supporting services. Hence the ridiculous situation often arises, in which it is easier to obtain the budget for purchase of new equipment than for repairing old ones. Agencies like IDRC cannot be expected to support routine service activities of institutions in developing countries, but they can initiate establishment of, say, a central pool of technical expertise for specific services. Chemical microanalysis service is one example, maintenance of electronic scientific equipment another example. These service centres can be initiated at an institution with good potential, and can provide countrywide service on a contract basis.

The need for relevant and up-to-date scientific and technological information cannot be over-emphasized. Paradoxically, it is easier to obtain information from the developed countries, through journals, technical reports and other channels of communication, than from the developing countries themselves. This is partly explained by the absence of secondary and tertiary publication services in the developing countries. Some countries, such as Thailand, have planned to establish the National Scientific and Technological Information Centre, concentrating on obtaining and processing endogenous information for further use, as well as linking up with international networks. However, such plans are only at a rudimentary stage and require external support for realization. This aspect of service is closely related to the establishment of technology data bank and can be jointly implemented.

## 8. ORGANIZATION OF RESEARCH SYSTEM AND THE ROLES OF EXTERNAL AGENCIES

Over the past few decades in Southeast Asia, particularly in the ASEAN countries, research and development research have made considerable progress as a result of increasing familiarity with the methods and practices imparted through study and training in Western universities. Local conditions in a developing country, however, impose certain constraints and limitations on the conduct of research in a largely bureaucratic setting, as universities and research institutions are usually state-owned. The comparative lack of dialogue between the implementors, policy-makers and researchers may have caused the over production of fragmentary researches which may have served as good academic exercises but have had little relevant impact to the solution of urgent development problems. In Thailand, in education research, relatively inefficient administration of academic research fails to make optimum use of the potentially large research manpower in the universities. This could have been used to supplement the efforts of ministerial agencies, in promoting applied research to meet the needs of education planning and administration.<sup>(16)</sup> The same can be said in other fields of development research. However, recently universities and development planning agencies have had more interaction through various seminars and conferences. In addition, there are now on university councils a few members from planning agencies, and on the boards of planning agencies, there also are a few researchers and professors from the universities.

Overall in Southeast Asia, it can be said that there are four types of institutions carrying out research related to development. These are universities, government operating agencies, planning agencies and external agencies. Each type has a different focus for its research. They many times compliment each other, particularly when there is a definite jointly planned programme. The role of external agencies in stimulating the joint research and development project/programme is quite critical. One example is the "school mapping" or local education planning project carried out in Thailand

over the past few years where the planning agencies and the National Education Commission took the lead in working closely with the Office of National Primary Education and its Provincial Offices. Both agencies invited a few professors from Chulalongkorn University's Faculty of Education to carry out research and training tasks. The project was stimulated by the International Institute for Education Planning. Partial financial support was given by IDRC and the World Bank. Let us now proceed to describe some characteristics of different types of research in the four types of institutions. Furthermore, there have recently been information centres appearing on the scene to support development-oriented research.

### 8.1 Universities

In the faculty and departmental units, research tends to be disciplinary-oriented and in general quite fragmented. Some examples of research in education are the teaching learning process, the psychology of learning, counseling and guidance, the administration of students affairs. These research topics are generally of the internal efficiency type. Support of research of this type could be left to appropriate academic support agencies. Agencies dealing with development research should focus only on those fundamental research problems that have potential for better understanding with linkage to development, e.g. support to genetic research that provides the link to health problems or industrial developing problems.

However, in the interdisciplinary research institutes, such as a population institute, an environmental institute and social science research institute or the Asian Institute of Technology, research topics tend to be development-oriented. Many of these institutes are beginning to receive contract research from the government and private enterprises. Some of the examples are the subsidence of Bangkok, provincial planning methodology, regional water resources development. This type of research should be supported by external development agencies.

## 8.2 Planning Agencies

In Southeast Asian countries, there are usually planning agencies in health, education and economics at the national level. These agencies, today, have reasonably viable research units. Many times they also give research grants as well as contract out research or commission research to various universities and well-known professors and researchers. Research here is usually policy-oriented. Sometimes these research units work closely with implementing agencies in carrying out pilot projects for experimentation. Examples of these are: in Thailand, the National Education Commission, the National Economic and Social Development Board, and the planned Technical Development Institute; in Indonesia, BP3K, BAPPENAS; in Malaysia, the Planning Unit of the Ministry of Education, etc. External agencies can play a vital role in strengthening the capacity for research in these agencies.

## 8.3 Government Operating Agencies

Research in these agencies tends to be for administration purposes. Facts and figures with some simple analysis are usually required for the purpose of budget requests and annual operational planning. Only in a few cases is evaluation type research carried out as a requirement to satisfy conditions imposed by an external lending agency, although this type of research if carefully planned could be utilized to monitor for improvement of the implementation process. An external agency can play an important role in such a process.

## 8.4 External Agencies

External agencies such as IDRC, the International Council for Educational Development (ICED), the International Institute for Education Planning (IIEP), the World Bank, etc. do carry out valuable comparative research concerning development. Many of these activities have been carried out jointly by researchers of the external agencies



with researchers from developing countries. The results, viewed from the social and cultural contexts by developing country researchers, are extremely useful for policy-makers. Joint research efforts such as these should be further supported. In addition, these agencies can assist in triggering and catalyzing the interests of the first three types of institutes to form networks within the developing country and among countries in the region. The network to be discussed in detail later in section 9.2 could provide a forum for sharing of experiences and for bringing research, policy formulation, planning and implementation closer together.

### 8.5 Information Centres

During the last decade, science and technology and the information they generate, have undergone a "snowballing" process which is still continuing at an even greater pace. This has created an entirely new situation for users and for providers of information, both confronted by huge masses of information they cannot ignore but find increasingly difficult to control. Consequently a far reaching information revolution has taken place, completely changing the methods and thus enabling efficient access to information, which today implies the utilization of new technologies of telecommunication, and the setting up of specialized centres and networks for the sharing of resources and of tasks.<sup>(17)</sup> Support of such tasks and centres, as well as access to professional know-how, are essential for development and development research.

## 9. STRATEGIES FOR DEVELOPMENT RESEARCH SUPPORT : FUTURE ORIENTATIONS

Since development is location, temporal and cultural specific, it is necessary to nurture indigenous capacity for research. The main aim of an external development research agency should, consequently, be to further strengthen this capacity particularly in research related to policy, and to help bring research closer to planning and implementation

of the results suggested by research. Some examples of these types of research are: research related to policy issues, research related to attitudinal change, technology impact studies, feasibility studies, case and comparative studies, monitoring and evaluative research on innovation and reform, cost studies and financing, factors promoting and inhibiting the mobilization of resources, social service related to educational, rural, urban and technology development, etc.

In addition to the consideration of the types and the substantive content areas of priorities for research that should be supported one should be careful about the question "how". How is the research to be supported? Over the past two decades, external development agencies usually assisted developing countries in specific projects by utilizing various modalities of support. Some are in-kind and some in-cash grants. These modalities are, for examples, training, expert services, seminars and conferences, exchange of information, etc. Discussions on these various modalities have been well documented and well-known to those involved in development and will not be discussed here.

Recently, as developing countries gain in experience and there are more capable and a greater number of researchers and planners, new avenues of support seem to be emerging and will play a vital role in the future. These are programme support and network support. Both will be discussed here.

### 9.1 Programme vs. Project Support<sup>(18)</sup>

In the project approach, support in kind and in cash are provided to implement a specific project. The project may be a development project, research project or development project containing a research component. The project may be identified by either the donor agency or the host country. Normally, the donor publicizes that funds will be available for projects in a specific area. The agency then solicits project proposals and decides to fund those deemed to be most

attractive from the perspective of the donor agency and its professional staff. The programme support approach involves a mechanism quite different from that described above. This strategy involves the allocation of a lump sum grant to an agency or organization involved in development. Usually the donor agency specifies broad guidelines with respect to the types of expenditures for which the funds can be used. For example, it may be used for research, local training, overseas' training, seminars and conferences, publications, etc. The actual projects and activities to be supported, however, are determined by the host country nationals. The foreign donor agency is not involved in the decision-making related to specific project selection. All decision related to allocation of the programme support funds are made by nationals of the particular developing nation in question. Actually, some donor agencies use both approaches.

Probably the most persuasive reason for project support, from the point of view of a donor agency, is the accountability to their legislative bodies or boards approving the foreign aid appropriations, since a project is better defined than general programme funding. In addition, it is always claimed by donor agencies that they can best define areas of project support since they have more technical expertise than the local people. Though many donor agencies have excellent and well-trained staff, it is doubtful that they know local needs better than the host country nationals.

A third assumption is that local agencies lack staff capacity to make sound decisions with regard to the allocation of foreign assistance funds. This may have been true in the past, but not now. Related to the third assumption is the concern about corruption in the bureaucracies of the host country. A final assumption is that certain problems or areas of activities are of universal importance in all developing countries. With this assumption, it is easy for a donor agency to establish logically consistent packages that have intellectual appeal. It is satisfying and reassuring to know that activities in country [x] are consistent with and related to those in country [y]. Given these various reasons and assumptions, it is easy to see why the project support approach has tended to dominate foreign assistance.

There are many weaknesses in the project support approach.

First is the high overhead cost. Given the widespread inflationary trends, the management costs of providing foreign assistance tend to spiral, since the professional staff of donor agencies have very high salaries and emoluments in comparison with local professional of similar capabilities.

Second is the ignorance of local needs. It is difficult for even well-trained development professionals of donor agencies to know local needs and priorities. Also such needs and priorities may frequently shift or change, depending on local conditions. There is also a tendency for professionals of donor agencies to promote projects consistent with their own academic training and experience, rather than those activities most needed by the host country.

The third weakness is the distortion of professional activities in developing countries. Donor agencies usually publicize the types of projects for which external funds are available. Professionals in developing countries then submit proposals to compete for such funds. Unfortunately, this may lead to serious distortion. Third World economists, for example, may view reform of small scale irrigation as a major areas of concern, but instead shift their professional interests to problems of women or satellites or television education, following the availability of donor funds in these areas.

Fourth is the creation of negative attitudes towards donor countries. As the pool of well-trained professionals in developing countries has grown, there has been increasing frustration with the tendency for donor agencies to impose their own agenda on developing nations.

Fifth is the creation of skepticism about the ultimate purpose of foreign assistance. Since the donor agency decides which project to support there is an assumption that benefits involved will accrue

primarily to the donor country. This is particularly acute in the selection of research areas. Developing country researchers may feel that they are conducting research to serve the needs of the donors, and not to the benefit of their own countries.

General programme support is a challenge for the coming decades. As tensions between the North and the South grow and are likely to be more intense, approaches and methods suitable to the 50's, 60's and 70's are no longer appropriate.

In the past decades, many donor agencies strongly encouraged developing countries to decentralize their public management systems so as to be more responsive to local needs. Now the time has arrived when the donor agencies themselves should likewise modify their own management systems to make them more responsive to the developing countries needs. If a donor agency does not have sufficient trust to provide several types of programme support to a government, then perhaps it should not be involved with that particular government at all.

By emphasizing the programme support approach, donor agencies can: 1) reduce overhead costs, 2) better respond to local needs and priorities, 3) avoid distorting professionals' use of time in developing countries, 4) create a more positive attitude toward donor governments and agencies, and 5) show that assistance is genuinely intended to benefit the governments and its people concerned.

## 9.2 Network Support

Over the past two decades, there have been closer cooperation among nations, organizations, and individual researchers. Examples are the Southeast Asian Ministers of Education Organization (SEAMEO), the Southeast Asian Fisheries Development Centre (SEAFDEC), the Regional

Institute of Higher Education and Development (RIHED), the UNESCO Regional Office for Education in Asia and Pacific (ROEAP) and the UNESCO Regional Office for Science in Southeast Asia. In addition, there are permanent committees for various activities of common concern of ASEAN (Association of Southeast Asian Nations). These organizations do form networks among developing nations as well as between developing and industrially developed nations. The network is based on the concept that developing countries can learn from the sharing of each other's experiences just as much, or sometimes more than learning from industrially developed countries. When we were students, we remembered that we learned from each other just as much, or sometimes more than we learned from our teachers.

In education research, there was a clear in-depth case study articulately presented by an IDRC staff member.<sup>(19)</sup> He concluded from the studies that, in general, institutionalized research in the Third World is: new, growing rapidly, under-financed, uncoordinated, fragile, still dominated by a tradition of psychopedagogical research, unable to train locally the next generation, subject to international fads, dependent on First World concepts and methodologies, and living on its potential. With a few exceptions, growth is tied to foreign assistance and often to key individuals within the country or a region. Direct, informal contacts are quite important for diffusing research. In Southeast Asia, many countries have gone further ahead and some are lagging a little behind.

It has been suggested that networks or connections of three kinds be further strengthened and supported. The first kind is connecting the worlds of research: the First and the Third Worlds; second, connection within the Third World; and third, connections between education researchers and social scientists. There are many ways of forming connections. A network is one of the ways; a consultative group is another.

### 9.3 A New Orientation

Development and development research assistance programmes in the past have often failed to meet their intended high expectations. This in turn has led to a serious questioning of funding for development assistance. Hopefully, it is not too late to try new approaches which take into new account the greatly improved human resources capacities and creativity existing in developing countries. A new orientation is essential if foreign assistance for development is to be optimally effective. With emphasis on general programme support and network support, donor agencies can show their genuine sincerity towards improving the human condition and eliminating out-moded forms of paternalism and dependency.

## 10. CONCLUSION

In reflection, it is recalled that in the Eastern concept, the purpose of living and learning is not to exploit nature or to overpower it, but to understand, appreciate, love and also live in harmony with nature. That, to many, may seem to be the key to the future guidelines for the goal of science and research. Looking to the future, science and technology, which are the instruments for development, should serve to prepare all of us to cope with basic problems and issues relating to man and his environment.

Man must learn to live peacefully with other human beings, with society and its cultural heritage, and with nature. The foregoing implies that we must learn the problems and issues of health care, preventive and curative; food and agriculture; clothing and housing; land and water; energy; science, technology and society.

Science, technology and development which concern the life and living of all people should be made accessible to all; for in the long run we will never be able to solve any of the individual, national, regional or global problems if only some children and some people learn how to live in harmony with nature and society, while others are neglected to remain ignorant and to lead their lives in vacuum without direction.

Reflecting over a slightly different but related dimension, over learning from the varying cultural heritages, the concern of the misdirection of the application of science and technology for development, the domination or sharing of ideas and resources, and over the successes and shortcomings of past cooperation in research and development, it is the learning from each other which is relevant. It is not just the content, but much more the mode of cooperation that matters. The crux is the style of cooperation.

If the goal of development is development in harmony with culture and environment and if learning from each other in sharing of information and knowledge is essential, then our wisdom tells us that cooperation as co-equals is the key to the future guidelines of development. (20)

#### 11. ACKNOWLEDGEMENTS

We wish to acknowledge with appreciation the stimulation and encouragement by Dr. Jingjai Hanchanlash, Director of the Asia Regional Office of IDRC, without whose support this paper would not have been materialized. Appreciations are also extended to Mrs. Emilie Ketudat for critical comments and suggestions, and to Mrs. Yupa Soodjitporn for typing the final version of the manuscript.

---



12. REFERENCE

- (1) Sippanondha KETUDAT, "Science and Technology in Harmony with Culture and Environment", Journal of the Science Society of Thailand, Vol. 9, No. 2, pp. 59-62, 1983.
- (2) John S. MAYO, "A Global Force for Peaceful Change", Economic Impact, Vol. 42, pp. 21-28, 1983.
- (3) Education for Life and Society : A Report of the Committee for Establishing the Framework for Educational Reform, The Office of the National Education Commission, 1974.
- (4) Sippanondha KETUDAT, "The Relations between Research, Planning, Decision Making and Implementation : The Thai Experience in Primary Education Reform", Paper presented for discussion at the Research Seminar on "The Prospects of Education Planning Related to Contemporary Development Problems", convened by the International Institute for Education Planning, Paris, 3-8 October 1983.
- (5) Gerald W. FRY and Rung KAEWDAENG, "Budgeting for Greater Equity : A Normative Regression Analysis", International Journal of Policy Analysis and Information System, Vol. 6, No. 2, pp. 115-131, 1982.
- (6) Bikas SANYAL, Waldo PERFECTO and Adriano A. ARCELO, Higher Education and the Labour Market in the Philippines, UNESCO/PARIS, Wiley Eastern Ltd., 1981.
- (7) Claud TIBI, International Institute for Education Planning, Paris (to be published 1983-84).
- (8) Earnesto SCHIEFELBEIN, Educational Financing in Developing Countries : Research Findings and Contemporary Issues, IDRC-TS38C, 1983.

- (9) Sippanondha KETUDAT and Gerald W. FRY, 'Relations between Educational Research Policy, Planning and Implementation : The Thai Experience', International Review of Education, Vol. 27, pp. 141-152, 1981.
- (10) National Economic and Social Development Board, The Fifth National Economic and Social Development Plan (1982-1986), The Office of the Prime Minister, Bangkok, Thailand, pp. 211-213, 1981.
- (11) National Education Commission, National Youth Promotion and Coordination Committee, Perspective Policies and Planning for the Development of Youth, Office of the Prime Minister, Bangkok, Thailand, p. 4, 1981.
- (12) M. HIBLER, "IDRC's Approach to Science and Technology for Development", Science, Vol. 209, pp. 362-367, 1980.
- (13) R.M. BELL, "Approaches to National Science Policy", ASEAN-EEC Seminar on Science and Technology Indicators and Science Policy, Royal Society, London, June 13-17, 1983.
- (14) Alvin TOEFFLER, The Third Wave, Bantam Books Inc., U.S.A., 1980.
- (15) Harland CLEVELAND, "Information as a Resource", An address to the Fourth General Assembly of the World Future Society on "Communication and the Future", Washington D.C., July 19, 1982.
- (16) Patya SAIHOO, Supang CHANTAVANICH and Utumporn THONGUTAI, Research Environmental Study : Thailand, Office of the National Education Commission, Bangkok, Thailand, July 1982.
- (17) Jacques VALLS, Information Services for Developing Countries, Library and Regional Documentation Center, Asian Institute of Technology, Bangkok, Thailand, 1983.

(18) Summarized from private discussion between Sippanondha KETUDAT and Gerald W. FRY.

(19) Robert G. MYERS, Connecting Worlds, IDRC-T535C, IDRC, 1981.

(20) Sippanondha KETUDAT, "The Roles of Culture and Scientific Cooperation", Universitas, Vol. 25, No. 2, pp. 127-134, Franz Steiner Verlag GmbH, Federal Republic of Germany, 1983.