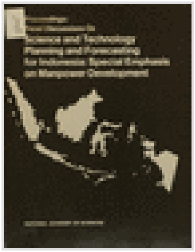

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Panel Discussions on Science and Technology Planning and Forecasting for Indonesia: Special Emphasis on Manpower Development

Jakarta, Indonesia
November 8-10, 1982

Jointly sponsored by

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PREFACE

The continuing economic growth of Indonesia is leading to increasing demands on science and technology. The country's future development will depend heavily on its ability to use science and technology effectively to make the best use of its natural resources. This task will be undertaken by broadening the scope of human activities and raising the quality of Indonesia's human resources. A better quality of life for the majority of the Indonesian people can only be realized through accelerated growth with equity.

Growth and growth rates cannot be viewed separately from the direction of growth and pattern of development within the broad social context. Development policies must, therefore, be directed toward fulfilling basic human needs, thus accelerating the growth process. The structure of production and utilization of productive resources must be arranged or rearranged with the above priorities in mind.

One of the roles of research, science, and technology is to promote value-added processes and the creation of jobs through industrial development. With the benefit of science and technology, much progress has already been made during the first three 5-year development plans (REPELITAs).

During the first 5-year development plan (1969-1974), emphasis was placed on the agricultural sector and its supporting industries. The second 5-year plan (1974-1979) again emphasized the agricultural sector while promoting industries that processed raw materials. The current 5-year plan (1979-1984) also emphasizes the agricultural sector and self-sufficiency in food while continuing to promote raw material processing industries. The fourth 5-year plan (1984-1989) will stress the agricultural sector in continuing efforts to achieve self-sufficiency in this area, while promoting industries that produce industrial machinery for light and heavy industries, both of which will be further developed in the subsequent 5-year plan.

These development goals pose a challenge to Indonesia: how to produce the large numbers of trained personnel required for programs designed to meet these goals. According to B. J. Habibie, Minister of State for Research and Technology, approximately 70,000 engineers, 21,000 scientists, 26,000 agriculturists, 11,000 accountants, 16,000 economists, and 337,000 administrators and managers will be needed by the year 1990. In the energy sector alone, more than 5,000 engineers, scientists, and technicians will be needed by 1985.

Achieving these levels of manpower development will be difficult. Indonesia must increase significantly its output of trained personnel and improve the quality of their training within severe constraints on time and resources. This problem can only be solved by making maximum use of existing manpower and institutional mechanisms, by creating new institutions where necessary, and by using the most suitable training technologies, both old and new.

PURPOSE OF PANEL DISCUSSIONS

To examine these problems and needs, officials of the Ministry of State for Research and Technology and the Indonesian Institute of Sciences (LIPI) and staff of the Board on Science and Technology for International Development (BOSTID) of the U.S. National Research Council (NRC) selected the topic, "Science and Technology Planning and Forecasting for Indonesia: Special Emphasis on Manpower Development," for discussions that were held in Jakarta, November 8-10, 1982. (See Appendix A for the agenda of these discussions and Appendix B for a list of participants.)

These discussions were but one of a series of activities in a program of cooperation between BOSTID and the Indonesian government. Begun in 1968, a series of workshops have focused on food policy, industrial and technological research, natural resources, and rural productivity. The Indonesian Institute of Sciences and the Ministry of State for Research and Technology invited the Board on Science and Technology for International Development to jointly sponsor the meeting and provide a counterpart group of specialists from the United States. BOSTID participation was made possible through a cooperative project sponsored by a science and technology loan program from the U.S. Agency for International Development to the government of Indonesia. As part of the program two or three activities are held each year such as panel discussions, workshops, seminars, or provision of small advisory groups.

At the opening plenary session, participants were welcomed to Indonesia by Sukadji Ranuwihardjo, assistant to the Minister of State for Research and Technology. H. Tb. Bachtiar Rifai, chairman of LIPI, informed participants that the main purpose of the panel discussions was to recommend improvements in the process of planning science and technology in Indonesia (Appendix C). More specifically, steps should be identified for enhancing Indonesia's capacity for manpower planning, collecting the relevant data and analyzing relative strengths and weaknesses, determining science indicators and trends, and hence helping Indonesia establish near-term objectives and priorities. Walter A. Rosenblith, foreign secretary of the National Academy of Sciences, also addressed the plenary session (Appendix D).

Indonesian participants in the discussions then described three aspects of Indonesian science and technology management: science and technology institutional policymaking, current planning of science and technology manpower development, and the science and technology education system (see Appendixes E, F, and G, respectively).

Participants were divided into four technical working groups on:

- Biotechnology and agro-industry
- Water and environment
- Industrial development and microelectronics
- Marine science and underwater technology.

These groups were asked to give special emphasis in their discussions to government policies and institutional needs, educational needs and mechanisms, manpower planning, R&D management and planning, transfer of technology, and linkages between universities, research institutions, and industry.

The working groups met for a full day following the first day's plenary discussions. On the third day, the working group chairmen read the recommendations and conclusions that emerged from their groups at a plenary session and solicited comments from the other participants. These comments, as well as comments and suggestions made during the subsequent cross-cutting plenary session, were taken into consideration in formulating the final conclusions and recommendations.

Detailed recommendations and conclusions are contained in the individual working group reports that follow. Additional recommendations that resulted from a final plenary session devoted to cross-cutting issues are included in the final chapter of this report.

ACKNOWLEDGMENTS

These panel discussions were jointly organized and sponsored by the Indonesian Institute of Sciences (LIPI), the Ministry of State for Research and Technology, and the U.S. National Research Council.

Participants would like to acknowledge the generous support of the U.S. Agency for International Development Mission, Indonesia, and they would particularly like to thank Jerome Bosken and his staff for their assistance. They also appreciate the valuable contribution of the workshop's secretariat, under the direction of Moertini Atmowidjojo, head of the Bureau of International Relations, LIPI.

CONTENTS

SUMMARY OF RECOMMENDATIONS AND CONCLUSIONS

GENERAL PLENARY

Within the next 5-year plan, Indonesia's development policy will require a dramatic expansion in scientific and technical manpower. Currently, there is no single government agency or department that seems capable of mobilizing society for this enormous task. In addition, there is a need to strengthen linkages between education, research, and the user community, as well as to increase scientific attitudes and consciousness.

- It is recommended that a National Council on Scientific and Technical Manpower and Training be formed, composed of representatives of all relevant government departments, industry, and the several levels and types of educational institutions. It would have the appropriate staff to gather and analyze manpower needs and trends in the context of development plans and institutional strengths and would provide a forum for broad-based input into policy and decision-making in this area.

- To link university training more directly to the needs of the nation and to production and management problems within industry, it is recommended that the following measures be considered:

    -- Create a system of Indonesian government grants to be made to university faculty on a long-term, project-by-project basis, enabling them to employ half-time graduate student assistants.

    -- Provide incentives for private business to fund university research and development.

    -- Supplement university budgets to provide extension services to users.

-- Establish institutional linkages through exchange programs with private companies, universities, and research centers in developed countries.

- Science is a human enterprise that, given an appropriate infrastructure, possesses an extraordinary degree of self-correction. The essential elements of this process seem to be open communication and critical peer review. It is suggested that an Indonesian Association for the Advancement of Science and Technology be established with sections corresponding to the fields of scientific and technical endeavor. Such an association may wish to publish a peer-reviewed journal.

- There is a clear-cut need to enhance the educational background and scientific awareness of the general population, even those who have not enjoyed a formal education, to increase their ability to adapt to technological innovations. It is recommended that steps be taken to improve science teaching at the primary and secondary levels and that consideration be given to using new forms of educational technology, such as television and other media, to provide scientific information to the general population. It is further recommended that the rapid expansion of primary and secondary education to a larger percentage of the population continue to be stressed. This provides the broader based educational pyramid of mathematically and scientifically literate workers needed by a technologically based industrial sector. This is necessary to attract and hold such industry, as well as to prevent highly trained engineers and scientists from migrating to other areas. It also gives a larger percentage of the population a stake in the benefits of science and technology, making the inevitable changes more acceptable and popular within Indonesia.

- The higher education system needs to increase rapidly the number of students and graduates in science and technology areas, but a major bottleneck appears to be a shortage of trained faculty. In the short term, the only answer may be using existing faculty more efficiently. Average ratios of students to faculty appear low by U.S. standards, as do average weekly teaching loads. There may be possibilities for increasing average class size and pruning curricula. If faculty are asked to assume heavier teaching loads and to devote more time to their institutions, it is recommended that a means be found for significantly increasing their salaries, perhaps by supplementation directly or indirectly. This may involve separating faculty salaries from the government scales by excluding faculty from the government civil service structure or providing differential salaries with higher remuneration in areas of manpower shortages. It is also recommended that the current system of ranks, promotion policies, and career development be generally reexamined with the goal of increasing incentives for productivity and merit.

BIOTECHNOLOGY AND AGRO-INDUSTRY

Biotechnology promises to have an important impact on Indonesian industry in the areas of agriculture, health care and pharmaceuticals, chemicals, and biomass conversion. This working group elected, however, to limit its discussions to food resources, with particular emphasis on productivity, nutrition, and postharvest technology. Biotechnologies relevant to the agro-industrial sector, so-called "agro-biotechnology," include tissue culture, clonal propagation, somaclonal genetic variation, protoplast technology, and recombinant DNA technology.

- It is recommended that special emphasis be placed on training manpower in agro-biotechnology and food technology and engineering.

Suggested modes of training include having individuals trained abroad; importing a full faculty to teach graduate courses at an Indonesian school; enrolling candidates abroad and having them return to Indonesia to undertake their research; inviting recently retired professors or scientists to Indonesia; establishing long-term, close cooperative agreements with sister universities in developed countries; and instituting sabbatical leave systems in Indonesian universities and research institutions to encourage study abroad.

- To facilitate the eventual development of agro-biotechnology industrial centers in Indonesia that will link industrial development with both new technologies and university talent, it is recommended that a Crop/Agro-biotechnology Industrial Center (CABIC) be established.

Ideally, such a center would maintain a direct association with an institution of higher learning; serve as a model for eventual replication in similar or related areas; and focus primarily on palm and soybean oil, striving initially to evolve new plant varieties for increased production, new approaches to disease and pest control, and new innovations in postharvest technology and processing.

- While a major long-term project to develop a "master plan" is not favored, it is recommended that some type of a "food resource development plan" be evolved for Indonesia.

This task would require assembling statistical data in order to upgrade the quality of information on plants, animals, processing, credit, and markets that is available to potential investors and to provide some assurance that courses of action being planned are consistent with the overall goals of the country.

WATER AND ENVIRONMENT

Water

Water is essential to economic development. In Indonesia, the management of water is now excessively fragmented administratively, resulting in inefficiencies and gaps in knowledge. Sufficient data to permit sound water balances are not available. Furthermore, there is a lack of capability in hydrology, particularly groundwater hydrology, and limnology.

- It is recommended that the following approaches to accelerating the provision of trained scientists, engineers, and administrators in Indonesia be considered:

  -- Utilize specialists from abroad through individual long- or short-term assignments to Indonesian institutions. Or, preferably, arrange for university-to-university affiliations in which faculty members from an institution abroad visit Indonesia.

  -- Send Indonesians to industrialized countries for S-III (Ph.D.) programs.

  -- Send Indonesians for coursework abroad but have them return to Indonesia for their fieldwork.

  -- Utilize high-quality personnel at Indonesian government and industrial laboratories to serve as adjunct professors and to conduct research of common interest.

  -- Arrange for Indonesian students to undertake their research at nearby government or industrial laboratories under the joint supervision of the university or educational institution.

  -- Conduct field research outside Java to address problems in rural areas and to stimulate research and education at institutions in these areas.

  -- Address research of joint interest to the centers for environmental studies located in 29 Indonesian universities.

- Whereas provision of water supplies and sanitation services for both urban and rural areas should continue to enjoy the highest priority, it is recommended that special emphasis be placed on distribution of water to the 135 million inhabitants of rural Indonesia.

- Because only a few R&D institutions are addressing the problems connected with community participation in water projects--and they are addressing the technical issues--it is recommended that far more attention be given to the behavioral and social sciences and to devising strategies that encourage communities to participate in water supply and sanitation programs.

- Often the equipment and support services readily available in the industrialized countries are not at hand in Indonesia. For this reason, and because Indonesia has a labor-intensive economy and is expected to have one for some years, it is recommended that the benefits of the transfer of technology from capital-intensive economies be thoroughly examined.

- In recognizing the importance of water to economic development and public health, it is recommended that a comprehensive water resources agency be established in Indonesia to address the wise use of this limited resource.

Environment

Indonesia is composed of 13,500 islands, each of which has unique environmental features. Understanding and wisely developing the Indonesian environment is thus a large and complicated task. Educational policy in Indonesia for environmental matters is centered around the 29 centers for environmental studies. These centers may not be as effective as they should be, however, because each is small.

- It is therefore recommended that steps be taken to encourage formation of consortia of centers with common interests and emphasis, perhaps designating one institution as the leading center for each consortium.

These consortia would prepare development plans that specify priorities and serve as a basis for long-term financial commitments so that qualified manpower can be trained or acquired and study programs of adequate depth developed.

Solutions to environmental problems, including those of manpower development, could be hastened through closer links between universities, government agencies, research institutions, and industry.

- It is recommended that such linkages be encouraged by government agency development of environmental technician training programs and by more use being made of an existing program whereby agency employees return to universities for postgraduate education.

- There is a clear need in addressing problems of environmental quality issues as well as of water pollution. Therefore it is recommended that a "watchdog" or regulatory environmental agency be established for this purpose that is, and is perceived to be, independent of other government agencies.

INDUSTRIAL DEVELOPMENT AND MICROELECTRONICS

Current revolutionary technological developments in microelectronics represent both opportunities and constraints for Indonesia's accelerating industrialization program. Dealing effectively with these will require substantial expansion of both education and research in the microelectronics field. There is no question but that Indonesia must rapidly develop its capacity to utilize microelectronic technology effectively in support of industrialization. Serious issues, however, must be addressed with respect to the desirability and productivity of manufacturing advanced microelectronic devices, equipment, and systems in the coming decade in-country in view of the capital-intensive character of such production, rapid obsolescence of technology, and intense competition among the industrialized countries. Until the latter issues have been resolved, the full implications of microelectronics for manpower development in the industrialization field cannot be reliably foreseen.

Even if Indonesia's near-term activities with respect to microelectronics are limited primarily to providing for effective utilization of these powerful tools in industry (and elsewhere in the economy and society), much can be done to augment what is surely an inadequate supply of trained manpower in this field.

- It is recommended that:

  -- For the next 3-5 years, education pilot programs in microelectronics be concentrated in no more than three universities adjacent to industrial centers, thus avoiding dilution of scarce human resources and subcritical, ineffective "diversification."

  -- University programs in microelectronics be kept relevant to industry's needs by establishing university-industry links, primarily through joint university-industry research programs and cooperative education schemes.

  -- R&D institutions (for example, LIPI) be used primarily for advanced development programs in utilization of microelectronics to serve defense, government, and industry.

  -- Priority be given to applications of microelectronics (as opposed to product development) and to development or adaptation of software.

-- Assistance from donors--bilateral and multilateral--be sought to bring faculty from abroad for 1- or 2-year assignments to strengthen a designated pilot university program in at least the formative years.

-- Continuing education programs in the universities be developed for graduates to keep them abreast of developments in this fast-moving technology.

-- To the greatest extent possible, students in secondary and even primary schools be exposed to concepts that will make them computer literate.

-- Formation of a computer techniques professional society be initiated, perhaps affiliated with the International Institute of Electrical Engineers.

MARINE SCIENCE AND UNDERWATER TECHNOLOGY

The Indonesian seas cover an area of over 5 million square kilometers. Presently, inadequate numbers of technically trained and skilled manpower are available to carry out research programs to develop and manage the renewable and nonrenewable marine resources. It is, therefore, imperative that manpower development in marine science and technology at all levels be planned and incorporated into Indonesia's overall national development plan. Three general approaches to meeting the manpower needs of this plan were identified:

- Direct technical assistance by foreign scientists and technicians
- External training of Indonesian scientists and technicians
- Internal training of Indonesian scientists and technicians.

Direct technical assistance by hiring a foreign scientist or technician provides an instantaneous, but ultimately temporary, solution to a manpower need. External training of Indonesian scientists and technicians requires 2-5 years, but native expertise results once the training period is complete. Internal training of Indonesian scientists and technicians can only be carried out effectively if the academic infrastructure is already fully developed. Since this solution is both permanent and signals full technological development, it is a worthy objective.

- Thus it is recommended that overall efforts to increase participation in general education, and thereby develop the academic infrastructure, be augmented and supported as the highest priority aspect of manpower development in Indonesia.

- The following priorities for marine science manpower development required to conduct the program currently planned for the 1984-1989 period are recommended:

Direct Technical Assistance

-- English language instruction, especially for those applying to study abroad, would increase the efficiency and decrease the frustration of Indonesian technicians and scientists participating in advanced technical courses taught in English.

-- Training opportunities in marine geology and geophysics and ocean engineering in two or more Indonesian institutions should be established to develop the manpower needed to assess the geological context and specific distribution of nonliving marine resources and to plan and assess coastal public works as well as offshore oil and gas structures.

-- Procedures should be established for developing coastal area management planning. Building up indigenous expertise through foreign training is a necessity.

External Training

-- The importance of marine science following completion of Law of the Sea negotiations requires that the scale of traditional external academic training for marine scientists be increased dramatically.

-- Foreign licensing of companies involved in extraction of Indonesian living and nonliving resources should be augmented to require a training component for marine technicians.

Internal Training

-- Existing mechanisms for advanced training could be used more effectively and upgraded if incentives for involving faculty and students conducting research were increased.

-- The curriculum of selected secondary schools or polytechnic institutes should be augmented to provide specific training for marine and fishery technicians. Alternatively, an S-0 (nondegree) training program for such technicians could be developed (see below).

-- Marine-oriented vocational training should be developed for secondary schools.

-- University programs should be augmented by developing a marine extension component similar to the agricultural extension systems used by U.S. land-grant colleges.

-- A 2-year college diploma program (or S-0 program) should be developed to emphasize marine science and technology. Such a program, similar to the one being developed in agriculture, could aim at attracting the sons and daughters of the over 1 million Indonesian families currently engaged in fisheries and sea-related activities.

WORKING GROUP REPORTS

BIOTECHNOLOGY AND AGRO-INDUSTRY

Biotechnology--defined here as the application of scientific and engineering principles in the form of biological agents to the processing of materials--promises to have an important impact on Indonesian industry in the areas of agriculture, health care and pharmaceuticals, chemicals, and biomass conversion. This working group elected, however, to limit its discussions to food resources, with particular emphasis on productivity, nutrition, and postharvest technology.*

Biotechnologies relevant to the agro-industrial sector, so-called "agro-biotechnology," include tissue culture, clonal propagation, somaclonal genetic variation, protoplast technology, and recombinant DNA technology--terms that merit further explanation.

Tissue culture involves growing cells in a test tube environment on a nutrient medium. It is possible to select breeding lines from plants regenerated from genetically modified cells grown in test tubes. Such selection could result in plants resistant to pesticides or herbicides, cereals that fix nitrogen, anti-leaking genes that improve nitrogen fixation, and crops with increased photosynthetic efficiency, salt tolerance, disease resistance, and improved horticultural traits. Agro-biotechnology techniques might also be applied to cellulose-eating yeast and bacteria, improved commercial yeast strains and fermentation technology to enhance the synthesis of food ingredients such as casein, antioxidants, antimicrobial agents, amino acids, pesticides, growth stimulants, and growth regulators.

In clonal propagation, tissue culture is used for the high-frequency production of plants. This technique allows the efficient cloning of plants difficult to propagate using conventional horticulture technology, as well as the efficient generation of unique breeding lines for development of new varieties. It is particularly relevant to the production of elite hybrids. In this regard, somaclonal genetic variation--the variability found in plants regenerated from tissue culture--also provides an opportunity for the rapid development of new breeding lines.

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*See Appendix H for a list of material provided to this working group.

Protoplast fusion involves the enzymatic digestion of cell walls which renders cells more receptive to chemical and physical manipulation. This is the most direct method of introducing genetic variability. A unique mixture of nuclear and cytoplasmic genes is obtained, which may segregate or recombine, resulting in a wide range of genetic combinations that are not possible using conventional hybridization. In a number of plant species, protoplasts can be regenerated into complete plants. When protoplasts are genetically altered, therefore, completely new crop varieties can be produced from genetically modified protoplasts. The most useful combinations could be isolated and incorporated into a breeding program.

Gene transfer via recombinant DNA. Recombinant DNA is a technology associated with the transfer of genes between organisms. Fragments of DNA are isolated from one organism, attached to a plasmid, and transferred to a second organism. Application of recombinant DNA technology offers the ability to transfer genes that control photosynthetic efficiency, photorespiration, transpiration, and nitrogen fixation, as well as the ability to transfer genes that regulate drought resistance, cold tolerance, salt tolerance, and efficient nutrient utilization, thereby permitting plant cells to grow in adverse climates. Techniques for the use of recombinant DNA to modify crop plants genetically are similar to those originally developed for use with bacteria. Gene transfer is accomplished by first identifying and isolating the gene desired for introduction into a crop plant. This gene is separated from the donor chromosome using restriction enzymes to fragment the donor DNA. The fragment containing the desired gene must then be recombined with a plasmid capable of entering the host plant cell. Upon entry, the plasmid containing the new DNA must undergo replication and gene expression to complete the introduction of a new gene product into a crop plant. The most frequently used plasmid (small circular DNA) for transfer of DNA to higher plants is the Ti-plasmid, which occurs naturally in the soil bacterium *Agrobacterium tumefaciens*.

Agro-biotechnology will be used as an adjunct to conventional plant breeding for development of special parent plants and for cloning crops unable to be efficiently propagated using conventional horticultural technologies/methodologies. Clonal propagation is presently being used on a commercial basis for palm, and it can be integrated immediately into a breeding and development program.

SCIENTIFIC AND TECHNOLOGICAL MANPOWER NEEDS

- It is recommended that special emphasis be placed on training manpower in agro-biotechnology and food technology and engineering. More specifically, this would require specialized training of plant breeders, fertilizer chemists, integrated pest management specialists, soil biologists, irrigation engineers, seed technologists, food chemists, food technologists, food engineers, agricultural engineers, resource economists, and nutritionists. Special training can be provided through linkages for work in plant cellular genetics (i.e., protoplast technology), somaclonal genetic variation, cytoplasmic genetics, cell culture technology and molecular microbiology (i.e., mutagenesis), recombinant DNA, and fermentation technology.

Suggested modes of training include having individuals trained abroad, importing a full faculty to teach at an Indonesian graduate school, and enrolling candidates abroad and having them return to Indonesia to undertake their research, using local problems and materials as their subject.

The possibility of inviting recently retired professors or scientists to Indonesia should also be explored. Several Indonesian scientists could act as counterparts to the visitors while they work in Indonesian educational establishments, thus allowing the Indonesians to receive training through apprenticeship. This system may improve the atmosphere for research within the universities, especially since it is felt that the approach to research work currently being performed in Indonesian universities is piecemeal and does not represent a coherent, continuous process.

Indonesian universities might also be strengthened through a long-term, close cooperative agreement with a sister university in a developed country, similar to the ones undertaken between the Agricultural University in Bogor (IPB) and the University of Wisconsin or the University of Sao Paulo in Brazil and Ohio State University. Exchange of faculties and facilities for graduate training are among the benefits of such scientific cooperation. Similarly, the introduction of a sabbatical leave system into the Indonesian university or research institution system may be another means of improving the scientific capability of Indonesian researchers.

Thus far, existing professional societies in Indonesia have successfully stimulated preparation of scientific papers for presentation at seminars or congresses organized by these associations for their members. They, therefore, represent important tools for boosting the development of science and technology. Moreover, they may function as a training ground for young scientists--they have certainly been useful in creating a healthy scientific atmosphere. The potential of professional societies should be explored further, especially in setting norms for good quality research. Private companies should be encouraged to support these societies.

AGRO-BIOTECHNOLOGY INDUSTRIAL CENTER

The establishment of agro-biotechnology industrial centers in Indonesia could be a means of linking industrial development with both new technologies and university talent for "input" and training.

- To facilitate this development, and to orient it to the needs, cultures, and societal imperatives of Indonesia, it is recommended that a Crop/Agro-biotechnology Industrial Center (CABIC) be established.

Ideally, such a center will maintain a direct association with an institution of higher learning and will serve as a model for eventual replication in similar or related areas or at other sites. This center will focus primarily on palm and soybean oil, striving initially to evolve new plant varieties for increased productivity, new approaches to disease and pest control, and new innovations in postharvest technology and processing. A number of the essential components for such an agro-biotechnology center are already established, including an Institute for Estate Crops, which is using plant tissue culture and plant pathology techniques, is examining plant protection, and has agronomic expertise. CABIC could pull these activities together for immediate business development and manpower training.

CABIC would consist essentially of approximately 2,000 hectares of land, located in reasonable proximity to existing palm plantations and soybean farms and a leading university. The land area would encompass a pilot plantation, a nursery, a biotechnology center, and a pilot processing facility. Such a center would likely have enormous training benefits and would serve not only as the basis for replication of agro-industries, but also as the base for socioeconomic studies and for the use of biotechnology techniques in the years ahead.

The professional staff would have appointments in the university and would be required to teach and supervise theses training at all levels, which would focus on technical problems relevant to agro-biotechnology industries. CABIC would provide students with an integrated understanding of high-technology agriculture and agro-biotechnology, as well as a "hands-on" approach to business development, all in an enhanced scientific and technological setting. CABIC would also nourish appropriate relationships with foreign universities for food science and engineering training, agro-biotechnology training and agro-industry management, as well as an appropriate relationship with biotechnology corporations for food and agricultural development.

FOOD RESOURCE DEVELOPMENT PLAN

- While a major long-term project to develop a "master plan" is not favored, it is recommended that some type of "food resource development plan" be evolved for Indonesia.

This task would require assembling statistical data in order to upgrade the quality of information on plants, animals, processing, credit, and markets that is available to potential investors, as well as to provide some assurance that courses of action being planned are consistent with the overall goals of the country. Such a plan may help build confidence in investors weighing investment opportunities in agro-biotechnology industries in Indonesia.

Agriculture will remain the central theme of development in Indonesia over the next decade, together with industry which is now being promoted. To realize its rich potential for agro-industrial development, Indonesia must evolve unique competitive advantages in the production of certain crops and specialized end-products. This will require a renewed focus on its unique resources for agricultural production and acknowledgment of the obstacles that must be faced in the form of sometimes adverse environmental conditions, pests, diseases, and water shortages. Indonesian needs should be recast as opportunities to produce food, feed, fiber, and agrochemicals in an agro-industrial setting, aided by the techniques of high-technology agriculture and biology that are now available.

WATER AND ENVIRONMENT

The Government of Indonesia has begun to make significant investments both in urban and rural water supplies, consistent with the United Nations Drinking Water Supply and Sanitation (DWSAS) Decade, and in the protection of the environment with the establishment of centers of environmental studies at 29 institutions of higher education throughout Indonesia. Continued implementation of these initiatives, however, will require the government to address several critical problems.

In its discussion of environmental and water policies in Indonesia, this working group considered four major priority areas: (1) basic human needs; (2) natural resources and environment; (3) industrialization; and (4) social, economic, and cultural factors, philosophy, and law.

WATER

Water is essential to economic development. In Indonesia, the management of water is now excessively fragmented administratively, resulting in inefficiencies and gaps in knowledge. Sufficient data to permit sound water balances are not available. Furthermore, there is a lack of capability in hydrology, particularly groundwater hydrology, and limnology.

To exploit its water resources effectively and to prevent their degradation, the Government of Indonesia needs to establish and implement policies that permit a continuing inventory of its resources. Additional meteorological and hydrological data must be gathered and evaluated. Baseline data must be fixed so that changes in water resources can be determined. For example, wells must be logged, and the extraction of groundwater must be regulated to prevent a permanent loss of this valuable resource.

Provision of water supplies and sanitation services for both urban and rural areas should continue to enjoy the highest priority, with special emphasis on distribution of water to the 135 million inhabitants of rural Indonesia. Much can be accomplished by promoting community participation in the initiation of projects.

Water is also important to industry; however, without a well-defined government policy, industry can be wasteful. Much of the industrial need can be satisfied by water of lower quality, thereby conserving limited resources of high-quality water for high-quality needs, such as drinking. Pricing policies can encourage the use of a hierarchy of water quality, including recycling and reuse of wastewaters.

The provision of additional energy supplies and development of new agricultural lands also depend heavily on the availability of water. Power is costly. It may be possible to provide low-cost hydropower in rural areas by the construction of small impoundments for water supply and irrigation. Soil-water problems, particularly in semiarid areas, require government attention if agriculture is to be developed in the less humid areas of Indonesia.

Because all pollution problems cannot be addressed simultaneously, monitoring of water quality must be instituted to permit the establishment of priorities for investment in treatment. Most important, because pollution abatement is far more costly after pollution has occurred, government policy should promote pollution control as economic development takes place.

In recognizing the importance of water to economic development and public health, consideration should be given to establishing a comprehensive water resources agency in Indonesia to address the wise use of this limited resource. Coordinating committees and councils, involving the many agencies with an interest in water, have been notoriously ineffective in the United States in resolving national and local water conflicts and promoting effective utilization of water.

Finally, because the scarcity of human resources in the water sector and in the educational and scientific institutions is so acute, as shown below, every attempt must be made to engage all public and private institutions in the effort to make optimum use of water resources in Indonesia.

Manpower Planning

Although the data on manpower in Indonesia are not precise, they do reveal a serious shortage of professional personnel at all levels. Over the next decade, a particularly large shortage of teachers in engineering, science, and administration/management is forecast. This lack of teachers ensures that this shortage will continue in the future.

High-quality engineers, scientists, and managers are in great demand inside and outside Indonesia. Attracting such individuals to Indonesian educational institutions demands that these institutions be able to compete for the highest quality personnel, and this in turn requires some changes in policy. Qualified job candidates must be given appropriate incentives such as research grants, study leaves, and market-level salaries on campus so that outside employment does not entice them away from their university responsibilities. Their major commitment must be to the university and its students. Every country with outstanding universities encourages its institutions to compete for the best students; Indonesia must do the same.

The Second National Workshop on the DWSAS Decade held in Bali in October 1982 found that the rural water supply program, intended to bring water and sanitation to 135 million people by 1990, would require about 135,000 trained people at all levels. Training them, as well as the personnel needed for urban water programs in Indonesia, is a mammoth task. In addition, Indonesia urgently needs certain specialists such as hydrologists and limnologists now, and other needs will surely develop as the program progresses.

Given the massive shortage of personnel at all levels described above and the difficulties in initiating education for the highest scholastic levels, it is clear that all institutions with a potential contribution to the educational process must be pressed into service and used to their fullest capacity. Expatriate organizations operating in Indonesia should be encouraged, if not required, to incorporate training of Indonesian nationals into their operations. Because the subprofessional level has been neglected, special efforts must be made to establish and strengthen polytechnics (in addition to what is currently being done with the World Bank loan), other technical-level training institutions, and the public school system. The availability of technicians will free the more highly trained individuals to conduct the professional-level work for which they were trained, including R&D.

The more prestigious and better staffed universities are on Java; better trained personnel are also needed for the outlying islands. Cooperative training and research programs between Javanese and other institutions with similar problems might be organized to address problems facing the outlying rural areas while at the same time enhancing their educational institutions.

- It is recommended that the following approaches to accelerating the provision of trained scientists, engineers, and administrators in Indonesia be considered:

  -- Utilize specialists from abroad through individual long-term or short-term assignments to Indonesian institutions. Or, preferably, arrange for university-to-university affiliations in which faculty members from an institution abroad visit Indonesia to provide the critical mass and to assist with several Indonesian scholars simultaneously, thereby creating the opportunity for a critical mass.

  -- Send Indonesians for S-III (Ph.D.) programs to industrialized countries. While this appears to be the most obvious approach, it may not be the most successful. Research programs might not be appropriate to Indonesia because of the considerable support services and equipment readily at hand in the industrialized world but not available in Indonesia. Furthermore, research topics may not be relevant. When these students return to Indonesia, they may lack a community of scholars with whom to interact and thus may soon find other challenges more rewarding.

The high value of their education will make them excellent targets for employment at other than Indonesian research or teaching institutions.

-- Send Indonesians for coursework abroad but have them return to Indonesia for their fieldwork. This would make their research more relevant but would not produce the number of trained personnel needed.

-- Utilize high-quality personnel at Indonesian government and industrial laboratories to serve as adjunct professors and to conduct research of common interest.

-- Arrange for Indonesian students to undertake their research at nearby government or industrial laboratories under the joint supervision of the university or educational institution.

-- Conduct field research outside Java to address problems in rural areas and to stimulate research and education at institutions in these areas.

-- Address research of joint interest to the centers for environmental studies (see below).

R&D Management and Planning

The major constraints to the provision of a water supply in Indonesia are not water technology or even money; rather, they are institutions and the personnel needed at all levels to staff them. The provision of a water supply requires that communities be informed of the benefits of water supply and sanitation projects and their active participation in these projects be sought. Communities must also be told which operating facilities as well as maintenance and extension services they are expected to provide.

- <u>Because only a few R&D institutions are addressing these problems, and they are all addressing the technical issues, it is recommended that far more attention be given to the behavioral and social sciences and to devising strategies that encourage communities to participate in water supply and sanitation programs</u>.

Research and development efforts in Indonesia should concentrate on applying the existing technology, which is already well developed, and adapting it to that country's social, cultural, economic, and technical conditions. Often, more ingenuity is required in Indonesia because the equipment and support services readily available in the industrialized countries are not at hand.

Transfer of Technology

- For the reasons mentioned above, and because Indonesia has a labor-intensive economy and is expected to have one for some years, it is recommended that the benefits of the transfer of technology from capital-intensive economies be examined thoroughly.

One of the best approaches to such a task is the participation of Indonesians in regional and international professional and scientific organizations and meetings. The most appropriate technology may be that developed in India, Thailand, Singapore, or other countries in the region. In time, however, Indonesia may well be the source of appropriate technology for other countries.

ENVIRONMENT

Indonesia is composed of 13,500 islands, each of which has unique environmental features. Understanding and wisely developing the Indonesian environment is thus a large and complicated task.

The Indonesian government has undertaken this task by establishing environmental studies programs in 29 Indonesian universities (Table 1) and specific environmental policies in some areas (Table 2). The university environmental studies programs are adequate in number but require increased support and development if they are to reach their full potential. Governmental policies have yet to be developed in areas left blank or marked "0" in Table 2.

Efforts must be made to optimize resource use, particularly in those areas (fisheries, forests, water supply, etc.) where over-exploitation is a possibility. Effective resource utilization maintains ecological stability of the environment from which the resource is extracted. The following factors must also be taken into account: (1) impacts of modernization and population growth, (2) environmental management and policy issues, (3) land-use planning and land tenure, and (4) natural hazards.

Manpower Development

Educational policy in Indonesia for environmental matters is centered around the 29 established centers. These centers may not be as effective as they should be, however, because each is small.

- It is therefore recommended that steps be taken to encourage formation of a consortia of centers with common interests and emphases, possibly designating one institution as the leading center for each consortium. In this way, scarce resources can be shared and interaction among institutions encouraged. These consortia should prepare development plans that specify

TABLE 1 List of Centers for Environmental Studies in Indonesian Universities and Their Specialties

Center	Specialty
1. University of Indonesia, Jakarta	Human ecology
2. Bogor Agriculture University, Bogor	Watershed ecology, tidal agroforestry
3. Bandung Institute of Technology, Bandung	Settlement and industrial ecology
4. Padjadjaran University, Bandung	Environmental toxicology, environmental law
5. Gadjah Mada University, Yogyakarta	Geographical ecology
6. Diponegoro University, Semarang	Ocean and mangrove ecology
7. Arlangga University, Surabaja	Coastal settlement and industrial ecology
8. Brawidjaja University, Malang	Brantas upstream ecology
9. Surabaja Institute of Technology, Surabaja	Coastal settlement and industrial ecology
10. Jember University, Jember	Upstream ecology
11. Udayana University, Denpasar	Ecology of island parks and tourism
12. University of North Sumatra, Medan	Coastal ecology, Malacca Strait, Imperata, and tropical forests
13. Andalas University, Padang	Bukit Barisan mountain ecology and regional mining
14. Riau University, Pekanbaru	Swamp, island, and plain ecology
15. Sriwdjaja University, Palembang	Tidal swamp ecology
16. Hasanuddin University, Ujungpandang	Lake and coastal ecology
17. Mulawarman University, Samarinda	Plain tropical

TABLE 1 Continued.

Center	Specialty
18. Lambung Mangkurat University, Banjar Baru	Freshwater and swamp ecology
19. Cendrawasih University, Jayapura	Mountain/alpine ecology
20. Pattimura University, Ambon	Ocean ecology
21. Palangkaraya University, Palangkaraya	Peat and forest swamp ecology
22. Nusacendana University, Kupang	Arid/savanna ecology
23. Tadulako University, Tadulako	Resettlement ecology
24. Tanjungpura University, Pontianak	Swamp and peat ecology
25. Jenderal Sudirman University, Purwokerto	Coastal and brackish water ecology
26. Lampung University, Tandjungkarang	Transmigration and resettlement ecology
27. Sam Ratulangi University, Manado	Coastal, ocean, and island ecology
28. Syah Kuala University, Banda Aceh	Human ecology
29. Bengkulu University, Bengkulu	Agroforestry ecology

TABLE 2 Matrix of Environmental Areas, Problems, Government Policy (+ = existent; 0 = nonexistent), Priority, Focus of Current Research and Development on the Problem, and Other Institutions Potentially Involved in the Problem

Areas	Problems	Government Policy	Priorities Present	Priorities Future	Research and Development	Others
I. Resource Inventory	Meteorology	+	1		Dept. of Public Works (DPMA)	Soc. cc.
	Groundwater	0/+	1			Panitia Koordinasi Penelitian Masalah Air
	Water balance	0	1		Directorate of Env.	
	Surface runoff	++			Geology	Doc. + info.
	Limnology	0	1		LGPN-LIPI[a]	Universities outside of Java
	Baseline studies	0	1		UGM	
	Hydrology	0	1		ITB UNIVBRAW	Conservation policy
II. Resource Utilization						
1. Domestic supply	Supply of 60 l/p/d					
	For urban population	+	1			
	For rural population	+	1			
	Source, groundwater, surface runoff d.p., and distribution	+				
	Urban	+				
	Rural	0/+	1			
2. Agriculture	Drainage	+			Deparments of Agriculture and Public Works (DPMA)	Cropping system
	Irrigation	++				Local management
	Soil water	0	1			Aquaculture
	Watershed	+				
3. Industry/ electricity	Multiple-use system (sequentilling)	0	1		DPMA	For rural communities potential is there
	Recycling					
	Microhydroelectricity	+		1	ITB	Transport
III. Water quality	Pollution by:	+			DPMA-PU	
	industry	general	1		Litbang Depkes	
	domestic	policy	1		PSL[a]	
	agriculture		1			
	mining		1 ('84-'85)			
	Monitoring	+ policy is not well distributed enough	1		DPMA Ministry of Health Industries	
	Treatment	+	1		PU-Ciptak Karya	

[a]LGPN = Lembaga Geologi dan Pertambangan Nasional (LIPI)
UGM = Universitas Gadjah Mada
ITB = Institute of Technology, Bandung
UNIVBRAW = Universitats Brawidjaya, Malang
PSL = Pusat Studi Lingkungdo

priorities and serve as a basis for long-term financial commitments so that qualified manpower can be trained or acquired and study programs of adequate depth developed.

Manpower for the university environmental studies centers can be found in Indonesia, but external training of this manpower may prove necessary. The specific type of manpower to be trained should be evident from the consortial development plans described above. Once a high priority manpower development need is identified, steps can be taken to fill it.

Incentives for Indonesian students or junior faculty to seek advanced training in the priority area might take the form of a government commitment to subsidizing the training and providing subsequent research grants to assure development of teaching/research programs after training is completed. Such support helps assure that trained manpower is effectively utilized. Additional mechanisms to assure efficient academic use of trained manpower may be evident from a review of existing curricula and teaching loads. Incentives to assure that trained manpower devotes full time to university teaching and research must be established to assure efficient use of such manpower.

Joint Programs

Solutions to environmental problems, including those of manpower development, could be hastened through closer links between universities, government agencies, research institutions, and industry. Mutual personal respect and concern for Indonesia's environment and development can serve as the philosophical basis for such linkages.

- It is recommended that linkages be encouraged by government agency development of environmental technician training programs and by more use being made of an existing program whereby agency employees return to universities for postgraduate education.

Specific instances where linkages among diverse environmental institutions are particularly weak or strong can be used to identify high-priority needs and potential mechanisms for solving them. For example, no Indonesian program is currently focusing on dry-land ecology, yet research on agricultural soil moisture problems is being addressed by a formal joint program involving universities, LIPI, and the Ministry of Agriculture. A similar kind of joint program in dry-land ecology may develop from discussions now under way between the Team for the Formulation and Evaluation of National Major Programs on Research and Technology (PEPUNAS-RISTEK) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on problems of the dry-land ecosystem of Nusa Tenggara Timor. Joint programs of the type being conducted on agricultural soil moisture obviously make efficient use of scarce trained manpower resources. Such joint efforts should be a regular feature of Indonesia's response to environmental problems identified during the period when larger manpower pools are being developed through advanced training.

Transmigration

Transmigration is one environmental problem area that is both currently identifiable and potentially susceptible to an inter-institutional environmental research program. Initial discussions of this problem should focus on resources, particularly water, environment, and agriculture. Such discussions would be enhanced by closer linkages between university research centers and the Directorate of Transmigration and Manpower.

Regulatory Agency

Regarding water quality, pollution by domestic wastewaters, urban and agricultural runoff, and industrial and mining wastes is exacting a heavy toll throughout urban and rural Indonesia. Government laws against pollution are ineffective unless they can be implemented, and policies toward that end are urgently needed.

A clear need in addressing problems of environmental quality issues as well as problems of water pollution is a "watchdog" or regulatory environmental agency that is, and is perceived to be, independent of other government agencies. The present Ministry of State for the Environment, which supports the centers for environmental studies and helps obtain needed data, is not organized to perform this function. The centers for environmental studies are not influential enough, nor are they likely to be properly organized to implement pollution control measures, since they are located in universities. Nongovernmental organizations can be useful in identifying problems that need attention, but they are not likely to be effective in rural Indonesia. Any such regulatory agency must be staffed, of course, with high-quality science and technology personnel.

INDUSTRIAL DEVELOPMENT AND MICROELECTRONICS

Current revolutionary technological developments in microelectronics represent both opportunities and constraints for Indonesia's accelerating industrialization program. Dealing effectively with these will require substantial expansion of both education and research in the microelectronics field.

The driving force in this field is the fact that the science and technology of microelectronics continue to develop worldwide at a very fast rate that shows no signs of abating. The number of circuit elements that can be placed on a semiconductor chip is far from the limits determined by the laws of physics and continues to grow. Since chips represent the basic building blocks of computers and telecommunications systems, changes in microelectronic technology are rapidly reflected in changes in the sophistication and power of computers and communications equipment. The trend is toward smaller, cheaper, more efficient, and more intelligent devices. The product life cycle of typical microelectronic-based systems can be as short as 2 years.

Applications of microelectronic technology are having and will continue to have far-reaching effects on a variety of processes in industry and commerce. They are altering many aspects of manufacturing, quality control, data processing, product distribution, and information handling. These developments, in turn, are having a signficant impact on employment patterns, the character of work, manpower compensation, capital requirements, and other vital aspects of industrial activity.

To date in Indonesia these effects are most apparent in the growing utilization of microelectronics systems in microcomputers, telecommunications, and some consumer goods. The opportunities offered by this new technology, in both the industrial and defense sectors, to improve quality, reliability, and productivity as well as to respond to needs in new ways, are significant.

There is no question, therefore, but that Indonesia must rapidly develop its capacity to utilize microelectronic technology effectively in support of industrialization. Although this working group's discussion was directed toward the relationship of microelectronics to industrial development, the importance of microelectronics in many other fields, especially defense, where state-of-the-art applications are critical, is noted. Serious issues, however, must be addressed with respect to the desirability and productivity of manufacturing advanced microelectronic devices, equipment, and systems in-country in the coming decade in view of the capital-intensive character of such production, rapid obsolescence of technology, and intense competition among the industrialized countries. Until the latter issues have been resolved, the full implications of microelectronics for manpower development in the industrialization field cannot be reliably foreseen.

MANPOWER DEVELOPMENT

Even if Indonesia's near-term activities with respect to microelectronics are limited primarily to providing for effective utilization of these powerful tools in industry (and elsewhere in the economy and society), much can be done to augment what is surely an inadequate supply of trained manpower in this field. A first practical step would be development of a realistic, up-to-date inventory of manpower and material resources available to support intelligent utilization of microelectronics technology to supplement the present fragmentary knowledge of capabilities. On the basis of such an inventory, plans can then be developed for systematic reorganization of educational programs in electronics at universities, polytechnics, and vocational schools, necessarily including the expansion of the supply of teachers at all levels. Moreover, the strengthening of linkages among universities, R&D institutions, and industry is an indispensable component of a manpower expansion strategy for this technology.

- Within these broad guidelines, it is recommended that:

  -- For the next 3-5 years, educational pilot programs in microelectronics be concentrated in no more than three universities adjacent to industrial centers, thus avoiding dilution of scarce human resources and subcritical, ineffective "diversification." The S-I (undergraduate) level should be included in this effort, not limiting it to candidates for higher degrees.

  -- University programs in microelectronics be kept relevant to industry's needs by establishing university-industry links, primarily through joint university-industry research programs and cooperative education schemes. Industry advisory groups should be developed in this connection.

  -- R&D institutions (for example, LIPI) be used primarily for advanced development programs in utilization of microelectronics (but perhaps in some special cases for product development or adaptation) to serve defense, government, and industry. Their educational role, other than on-the-job training and projects in the cooperative education program, should be limited to providing opportunities for graduate student theses.

-- Priority be given to applications of microelectronics (as opposed to product development) and to development or adaptation of software. Development of computer systems and system architecture could be added later, and, after initial priorities are satisfied, these efforts could expand to encompass materials science and integrated circuit technology.

-- Assistance from foreign donors--bilateral and multilateral--be sought to bring faculty from abroad for 1- or 2-year assignments to strengthen a designated pilot university program in at least the formative years.

-- Continuing education programs in the universities be developed for past graduates to keep them abreast of developments in this fast-moving technology.

-- To the greatest extent possible, students in secondary and even primary schools be exposed to the concepts of computer literacy, not only to stimulate a flow of interested and qualified students to university and polytechnic programs, but also to create greater awareness of orderly and analytical methods of thought.

-- Formation of a computer techniques professional society be initiated, perhaps affiliated with the International Institute of Electrical Engineers.

MARINE SCIENCE AND UNDERWATER TECHNOLOGY

The Indonesian seas cover an area of over 5 million square kilometers. How fully and rationally these seas are utilized in the coming decade will affect Indonesia's economy; its ability to meet increasing demands for food, raw materials, and energy; its position in the regional community of nations; its national resilience; and environmental quality as a whole.

For centuries the rich and diversified life of the Indonesian seas has been an important source of fish protein. In recent years, hydrocarbons, natural gases, and minerals have been tapped from the shallower parts of these seas. These waters are also used increasingly for inter-island and international trade. Unfortunately, with the increasing utilization of the seas, the marine environment experiences more pressures, such as greater incidences of pollution and general degradation of certain coastal areas.

Presently, inadequate numbers of technically trained and skilled manpower are available to carry out research programs to develop and manage the renewable and nonrenewable marine resources in Indonesia. It is, therefore, imperative that manpower development in marine science and technology at all levels be planned and incorporated into Indonesia's overall national development plan.

PLANNING AND FORECASTING MARINE SCIENCE

To provide a basis for discussion of manpower needs, the excellent proposed marine science component of the fourth Five-Year National Development Plan (REPELITA IV) was described to the panel. It includes efforts that address the five major priorities of the Indonesian matrix on research and technology (see Table 3): (1) basic human needs; (2) natural resources and energy; (3) industrialization; (4) defense and security; and (5) social, economic, and cultural factors, philosophy, and law. The plan proposes efforts to meet basic human needs by means of:

- Assessing and developing natural resources, living marine resources, and aquaculture as a source of protein for human nutrition

TABLE 3 Marine Science Program in Relation to the National Research and Technological Matrix

Basic Human Needs	Natural Resources and Energy	Industrialization	Defense and Security	Social, Economic, and Cultural Factors; Philosophy and Law
• Living marine resources (as a source of protein)	• Physics (OTEC)	• Mapping	• Mapping	• Fisheries social structure (artisanal coastal fisheries)
	• Geology and Geophysics	• Fisheries (pelagic)	• Meteorology	
• Aquaculture (as a source of protein)			• Physical Oceanography	
• Control of marine pollution	• Control of marine pollution	• Aquaculture (shrimp)		• Control of marine pollution
		• Geology and Geophysics		
		• Marine pollution		
• Coastal area management	• Coastal area management	• Coastal area management	• Coastal area management	• Coastal area management
• Ocean engineering	• Ocean engineering	• Ocean engineering	• Ocean engineering	

- Studying marine pollution to assure that marine protein and environments are safe for human use

- Developing coastal area management plans to assure that marine environments will be developed for their highest and best human use

- Developing ocean engineering to assist in formulating safe, efficient human uses of the marine environment.

With regard to natural resources and energy, the plan proposes:

- Assessing the energy potential of ocean thermal energy conversion (OTEC) by means of a joint endeavor with foreign investigators

- Developing marine geology and geophysics to provide a framework for understanding the distribution of nonliving marine resources such as petroleum, phosphorite, tin, manganese nodules, and other potential marine minerals

- Using marine natural resources and energy safely, thoughtfully, and efficiently through development of expertise in marine pollution, coastal area management, and ocean engineering.

The plan includes efforts to develop marine industrialization by means of:

- Developing maps to assure safe navigation in Indonesian waters

- Studying the potential of industrial fisheries for exportable living resources such as tuna fish and an aquaculture industry for shrimp

- Conducting marine geological studies of nonliving industrial materials (construction aggregates, ores, etc.)

- Developing expertise in marine pollution, coastal area management, and ocean engineering.

The plan proposes efforts to enhance defense and security by means of:

- Mapping the sea floor, such as in the Macassar Strait

- Developing expertise in marine meteorology, physical oceanography, and ocean engineering.

Finally, the plan proposes to enhance knowledge of social, economic and cultural factors, philosophy, and law by:

- Studying current cultural practices in marine fisheries

- Providing technical knowledge of marine pollution suitable for subsequent assessment of the social, economic, cultural, and legal consequences of some types of industrial development

- Assessing the social, economic, cultural, and legal aspects of coastal area management.

MEETING MANPOWER NEEDS

Three general approaches to meeting the manpower needs of efforts described above in Indonesia's fourth Five-Year Development Plan were identified:

- Direct technical assistance by foreign scientists and technicians
- External training of Indonesian scientists and technicians
- Internal training of Indonesian scientists and technicians.

Which approach is selected for solving specific manpower development problems hinges on the time scale within which a solution is needed. Direct technical assistance by hiring a foreign scientist or technician provides an instantaneous, but ultimately temporary, solution to a manpower need. External training of Indonesian scientists and technicians requires 2-5 years, but provides native expertise once the training period is complete. Internal training of Indonesian scientists and technicians can only be carried out effectively if the academic infrastructure is already fully developed. Since this solution is both permanent and signals full technological development, it is a worthy objective. Internal training in marine science, as in all fields, grows from a well-developed educational pyramid.

- <u>Thus it is recommended that overall efforts to increase participation in general education be augmented and supported as the highest priority aspect of manpower development in Indonesia.</u>

- <u>The following priorities for manpower development in the areas of marine science and underwater technology are recommended. It is recognized, however, that a problem important enough to warrant direct technical assistance usually also warrants immediate efforts to develop expert Indonesian manpower through external, and eventually internal, training programs.</u>

Direct Technical Assistance

Acknowledging the present level of Indonesian expertise and the immediacy of Indonesia's need for such expertise, it is recommended that Indonesia seek direct technical assistance of trained manpower in the following areas:

- English language. Instruction is needed to increase the efficiency and decrease the frustration of Indonesian technicians and scientists participating in advanced technical courses taught in English.

- Marine geology and geophysics. Indonesia has no marine-oriented training program in geology despite the fact that 80 percent of its territory is under the ocean. Establishing such training opportunities in two or more Indonesian institutions appears to be a wise investment in developing the manpower needed to assess the geological context and specific distribution of nonliving marine resources.

- Ocean engineering. The situation parallels that of marine geology and geophysics. The need for planning and assessing coastal public works as well as offshore oil and gas structures demands an immediate remedy.

- Coastal area management. The continued rapid development of the Indonesian economy coupled with population pressures and the array of potentially conflicting uses of coastal zone areas suggest that procedures be established immediately for developing coastal area management planning. Building up indigenous expertise through training in this field out of country is a necessity.

External Training

Two areas of external training were considered:

- Traditional academic training for advanced degrees

- Nontraditional, apprenticeship-type training coupled to licensing for foreign industrial fishing and offshore structure repair and maintenance.

External academic training for Indonesian scientists seeking advanced degrees has been practiced for many years. The new importance of marine science following completion of Law of the Sea negotiations requires that the scale of this training for marine scientists be increased dramatically. A steady, long-term commitment to advanced training of an agricultural faculty proved effective in the 1960s, and a similar investment in marine science in the 1980s would reap future benefits. The concept of Indonesian training by a consortium of U.S. institutions seems an idea worthy of further study.

Foreign licensing of companies involved in extraction of Indonesian living and nonliving resources should be augmented to include a training component for marine technicians. Such training should be made a prerequisite for licensing and would lead quickly to a coterie of trained Indonesians who could eventually man Indonesian resource recovery operations.

Internal Training

Internal training depends upon better use of existing training mechanisms, upgrading these mechanisms, and developing nontraditional mechanisms. Existing mechanisms for advanced training could be used more effectively and upgraded if incentives for involving faculty and students conducting research were increased. Some new incentives might include the establishment of a peer-reviewed research grants competition in which modest funds for faculty salary augmentation and research student stipends, as well as equipment, supplies, travel, and publication expenses, could be obtained. Such a grant program seems appropriate for the Ministry of State for Research and Technology, but it should be broadly based by establishing a policy that the R&D budget of all state agencies and multinational corporations operating in Indonesia include funds earmarked for university research grants.

Nontraditional training mechanisms for developing marine technicians and increased appreciation for marine topics should also be developed. The curriculum of selected secondary schools or polytechnic institutes should be augmented to provide specific training for marine and fishery technicians. Alternatively, an S-0 (nondegree) training program for such technicians could be developed in selected universities. U.S. institutions already offering such programs may have useful advice on an appropriate curriculum for such technical training programs. In addition, marine-oriented vocational training should be developed for secondary schools. Curriculum materials for secondary school study of marine science developed in the United States could perhaps be adapted to the Indonesian context.

University programs should be augmented by developing a marine extension component similar to the agricultural extension systems used by U.S. land-grant colleges. Sea-grant colleges have experience in marine extension programs and could be a source of advice to Indonesian institutions seeking to develop such nontraditional (primarily adult) training programs. Establishment of marine extension programs might be doubly beneficial by exposing faculty to the cultural aspects of fishing, as well as extending practical academic knowledge to users of the marine environment.

A 2-year college diploma program (or S-0 program) should be developed to emphasize marine science and technology. Such a program, similar to the one being developed in agriculture, could aim at attracting the sons and daughters of over 1 million Indonesian families currently engaged in fisheries and sea-related activities.

Both traditional and nontraditional manpower training will succeed only if they can draw upon a populace with a solid general education. Current attrition rates in Indonesian school systems appear to preclude or at least seriously inhibit the prospect of such an educated populace.

Finally, development by Indonesia of industries based on marine resources, underwater technology, and fisheries mandates a broadly based pyramid of educated, literate workers at all skill levels. Modern industry overall can only be sustained with the support of a large labor force of persons who have completed junior and senior high school--two levels that need expansion within the scope of the fourth 5-year plan. Currently, only 34 percent of Indonesian students are finishing junior high and only 12 percent are completing senior high school. This aspect of the manpower requirement is a part of all manpower planning models.

Expanding the primary and secondary education base of the manpower development pyramid is essential to develop an industrial infrastructure in the marine and other fields. It will also help reduce social tensions as the families of fishermen and farmers are displaced by more capital-intensive methods. Furthermore, it provides for greater social justice and more equitable income distribution as development occurs. The most recent estimates of the rate of return to expanding educational opportunities in Indonesia at the primary and junior high school levels is 34 percent, making it a very good investment from an economic growth and development perspective.

SUMMARY OF PLENARY SESSIONS

At the opening plenary session of this meeting, Indonesian participants described three aspects of Indonesian science and technology management: science and technology institutional policymaking, current planning of science and technology manpower development, and the science and technology education system (see Appendixes E, F, and G, respectively). Two panels of U.S. participants then commented on these reports and discussed science and technology forecasting and planning as practiced in the United States. At the closing plenary session, all participants discussed ideas and recommendations arising from the working group discussions. A number of issues raised at these plenary sessions are presented below.

OPENING PLENARY

Collecting Data on the Education System

It is quite beneficial to collect systematically data on the number of graduates of the education system at all levels and earnings of all persons by years of schooling and by field. Later analyses of these data would measure progress being made in developing manpower and, by including earnings in the private sector, would emit warning signals of shortages so that action could be taken to reduce quotas and to help the system respond where the needs are most acute.

To obtain the best possible data, the following steps should be taken:

- Define the issue as specifically as possible. Good communications with science and technology policymakers is essential to ensure that the issue is appropriate and of value to them.
- Determine the kind of data needed.
- Determine and pretest the survey instrument.
- Obtain sufficient funds for a survey.
- Collect, tabulate, and interpret available data.

To stimulate a positive response to the data collection process, the following steps are recommended:

- Develop a quick feedback mechanism.
- Demonstrate direct impact.
- Have personal contact with the respondent.

Steps should then be taken to ensure that the material is made available as quickly as possible. This could include producing rough, unpublished copies of the first approximation of results of the survey and preparing sets of statistical tables and a short report giving highlights of the survey. Finally, an in-depth analysis is made for further use.

Manpower Planning and Rate-of-Return Analysis

Education is an investment with a very high payoff for economic growth and development. The 25.5 percent rate of return to expanding primary education and 15-20 percent rates of return at the secondary level estimated for Indonesia confirm this fact. Rates of return to scientific and technical manpower at the college level have not been studied because of insufficient data. Collection of data, therefore, on earnings in private industry at each level of schooling and in each field should be part of the manpower planning effort.

The manpower plan developed for Indonesia by a World Bank team in 1979 indicates a need for trained manpower far beyond that currently being produced: an additional 3,900 engineers per year, 1,200 scientists, 700 agricultural scientists, 700 accountants, 900 economists, and 500 trained managers. The total of these needs is very close to the 8,585 per year shortfall of scientific and technically trained personnel projected by the Indonesian Institute of Sciences (see Appendix F).

Whether manpower planning in each of the narrow scientific fields beyond this level of specialization is necessary or desirable is debatable. Other countries have found that planning 5 or 10 years ahead and attempting to forecast overly narrow occupational needs is a mistake; needs change, leading to a faulty forecast. Furthermore, there may not be enough teachers to produce the needed 8,585 graduates per year.

A better approach to manpower planning may entail looking ahead 5 years and alleviating possible bottlenecks by initiating or maintaining the scientific and technical training efforts at all levels--primary school through doctorate work--required to maintain the base of high-tech industry. This approach can be augmented with the collection of data on earnings in the private sector (government salaries can be misleading) and some calculation of rates of return at primary, secondary, S-0 (nondegree), and college levels for use as warning signals of shortages, and for use in setting priorities when all needs indicated by the manpower plan models cannot be met at once. This action should appeal to the World Bank, who wishes to put its money where it will reap maximum benefit.

Finally, regarding the technical input-output methods of manpower planning, procedures originally developed by Nobel Laureate Jan Tinbergen involve the calculation of "technical coefficients" (see Tinbergen, Economic Development Planning, McGraw-Hill, New York, 1967, pp. 128-148; and B. Ahmad and M. Blang, The Practice of Manpower Forecasting, Jossey-Bass, San Francisco, 1973, pp. 8-18). A coefficient is obtained by dividing the number of workers at each education level (starting with unskilled and primary school graduates) in the best-practice plants in each industry by each respective industry's current output. The projected output for each industry found in the next 5-year plan is then multiplied by its respective technical coefficient to obtain the manpower requirements at each level of schooling for that industry and in turn the educational requirements for all industries.

The requirements both for college graduates in all scientific, social science, and technical fields and for mathematically and scientifically literate junior and senior high school graduates are vastly above the numbers being produced currently. The requirements must be filled if the transfer of science and technology to Indonesia and the development of the necessary industrial base are to succeed.

Four specific suggestions for dealing with this problem are:

- Establish a body within the Indonesian development effort that has responsibilities for scientific and technical manpower planning and rate-of-return analysis, and for encouraging and aiding manpower development at all levels. The Ministry of State for Research and Technology, the Ministry of Education and Culture, and some universities should be represented in this body so that manpower planning will not be focused too narrowly and the impact of science and technology on the economy will be considered.

- Establish a major system of grants and contracts from the Indonesian government to the universities designed to bring them into contact with the nation's scientific, social, and technical problems and the practical and technological problems of individual industries. This concept could be viewed as a system of land-grant institutions authorized to undertake research, manpower training and development, and extension of the fruits of research to industry. One way to begin may be to set up pilot programs that involve two or three selected institutions. It may be feasible to make actual grants of land in less-populated areas, and sea grants as well, to universities for experimental purposes. Such a program could be supplemented by research grants not only for research and data analysis in agriculture, but also for the transfer and adaptation of science, social science, and technology to all fields. These grants would strengthen those institutions that are relied on to provide a continuing flow of science, social science, and technically trained manpower.

- Initiate new financing arrangements to expand the number of students trained at the S-0 (nondegree) and college degree levels. This can be accomplished with modest additional cost by implementing a system of ability-to-pay pricing, a policy typical of electric, water, gas, and other public services in most countries. This would entail:

  -- Higher college tuitions in Indonesia

  -- Tapping the unutilized resource of intelligent young people from low-income homes by establishing a system of need-based grants. These would necessitate creating a computerized "need analysis system."

  -- Offering such prospective students a grant-loan-work/study package.

  Offering a 2-year college diploma (or associate degree) at schools in or near heavily populated areas would help reduce costs and therefore increase enrollment.

- To help support industry, broaden the base of educated manpower by offering good primary and secondary educations, which can be followed with a less costly and more successful development of specific applied skills as Indonesians are trained on the job. Without a vigorous effort to expand the primary and secondary educational system to more of the population and to train the additional teachers needed, the transfer of science and technology for economic development in Indonesia will be greatly hampered.

CLOSING PLENARY

The final day's plenary sessions dealt with a number of cross-cutting topics included in the terms of reference for the workshop:

- Government policy and institutional needs
- Educational needs and mechanisms
- Manpower planning
- Research and development management and planning
- Transfer of technology
- Linkages between universities, research institutions, and industry.

During this session, all participants were asked to make suggestions and comments on each topic. Each comment was discussed by all participants, but no formal action was taken on any of them. The suggestions summarized below, therefore, should be viewed as recommendations made by individual participants rather than by the group as a whole. Many of them may, however, be worthy of formal consideration by U.S. and Indonesian officials, thus justifying their inclusion here. Since manpower planning was the central theme of this meeting, that topic, which was included in the terms of reference, as well as technology transfer, which was not discussed in detail, are not summarized here.

Government Policies and Institutional Needs

Establishing a New National Council Within the next 5-year REPELITA, Indonesia's development policy will require a dramatic expansion in scientific and technical manpower at all levels of professional and subprofessional competence. No single mechanism or set of incentives are in sight to provide this expansion, and no single government agency or department seems capable of mobilizing society for this enormous task.

It is therefore recommended that a National Council on Scientific and Technical Manpower and Training be formed, composed of representatives of all relevant government departments, industry, and the several levels and types of educational institutions. This body would monitor manpower developments, suggest corrective measures and new initiatives, and act as a forum aiming at optimal utilization of available manpower by appropriate cooperative arrangements if indicated. Successful examples of cooperation between government, private, university, and R&D sectors (for example, aeronautical industry) could be used as models for extension into other industrial sectors.

The proposed national council may wish to reexamine how efficiently science and technology manpower is used in the government sector. Since government salaries are far below the market price in the private sector, the government's demand for science and technology manpower may be exaggerated, resulting in inefficient use of such manpower. Furthermore, the proliferation of universities, scientific institutes, and research units may be resulting in a large number of Indonesia's better scientists spending disproportionate amounts of their time on administrative duties.

The proposed national council may also wish to examine policies which are not intended to directly affect science and technology but which may have powerful, if hidden, effects.

The formulation of science and technology policies, plans, and programs calls for sound information on a country's scientific and technological potential. It is further recommended that the national council described above have a branch dedicated to the development and analysis of a set of comprehensive, integrated science and technology indicators. The branch should comprise professional analysts with specialized training in economics, statistics, manpower development and forecasting, and related fields. They should also be familiar with scientific and technological issues.

The proximity of this branch to the government's science and technology policymaking organ would permit close contact between policymakers and analysts, who must be aware of issues and policies under consideration and direct their studies accordingly. It would also lend the prestige of the council and highlight the importance of this activity to the policy-setting process, thereby enhancing the likelihood of greater cooperation by those from whom information is required. Such a branch would have no policymaking powers or responsibilities. Rather, it would collect and analyze information on the country's financial and manpower scientific and technological resources, forecast long- and short-term resource supply and demand, and measure and assess the outputs and impacts of the country's scientific and technological activities relative to national goals.

To facilitate the early development of indicators and to provide a means for international comparisons, it is suggested that such indicators be compatible with those used by the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Establishing a New Scientific Association The essential elements of the scientific process appear to be open communication and critical peer review. As long as the national communities of the scientific and technological disciplines are below critical size, however, they often lack the essential ingredients that scientific societies and scientific journals represent. Presently in Indonesia, disciplines are developed disproportionately. Some groups are strong enough to adhere to the appropriate unions forming the International Council of Scientific Unions (ICSU), while other groups of scientists are struggling for the desirable visibility that a society or a journal can provide. This issue is not unrelated to the development of competent manpower since young engineers and scientists often gain their real appreciation of quality from attending meetings and following the literature.

It is therefore recommended that an Indonesian Association for the Advancement of Science and Technology be constituted with sections corresponding to the fields of scientific and technical endeavor. Such an association may arrange to publish a peer-reviewed journal of high quality. It would also provide a measure of cohesion to the growing Indonesian scientific and technical community.

It is recognized that current programs permit government employees to be seconded to other ministries or institutions without any loss of benefits or prerogatives. It is recommended that greater emphasis be placed on this process to maximize the use of scientific and technological manpower.

Educational Needs and Mechanisms

Trained Faculty A university or higher education system is more than merely an institution for meeting society's scientific and technological manpower needs. It also preserves and develops the national culture, transmits and expands knowledge in a wide range of disciplines, and enriches the intellectual life and perspectives of its students and society. In the context of Indonesia's development needs, however, the higher education system also has a special obligation to organize its scarce resources as effectively as possible to assist in the national development effort.

The higher education system needs to increase rapidly the number of students and graduates in science and technology areas. A major bottleneck, however, appears to be a shortage of trained faculty. In the short term, the only answer may be to use existing faculty more efficiently. Average ratios of students to faculty (see Appendix G, Table 10) appear low by U.S. standards, as do average weekly teaching loads. There may be possibilities for increasing average class size and in pruning curricula.

If faculty are asked to assume heavier teaching loads and devote more time to their institutions, means must be found for increasing their salaries, perhaps by supplementation directly or indirectly. This may involve separating faculty salaries from the government scales by excluding faculty from the government civil service structure or providing differential salaries with higher remuneration in areas of manpower shortages (which would also serve to attract more students to these areas). Supplements could also be provided through greater use of research contracts with R&D organizations, consulting arrangements, and so forth.

The current system of ranks, promotion policies, and career development should be generally reexamined with the goal of increasing incentives for productivity and merit. The current mandatory retirement age for faculty appears low and consideration could be given to raising it, perhaps on a selective basis (by disciplines and by individuals).

To enhance the efficiency of existing faculty, it may be possible to employ more advanced educational technology such as video cassettes and packaged programs, although this will require some training of faculty in these methods. Other short-term measures are:

- Appointing "clinical" or "adjunct" professors from R&D organizations, industry, multinational corporations, etc.

- Using more teaching assistants and subprofessional technical helpers to free regular faculty from routine tasks. For example, because S-I graduates must often wait a long time between graduation and the receipt of a permanent assignment, they could be employed in the interim as teaching or research assistants, tutors, etc. To augment the number of basic science faculty in Indonesian universities, a program could be devised to enlist recent unemployed graduates of U.S. doctoral programs.

- Developing cooperative programs among universities located close to one another through an allocation of programs to avoid duplication, sharing of faculty, cross-registration of students, etc.

Upgrading the skills of faculty and R&D personnel is a continuing need. In-country workshops and summer institutes modeled after those conducted by the U.S. National Science Foundation may be the most efficient way.

Cooperation with Institutes Abroad Current mechanisms for achieving cooperation with developed countries include fellowship programs, joint research collaboration, exchange programs, special training programs, technical assistance programs, seminars, and workshops. It may be useful for Indonesia to evaluate the past experiences with each type of program and subjects covered and identify gaps. It would also be useful to have an American agency inventory the institutional and disciplinary distribution of Indonesian students in the United States in light of Indonesia's needs and U.S. institutional capabilities.

Tuition Rate Structure University tuitions in Indonesia seem too low (and are lower apparently than for secondary schools) and thus subsidize the well-to-do. Raising tuitions would help increase revenues for higher education, including salary adjustments. A program of scholarships and loans for the needy, combined with higher tuitions, would be preferable and more socially equitable, and would extend college education to a larger number without raising the tax costs. Furthermore, scholarships and loan forgiveness could be used to attract students to science and technology areas. A national service concept for graduates receiving scholarships for advanced training (overseas) could require that they return to teach for a certain number of years. This may also help alleviate faculty shortages.

Role of Basic Science A strong argument can be made for emphasizing basic and general education within science and technology programs rather than more narrow, specialized training, since the former is more efficient in using faculty resources and provides greater flexibility in adjusting to unforeseen developments in science and changing manpower needs. Likewise, the health of basic science cannot be overlooked because of more pressing shortages in technological areas. A number of basic scientific areas urgently need development, for example, biochemistry, and problems of placement in the basic sciences (outside of universities) should be addressed.

Attracting and Keeping Qualified Students An improved counseling system at the secondary level and an improved placement program at the higher education level are needed to identify and attract into science and technology the ablest students. The high attrition rates in some scientific and technological disciplines are a cause of concern. Secondary science education may need strengthening, and degree requirements should be reexamined. The requirement of a thesis at the S-I level, in particular, may result in an excessive length of time for completion of the first degree.

Scientific Awareness of the General Population There is also a need to increase the scientific awareness of the general population, even those who have not enjoyed a formal education, to increase their interest in and ability to adopt technological innovations. In enhancing the understanding of science among primary and secondary students, and the population generally, consideration should be given to using new forms of educational technology, for example, professionally prepared television programs and videotapes, science fairs, and mobile scientific exhibits.

Research and Development Management and Planning

Research and development planning in Indonesia is well advanced. Plans are thoughtfully prepared and are comprehensive. Research management, on the other hand, appears to need improvement. There have been numerous reports of inadequate maintenance of research equipment and a pervading view that academic R&D staff are used inefficiently because low salaries force most of them to take second and third jobs to support themselves and their families. These problems led participants to make several suggestions for improved R&D management.

The establishment of a federal research grants program would provide a mechanism through which R&D personnel could obtain funds for equipment and its maintenance, research assistance, travel, publication expenses, and, where necessary, supplementation of their salaries. Such a system could provide both the incentive and the means for research staffs to increase their productivity. This concept is described more fully in the next section. Funds to support such a program might come directly from industry. The Peruvian government, for example, requires that 2 percent of industry's pre-tax income be spent on R&D or turned over to the government for R&D allocation.

Other suggestions for improving R&D management include sponsoring research management workshops in Indonesia, or special training courses in research management, in addition to those already being given. Such workshops and courses could be staffed by research managers from developed countries, by personnel from multinational corporations operating in Indonesia, or by senior Indonesian research management personnel. It was also suggested that Indonesians visit developed countries to work with research management staffs at appropriate institutions.

Linkages Between Universities, Research Institutions, and Industry

Grants Program A major incentive to both more research and research focused on national needs might be a system of Indonesian government-supported research grants to university faculty and research institute staff on a project-by-project basis. Research conducted under such a grants program should be directed toward expanding basic knowledge and solving problems of community, regional, or national significance. Such research support would:

- Enable faculty and staff to employ half-time graduate student assistants who would thereby be trained and brought into direct contact with the problems of the nation and of industry.

- Provide incentives for faculty to stay on the university campuses through salary supplementation to match more nearly market salaries in the same disciplines and through funding sabbatical leaves used to update their skills.

The Ministry of State for Research and Technology could provide such grants directly on problems under its purview, as well as use its coordinating function with the R&D branches of the 11 other governmental departments to encourage each to provide a significant fraction of their R&D budgets for building centers of excellence throughout Indonesia. Firms operating in Indonesia should also be encouraged to have some their R&D (which involves adapting technology to Indonesia's needs) done by faculty and research institute staffs, perhaps through a combination of regulations and tax deductions. This should eliminate the current criticism that university training tends to be too divorced from the needs of the nation and of industry. Industry as well as government could then, in the long run, depend on the universities for a continuing flow of scientifically and technically trained manpower tuned to the needs and problems of industry and of the nation.

Extension Services Research involvement by faculty members will not only improve their teaching capabilities; it will also, where appropriate, provide a higher level of training for M.S. and Ph.D. candidates and help them extend the fruits of science and technology to industry and agriculture through extension. Research results applicable to national/regional problems must be comprehensible to the officials and citizens coping with the problems. Extension programs in U.S. land- and sea-grant colleges provide this service as well as keep university faculty aware of the problems facing officials and citizens. Since both features of such an extension system appear needed in Indonesia, it is recommended that several university and research institution budgets be supplemented to employ extension specialists to work with research workers and provide a vehicle for conveying research results and advanced technical information to users in the community. This link between extension, research, and instruction could also serve as a foundation for upgrading the S-I instructional program, and it could keep S-I students attuned to the practical needs of their discipline.

Linkages Between Industry and Research Personnel Effective linkages between industry and research personnel are also important, and there are currently serious problems in this area. For example, because universities cannot compete with industry salaries, industries recruit faculty and potential faculty away from universities, thereby eliminating prospects for future trained manpower. Corporations could help alleviate this problem by:

- Providing supplemental salaries to university faculty
- Giving equipment, perhaps with the encouragement of tax deductions
- Lending staff to teach courses in areas where no available university staff exists
- Hiring students and faculty to work part time
- Contributing R&D funds.

In some advanced areas of science and technology, resources for advanced training may rest in R&D organizations outside the university. It might be possible in such cases for these organizations to grant degrees in cooperation with selected universities. Whether degree granting or not, the use of senior scientists from industrial R&D organizations as adjunct professors in nearby universities should be promoted, and corporations, particularly multinational, should be encouraged to develop their own training programs or pay for their employees to attend technical schools. This system is used by the Bechtel Corporation in its Indonesian heavy construction operations. Perhaps the U.S. Chamber of Commerce in Indonesia would serve as a forum for stimulating this type of activity among U.S. companies.

As linkages between industry and technological manpower development grow, it may even prove feasible for multinational corporations operating in Indonesia to provide direct support to universities or research institutions in areas of common interests.

APPENDIXES

APPENDIX A

Workshop Agenda

MONDAY, NOVEMBER 8

9:00	Opening session:
	Welcome Sukadji Ranuwihardjo Ministry of State for Research and Technology
	Response Walter A. Rosenblith U.S. National Academy of Sciences
	Opening Address H. Tb. Bachtiar Rifai Chairman, Indonesian Institute of Sciences (LIPI) Coordinator, Team for the Formulation and Evaluation of National Major Programs on Research and Technology
10:10	Break
10:40	Plenary session:
	The Science and Technology Institutional Policymaking System in Indonesia --Sukadji Ranuwihardjo
	Current Science and Technology Manpower Development Planning in Indonesia --Didin S. Sastrapradja
	An Overview of Higher Education in Indonesia with Special Emphasis on Science and Technology --D. A. Tisna Amidjaja
11:50	Review of agenda for balance of the panel discussions

12:00	Lunch break
13:00	Plenary session: "Forecasting and Planning, Including Data Collection/Indicators"
15:00	Break
15:30	Plenary session (continued)
17:30	Introduction to the terms of reference for the working group sessions
19:00	Reception hosted by Dr. and Mrs. Jerome Bosken

TUESDAY, NOVEMBER 9

8:00	Working group sessions: Biotechnology and Agro-industry Water and Environment Industrial Development and Microelectronics Marine Sciences and Underwater Technology
10:00	Break
10:30	Working group sessions (continued)
12:00	Lunch break
12:30	Working group sessions (continued)
14:40	Break
15:00	Working group sessions (continued) Drafting conclusions and recommendations by chairmen, co-chairmen, and rapporteurs

WEDNESDAY, NOVEMBER 10

9:00	Plenary session: Overview of working groups' conclusions and recommendations
10:00	Break
10:30	Plenary session: Cross-cutting discussions

13:00	Lunch break
14:00	Drafting priorities, recommendations, and conclusions by chairmen, co-chairmen, and rapporteurs
15:00	Plenary session: "Final recommendations and conclusions"
	Closing remarks
19:00	Dinner hosted by the Minister of State for Research and Technology

APPENDIX B

List of Workshop Participants

UNITED STATES PARTICIPANTS

Prof. Walter A. Rosenblith, Foreign Secretary, National Academy of Sciences, Chairman

Dr. John Andelin, Assistant Director, Science, Information, and Natural Resources, Office of Technology Assessment, U.S. Congress

Dr. Ernest J. Briskey, Dean, School of Agriculture, Oregon State University

Dr. Dirk Frankenberg, Director, Marine Science Program, University of North Carolina

Dr. Roland J. Fuchs, Chairman, Department of Geography, University of Hawaii at Manoa

Mr. William A. W. Krebs, Vice President, Arthur D. Little, Inc.

Dr. James Marsh, Jr., Marine Scientist, Marine Laboratory, University of Guam

Dr. Walter W. McMahon, Professor of Economics and of Education, University of Illinois

Dr. Daniel A. Okun, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina

Dr. George Schillinger, Associate Professor of Management and Operations Research, Management Division, Polytechnic Institute of New York

Dr. William R. Sharp, Scientific Director and Executive Vice President, DNA Plant Technology Corporation

Mr. William L. Stewart, Deputy Director, Division of Science Resources Studies, National Science Foundation

Mrs. Rose Bannigan, Staff Officer, Board on Science and Technology for International Development, Office of International Affairs, National Research Council

Ms. Sabra Bissette Ledent, Proceedings Editor

INDONESIAN PARTICIPANTS

Prof. Sukadji Ranuwihardjo, Assistant for Coordinating Formulation and Policy Evaluation for Research and Technology Programs, Ministry of State for Research and Technology, Chairman

Dr. Alfian, Director, National Institute for Cultural Studies, Indonesian Institute of Sciences

Prof. Amiruddin, Rector, Hasanuddin University

Dr. Aprilani Soegiarto, Director, National Institute of Oceanology, Indonesian Institute of Sciences

Dr. Arjuno Brojonegoro, Director, National Institute for Chemistry, Indonesian Institute of Sciences

Dr. Didin S. Sastrapradja, Deputy Chairman for Natural Sciences, Indonesian Institute of Sciences

Dr. H. M. Eidman, Dean, Faculty of Fishery, Bogor Agriculture University

Dr. Hasbi Tirtapradja, Dean, Faculty of Agriculture, Padjadjaran University

Dr. Fred Hehuwat, Director, National Institute for Geology and Mining, Indonesian Institute of Sciences

Dr. Kasijan Romimohtarto, Head, Center for Ecological Research, National Institute for Oceanology, Indonesian Institute of Sciences

Dr. A. A. Loedin, Head, Agency for Health Research and Development, Ministry of Health

Mrs. A. S. Luhulima, Special Staff for R&D Management, Indonesian Institute of Sciences

Ms. Luwarsih Pringgoadisurjo, Director, National Scientific Documentation Center, Indonesian Institute of Sciences

Dr. Mien A. Rifai, Assistant Director for Scientific Matters, National Biological Institute, Indonesian Institute of Sciences

Prof. Moerjanto Ismadi, Faculty of Medicine, Gadjah Mada University

Mr. Mohammed Ridwan, Deputy Director General, National Atomic Energy Agency

Dr. Muhammadi Siswo Sudarmo, Deputy Chairman for Technology, Indonesian Institute of Sciences

Dr. Nilyardi Kahar, Assistant Director for Scientific Matters, National Institute for Physics, Indonesian Institute of Sciences

Maj. Gen. Otty Soekotjo, Head, Research and Development Center, Ministry of Defense and Security

Dr. Pranoto Asmoro, Chairman, National Coordinating Agency for Surveys and Mapping

Dr. Puruhito, Department of Surgery, Faculty of Medicine, Airlangga University

Dr. Purwo Arbianto, Department of Chemistry, Institute of Technology, Bandung

Prof. Sajogyo, Department of Social Economics, Bogor Agriculture University

Prof. Samsuud Sadjat, Faculty of Agriculture, Bogor Agriculture University

Dr. Setijati Sastrapradja, Director, National Biological Institute, Indonesian Institute of Sciences

Dr. Soemaryato Kayatmo, Director, National Institute for Electrotechniques, Indonesian Institute of Sciences

Brig. Gen. Soemitro Soehardjono, Deputy, Research and Development Center, Ministry of Defense and Security

Dr. Soenartono Adisoemarto, Head, Muzeum Zoologicum Bogoriense, National Biological Institute, Indonesian Institute of Sciences

Dr. Soetono, Faculty of Agriculture, University of Brawidjaja

Prof. Somadikarta, Dean, Faculty of Mathematics and Natural Sciences, University of Indonesia

Dr. Subagjo Soemodihardjo, Head, Bureau of Coordination and Science Policy, Indonesian Institute of Sciences

Dr. Suharso, Director, National Institute for Economics and Social Research, Indonesian Institute of Sciences

Ign. Suharto, Director, National Institute for Chemistry, Indonesian Institute of Sciences

Dr. Sumardi Sastrakusumah, Faculty of Fishery, Bogor Agriculture University

Dr. Suwarto Martosudirdjo, Director, National Research Center, Indonesian Institute of Sciences

Dr. D. A. Tisna Amidjaja, Director General of Higher Education, Ministry of Education and Culture

Mr. Trisura Suhardi, Chief, Agency for Research, Ministry of Industry

Dr. F. G. Winarno, Director, Faculty of Technology Development Center, Bogor Agriculture University

OTHER PARTICIPANTS

Dr. Jerome Bosken, Director, Office of Science, Technology & Energy, U.S. Agency for International Development, Indonesia

Dr. Katherine Schmeding, Consultant, Office of Science, Technology & Energy, U.S. Agency for International Development, Indonesia

Dr. A. B. Van Rennes, U.S. Technical Adviser to the Chairman, BPPT, Jakarta, Indonesia

WORKING GROUP MEMBERS

Biotechnology and Agro-industry

Prof. A. A. Loedin (Chairman)
Dr. William R. Sharp (Co-chairman)
Dr. Mien A. Rifai (Rapporteur)
Prof. Amiruddin
Mrs. Rose Bannigan
Dr. Ernest J. Briskey
Prof. Didin S. Sastrapradja
Dr. Hasbi Tirtapradja
Dr. Purwo Arbianto
Prof. Samsuud Sadjat
Dr. Katherine Schmeding
Mr. William L. Stewart
Mr. Suharto
Dr. Susono Saono
Dr. F. G. Winarno

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Dr. Setijati Sastrapradja (Chairman)
Dr. Daniel A. Okun (Co-chairman)
Dr. Soenartono Adisoemarto (Rapporteur)
Dr. Alfian
Dr. John Andelin
Dr. Roland J. Fuchs
Dr. Fred Hehuwat
Dr. Kuniati
Prof. Moerjanto Ismadi
Prof. Sajogyo
Dr. Soetono
Dr. Suharso
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Mr. William A. W. Krebs (Co-chairman)
Dr. Nilyardi Kahar (Rapporteur)
Mr. Arjuno Brojonegoro
Dr. Fred Hehuwat
Mrs. A. S. Luhulima
Ms. Luwarsih Pringgoadisurjo
Mr. Mohammed Ridwan
Dr. Puruhito
Dr. Walter A. Rosenblith
Dr. George Schillinger
Brig. Gen. Soemitro Soehardjono
Prof. Sukadji Ranuwihardjo
Mr. Trisura Suhardi
Dr. A. B. Van Rennes

Marine Science and Underwater Technology

Dr. Aprilani Soegiarto (Chairman)
Dr. Dirk Frankenberg (Co-chairman)
Dr. Kasijan Romimohtarto (Rapporteur)
Dr. H. M. Eidman
Dr. James Marsh, Jr.
Dr. Walter W. McMahon
Dr. Subagjo Soemodihardjo
Dr. Sukarya Somadikarta

APPENDIX C

Opening Address
H. Tb. Bachtiar Rifai

It is both an honor and a pleasant duty for me, on behalf of the Team for the Formulation and Evaluation of National Major Programs on Research and Technology (PEPUNAS-RISTEK), to join Professor Sukadji Ranuwihardjo in extending my heartiest welcome to the opening session of the Panel Discussions on Science and Technology Planning and Forecasting for Indonesia, with Special Emphasis on Manpower Development, jointly sponsored by the office of the Minister of State for Research and Technology, LIPI, and the U.S. National Academy of Sciences.

I also wish to convey Minister B. J. Habibie's apology for not being able to attend this very important gathering due to a special governmental mission he had to lead to Singapore. However, he expressed his very keen interest in the issues and outcome of the discussions during the coming three days, and he wishes you every success in your deliberations.

A LONG-STANDING RELATIONSHIP

The Indonesian scientific community has enjoyed a long-standing relationship with the U.S. National Academy of Sciences. One among so many joint undertakings, you might recall, was the NAS-LIPI Workshop on Food held in Jakarta in 1968, the findings of which were the basic source for the formulation of the ensuing policy on food for the first Five-Year Development Plan. The Second Workshop on Food and Nutrition, convened by LIPI in Bogor in 1978, was national in nature, although it was attended by a number of U.S. scientists sponsored by NAS. Meanwhile, the Coordinating Minister for the People's Welfare, anticipating the fourth 5-year plan, has asked LIPI to convene the Third Workshop in 1983, and I hope it will also be attended by NAS-sponsored U.S. participants.

I am indeed happy to note that despite the many global, regional, and national problems encountered by our respective countries, we have succeeded in maintaining our cooperation. It is, therefore, my sincere hope that this existing cooperation will eventually grow even stronger and cover wider priority program areas. Thus, apart from organizing scientific discussions, this cooperation could perhaps go further into identifying prominent local problems to be tackled jointly in follow-up action programs.

In terms of target setting, it was expected that by the end of the second 5-year plan (1979) Indonesia would be able to produce "half-finished" products from raw materials. While agriculture still plays an important role, it is expected that by the end of the third 5-year plan (1984) we will be able to produce a wide variety of "finished" products. And by the end of the fourth 5-year plan (1989) a firm base for our industrialization should be completed to enable us to take off.

SUBJECTS FOR DISCUSSION

Within this very context, four sub-themes have been selected for the present discussions on science and technology planning and forecasting, emphasizing especially the manpower development aspects: (1) biotechnology and agro-industry; (2) water and environment; (3) industrial development and microelectronics; and (4) marine science and underwater technology. Another consideration in selecting topics was the avoidance of unnecessary duplication while promising the best perspectives for Indonesia and maintaining the integration of various fields.

To quote Ward Morehouse, just as technology is only one variable among many affecting economic and social change, so also must technology policy be seen as an integral part of the domestic and foreign economic, social, and political policies of a given developing country. The lack of effective integration of technology policy with overall economic, social, and political policies has resulted in the ineffectiveness thus far of most policy instruments devised by developing countries to cope with technological dependence and enhance technological autonomy.

This, then, may raise the haunting question of whether technology policy is a logical point for analysis or action, as it is clearly constrained by larger economic, social, and political policies and forces. If the trends of the last 30 years continue to the end of this century, technology--or more broadly, the capacity to generate, control, and use socially significant and instrumental knowledge--will be a critical, if not the critical, factor in how effectively countries cope with their own problems and with one another. In short, the old adage that control of knowledge is power bids fair to be an evermore accurate description of the future course of human affairs.

SOCIAL EQUITY

There seems to be considerable evidence supporting a positive correlation between increased technological autonomy and greater social equity, although they may not necessarily be causally linked. Thus far all of Indonesia's 5-year plans have given priority to the achievement of social equity, and the "Eight Paths of Social Equity" have even been formulated.

Social equity as a national goal is often defined as having three basic components:

1. Meeting the minimum needs of most, if not all, of the population
2. Providing opportunities for productive employment for most, if not all, of the population
3. Less unequal income distribution, leading to satisfaction of basic social wants of most, if not all, of the people.

There are, of course, many other important nonmaterial needs involving identity and freedom that are to be found in the most forward-looking definitions of basic human needs, but the concept itself is sufficiently fraught with possibilities of misunderstanding, misuse, and political manipulation that it seems preferable not to employ it.

According to Volker Rittberger, building indigenous capabilities might mean, in one case, beginning with the creation of a viable scientific and technological infrastructure. This would imply the establishment of large-scale and differentiated education and training facilities and programs for technicians, engineers, and scientists; the initiation of bottom-up institution building; and the fostering of R&D oriented toward satisfying local users' needs. The success of these measures would depend on whether they contribute to a synthesis of traditional knowledge and skills, on the one hand, and modern science and technology, on the other.

In another case, promoting indigenous scientific and technological capabilities could mean the adaptation and reorientation of the existing, relatively advanced scientific and technological institutions and capabilities of a developing country. Frequently, the scientific and technological establishment in more advanced developing countries remains separated in its work and aspirations from its national societies. In spite of potential social and political obstacles, it would, therefore, be necessary both to reshape the national systems of higher learning and academic research to bring them in closer contact with national problems and to direct potential local users of R&D toward potential domestic suppliers.

One may conclude that the developmental relevance of promoting scientific and technological capabilities hinges on the socioeconomic and political direction of the process. Institutions and processes that ensure adequate representation of national interest groups, already organized or yet to be organized, vis-à-vis the central and regional administrations in developing countries, may be an elementary ingredient in self-reliant development, particularly in the field of science and technology.

I would like to take this opportunity to extend my appreciation and gratitude to the U.S. government, the Agency for International Development, and the U.S. National Academy of Sciences for their

continuous cooperation and support. My special thanks also goes to the office of the Minister of State for Research and Technology, to LIPI, to the various ministerial departments, institutes, and universities, and to all those who directly or indirectly assisted and contributed to the organization of this panel discussion. The valuable contributions of all participants are hereby also gratefully acknowledged.

I am confident that your joint endeavor will be successful and will not only be beneficial to Indonesia but also to other developing nations. In fostering this sincere hope I have, therefore, genuine pleasure in declaring the Panel Discussions on Science and Technology Planning and Forecasting for Indonesia, with Special Emphasis on Manpower Development, officially open, and I sincerely wish you every success in your deliberations.

APPENDIX D

Opening Remarks
Walter A. Rosenblith

Professor Rifai and Professor Sukadji, it is a great pleasure for me to have the opportunity and the privilege to visit your country and to represent the National Academy of Sciences. This is my first visit to Indonesia, although several of my colleagues have been here before. Fortunately, I have already had an opportunity to meet two gentlemen here today: President Frank Press [president of the National Academy of Sciences] and I had the pleasure of hosting a luncheon for Minister Habibie and Professor Sukadji in Washington and, subsequently, we met Professor Rifai in Rome at the Pontifical Academy. So although I cannot say that we are old friends, I have the distinct feeling that we will become good friends. President Press sends his warm greetings to this joint meeting; he is very much concerned about the issues on our agenda, and he will follow with great interest the outcome of our discussions.

A PERSPECTIVE

Looking a bit more historically and philosophically at the issues before us, I shall take the liberty, as one who grew up in Europe and was educated in the French tradition, to mention a few historical landmarks for the sake of perspective and context.

Engineering as an art and as a profession goes as far back as war and as built human habitations. Thus both military and civil engineering have been with us through recorded history. A decisive shift came at the time of the first industrial revolution, when people started to take seriously the doctrine of the French encyclopedists, according to which science, knowledge, and education would be the engines of progress. While the philosopher Condorcet expressed this viewpoint most articulately, it was Napoleon who began to translate it into reality by establishing the earliest institutions specializing in engineering education. The so-called scientific revolution had, of course, taken place quite a bit earlier, but it had not yet accumulated sufficient scientific capital to make its "income" directly relevant to the engineering needs of society. As we think back to the early 19th century, Carnot described the cycle named after him, but no one was around to say that there would be limitations on the internal combustion engine. Yet at that time a profound understanding of heat engines began to develop.

Today we live in a world which is increasingly what we call "man-made" (we should, of course, understand this to mean man- and woman-made). This phrase does not imply that we can afford to neglect our natural resources or our natural environment--we would do so at our risk and peril--but all nations, at whatever stage of development, have to ask themselves continuously: Are we using science and technology adequately and appropriately? Are we coupling them effectively to societal needs? And are we trying to assess and prevent unintended consequences? A man-made society recognizes two forms of capital: one form in the United States we are inclined to call "green" (that is, the color of dollar bills), and another form of capital that we might call "grey" because the surface of the cortex of the human brain looks grey. The right combination of natural resources together with green and grey capital foster the development process.

LOOKING AT HUMAN RESOURCES

Since we are going to talk about manpower, that is, human resources, we must ask ourselves: What is the appropriate investment in an organization of a country's educational system at different stages of development? In other words, is a nation's capital appropriately invested not just at the level of higher education, but in the various branches that make up an educational system.

One of the most important ways of evaluating the effects of education is to assess the extent to which it satisfies a nation's manpower needs. One must be able to monitor almost continuously the trends in order to know, without waiting decades, whether one is proceeding in the right direction. A better understanding of whether or not a given education policy is proving successful requires several indicators for effective monitoring. In addition to the traditional measures such as GNP, per capita income, demographic trends, and health status, it is important to track how manpower needs are filled and can be dealt with in the future. The needs are multiple: agriculture, industry, government, and education itself. In higher education a nation's cultural fabric demands that attention be paid to a balance between the different disciplines and professions.

These issues, together with a "work ethic," indispensable to development, are too important and too complex to be left to a single discipline. It is for this reason that this gathering represents many disciplines, many social roles, many viewpoints, and reflects many experiences. I learned in Washington a saying that I am fond of quoting: "Where you stand depends on where you sit." During the next few days we will have a chance to test this folk wisdom, and I hope fruitfully transcend it.

When one is dealing with skilled manpower, there is a very real constraint: it cannot be produced instantaneously. In spite of the success of some crash courses for learning foreign languages, there is no equivalent to instant coffee for scientific and technical manpower. You must, therefore, take account of the necessary lead times as you look ahead to the next REPELITAs for which you want to obtain the correct and appropriate mix of manpower. When one looks at such issues from the often too-narrow viewpoint of higher education, one can come up with numbers such as 4-8 years. An MIT colleague developed a model of manpower generation that follows about the same kind of cycle as the famous "corn and hog" cycle in agriculture, that is, about 7 years. Among the factors that determine this lead time are several that concern information: How do young people find out about the needs that exist in a society? How well are they (and often their parents) prepared to act upon this information?

In the United States, one of these informational factors can be fairly easily identified. It is probably not decisive, but it represents, at least symbolically, the demands of today. The Sunday New York Times and other key newspapers print supplements listing advertisements requiring various degrees of technical, scientific, and professional education for job openings, and many bright students read those ads before deciding what field they are going to go into. Well, the Italians have a saying "si non e vero, e bene trovato"--if it isn't true, it's at least well invented.

The fact is that young people experience many competing influences with respect to their future careers. Having been provost at MIT for nearly a decade, I am aware of the fact that we had a period during which two-thirds of MIT's undergraduates were engineers, followed by a period in which only one-third were engineers, and now we are back to two-thirds. As you can easily realize, such shifts present severe staffing, space, and tenure problems for educational institutions as well as problems of intellectual balance. This represents just one example of our problems of development, but it does raise a question: Should we remove the freedom for every student entering MIT that allows him or her (25 percent of the students at MIT are now women) to choose their major? They are among the brightest students in the country, and their motivation is a great asset for the future. Thus institutions are forced to make mid-course corrections more often than they would like to, and there is no peaceful, steady state in education, only continuing adaptation.

In going from the first industrial revolution to what people now call the second or even the third technical revolution, we sense a continual state of change. Whether this change represents revolution or evolution, we have a growing ecology of knowledge institutions. That ecology needs continuous readjustment which means that new institutions are born and that societies should also have the necessary courage to decide that certain institutions no longer play a useful role and give them a decent burial. However, that is a hard thing to do.

INSTITUTIONAL GROWTH IN THE UNITED STATES

I would like to speak briefly about institutional growth in our country, not as a model but just as a case history. We saw earlier that the French started their institution building in the areas of science and technology in the late 18th and the early part of the 19th century. In the United States, the first institution--which most of you are familiar with--was Harvard, which was founded in 1636. It is interesting to read why Harvard was founded (there were only six students at the beginning): "...so that our future (religious) ministers would not be illiterate." That was a very special purpose, and I think Harvard has survived that initial purpose rather well.

Morrill Act

Industrialization and its influence upon education in the United States was perhaps most expressed in the 1860s. At that time, the United States was involved in a civil war about the issue of slavery and yet, in the midst of that war, certain actions were taken that had far-reaching consequences. Perhaps the most far-reaching action was the Morrill Act, or the so-called Land-Grant Act. Adopted by Congress in 1862, and signed by President Abraham Lincoln, the act specified that "...there should be at least in each state, one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

That act was responsible for the creation of two institutions in each state. One kind of institution became known as the "aggies" (also known as the "cow" colleges) and the other as the colleges of mechanical arts. Those institutions have played an enormous role in transforming the United States from an agricultural into a modern society. Our great private institutions--Harvard, Yale, Columbia, Princeton, and, after the second World War, Stanford--all left their imprint on our country, but the living embodiments of the Morrill Act--the universities of California, Michigan, Minnesota, Illinois, Iowa, Wisconsin, etc.--made American higher education unique. Of course, these universities did not remain confined to the applied fields but followed the broader charter spelled out in the act.

It may surprise you to learn that MIT is a strange combination: a private institution but also a land-grant college. MIT was founded in the early 1860s, and President Lincoln signed the charter of the National Academy of Sciences in 1863. This was an explosive period for the birth of new institutions capable of acting as motors of societal progress, and much of American industry was built by alumni of these institutions.

The Impact of Graduate School

It was only toward the end of the 19th century and the beginning of the 20th century that graduate schools started to make their impact. American academics visited Europe, were impressed with the model of the German university with its graduate work, and adapted that model to American realities. That was a very important step. In 1910, Flexner was asked to review the status of American medical schools for the Rockefeller and the Carnegie foundations. He did so and concluded that besides other weaknesses they were not making effective use of advances in the natural sciences. This new knowledge was beginning to supplement the then-traditional practice of medicine as an art. But problems of education never stay "solved." At the Institute of Medicine, which is part of the "Academy complex," we are undertaking a study that one might call "Flexner revisited"; looking at medical education almost three-quarters of a century later, one wants to be sure that it is not only up to date in biochemistry, but that it also encompasses the population sciences, the behavioral sciences, and modern information handling in order to equip the future physician for practice in today's society.

Science and Government

These were some of the developments in higher education. During this same period, the Academy expanded its activities. In 1916, it established the National Research Council to bring together scientific and technical talent in relation to the war effort. In 1918, President Woodrow Wilson asked the Academy to perpetuate the National Research Council to stimulate research, to "survey the larger possibilities of Science," to promote international cooperation, etc. The period after the Second World War saw a further extension of the National Research Council which is today the operating arm of the Academy complex.

The Second World War, with its Manhattan Project and its radiation laboratory (where radar was largely developed), gave the nation an entirely different consciousness regarding the potentialities of science and technology and the institutions required to translate these promises into reality. Vannevar Bush's Report to the President,* Science the Endless Frontier, of the mid-1940s spelled out the vision for the post-war era. It led almost directly--but not without considerable pulling and hauling--to the formation of the National Science Foundation in 1950. Its first appropriation was $3 million, and it specified that no money was to be spent for social science. Today the National Science Foundation has a budget of roughly $1 billion.

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*Requested by President Franklin Roosevelt and submitted to President Harry Truman.

Many other government agencies support science. Today, the National Institutes of Health, whose major growth occurred under President Dwight Eisenhower, contribute even more than the National Science Foundation in support of basic research (in this instance, biomedical science) in the United States. The several government agencies, most of which are mission oriented, constitute an overall pluralistic scheme which allows the research universities to integrate forefront research into graduate and postdoctoral education. In addition, the United States has many government laboratories and a large number of industrial R&D units. Government support of research is characterized by the fact that most of this money is not spent intramurally (that is, inside governmental institutions). Rather, it is used to sponsor research in the universities and elsewhere under what we call "peer control," that is, ideally speaking, the quality is controlled by the best peers in the country. Undoubtedly this system has weaknesses, but we have developed something like an ecology of knowledge institutions, which, by and large, operates reasonably well and which is strongly coupled to the development of scientific and technical manpower.

The United States has over 3,000 institutions of higher education (including junior colleges), over 12 million students, and about .75 million faculty members. Each year, these institutions grant about 1 million bachelor's degrees, approximately 400,000 master's degrees, and over 30,000 doctor's degrees. However, only about 55,000 bachelor's degrees and about 2,500 doctorates are in engineering. As a comparison, Japan graduates about 65,000 engineers annually or one-sixth of all Japanese bachelor's degrees. Our health care system employs over 5 million people, and roughly 15,000 M.D.s are graduated from our medical schools each year. We are thus dealing with a rather significant number of people involved either directly in science or technology and in systems based on the use of science and technology.

If I may speak with some levity, through the ages humans--at least in the West--have longed for a fountain of youth. The American graduate school is a reasonable approach to this desire: it keeps old professors "alive"; it forces them to stay alive--otherwise, they will have no graduate students. The graduate students provide intellectual transfusions wherever they themselves go to learn. The graduate school is a rather unique institution since it has established, via the sponsorship of research, relations to government and to industry. It is not unusual to see a graduate student act as a consultant either to an industry or to a government agency. Graduate and postdoctorate students tend, of course, to make the rest of the academic staff obsolete. Sometimes we do not like the tempo at which this obsolescence occurs; but in Lord Flowers' formulation, institutions of knowledge are driven by intrinsic forces (that is, forces coming from inside the disciplines) and by extrinsic constraints that express societal needs. There is thus a need for compromise between these two sets of forces, a compromise that benefits both society and scientific and technical progress.

APPENDIX E

The Science and Technology Institutional Policymaking System in Indonesia

Sukadji Ranuwihardjo

This short paper will give background information on the organization, responsibilities, and working mechanisms of governmental agencies and institutions that deal with science and technology in Indonesia. While decisions on national policymaking in science and technology lie in the hands of the President of the Republic, which follows the Guidelines of State Policy (GBHN) promulgated by the People's Consultative Assembly (MPR) every 5 years, interactions of various governmental agencies and institutes bear the burden of delineating and specifying the details of science and technology policy at the operational level.

Since the modification in 1978 of the State Ministry of Research, established in 1973, to become the present State Ministry for Research and Technology, the Minister is responsible for the formulation and coordination of government policy in research and technology and their application for national development. However, the development of research and sciences within the educational system lies within the responsibilities of the Minister of Education and Culture.

The following illustrates the implementation of responsibilities of the Minister of State for Research and Technology, which is the central focus of this paper.

ORGANIZATION OF SCIENCE AND TECHNOLOGY IN INDONESIA

Six national science and technology institutes are not within the responsibilities of a certain ministry (nonministerial government institutes):

- Indonesian Institute of Sciences (LIPI)
- National Atomic Agency (BATAN)
- National Outerspace Institute (LAPAN)
- Coordinative Agency for National Survey and Mapping (BAKOSURTANAL)
- Central Bureau of Statistics (BPS)
- Agency of Development and Application of Technology (BPPT).

By presidential decrees numbers 44 and 45 of 1974, all technical ministries were requested to establish an Agency for Research and Development, with the main objective to give support for the successful mission of that individual ministry. Among these, the Ministerial Agency of the Ministry of Agriculture has been the largest. Under its jurisdiction, many well-established research stations and institutes are located throughout the country.

There are 43 state universities as well as hundreds of private higher learning institutions that have research institutes, centers, and laboratories of their own. The formulation of science policy and its implementation within the educational system lies completely under the responsibility of the Minister of Education and Culture.

THE SCIENCE AND TECHNOLOGY POLICYMAKING SYSTEM IN INDONESIA

In the context of the policymaking system on science and technology in Indonesia, special reference should be made to the Indonesian Institute of Sciences (LIPI). LIPI controls 11 national research institutes covering natural sciences, technology, and social and cultural sciences. It was established by presidential decree in 1967 as a reorganization of the defunct Institute of National Research and the Indonesia Science Council (MIPI). Its major tasks have been specified as:

- Fostering the development of science and technology in Indonesia for the benefit of human welfare and the Indonesian people
- The pursuit of scientific truth, in which academic and research freedom is secured
- Preparing for the establishment of an Indonesian Academy of Sciences.

To implement its major tasks, LIPI performs certain functions, the most important of which are:

- To render advice to the national government on the formulation of a national policy on sciences
- To give direction and guidance on the development of existing research and technology agencies
- To foster and develop research manpower with the goal of creating a high-quality scientific staff
- To establish collaboration with international agencies and foreign scientific institutes.

The role and function of LIPI in the policymaking system in science and technology is very important. With the establishment of the office of Minister of State for Research and Technology in 1973, the coordinating function of the policymaking system in science and technology as well as the administrative and budgetary control of national research and scientific institutes are assumed by the Minister of State for Research and Technology. He is also responsible for coordinating the functioning of governmental research and development agencies in the technical ministries to assure good cooperation and their convergence toward the goal of national development.

In 1978, the Minister of State for Research and Technology established the Team for the Formulation and Evaluation of National Major Programs on Research and Technology. The main task of the team is to formulate a national program on research and technology and to continuously monitor and evaluate planning and implementation.

The Minister subsequently issued five major priorities of research and technology covering:

- Basic human needs
- Natural resources and energy
- Industrialization
- Defense and security
- Social, economic, and cultural factors; philosophy and law.

Each of these covers the categories of land, sea and marine, air and space, and environment, so that these major priorities can be visualized as a national matrix on research and technology. Since its establishment in 1978, the national matrix of research and technology has become the framework of research programs of nonministerial governmental research institutes as well as ministerial research and development agencies. The content of the matrix has been developed as a rolling plan and revised or redefined to focus more sharply on national priorities through consensuses reached in national workshops on science and technology which are held every 2 years.

The direct leverage of the Minister of State for Research and Technology is on nonministerial governmental research institutes through the scrutiny of their annual budgets. This assures that the programs of those agencies will be convergent to the needs of national development and also guarantees the optimal use of financial resources. The coordinative function of the Minister of State for Research and Technology upon Ministerial Agencies of Research and Development is implemented through national workshops and coordinative meetings held every year.

CONCLUDING REMARKS

Salient points on the mechanism of science and technology policy system in Indonesia involves five major points:

1 A political decision on science and technology is promulgated by the People's Consultative Assembly (MPR) once every 5 years as a part of the Guidelines of State Policy (GBHN) which are mandatory and implemented by the President of the Republic.

2 At the executive level, the responsibility for formulating science and technology policy is in the hands of the President. He is assisted by the Minister of State for Research and Technology and the Minister of Education and Culture in the matters related to educational systems. In formulating the science and technology policy, the President also receives advisory input from the Indonesian Institute of Sciences.

3 Under the President, the Minister of State for Research and Technology assumes responsibility for formulating and planning an overall science and technology policy to assure that all scientific and technological efforts will be directly geared toward national development objectives.

4 The Minister of State for Research and Technology is responsible for the coordination of science and technology activities of all governmental agencies.

5 Ministerial Agencies of Research and Development work under the directives of their prospective ministers, yet these programs should be convergent with the overall science and technology policy, which in the last 5 years has been formulated in the National Matrix of Research and Technology.

APPENDIX F

Current Science and Technology Manpower Development Planning in Indonesia

Didin S. Sastrapradja

INTRODUCTION

As we are already aware, science and technology play an important role in the socioeconomic development of a country. Conversely, to be able to perform their roles effectively, science and technology must themselves be developed. Thus the two are reciprocally dependent. From this standpoint, it follows that developing an indigenous capability in science and technology is a prerequisite for a developing nation to achieve progress.

The most pressing problem confronting developing nations such as Indonesia is the acute shortage of qualified scientific and technological personnel. This is a serious drawback since such personnel are the key factor in science and technology development.

Much effort has been made by the Indonesian government to overcome this manpower problem. During the past several years national education at all levels has been vastly expanded quantitatively. State universities have been established in all but one province, and the number of university graduates has soared in the past several years. Nonetheless, all these efforts are far from adequate to meet the growing need for qualified manpower.

Thus it becomes increasingly clear that development of human resources must receive top priority. This is particularly true in the case of scientific and technological manpower. This paper will attempt to highlight some possible action programs to remedy the situation.

CURRENT PROBLEMS

Despite the growing yearly output of university graduates, Indonesian research institutions always have a hard time recruiting the needed research staff. The Indonesian Institute of Sciences (LIPI), for instance, never has succeeded in filling all the yearly increase of allotted research personnel. In a way, this state of affairs sounds a bit controversial since, according to a much publicized report, there are many Indonesian university graduates who remain unemployed for an extended time due to the limited availability of suitable jobs. To some extent both statements are verifiable.

There is a strong tendency for the present young generation to think that a career in the field of science and technology is anything but appealing. Inadequate salary, limited living facilities, unclear prospects for the future, etc., are among the factors that discourage young prospects. It may be true that material gain is not the primary motivation for a career scientist or technologist, but everyone knows that it is necessary. Thus to neglect it is to incite grievous consequences.

In terms of salaries and other facilities, private enterprises, especially foreign-based private companies, have much more to offer. Therefore, it is normal for them to become the primary targets for those seeking jobs that pay well. And more often than not, they get the best candidates, since government research and development institutions cannot match their salaries.

Although there are many universities in Indonesia now, the total yearly output is still too small to meet the increasing national need. This, of course, reflects the limited productive capacity of the Indonesian universities. Many of these universities, especially the ones located outside Java, are still in the developing stage and are composed only of a limited number of faculties. In other words, only certain branches of science and technology are covered. Lack of laboratory facilities, shortage of teaching staff, and inadequate teaching material aggravate the already unfavorable situation. All these problems contribute to the limited productive capacity mentioned above.

We are all aware of the importance of knowing a foreign language--English, in the case of Indonesia--as a master tool for anyone engaged in science and technology activities. However, the ability of a large number of Indonesian university graduates to use English is very minimal. This situation has handicapped the recruitment for and upgrading of science and technology programs.

ACTION PROGRAM

In light of the aforementioned situation, development of scientific and technological manpower will be the focal point of our program for the next several years--not only to increase the quantity but, more important, to improve the quality of trained manpower. This is a tough task. It requires cooperation and concerted effort of all institutions concerned as well as political will from the government.

The following are some feasible measures for action programs.

1. Upgrading of Research Staff

To some extent the upgrading activity has been carried out regularly. During the next several years, however, this activity will be drastically increased. All possible ways and means will be explored and utilized to the maximum to get the best result. The program will include degree and nondegree programs and formal and nonformal education, in-country as well as abroad. Postgraduate studies and research studentships will be part of a regular and continued program for junior staff. Participation in international scientific meetings, study tours, and refresher courses for senior scientists are to be encouraged and accelerated.

2. Recruitment

To fill the immediate needs for young research personnel, active promotion and talent-scouting programs are necessary. The following three action programs are considered feasible.

- To provide scholarships for interested potential students currently studying in various universities abroad. After finishing their studies, they are obliged to return to Indonesia to work for the government at a given research institution for a certain period of time.

- To select the best potential high school students and educate them at government expense in universities abroad or in country. At the termination of the schooling, they would serve at government research institutions for a predetermined period of time.

- To motivate Indonesian scientists working in overseas institutions to return and work in Indonesia. Adequate research facilities, a good research atmosphere, and decent salaries are necessary to accomplish this goal. This strategy has been implemented successfully in South Korea.

3. Making Science and Technology Attractive

There are ways to make a career in the field of science and technology more attractive than it is at the moment. Some of the important ones include:

- Develop a Stimulating Career System. Presently the career system in science and technology is regulated by Presidential Decree No. 22 of the year 1977. It is elaborated by LIPI and circulated in the form of document 419/Kep/J/10/1980, dated April 28, 1980.

  According to this regulation, scientists and technologists enjoy a ranking system which, unlike the ordinary government's employees, is nonstructural and open in character. That is, any research worker is eligible for the top-most rank, irrespective of the structural staffing formation. Of course, he/she must be very good in the job. There are four ranks in all, each of which carries an additional monthly remuneration, which differs according to rank.

At the moment, however, the system is applicable only to research workers and does not apply, for instance, to librarians, statisticians, computer experts, technicians, etc. Since we know that without their assistance research workers would be extremely hampered, a similar career system for supporting staff also must be developed.

- Develop a Better Incentive System. To stimulate better work and greater productivity, some type of incentive system should be developed. Incentives or rewards should be given to research workers who have produced outstanding results. It may be in a material or nonmaterial form. Material incentives can be in the form of housing facilities, transportation means, financial rewards, etc.

- Adopt a Sabbatical Leave System. As in most research institutions in the world, Indonesia is contemplating the adoption of a sabbatical leave system to give Indonesian research workers a chance to deepen and broaden their scientific horizon. This would give them a free hand to select whatever research they want to do and to develop freely their expertise and know-how in their respective scientific discipline and specialization.

OTHER NECESSARY MEASURES

Without an adequate infrastructure and effective supporting mechanisms, it would be difficult for scientists to achieve maximum results. Therefore, these two aspects must be taken into account in developing an indigenous science and technology capability.

One important factor requiring our immediate attention is the availability of sufficient funds for scientific and technological activities. The budget presently allotted for research and development in Indonesia amounts to about 0.2 percent of the GNP. To foster R&D activities, the budget needs to be increased to at least 1 percent of the GNP as recommended by the Conference on the Application of Science and Technology in Asia I (CASTASIA I) in 1968.

A suitable academic atmosphere is necessary for the growth of national science and technology. It includes many aspects, namely, better personal relationships, greater freedom to select research topics, and more opportunities for research workers to participate in the process of planning, programming, and directing their institutions. Scientific gatherings are to be promoted and scientific associations fostered and strengthened.

The principal contribution of science and technology to national development is the provision of data and information obtained through research and development activities. It is evident that the science and technology information system network in this country has to be upgraded and expanded in the best possible manner. Capability in data processing and analysis needs to be improved. To support all these activities, a national computerized data center is an absolute necessity and must be established without delay.

Another possibility worth considering is to take advantage of available senior scientists from developed countries nearing retirement to do research in Indonesia. Undoubtedly such scientists are very well versed in their field of specialization. It would benefit Indonesia if these scientists could be persuaded to spend a year or so in this country to do research and, at the same time, train as many junior scientists as possible.

Last, but not least, contracting researchers (packet system) for university students who show promising talent may be worth trying. In this way interest in research and development as a profession may grow among the university students.

EXPECTATION AND FACTS

As mentioned in the opening address, the Minister of State for Research in his 1977 report to the cabinet put forward a future projection of the need for scientific manpower up to the year 2000. The figures adopted were the results of a 1976 workshop on the needs for scientific and technological manpower sponsored by the office of the Minister of State for Research. At its conclusion, the workshop projected scientific manpower needs to be 33,650 in 1975; 119,500 in 1985; and 391,850 in 2000. This projection took into account the predicted growth of GNP, expansion of the sectoral development program, and population growth.

The total scientific and technical personnel in 1975 was estimated to be 10,250. Assuming that figure to be correct, it is evident that to meet the projected figures, the manpower has to be multiplied many fold, namely, 11.7 times by the year 1985 and 38.2 times by the year 2000. In view of the current limited productivity of the existing universities, to reach such a high level is out of the question.

The Ministry of Education and Culture has optimistically predicted that university graduates in 1985 will number around 148,120. Past experience indicates that about 1.6 percent of these graduates will take positions in research and development institutions. In other words, only 2,370 of these university graduates will enter into research and development as a profession. Thus, from 1975 to 1985 the yearly shortage of manpower, as compared to the projected need, would be 8,585 in the average (see Table 1).

THE NEED FOR GRANTS-IN-AID

From the above table it is evident that we must look for other ways and means to minimize the gap. Indeed, an effort has been initiated but only on a piecemeal basis. To be more effective this effort must be greatly accelerated and expanded. It must also be carried out in an integrated manner involving all relevant institutions. Vocational schools, polytechnics, nondegree extension

TABLE 1 Projected Need and Input From Universities of R&D Personnel

School Year	Projected University Graduates	Estimated R&D Manpower Input[a]	Projected Yearly Increase (Average)[b]	Shortage
1980/1981	36,943	591	8,585	7,994
1981/1982	51,958	831	8,585	7,754
1982/1983	72,242	1,156	8,585	7,429
1983/1984	91,381	1,462	8,585	7,123
1984/1985	116,567	1,865	8,585	6,720
1985/1986	148,120	2,370	8,585	6,215
TOTAL	517,211	8,275	51,510	43,235

[a] It is assumed that 1.6 percent of university graduates settle for R&D professions.

[b] Figures in this column are derived from the following simple calculation:

Ideal manpower need in 1975 = 33,650
in 1985 = 119,500
Shortage = 85,850
Yearly average = 8,585

programs, and other similar programs have to be established all over the country.

Notwithstanding the importance of enhancing education and training in science and technology within the country, there is no denying the importance of education and training in other countries. They serve to complement those organized nationally, and thus they deserve promotion and encouragement. The need for overseas education and training is felt more strongly in those scientific disciplines that are given low priority or are being neglected in Indonesian universities.

Up to the present, nearly all overseas education and training are made possible by study grants and scholarships provided by a number of industrialized countries and international bodies. Thus the opportunities for researchers to improve their skills and know-how by training outside their own country are very minimal. To remedy the situation Indonesia must initiate action programs. A suggestion has been forwarded to the government to explore the possibility of locating resources of the state for this purpose.

In the meantime, efforts should be initiated to obtain as many grants-in-aid as possible, covering as many fields of science and technology as possible. Those already at hand must be utilized more effectively and efficiently. The grant-in-aid program should include various aspects, such as study grants, research grants, consultants, scientist exchange program, study tours, laboratory facilities, etc. Grants to organize training courses for special skills, such as R&D management, R&D methodology, and on-the-job training, would be very valuable, since such training can accommodate a greater number of participants at a relatively lower cost.

Regarding the present meeting, it would be most appropriate if it uses this opportunity to determine the best-suited cooperative programs between Indonesia (Ministry of State for Research and Technology, LIPI) and the United States (National Academy of Sciences). We do hope that the Academy will be in a position to assist us in our effort to strengthen our scientific and technological manpower by implementing the aforementioned action programs. To do so, we propose the following ways:

1. Provision of grants-in-aid for manpower development. It may take the form of:

   - Study grants in overseas universities, covering degree and nondegree programs
   - Sponsorship for training and various scientific meetings in Indonesia
   - Funds for research in some special aspects of science and technology
   - Funds for participation in international scientific meetings abroad
   - Provision of experts and consultants.

2. Promotion by NAS in order to draw the attention of U.S. scientific foundations, government institutions, and private organizations, and to invite support for Indonesia.

3. Identification of appropriate universities in the United States for Indonesian students or research workers assigned to study there. Pre-registration communication with top ranking university officials through NAS will hopefully facilitate entry procedures.

4. Exploration of the possibilities of inviting qualified and available U.S. senior scientists to do research on local problems in Indonesia for a couple of years. These scientists would work together with Indonesian scientists, and the activities would include on-the-job training for young Indonesian scientists.

Bearing in mind the facts and problems described above, it is concluded that all possible means and ways must be pursued and tested in our drive to strengthen Indonesian scientific and technological manpower resources. Since manpower development takes a long time, the steps mentioned above must be taken immediately. If not, the gap between the existing manpower resources and the projected ones will get even wider, and our goal to be self-reliant in science and technology may remain only a goal for the years to come.

APPENDIX G

An Overview of Higher Education in Indonesia with Special Emphasis on Science and Technology

D. A. Tisna Amidjaja

To obtain a clear picture of the state of the art and the planned directions for development of science and technology education on the tertiary level in Indonesia, it is necessary to look at the total framework of the higher education system. This is true, especially, due to the fact that the whole system is still in the process of development. In this process, the proper functioning of the institutions of higher learning and the limited resources serving the functions of the institutions should be more closely linked. Policies of priority setting should be designed so as to ascertain the development of all the fields of studies needed by society and demanded by the development process as stipulated in the REPELITAs. Indeed, a new era of planned national development in Indonesia, begun in 1969, has had a bearing on the development of higher education.

In the period between the establishment of the first institutions of higher learning in 1950 and the initial years of planned development in Indonesia, higher education evolved without an integrated cohesive strategy among the universities, and each followed its own conceived role and course of development. Meanwhile, development was hampered by severe shortages of funds and uncertainty concerning the overall development of the country's economy.

Since the beginning of the "new order" in Indonesia, much rethinking has been done and many studies have been made seeking answers to basic questions about higher education. These have been used to formulate systematic development policies for higher education in Indonesia and to derive roles and define functions within and among the institutions of higher learning that are relevant to the needs and challenges of this fast-developing country. Higher education has, since then, embarked upon a more systematic pattern of development.

THE CHALLENGES CONFRONTING HIGHER EDUCATION

Clearly, in fast-developing countries such as Indonesia, education, and particularly higher education, play an important role in fulfilling the demands of development for breakthrough ideas and in providing the needed manpower. In trying to cope with their missions at an ever-increasing pace, scope, and magnitude, while fully aware of their shortcomings, the institutions of higher learning are facing tremendous challenges covering a very broad front:

- Catering to the increasing demands for higher education
- Fulfilling the demand for professionals and highly skilled technicians, created by the fast-developing economy of the country. In many cases, new programs have to be developed to respond to new requirements in quality or even to new types of professions
- Fulfilling the requirements of improving the nation's research capabilities, in particular its manpower aspects
- Catering to the needs of the higher education system itself, in particular the provision of the needed manpower to alleviate the present shortages and to meet the requirements for growth and expansion
- Fulfilling the ever-increasing expectations and needs of society for the public services of the university.

THE PROBLEMS OF HIGHER EDUCATION

In entering the new phase of planned development in the early 1970s, we realized in general that our higher education was hampered by many shortcomings from meeting the new challenges and demands of a growing society. No relevant data on a nationwide scale existed, however, to identify the problems more specifically and for further strategic planning of development. If data were available, they would have to be processed to reveal certain performance indices of our higher education in general. This would, in turn, convince the universities of the necessity for a systematic approach in the total development of higher education, in which each institution of higher learning should consider itself as one link in a single chain, each of which has a specific task in confronting the tremendous problems in concert. To identify these shortcomings, surveys were conducted in 1974-1975, and were analyzed to formulate basic solutions and the necessary corrective actions.

Institutions of higher learning face many problems, a number of which stem from the central problem of low internal efficiency. Internal inefficiency diminishes higher education's ability to contribute effectively to national development. Below are some of the features of low internal efficiency:

- Low productivity. This is manifested by high dropout and high repeater rates. Repeaters prolong normal study time, inflate the total number of students, and, in a vicious circle, contribute to a diminution of institutional efficiency.

- Low absorption capacity in meeting the expanding needs created by the development of an expanded secondary education system. This amplifies problems of student selection at the tertiary level.

- Inadequate budgets. These adversely affect all aspects of the teaching-learning process.

- Unequal distribution of institutions among the different regions. There is too high a concentration of institutions of higher education on Java.

- Levels and types of fields of study are not structured to meet the real needs of Indonesia. Too much emphasis has been placed on the "first degree" level of training and "academic" education which fails to relate theory into practice. Too little attention has been given to other levels and more practical types of post-secondary education.

- Rapid expansion of the system has made it difficult to recruit highly qualified and dedicated staff. This is exacerbated by the limited resources available to pay satisfactory salaries and maintain a high level of personal professional development to serve the national interest.

THE BASIC ISSUES OF HIGHER EDUCATION

In formulating solutions and long-term programs, we have to face certain basic issues of higher education.

- How to utilize scarce resources as efficiently and effectively as possible.

- How to devise an academic structure and courses of study that cope with the needs of a rapidly changing society.

- How to interpret and implement the principle of regional equity and balanced growth in the system.

- How to keep human resources abreast of new developments and nurture their personal interest and commitment to national development.

- How to increase the absorption capacity of higher learning institutions in order to deal justly in the selection of students from the expanded secondary system while serving the needs of national development.

To be able to respond to these issues, a "systems" development approach to problem-solving has been adopted. The pattern of random growth among the universities has been left behind. In the development process, each institution of higher learning is considered one link in a single chain. Together, they confront mounting problems while moving toward a common goal.

The system is "mission" oriented. Having identified roles and functions within the system, each institution is assigned particular tasks relevant to the institution and the nation as a whole. The programs of each institution are developed with a certain degree of autonomy. These missions aim at the short-term as well as long-term goals of higher education.

To establish the new system, higher education has to face the problem of developing three processes simultaneously:

1 Improving the performance of the prevailing "system"

2 Searching for methods of changing to a more relevant national system of higher education

3 Increasing institutional growth in order to increase absorption capacity to meet the growing demands of higher education.

BASIC POLICY ON THE DEVELOPMENT OF HIGHER EDUCATION

Based on the findings of the 1974-1975 surveys, the Minister of Education and Culture decreed the "Basic Policy for the Development of Higher Education." This policy instructs and guides the development of higher education and post-secondary education institutions. These policies include:

- The roles and functions of institutions of education:

  -- Play the role of development agents, introducing the modernization process to effect national development.

  -- Have three unified functions which are specified in the TRIDHARMA. This trilogy consists of teaching, research, and public service, constituting an integrated whole. The unity function is considered fundamental. It is envisaged that institutions of higher education will become efficient only insofar as they apply this unified concept to the performance of their roles as agents of development.

- Assignments of roles and tasks. Within the "mission-oriented system," specific roles and tasks are assigned to particular institutions. When making assignments, special consideration is given to using the resources of a particular institution, especially in relation to its manpower, while maintaining balanced development among the various institutions located in the regions (islands).

- Basic principles on which the institutional undertakings in higher education are performed. These have been stipulated and elucidated. They include: responsible academic freedom, democratization of the teaching and learning process, life-long education, informal as well as formal education of students, and development of a campus and academic community.

- Management principles within and between the higher education institutions as well as the relationship between the government (state) and the institutions. These principles aim at developing a "systems management" pattern to serve as a guide to higher education institutions exercising a certain degree of autonomy. However, it assists in establishing complementary linkages between the institutions and is orchestrated in a national framework of long-range development, with the basic policy guidance of the government.

- Work program. Short-term, medium-term, and long-term work program policies are outlined. These concern key issues of prime importance which must be dealt with in order of priority if we are to improve higher education according to a systematic strategy.

TOWARD THE IDEAL NATIONAL SYSTEM OF HIGHER EDUCATION

Basic development policy is geared toward the establishment of a national system of higher education, consisting of public and private institutions and operating under a single management pattern. Within such a system, the possibility exists of assigning particular roles and functions to each institution. In this way, institutions serve national purposes as well as those related to their local environments. As envisaged in the "Guide to the Implementation of Basic Development Policy," the national system of higher education will evolve in line with the following operational policies:

- A well-formulated enrollment allotment will be given to each institution for the next 10 years, relating its particular roles and functions to the service of national as well as local needs.

- Academic disciplines of each institution will be restructured in the next 10 years in accord with its assigned roles and functions.

- A general policy on education will govern the work of the system with regard to standardizing educational processes and student requirements and ensuring cooperation among the universities.

- Administrative commitments will be made to ensure program support for the long-term development plan.

- Universities will be committed to staff development, and infrastructure support will be given to programs that the administration has determined conform with agreed strategies.

These policies must be pursued if the system is to be established.

From these operational policies a program structure was developed, comprising major program categories, major programs, and programs serving as the "Framework for Long-Range Development of Higher Education." Each institution of higher learning derives its annual and long-range development plan from this framework by means of the generally adopted "PPB System" and through the guidance of the so-called "Coordinative Program Memo" of the Director General of Higher Education, indicating the budget ceilings for the major programs for the following year, while indicating the trend for 3 consecutive years and program priorities.

Priority is being given to mitigating the bottlenecks experienced in the present system. Policies are aimed at solving problems in order to improve the productivity of higher education. Because these policies aim at immediate effects, they are considered short-term measures. In view of the nature and scope of limitations faced by the system, even these short-term policies need about 5 years to be effected.

It is anticipated, therefore, that efforts should be undertaken to implement simultaneously:

- Measures aimed at improving the performance of higher education while at the same time laying the foundations for more controlled growth

- Measures aimed at restructuring higher education and directing growth and evolving the system of higher education of the future. Development of the basic features of the new system and their subsequent manifestation are estimated to take 8 years.

Implementation of both short- and long-range policies should be considered against the background of realities in a developing society. This background is characterized by its ever-increasing demands, in particular, its demand for more education.

- Within the structure of the academic disciplines, priority has been assigned to: teacher education, engineering, sciences, management, and accounting. Agriculture and health are also fields that still need pushing. At present, relatively good programs exist in both, however, through foreign participatory programs. An academic structure that consists of nondegree, undergraduate, and graduate degree programs will require structuring academic disciplines into 3- and probably 4-digit classifications in the near future. These will be developed at later stages. The limited resources faced presently, and in the foreseeable future, dictate that resources be allocated to programs having high priority. The fundamental aspects of structuring academic fields to meet the nation's priority needs requires further study and elaboration if priorities are to be assigned rationally.

- The issue of enrollment is pressing and must be faced realistically by the administration. It is both socially sensitive and constitutes one of the most important variables in the planning of the budget structure. No easy solutions are in sight, but it must be coped with innovatively in the years to come.

- The enrollment problem cannot be solved by the public sector alone. It is, therefore, of major importance that the private sector become a viable contributor to the mitigation of enrollment pressures. Participation of the private sector in the national system of higher education will bring enrollment pressures within manageable bounds.

  A meaningful sum out of the national educational budget is set aside for use by the private sector, on a "matching-fund" principle, to support the development of the public sector.

- Private institutions as well as their public counterparts should design effective nondegree and diploma programs to supplement their present undergraduate degree programs. These programs should be oriented as closely as possible to the labor market.

  For this nondegree program to be meaningful within the system of higher education, large investments are needed, preceded by careful planning and preparation. Important nondegree programs that are now in the pilot project stage include the polytechnic programs and diploma programs for teachers.

- One of the major program categories to be implemented within the next 4-5 years is designed to increase institutional productivity. Within this program, efforts will be made to improve staff productivity by sharing resources. Mobility of teaching staff will be strongly encouraged to permit stronger institutions to assist weaker ones, thus enhancing productivity. Upgrading facilities and training staff in the use of new methods are also seen as ways to improve productivity.

To improve the productivity of students, strong measures will be taken to control the student body by adopting and implementing stricter academic rules. Without providing alternative nondegree courses, however, this option seems to have limited applicability.

Improvement in staff mobility, facilities and methods, and student discipline are thus expected to improve productivity. It is anticipated, however, that the process of improvement will be somewhat slow, in particular during the first years of this program.

- Bringing regional balance to the development of higher educational institutions requires time and the development of sound concepts. Through the distribution of academic disciplines and particular roles and functions to each institution, it is hoped to bring about more balanced growth among the institutions. This is in accord with the principle of regional equity in development, a major concern in the design of the national development system. The balanced approach, however, must be oriented to improve performance and the growth of the educational system. Regional universities should be encouraged to develop major academic programs that are simultaneously relevant to the region and can be developed into a national center of study for other regions experiencing the same needs.

  As a first step toward rectifying the imbalance among institutions, improvement of present basic undergraduate courses leading to the intermediate degree (*Sarjana Muda*) is planned for those institutions that do not yet have this capability. It is expected that within 3-4 years all institutions of higher education in the public sector will at least be up to standard with regard to basic education.

- As noted, the pressure exerted by the need for high-level manpower to implement national development programs has had a profound effect on the higher educational system. Studies have been and are being made to develop satisfactory approaches to solving the problems that have arisen. Several pilot projects are under way at both the postgraduate and the undergraduate nondegree levels, for example, polytechnics, teacher education. It is expected that these programs will have matured and will have become regular features of the educational system by the end of the third 5-year plan (1984).

The assumptions underlying these programs are two-fold:

- Both quantitative and qualitative improvement of the higher education staff are necessary for institutions to reach their full growth potential in relation to meeting national manpower needs.

- The establishment of postgraduate training programs for higher education staff is imperative if staff capable of creating and implementing degree and nondegree/diploma programs that meet most high-level manpower needs are to be available.

THE ADMINISTRATIVE SETTING

Post-secondary or tertiary education in Indonesia encompasses a broad spectrum of fields of studies implemented in several types of institutions, which can be classified as public or private.

Authority for all education catering to the general labor market and the needs of society rests with the Ministry of Education and Culture. Within the Ministry, the Director General of Higher Education (DGHE) controls 51 public institutions of higher learning comprising 30 universities, 14 institutes, and 7 academies of arts. Through directorship of the private institutions of higher learning and the nine coordinators for private institutions, the DGHE also oversees the operations and quality of 360 nonpublic programs in universities and so-called academies. These nonpublic programs also include institutions of higher learning and academies set up by ministries other than the Ministry of Education and Culture and catering to their own needs for manpower (see Table 1), except for those institutions under the Ministry of Religion and the armed forces.

As the chief administrator for higher education, the Director General of Higher Education is assisted by:

- Eleven consortia or boards of academic disciplines, i.e., Consortium for Education; Consortium for Social Sciences and Humanities; Consortium for Medical Sciences; Consortium for Engineering; Consortium for Mathematic and Natural Sciences; Consortium for Law; Consortium for Economics; Consortium for Agriculture Sciences; Consortium for Literature; Consortium for Psychology; Consortium for Interdisciplinary Fields of Studies

- A standing advisory staff consisting of experts on secondment from universities

- Ad hoc committees convened to consider special issues.

Within his executive function, the DGHE works through directorates, each headed by a director: Director for Academic Infrastructure, Director for Private Institutions, Director for Research and Community Service Development, and Director for Student Affairs.

TABLE 1 Types of Post-Secondary/Tertiary Educational Institutions Established by Ministries other than the Ministry of Education and Culture

Ministry	Institution	Years of study
Trade	Academy of Trade	3
	Academy of Metrology	3
Industry	Academy of Business Management	3
	Academy of Chemical Analyses	3
	Academy of Leather Industry	3
	Academy of Technical Industry	3
	College of Industrial Management	2
	Institute of Textile Industry	5
Communication	Academy of Meteorology and Geophysics	3
Health	Academy of Health Supervision	3
	Academy of Anaesthetics	3
	Academy of Roentgen Technology	3
	Academy of Nursery	3
	Academy of Physiotherapy	3
Social Affairs	College of Social Welfare	3
Justice	Academy of Immigration	3 (pending)
	Academy of Socialization (of prisoners)	3 (pending)

Four major kinds of institutions provide higher education:

- Universities with several semi-autonomous faculties
- Institutes with a number of faculties in a single professional field, i.e., the Bandung Institute of Technology; the Institute of Agriculture, Bogor; the Institute of Teacher Training and Paedagogical Sciences
- Hochschule in a single field of study, i.e., Technische Hochschule
- Academies in a single professional field.

THE SYSTEM OF STUDY

The Old System of Higher Education

Until 1979 the predominant features of the system were a framework for study (5 years after 12-13 years of pre-university education) and phasing of study (3 years Sarjana Muda, followed by 2 years at the Sarjana level), according to the old pattern of the Dutch higher education system. The internal arrangements and regulations of study followed the American pattern (credit system, assignments, tutorials, etc.). The system turned out graduates on one level of competence (monostratum system): the Sarjana.

The New Multistrata Higher Education System

A new system of educational stratification was introduced in 1979, and since mid-1979 the gradual introduction of a credit system with course requirements has been in effect. Each program of study consists of required and elective courses. The new system consists of programs in (1) the academic/university stream, and (2) the vocational/professional stream, known as the S-0 or diploma programs.

The academic stream comprises three strata:

- Stratum I (S-I), with a study load of 140-160 credits, to be completed within a minimum of 4 years and a maximum of 7 years. This is the Sarjana level of study.
- Stratum II (S-II) with a study load of 30-60 credits after S-I, to be completed within about 2 years after Sarjana. This is the Pasca Sarjana level of study.
- Stratum III (S-III), with a study load of 60-80 credits after S-II, to be finished within about 2 years after S-II. This is the doctorate level of study.

The vocational/professional stream (diploma programs) comprises: D-I, 1 year; D-II, 2 years; D-III, 3 years; and D-IV, 4 years. Examples of the diploma program are:

- Teachers education (D-I, D-II, D-III)
- Cartography/photogrammetry school (D-I)
- Surveyor school (D-II)
- Polytechnics (D-III).

A Sarjana can enter a specialist program (Spl and Sp2), for example, in technical fields such as highway engineering for civil engineers, and a variety of specialization programs in the medical sciences. A Pasca Sarjana or an Spl holder can enter the super-specialization program, Sp2.

For academicians who would like to enter the teacher/lecturer profession, it is obligatory to take the relevant Akta program, which will confer to them the license of competent teaching. This program has five levels (Akta I-V). Akta I and II confer competence for teaching in primary schools to D-I, D-II, D-III graduates of the institutes for teachers training or to Sarjana Mudas from other faculties (fields of study). Akta III and IV give competence for teaching in the secondary junior and senior high schools respectively, for D-III and Sarjana graduates of the institute for teacher training or from other faculties (fields of studies) with supplementary courses. Akta V gives competence for teaching in the universities (tertiary education), for Sarjanas.

The abilities of S-I, S-II, and S-III graduates are as follows:

- S-I (Sarjana) has the ability to:

  -- apply knowledge (relating to his profession) in productive activities and providing services to society
  -- follow the development of his field of science through scientific literature
  -- apply the concepts of his field of science to efforts that will raise (improve) his professional performance
  -- analyze and comprehend (make conclusions) facts or events relating to his profession or field of science.

- S-II (Pasca Sarjana) has the ability to:

  -- improve the services of his profession through developmental research
  -- participate in the development of his field of science
  -- develop his professional performance in a broader spectrum, through linkages with similar fields of science or professions
  -- formulate approaches for solving problems in society through scientific reasoning.

- S-III (Doctor) has the ability to:

  -- develop new concepts in his field of profession or science
  -- execute, organize, and supervise (lead) research programs
  -- take interdisciplinary approaches for professional application.

SALIENT FIGURES OF HIGHER EDUCATION

To bring the problems of higher education more realistically to the forefront, the following Tables 2-11 should be considered, keeping in mind the following observations.

The participation rate of the respective age groups in higher education is still low (3.7 percent). However, the absorption capacity of the institutions is very low (about 20 percent of the applicants could be absorbed by public institutions of higher learning), while the private institutions nurtured by non-Education and Culture Departments can only accommodate 25-30 percent.

The most serious constraint to increasing the absorption capacity is academic manpower. The teacher/student ratio is in general very low (per university or per field of study): 1:18 for the technical faculty and 1:8 for the science faculty. Of the total number of staff members, only about 14 percent have enjoyed a postgraduate (Sarjana) education. The same situation is true if we consider rank (which is, in a way, an indicator of competence for responsible teaching). Only 6 percent have the status of lektor to professor. By the end of REPELITA IV we will have to triple the number (from 21,000 to 65,000). Of those, at least 50 percent should have a post-Sarjana degree.

The need for graduates of certain fields of study to serve the economic growth is very great. We need to double or triple the annual output of engineering, science, agriculture, accounting, economics, and management graduates.

The expanding primary and secondary education system also demands a tremendous increase in the supply of teachers, a task that rests with the institutes of teacher education.

SPECIFIC OBJECTIVES

1. The government aims to develop institutions of higher learning as a supportive element to national development by producing a sufficient number of well-educated graduates. Among the disciplines, priority is given to:

   - Education/teaching (supply of teachers for secondary education)
   - Technology
   - Basic sciences
   - Management
   - Accounting
   - Agriculture
   - Health
   - Social sciences/humanities.

MULTISRATA STRUCTURE OF FORMAL EDUCATION

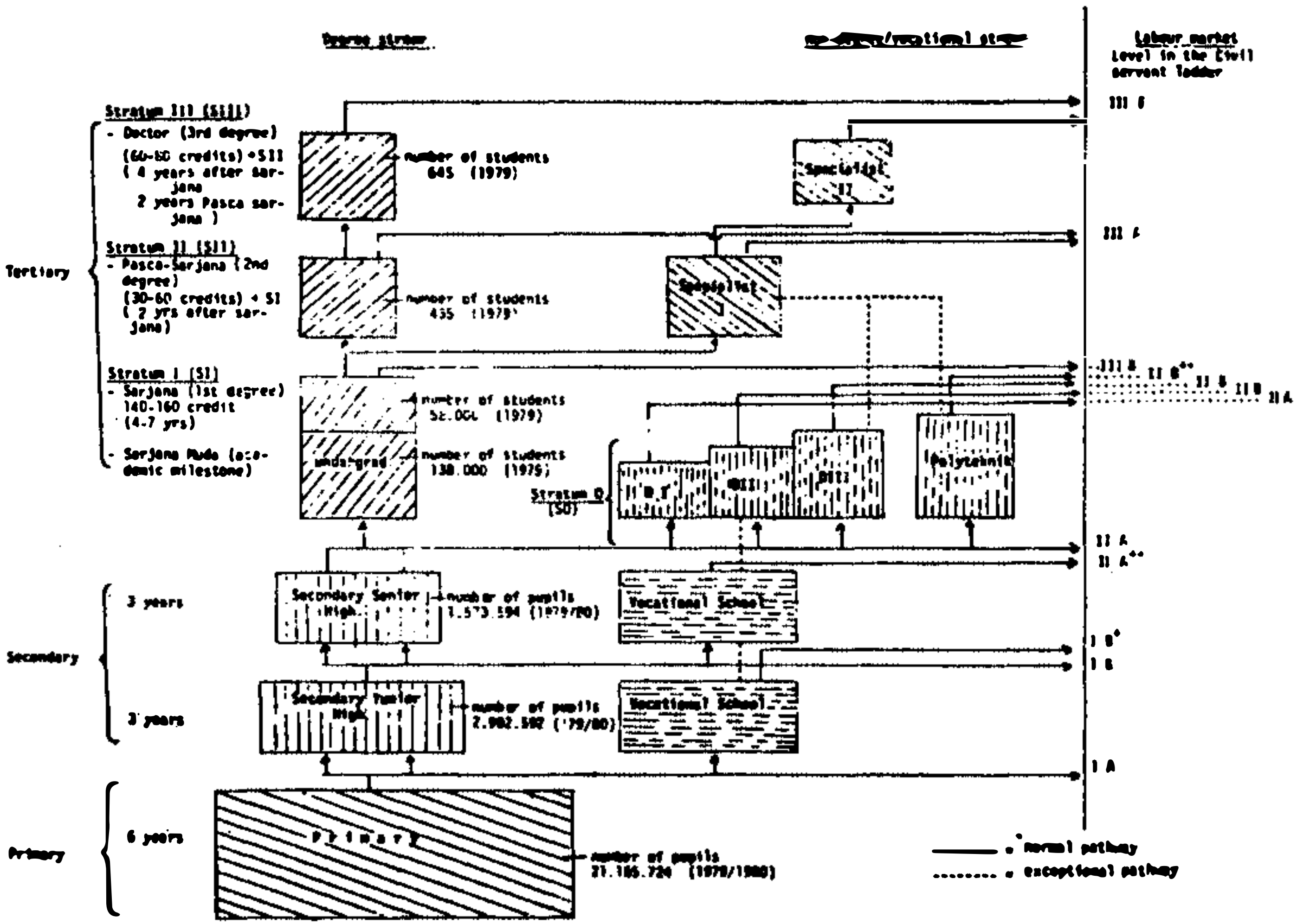


TABLE 2 School-Age Population (in Thousands) and Percent Participation in School Programs, 1979-1982[a]

Type and Level of Education	Number of School/ University Age			Number of Pupils/ Students			Percent of Participation		
	1979-1980	1980-1981	1981-1982	1979-1980	1980-1981	1981-1982	1979-1980	1980-1981	1981-1982
Primary School	23,858	24,497	25,456	17,836	18,855	20,274	74.8	76.9	79.6
Madrasah Ibtidaiyah				2,149	2,074	2,613	9.0	8.5	10.3
Secondary Junior High School	10,419	10,707	10,758	2,895	3,329	3,731	27.8	31.1	34.7
Secondary Junior Vocational High School				86	84	74	0.8	0.8	0.7
Secondary Senior High School	9,168	9,522	10,052	543	1,036	1,262	9.2	10.9	12.6
Secondary Senior Vocational High School				489	486	460	5.3	5.1	4.6
Secondary Sport School				242	232	214	2.7	2.4	2.1
Tertiary Education	15,374	15,930	16,298						
o Degree Program				420	497	559	2.7	3.1	3.7
o Nondegree (Diploma) Program				22	28	38	0.1	0.2	0.3

[a]Total Population, 1980-1981: 147,490,298; 1981-1982: 150,912,070.

TABLE 3 Number of Applicants and Number of Accepted New Students in Public Institutions of Higher Learning, 1979-1982

Pilot Project for Selection	1979-1980		1980-1981		1981-1982	
	Applicants	Accepted	Applicants	Accepted	Applicants	Accepted
I	96,230	14,300	139,525	15,015	156,556	16,161
II						
III	48,139	22,376	71,959	21,601	96,332	25,317
IV	48,866	12,102	57,974	31,028	67,636	14,847
I K I	631	554	961	656	1,167	768
TOTAL	193,866	49,332	270,419	50,300	321,691	57,093

NOTE: We see in Table 2 that participation of the respective age groups in higher education is low (3.7 percent). The plan is to increase the student population until 5 percent of the age groups are enrolled by the year 2000. To achieve this, the absorption capacity of the institutions of higher learning should be increased. The above table shows a capacity of only about 18-20 percent for public institutions.

TABLE 4 Number of Students Who Graduated Sarjana Muda (3-Year Program) as a Percent of the Total Student Body, According to Field of Study, for Public Institutions of Higher Learning, 1979-1982

Field of Study	1979-1980			1980-1981			1981-1982		
	Number of Students	Graduates	Percent	Number of Students	Graduates	Percent	Number of Students	Graduates	Percent
Psychology	1,215	36	3.0	1,254	59	4.7	1,896	51	2.7
Social Sciences	14,327	755	5.3	16,000	1,331	8.3	18,139	1,714	9.4
Mathematic and Natural Sciences	7,789	357	4.6	8,054	536	6.6	9,449	322	3.4
Education	60,173	6,263	10.4	69,682	7,989	11.4	77,078	7,892	10.8
Technology	24,592	1,713	7.0	27,428	1,881	6.8	28,779	646	2.2
Health Sciences	11,873	779	6.6	12,539	672	5.4	12,943	266	2.1
Law Sciences	25,982	1,257	4.8	27,464	1,960	7.1	33,194	1,019	3.1
Economics	26,069	1,543	5.9	27,581	2,670	9.7	30,658	1,952	6.4
Agriculture	21,375	1,201	5.6	24,984	1,671	6.7	28,816	1,726	6.0
Letters/Philosophy	6,867	363	5.3	7,733	855	11.0	9,389	632	6.7
Interdisciplinary	1,274	186	14.6	1,702	172	10.1	2,183	164	7.5
TOTAL	201,536	14,452	7.2	224,421	19,796	9.0	248,524	16,358	6.6

TABLE 5 Number of Students Who Graduated *Sarjana* as a Percent of the Total Student Body, According to Field of Study, for Public Institutions of Higher Learning, 1979-1982

	1979-1980			1980-1981			1981-1982		
Field of Study	Number of Students	Graduates	Percent	Number of Students	Graduates	Percent	Number of Students	Graduates	Percent
Psychology	1,215	112	9.2	1,254	120	9.6	1,896	1,896	6.6
Social Sciences	14,327	670	4.7	16,000	909	5.9	18,139	1,202	6.6
Mathematic and Natural Sciences	7,789	634	8.1	8,054	705	8.7	9,449	700	7.4
Education	60,173	1,744	2.9	69,682	2,239	3.2	77,078	3,048	4.2
Technology	24,592	1,772	7.2	27,428	2,119	7.7	28,779	2,400	8.3
Health Sciences	11,873	1,132	9.5	12,539	1,254	10.0	12,943	1,213	9.4
Law Sciences	25,982	932	3.6	27,464	1,276	4.6	33,194	1,575	4.7
Economics	26,069	1,039	4.0	27,581	1,172	4.2	30,658	1,201	3.9
Agriculture	21,375	1,532	7.2	24,984	1,583	6.3	28,816	1,957	6.8
Letters/Philosophy	6,867	143	2.1	7,733	254	3.3	9,389	317	3.4
Interdisciplinary	1,274	17	1.3	1,702	25	1.5	2,183	18	0.8
TOTAL	201,536	9,727	4.8	224,421	11,657	5.2	248,524	13,757	5.5

TABLE 6 Number of Students in Private Institutions of Higher Learning, Distributed Over Seven Regions

	Program				
Region	S-O	S-I	S-II	S-III	TOTAL
I	-	23,034	-	-	23,034
II	757	77,934	71	8	78,770
III	4	42,482	16	6	42,508
IV	638	35,081	7	3	35,729
V	167	25,931	9	9	26,116
VI	1,103	54,961	13	6	56,083
VII	-	25,085	6	2	25,093
TOTAL	2,669	284,508	122	34	287,333

TABLE 7 Number of Students in Private Institutions of Higher Learning, and Number of Students and Graduates in the Departments of Mathematic and Natural Sciences and Engineering

		Mathematic and Natural Sciences					Engineering				
			Graduates					Graduates			
			Sarjana Muda		Sarjana			Sarjana Muda		Sarjana	
Region	Number of Students	Number of Students	Local	State Exam	Local	State Exam	Number of Students	Local	State Exam	Local	State Exam
I	23,034	-	-	-	-	-	3,516	144	73	2	-
II	77,934	-	-	-	-	-	14,284	438	344	129	241
III	42,482	256	17	-	8	-	9,417	615	163	32	2
IV	35,081	376	11	-	-	-	8,630	758	226	50	10
V	25,931	-	-	-	-	-	2,714	119	56	91	-
VI	54,961	-	-	-	-	-	6,750	430	37	37	18
VII	25,085	-	-	-	-	-	3,863	147	95	-	-
TOTAL	284,508	632	28	-	8	-	49,174	2,651	994	341	271

TABLE 8 Number of Academic Staff, Specified According to Academic Degree Obtained in Public Institutions of Higher Learning, 1979–1982

	1979–1980			1980–1981			1981–1982		
Academic degree	Number of Public Institutions	Faculty of Physics	Tech-nology	Number of Public Institutions	Faculty of Physics	Tech-nology	Number of Public Institutions	Faculty of Physics	Tech-nology
Sarjana Muda	-	-	-	1,226	16	138	341	26	62
Sarjana	14,639	851	1,312	16,808	862	1,343	19,153	940	1,473
Doctorate	418	61	47	473	67	49	691	98	81
Master's, etc.	283	33	33	396[a]	34	34	105	-	6
TOTAL	15,340	945	1,392	18,803	979	1,564	21,290	1,064	1,622

[a]Including 16 senior high school-graduated instructors of the Surakarta Academy of Dance Arts.

TABLE 9 Academic Staff on the Faculties of Physics and Engineering, Specified According to Rank, in Public Institutions of Higher Learning, 1979-1982

	1979-1980			1980-1981			1981-1982		
Faculty	II	III	IV	II	III	IV	II	III	IV
Physics	71	640	172	60	738	181	34	828	202
Engineering	125	1,081	248	138	1,172	254	68	1,284	270

KEY:
II = Technical Assistants
III = Instructors
Assistant Professors
IV = Associate Professors
Professors

TABLE 10 Ratio of Teachers to Students in 40 Public Institutions of Higher Learning

Institution of Higher Learning	Number of Teachers	Number of Students	Ratio of Teachers to Students
UI	1,739	11,732	1 : 7
IPB	598	3,369	1 : 6
ITB	630	6,263	1 : 10
UGM	1,402	17,276	1 : 12
UNAIR	967	4,758	1 : 5
UNPAD	1,326	10,681	1 : 8
IKIP Jakarta	463	4,654	1 : 10
IKIP Bandung	384	8,503	1 : 22
IKIP Malang	347	3,245	1 : 9
USU	894	9,175	1 : 10
UNAND	527	3,746	1 : 7
UNSRI	532	7,423	1 : 14
UNLAM	352	4,996	1 : 14
UNMUL	131	3,008	1 : 23
UNHAS	720	8,502	1 : 12
UNUD	515	6,995	1 : 14
UNSOED	234	1,945	1 : 8
UNDIP	548	6,610	1 : 12
UNS	682	7,989	1 : 12
UNIBRAW	609	5,288	1 : 9
ITS	296	3,455	1 : 12
UNEJ	280	5,549	1 : 20
UNSYIAH	425	394	1 : 13
UNRI	215	2,656	1 : 12
UNJA	67	1,483	1 : 22
UNILA	174	2,850	1 : 16
UNTAN	129	3,694	1 : 29
UNPAR	96	835	1 : 9
UNSRAT	438	5,546	1 : 13
UNRAM	110	1,972	1 : 18
UNDANA	215	2,358	1 : 11
UNPATTI	205	2,707	1 : 13
UNCEN	101	1,556	1 : 15
IKIP Medan	485	5,107	1 : 11
IKIP Padang	339	1,811	1 : 5
IKIP Semarang	328	3,500	1 : 11
IKIP Yogyakarta	383	4,938	1 : 13
IKIP Surabaya	410	3,273	1 : 8
IKIP Ujung Pandang	329	3,738	1 : 11
IKIP Manado	349	3,220	1 : 9
TOTAL	18,974	201,930	1 : 11

TABLE 11 World Bank Estimates of the Supply and Demand for Certain Technical Manpower in Indonesia, 1979 and 1990

			Annual Additional Needs			
	1979	1990	Demanded by Economic Growth	Attrition	Total	Output of Higher Education (1979)
Engineers	15,000	69,000	5,000	300	5,300	1,400
Scientists	5,000	21,000	1,600	100	1,700	500
Agriculturists	8,000	26,000	1,800	200	2,000	1,300
Accountants	1,600	11,000	900	-	900	200
Economists	5,000	16,000	1,100	100	1,200	300
Administrators/ Managers	No data	337,000	-	-	-	500

NOTE: The calculation was based on 7 percent economic growth, an increase of employment of 3 percent, and an attrition rate of 2 percent.

For technology, a so-called "boosting program" is under way for the fields of civil engineering, and electrical, mechanical, and chemical technology. To achieve these aims, efforts are being made to improve productivity by:

- Expanding and improving physical facilities and staff to accept more students
- Improving student services and welfare
- Strengthening the management and organization of universities.

2. A new system of educational stratification was introduced in 1979:

   - The S-I strata will be standardized by 1986, will be based on a core/minimum curriculum for each field of study, and will introduce the semester-credit-system. The standard curriculum will be supported by certain criteria, i.e., teacher-student ratio, basic facilities, and instructional materials.
   - Diploma programs will be expanded. For the coming REPELITA IV, much effort is demanded to establish 6-12 new polytechnics (D-III), which are very capital-intensive investments. Yet the universities are encouraged to explore other diploma programs (D-I, D-II, D-III), which are not so capital intensive but have a high absorption capacity, such as diploma programs in the commerce sector and services and agriculture (field extension workers, interpreters, etc.).
   - The S-II and S-III programs, now under way as pilot projects in institutions of higher learning (they should already be established) in their definite form, will serve mainly to improve the quantity of the university staff.
   - The Sp1, Sp2 specialist programs (nondegree) will be developed especially for the medical field, and for certain specialization in engineering, for example, highway engineering, high-rise building, project management.

3. Universities which meet certain requirements will be given administrative support to establish an institution for research. Each university is encouraged to formulate its own "Major Scientific Orientation" (Pola Ilmiah Pokok, or PIP).

4. Each university/institute should submit its master plan for development over the next 10 years which will be implemented, that is, by "phase and turn," in REPELITA IV. Certain universities will be developed as the center of growth in a region and will also support the growth of other institutions in the region. Two universities that will serve this purpose are:

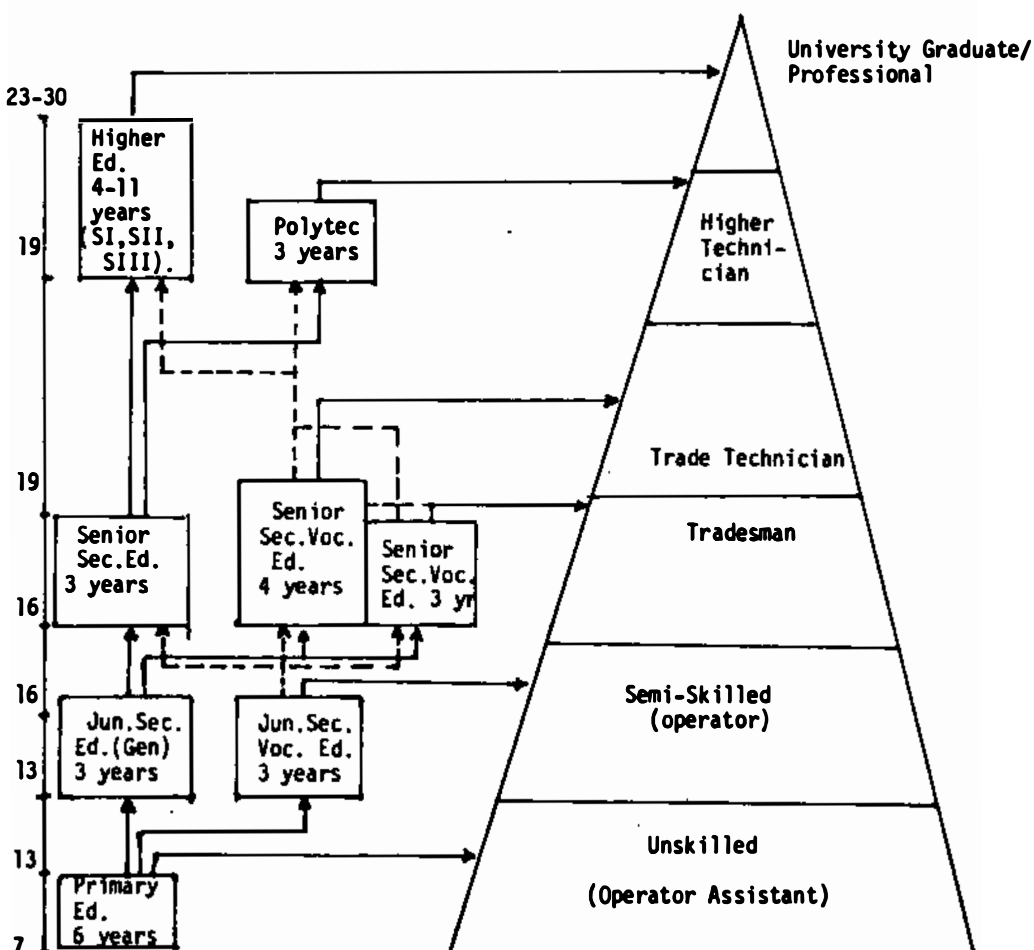
- Hasanuddin University for the eastern island universities
- University of North Sumatra and University of Sriwdjaja for the western universities.

The University of Indonesia and Bogor Agricultural University will move to the new campus (at least a greater part of the faculties) in REPELITA IV.

5. "Distant-Learning" techniques will be used for upgrading teachers and lecturers and to overcome the shortage of experienced staff members.

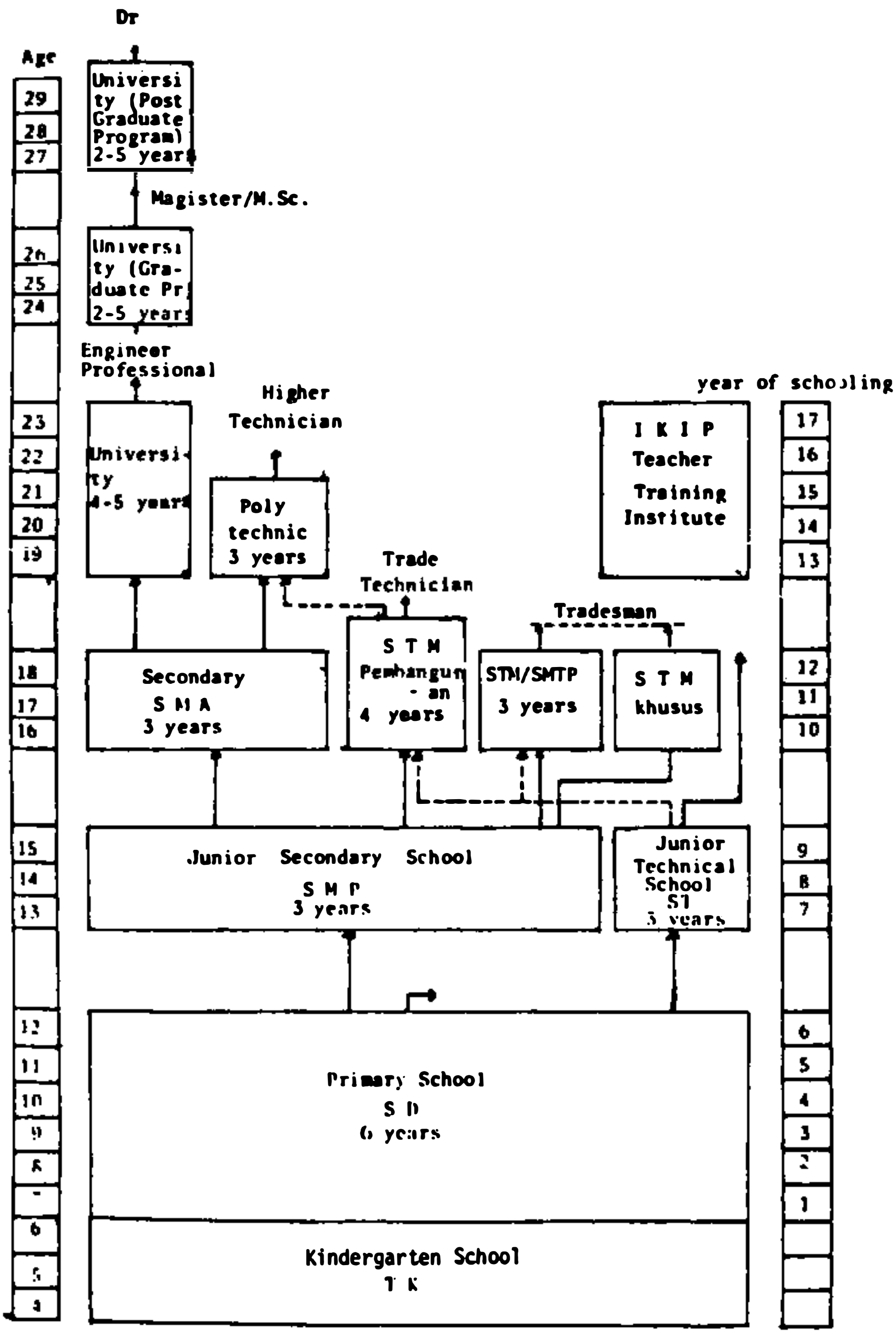
PRESENT AND FUTURE TRENDS OF THE TECHNICAL EDUCATION AND TRAINING SYSTEM IN INDONESIA

Based on the envisaged structures of modern industries and traditional ones, the following diagrams depict the existing educational and training structure in Indonesia.



School Ladder Structure

Labour Force Pyramid.


Dr
Age
University (Post Graduate Program) 2-5 years
Magister/M.Sc.
University (Graduate Pr 2-5 years
Engineer Professional
Higher Technician
year of schooling
University 4-5 years
Poly technic 3 years
I K I P Teacher Training Institute
Trade Technician
Tradesman
Secondary S M A 3 years
S T M Pembangun - an 4 years
STM/SMTP 3 years
S T M khusus
Junior Secondary School S M P 3 years
Junior Technical School ST 3 years
Primary School S D 6 years
Kindergarten School T K

The engineer's education follows the pattern and the average study load as described earlier. To obtain more practical experiences, linkages and cooperation are being and will be established with industries or with other users.

A good example is the design of the study program for electrical power engineers, where the curriculum and facilities were developed through tripartite cooperation between ITB-PLN-EDF. An additional semester (tenth semester) was fully devoted to practical training relevant to PLN's needs.

The polytechnic education is intended to train higher technicians. It includes a well-balanced, industrial-oriented training program, 45 percent of which is practical and laboratory work and 55 percent is theoretical education during the 3 years of training that totals about 5,000 hours. The educational program stresses the link between applied engineering and commerce theory and its practical use in industry or enterprise. At present there is one government polytechnic for mechanics in the Bandung Institute of Technology, as a result of Swiss and Indonesian Government Technical Cooperation, and it has been in operation since 1976. Six more are being built with credit from the World Bank, and they will start in operation on September 20, 1983, offering mechanical, electrical, electronic, and civil engineering. These six new polytechnics are located at Medan, Palembang, Jakarta, Bandung, Semarang, and Malang.

Eleven more are being planned and will be located in the provincial capitals. Their programs will include basic engineering in civil, electrical, electronics, telecommunication, chemical processess, power and energy, refrigeration and air conditioning, aeronautics, shipbuilding, foundry, and commerce. It is expected that they will begin accepting students by 1986. Agricultural polytechnics are also being planned for future development.

Vocational education is a skill-oriented education to fulfill the industrial demand for skilled craftsmen, and consists of about 50 percent practice and 50 percent related applied theory, covering engineering vocations, arts and crafts, music, traditional dance, social work, home economics, and commerce. These schools, mainly the public ones, are being developed and rebuilt by the development budget and loans from the World Bank, Asian Development Bank, and other bilateral financial credit or technical cooperation.

There are more than 500 public schools at present which have to be improved and updated, with about 22,500 graduates each year.

Limited skill training to serve the need for operators or limited skill workers is mostly done by the Ministry of Manpower through the establishment of fixed or mobile training centers throughout the country. These centers offer programs that range from industrial vocations and agriculture to home economics and business vocations.

This training is limited in time, ranging from 2 to 6 months per package, and has continuity in its progressive packages. This is intended particularly for the informal sector to train and retrain the existing industrial personnel as well as to train new job seekers.

Other ministries also offer limited skill training either for youths or adults, including the Ministry of Public Works, Ministry of Agriculture, Ministry of Youth, and Ministry of Education and Culture. On-the-job training is conducted by industry itself.

THE CRITICAL PROBLEMS OF TECHNICAL EDUCATION AND TRAINING

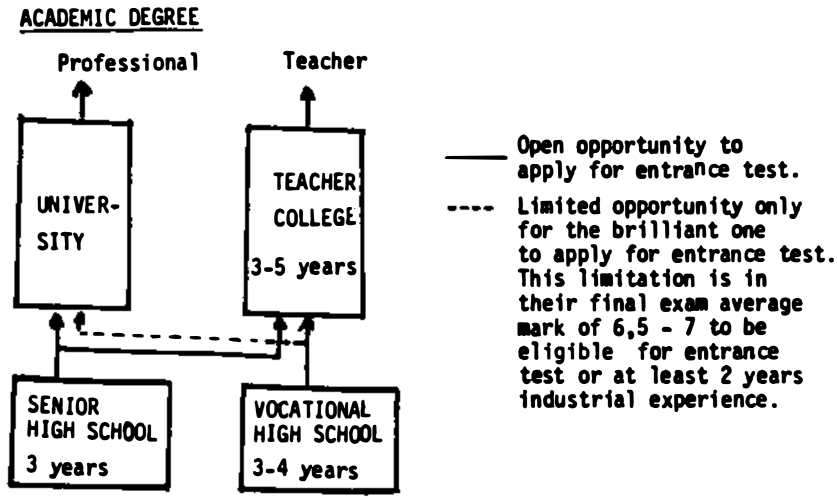
The most critical problems of technical education and training are teachers and instructors. Industrialized countries can afford to have technical teachers and instructors from the ranks of technicians or engineers who have had years of industrial experience in their system involved in teacher formation. For Indonesia as a developing country to adopt such a pattern is an illusion rather than a solution for several reasons:

- The industries, especially the modern ones, are still in their infancy. They had been established only several years when Indonesia embarked upon its 5-year plans, and they still have problems in recruiting qualified personnel to run their operation. Skilled personnel remain scarce, and they still need on-the-job training. The labor turnover is high, since hijacking of scarce qualified personnel among industries takes place, creating spiraling salary competition among the industries.

- In general, the salary scale in industry is much higher than in the educational sector. However, experienced people are still scarce in industry despite the better salary scales. Adopting the industrialized country's teacher formation system, although obviously desirable, in the end will be counterproductive.

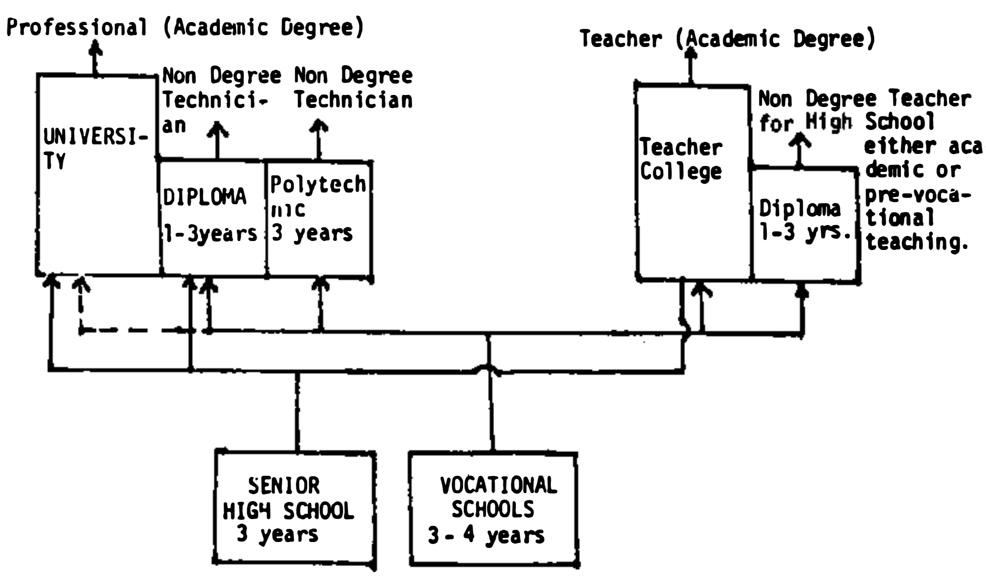
A different system, therefore, has to be created to form a sound starting point for the long-term future of teacher formation in a spiraling progressive process of industrial and economic development.

In general, the present teacher formation system in higher education is as follows:



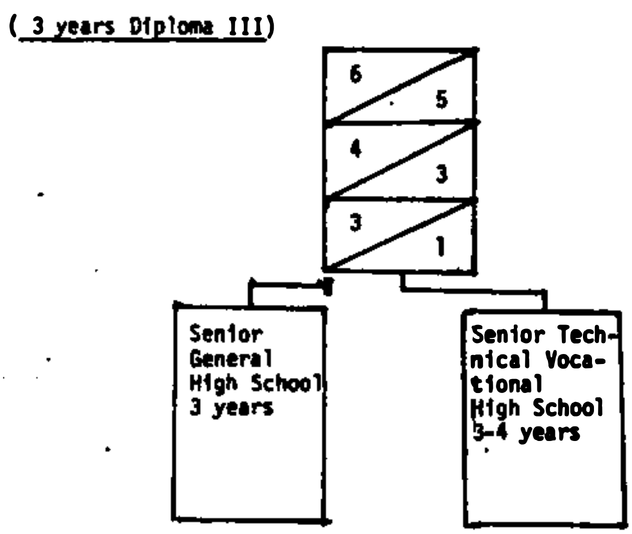
Senior high school graduates could take the program for high school teachers as well as that for vocational high school teachers, while graduates of senior vocational high schools are mostly in line for vocational teacher training. The programs for high school as well as for vocational high school teachers are theoretical or academic in nature and lack proficient skill training facilities. Most of the programs, if not all, are classroom-based theoretical teaching. Only recently two new technical teacher colleges (4-year) oriented to craftsmanship teacher training were established with assistance of a World Bank loan. The first 500 graduates will join the vocational education system in 1983. Although they are still in an academic environment, we hope that the outcome will be better, yet they will still need further improvement.

Since teacher needs in high schools and vocational high schools are far beyond the present scheme's capacity, a new scheme was recently developed as follows:



Since the provision of vocational teachers is not met quantitatively by the present scheme, and the level of their technical and vocational skills is still far from expectations, a new scheme of vocational teacher training integrated with total vocational school development has been created through the Vocational Education Development Center (VEDC), similar to the Polytechnic Education Development Center (PEDC). The VEDC has the following functions, among others:

- Studying the needs for applied technology in industry and its manpower needs to ensure curriculum relevancy
- Developing curricula for the schools
- Developing educational facilities and equipment for the schools
- Developing educational technology
- Providing teacher training and education
- Developing school management systems and training
- Providing industrial personnel with formal and informal training in specific fields
- Adopting and developing applied technology for dissemination to the schools or industries.



This scheme of vocational school teacher education is a 3-year Diploma-III program comprising three odd semesters in VEDC training of 2,640 hours and three even semesters of 2,400 hours of supervised teaching practice in the vocational schools. The three semesters in institution education (VEDC) is heavily oriented toward craftsmanship training and related applied theory (75 percent) and toward teaching methodology and didactics, including micro teaching/instruction (25 percent). This scheme currently is intended for workshop instructors as well as for applied theory teachers. All students are on a bound scholarship.

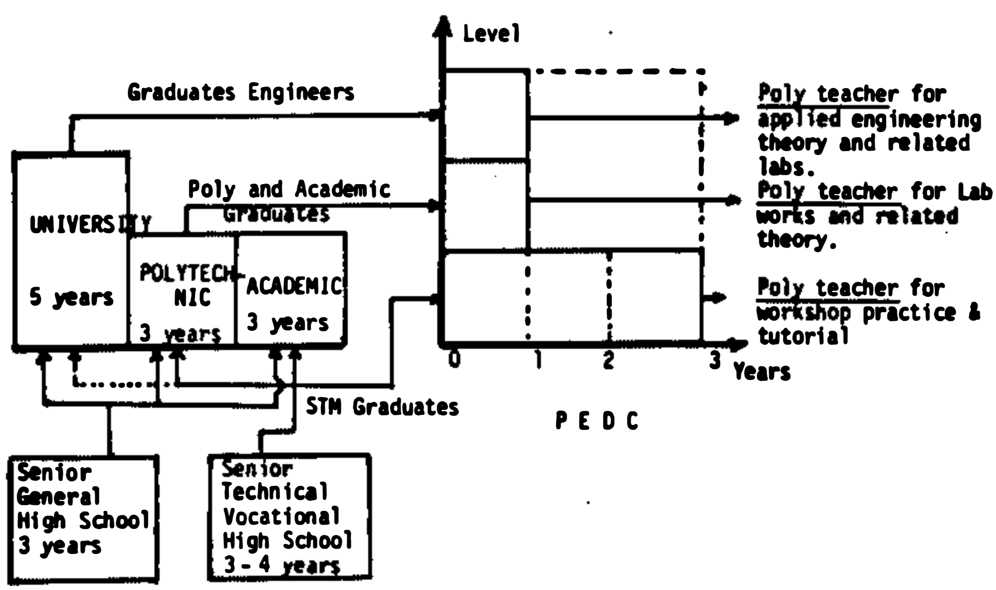
Three such VEDCs for engineering will be established: one is already in operation in Bandung under Australian-Indonesian Technical Cooperation and two are undergoing planning and construction, one in Medan with an Asian Development Bank (ADB) loan and UNESCO Fund in Trust Agreement and one in Malang under an ADB Loan with Swiss-Indonesian Technical Cooperation which is still being finalized. With these three engineering VEDCs we expect to fulfill our present need for 13,500 technical teachers/instructors within 9 years.

One VEDC for arts and crafts is being planned in Yogyakarta with an Asian Development Bank loan, and another for agriculture to be located in Cianjur is being studied by the Japanese team from the Japan International Cooperative Agency (JICA) before its planning and design. The agricultural VEDC has 45 hectares of farmland for practical farm training which may be partially financed by an ADB loan.

There are three types of polytechnic teachers:

1. Graduate engineers have to undergo adaptation training for 1 year in a Polytechnic Education Development Center (PEDC) to supplement their technological knowledge and skills (academic) with the more practical knowledge and skills needed to meet industrial needs. They must also follow the teaching methodology course. After the 1 year of training, these engineers become the lecturers for applied engineering theory as it is used in industry and also supervise some related laboratory work.

Polytechnic teacher education and training in PEDC has three levels of input at the development stage:



2. The polytechnic or academic graduates have to undergo 1 year of training to brush up on their engineering knowledge and skills and to obtain industrial-oriented knowledge and skills and to improve their laboratory work. They also must follow a teaching methodology course and teaching practice. Their major duties after finishing this training are to supervise the laboratory experiments, teach related theory, and conduct practical workshop training.

3. The technical vocational school graduates have to take 3 years of training in VEDC to reach at least the level of the Diploma-III polytechnic. Their major program is more professional workshop practice, laboratory experiments, and theory. After training, their major duties are teaching workshop practice, supported by workshop theory and laboratory experiment tutorials.

APPENDIX H

BACKGROUND MATERIAL DISTRIBUTED TO THE WORKING GROUP ON BIOTECHNOLOGY AND AGRO-INDUSTRY

Biotechnology: Indonesian Biological Resources Development Programme

Indonesian Institute of Sciences

This document represents a proposal on the establishment of an Indonesian Biological Resources Development Programme. The main objectives of the programme are to increase the benefit, the economic value and the yields of Indonesian biological resources, especially those which have not been developed as economic commodities but have the potential and are already being used by the community on a small scale.

Indonesia has rich and diverse biological resources. Many indigenous plants, animals and microorganisms could be exploited as sources of carbohydrates, protein, oils, fats, vitamins and many other chemicals for medical and industrial purposes. These commodities could contribute to the growth of the domestic commercial and industrial sectors, especially in the rural areas, because many of the sources of these commodities are found in rural areas and have been used by the community. The increased utilization of biological resources would generate secondary economic activities, such as processing and other industrial and commercial activities close to the source of raw materials. All of this will strengthen and diversify the economic basis in the rural areas. On the other hand, the new raw materials would form inputs in the production of new commodities and the stimulation of new economic activities in other regions and in cities.

One of LIPI's (the Indonesian Institute of Sciences) tasks is directed toward the development of science and technology and their application in the process of national economic development. Some research institutes of LIPI are already working on inventory, identification and evaluation as well as development of ways of improving the use of underdeveloped biological resources. The results are expected to be useful for the production diversification of plant and animal sources for food, health and industry. In turn, this will also diversify and expand job opportunities.

To extend the effort of improving the use of various underdeveloped commodities, an integrated development programme including research, development and manpower training should be established. Manpower development should be given special attention if this programme is to be realized faster. On the macro basis this programme will require the recruitment and advanced training of some 400 scientists, technicians and research managers.

Research development and training activities of this programme will be focussed in the area of food, feed, energy substitutes and chemicals which can be extracted from the indigenous flora and fauna of Indonesia. To fully develop these themes it will be necessary to complement the innovative work of LIPI and its institutes with additional financial and technical assistance. The estimated cost of manpower training, research and experimental production facilities and technical assistance is approximately $32 million for 10 years, excluding the cost of land which has been provided by the Government of Indonesia. The budget is expected from bilateral or international aid in the form of grants as well as loans.

BACKGROUND INFORMATION AND JUSTIFICATION

The objective of the proposal for the establishment of an Indonesian Biological Resources Development Programme will be to diversify and enhance the production and utilization of Indonesian biological resources, especially those which have not yet been developed into economical commodities.

The application of science and investment in research to improve the national capability in science and technology and to facilitate the development of Indonesian natural resource potentials is a well-established principle of past and current National Development Plans. Emphasis has been placed on stimulating the development of primary resources such as oil, natural gas, timber, and fisheries, as well as the intensification and the extension of agriculture into new areas outside Java to facilitate transmigration.

This has led to increased production of primary resources and food supplies and the expansion and diversification of economic activity. Further efforts are being made to diversify the economic base and to broaden employment opportunities through stimulation of secondary economic activity based upon the processing of raw materials into finished products for export and as inputs into the domestic economy. However, many indigenous renewable natural resources remain undeveloped and could offer further opportunities for major economic development and the improvement of the welfare of the Indonesian people.

The population of Indonesia is estimated at 150 million and is expected to increase to over 200 million by the year 2000. With this large and rapid growth in population, the development and diversification of biological resources can play a crucial role in expanding economic growth, catalyzing economic activities for domestic production and experts, expanding and improving food supplies, and generally contributing to enhance standards of nutrition, health and social welfare.

Our existing knowledge of biological resources indicates that many plants, animals and microbes offer themselves as sources of carbohydrates, protein, oil, fats, vitamins, minerals, medicinal bases and other materials, and have high potentials to be developed to have a value to commerce and industry. Various microorganisms also offer benefits to agriculture and agriculturally based industrial activities. Therefore, these biological resources are potential foreign exchange earners.

Based upon the current level of development and utilization, the biological resources in Indonesia can be grouped into four broad categories:

1. Resources that have been utilized, cultivated and intensively developed through agricultural methods (e.g., rubber, coffee, rice, cows);

2. Resources that have been utilized and cultivated, but have not yet been intensively developed (e.g., indigenous fruits, mushrooms, local chicken);

3. Resources that are known and utilized by harvesting directly from the wild cultivation management (e.g., medicinal plants, tengkawang, wild fruit species, marine algae);

4. Biological resources that are still relatively unknown: (e.g., microorganisms, plants and animals of economic significance).

The first group is represented by commodities which are already economically very important. The second group is made up of materials which are constantly utilized in the immediate surroundings of human settlements, but have not yet been developed intensively to become commodities of economic importance. In contrast, the third and fourth groups constitute the major underdeveloped biological resources in Indonesia.

If the resources potentials inherent in groups I-IV are to be fully realized, gaps between the current activities of basic, development and applied research agencies must be bridged. Based on the above considerations, a programme has been initiated by LIPI (the Indonesian Institute of Sciences) to develop the economic potential of biological resources of groups II, III and IV, and to enlarge the diversity of group I. This programme proposes the development of biological resources as an extension and rationalization of the research activities of the institutes within LIPI.

Research institutions within LIPI, i.e., the National Institute for Chemistry (Lembaga Kimia Nasional) and the National Biological Institute (Lembaga Biologi Nasional), are already carrying out work related to biological resources. For example, the National Biological Institute has undertaken a major inventory and evaluation of potential biological resources. Likewise, the National Institute for Chemistry has helped to identify chemical substances which can be extracted from biological sources and has developed techniques for their extraction. However, further actions in the form of integrated development efforts should be established. In this programme, efforts to integrate the activities could be developed to result in data and biological resources ready for development and application management.

As the programme evolves it will act as a clearinghouse for information and will offer data, materials, and advice on new procedures and processes, and ultimately will stimulate the government, commerce, and industry to start production. As links are strengthened between the programme and agencies such as the National Resource Survey and Mapping Agency (BAKOSURTANAL), the scope of information on the availability and utility of biological resources will be increased.

In addition to this very important role of increasing our awareness and understanding of potential biological resources and the development of methods of increasing their production and availability, the programme will complement other initiatives stimulated by the Government of Indonesia; among others it will facilitate important inputs to the activities of "PUSPIPTEK" at Serpong which is responsible for developing the technology so that it can be produced economically. Benefits from this new programme will also be experienced by various Ministries, such as those of Health, Industry, and Agriculture through improvements in the supply of medicinal substances or biofertilizers. The programme will also, in time, be able to accommodate specialized research on problems faced by other government agencies, industry and commerce. The programme should therefore be seen as bridging gaps between existing programmes which indicate the possibility of developing new forms of utilization of potential biological resources and programmes on production enlargement and diversification of economic commodities from plant, animal and microorganism sources.

Foreign donor assistance will be required to help in accelerating the development of the programme, especially funds for manpower training and research assistance, which will complement the initiative displayed by the Indonesian Institute of Sciences and its member institutes. When completed, this programme will have helped in achieving a better understanding of the potential domestic commercial and industrial uses of hitherto underdeveloped biological resources.

OBJECTIVES OF THE BIOLOGICAL RESOURCES DEVELOPMENT PROGRAMME

In accordance with Indonesia's Five-Year Plans, the main objective of the programme is to diversify and enhance the production and utilization of underdeveloped biological resources. The programme will contribute to the development of materials and processes which could further strengthen the national economic base and the sectors of Agriculture, Industry, Public Health and Rural Development.

a. Long-range objectives (25-30 years)

1. To increase economic growth through the stimulation of various forms of primary and secondary economic activity,

expansion of employment opportunities, increased efficiency of production and the diversification of domestic materials and exports

2. To improve standards of living and welfare of the society through the development of indigenous biological resources for new food sources, improved nutrition and health and the diversification of the economic commodity base.

a. Immediate objectives (5 years)

1. To establish a core group of scientists to initiate the research and development programmes of the center

2. To formulate a 5-year programme in order to convert the potential biological resources into new sources of food, medicinal, commercial, industrial, and domestic materials

3. To develop and implement a training programme to build up the skills of the core group of scientists, and to facilitate the increase of the availability of manpower by means of integrating the R and D, training and education activities

4. To rationalize and improve the facilities for research and development in order to increase efficiency

5. To implement development activities of the approved projects

6. To initiate and expand cooperation with established Indonesian regional and international institutes and universities with a view to bridging the implementation of the programme and to avoid unnecessary duplication

7. To accelerate the utilization of research findings through the dissemination and exchange of information and through further development of the findings.

SCOPE OF ACTIVITIES

a. Areas

The main activities of this programme will be in development and increasing the skills of the manpower. Fields of activities will focus on:

1. Human foods (to increase the availability of carbohydrates, protein, oils, vitamins, minerals, etc.)

2. Animal feed (development of the resources, utilization of agricultural wastes, processing of protein sources, etc.)

3. Chemical bases for industry (steroids, acetic acid, citric acid, vitamins, essential oils, anti-bacterial substances, organic binders, biofertilizers, etc.)

4. Energy substitutes (including nonconventional production of methanol, ethanol, thermo-combustion, and biogas)

5. Flora, fauna and microorganisms of economic importance (including commercial greenhouse plants, new domesticated animals and microorganisms of significance to industrial and agricultural processes).

b. Projects

The project to be undertaken will be in the form of integrated activities of development and education/training so that two purposes, solving certain problems and increasing capability/knowledge of the manpower, could be reached simultaneously. There are 10 kinds of research activities to be carried out, although the implementation could be done in stages in accordance with the availability of manpower, facilities, budgets and the existing needs. The 10 project activities are:

- Development of rhizobial inoculants as biofertilizers

- Development of low-cost, non-waste producing technologies based on the bioconversion of agricultural and agro-industrial residues for human food or animal feed

- Development of technologies for producing methanol, ethanol, biogas and charcoal from agricultural and agro-industrial residues

- Improvement of the technology and nutritional quality of traditional fermented foods

- Implementation of an agro-forestry system for developing optimum utilization of kitchen gardens

- Development of agricultural production and processing of *Costus* as a raw material for the contraceptive industry

- Quality improvement and resource development of indigenous chickens and ducks

- Development of a nursery of various aquatic animals as food resources

- Development and refinement of edible oils processing
- Development of processing and preservation of indigenous fruits.

INSTITUTIONAL FRAMEWORK

The management and the development of the Indonesian Biological Resources Development Programme will come under the direction of LIPI and will take place in LIPI's complex at Cibinong, Bogor. This is a development programme and is a step further in the effort to integrate the inventory and evaluation activities done by LIPI's research institutions. This programme is aiming also to bridge the activities done by research institutes doing basic research and those working for the applications of the findings. The relationships between the Biological Resources Development Programme and other institutions are shown in Annex 1.

MANPOWER

Due to a shortage of trained scientific manpower, care must be taken in the establishment of the Biological Resources Development Programme in order to:

- Make the best possible use of staff which can be drawn from within the LIPI organization to create the core staff needed to get the programme under way
- Train new scientists and technicians (in packaged systems)
- Make the best possible use of executive manpower in research institutions and universities in Indonesia as well as abroad based on scientific cooperation.

Manpower development must be seen as a continual process to be done through education in the country and abroad, as well as through the programme's research and development activities.

Manpower Availability

In the first phase, it is expected that several senior scientists from the National Institute for Chemistry and the National Biological Institute will be assigned as the core group of the programme. They would function as programme leaders for the main fields of research. Several M.Sc. and Diploma holder staff from the National Biological Institute and the National Institute for Chemistry and some technicians and administrative staff would also be assigned to the programme.

The members of the core group should be appointed from the date of the programme's inception. Their knowledge and skills would be extremely valuable in establishing laboratory lay-outs, specification of equipment ordered, designing research experiments, executing routine research work, and preparing project documents and reports and so on.

In addition to the people drawn from the existing institutes, another regular set of scientists and technicians will be required to make the programme function properly. The qualification needed would range from Ph.D. degree holders to well-trained technicians. Based on the current number of graduates from Indonesian universities, technical colleges, and special training courses, it will take approximately 10 years to train the required manpower. The manpower recruitment and development programme is therefore divided into two major time periods of five years each (see Annex 2).

i. First Five-Year Period - Phase I

Within the first five-year period the major objective is to recruit and/or train the critical mass of 205 scientific, technical and administrative personnel required to create a fully operational programme that addresses the five principal fields identified above. For this purpose, a maximum total of 25 scientific staff and 5 administrative personnel could be drawn from the National Biological Institute and the National Institute for Chemistry and other appropriate research bodies in the LIPI organization. The remaining 175 people will have to be recruited or drawn from other institutions elsewhere in Indonesia. With the current shortage of skilled scientists it is assumed that the majority of the scientific manpower required will have to be met by providing fellowships to finance an active programme of formal academic training and upgrading of professional skill.

The staffing of the programme during the first five-year period should be considered in the following three sub-stages:

Sub-stage 1 - Core staff are identified, formed and drawn from existing LIPI institutes comprising 5 senior scientists with Ph.D. or equivalent qualifications appropriate for the direction of the 5 principal research programmes. These programme leaders would be supported by 8 M.Sc. or Diploma scientists with appropriate skills and by 13 senior and junior technicians with a basic degree or similar appropriate training. In addition, some administrative staff would be required (Sub-stage 1 duration: 2 years from the launching of the project), and new recruitment as well as sending them for further study.

Sub-stage 2 - Staff who completed their Ph.D., M.Sc., Diploma and technical courses are coming in and will be integrated with the core staff and additional staff recruited from outside the LIPI network. The staffing complement at this point will be approximately 71 persons with the following qualifications: 10 Ph.D.s, 17 M.Sc. Diplomas and

36 senior and junior technicians. The administrative staff would be increased by a further 3 persons (Sub-stage 2: end of 2nd to end of 4th years).

Sub-stage 3 - First five-year complement is expected to reach the basic, critical level of 205 persons comprising: 20 senior scientists with Ph.D. degrees, one of whom will be the Director of the Programme, supplemented by 65 M.Sc. and Diploma staff, and 110 senior and junior technicians with an administrative support group of 10 (Sub-stage 3: end of 4th year to end of 5th year).

A detailed list of the skills required is presented in Annex 3.

Throughout the first five years an active programme of recruiting young people with the required skills for further degree training and technical education and then sponsoring their training will be undertaken. It would be wise to start to identify such people and appropriate training opportunities now and not to wait until formal approval of the programme. This would avoid unnecessary delays in sending people for training once the programme is launched.

During this period training opportunities and funds should also be made available to the core staff who have helped to establish the new programme. As new staff returning from training enter the programme it will be possible to release members of the core staff to enable them to upgrade their skills and qualifications.

In addition, some foreign advisors will be recruited for 1-2 years during this first phase. They will be assigned to do some aspects of research and development, and to train the Indonesian scientists and technicians. The detailed expertise and duration of the foreign advisors projected for the programme is outlined in Annex 4.

ii. Second Five-Year Period - Phase II

The second five-year period will allow the completion of the manpower development programme. The "critical mass" of people established during the first five years will be supplemented by the additional manpower returning from training. This will allow the adoption of additional research fields and increased versatility and output of the programme.

WORK PLAN

The Indonesian Biological Resources Development Programme has been designed into 5 phases (a phase of preparation, plus 4 subsequent phases) as outlined in Annex 5.

i. Preproject preparation phase

Prior to the commencement of the programme, efforts will be exerted to identify: (1) qualified candidates to be further trained and upgraded; (2) candidates to form core technical personnel to be recruited from within the LIPI framework and/or other sources. In the meantime, the construction of a housing complex and other basic facilities development will be kept ongoing to anticipate the commencement of the programme, so that by the time of the official start of the programme, these facilities will have been in function for the core personnel and their administrative staff.

ii. Phase I (up to 2 years after programme approval)

Up to 30 core scientific/technical personnel will be recruited during this phase. These technical personnel will accept the responsibilities of: (1) selecting the candidates to be further trained; (2) planning the development of laboratories and other required facilities, developing special sites for conducting special activities--such as microbial culture collection, inoculation chamber, chemical analysis laboratory and room for special laboratory equipment--formulating specification of equipment required, ordering and supervising the installation of equipment, designing the greenhouses and experimental farms including the required facilities; (3) planning and commencing research activities and development in 5 main identified research fields, planning programmes/activities in training for manpower development, arranging exchange of experts, recruiting short- and long-term foreign consultants, and coordinating routine research activities and development with the planned programme for the future.

iii. Phase II (up to 2 years following Phase I)

This phase is characterized by the commencement of activities on research and development covering exploration, inventory, identification, preservation and chemical analyses of underutilized biological resources. The results will be used further as inputs or starters for conducting research activities covered by 5 main programme areas.

In this phase the trained candidates are expected to have been ready for placement in the programme. Other activities that will be carried out in this phase are the greenhouse experiments and training of the extension and field personnel.

iv. Phase III (up to 1 year following Phase II)

This phase marks the completion of the first 5-year stage of the programme. At the end of this stage, it is expected that the critical mass in manpower will have been fulfilled. Meanwhile, activities in research and development will have been in progress and the recruitment will be continued.

v. Phase IV (up to 5 years following Phase III)

This phase is marked by the full operation of the programme, which results in: (1) publication and dissemination of the programme activities to the users, (2) extension of technologies to be developed further by the industrial and commercial circles; (3) execution of training programme for field or extension personnel to transfer knowledge on the utilization of biological resources and technology of processing; (4) monitoring and assessing the progress of the programme in line with the people's needs.

FINANCIAL REQUIREMENTS

The total estimated budget for operating the entire Biological Resources Development Programme will be US $32,000,000. This amount does not include the value of land and other counterpart funding by the Government of Indonesia. A major part of the funding will be sought from foreign aid. On top of this budget, the operational cost in maintaining the development of the project already planned still has to be met.

The budget may be broken down in the following major items:

1. Personnel

i. Full-time staff salaries, retirement pay and other benefits will be met by the Government of Indonesia (LIPI).

ii. Fellowships or scholarships for manpower training (doctorates, postgraduates, graduates and technicians) are estimated at US $6,437,125. This amount is required to cover tuition fees, pocket money, health insurance, book allowance, school equipment and other related needs. The details of this budget are listed in Annex 6.

iii. Recruitment of short-term (up to 6 months) and long-term (up to 2 years) foreign experts. It is suggested that the assignment of foreign experts be included as an integral part of the programme. It is estimated that the foreign expertise required is 185 man-months (Annex 4) at US $3,500 per month or a total of US $647,500 for the entire programme. These funds will be provided by the programme through bilateral aid. Housing for the experts will be provided by the programme as well.

2. Physical Facilities

i. Land. Selected site of 200 hectares has already been provided by the Government (LIPI).

ii. Costs for building, equipment, other facilities and maintenance are estimated at US $17,910,000 (Annex 7).

iii. Annual maintenance cost covering repairs and up-keep for the buildings, equipment service, replacement of fuel chemicals and other disposable materials, and depreciation rate of 15 percent of the capital, amount to a total of US $129,000.

Implementation plan of the facilities development is scheduled as listed in Annex 8.

3. Execution of the Development Programme

Budget for the execution of the operational activities of the development programme will be provided by the Government (LIPI). The following standard will be applied for the estimation: a Ph.D. or Master/Sarjana holder will be needing US $9,550 annually (for laboratory and field activities, supplies and individual facilities). For the first 5 years an amount of US $1,575,650 is required, and for the following 5 years of the Phase II the amount will be US $6,255,000.

4. Contingency Funds

For unforeseen and emergency matters contingency funds will be provided by calculating 10 percent of the total costs and capital or 0.1 x US $17,910,000. = US $1,791,000.

Further Phases

After 10 years, this programme is expected to be in full operation; therefore, substantial capital investment will not be required. The only routine and operational budget will be met by LIPI and state revenues.

It is also expected that the programme will be recognized among the industrial circles and will be able to overcome the arising problems. In this respect, contract research can be developed, from which income can be obtained to meet the running costs. Patent rights and other royalties may be expected to raise funds for the operation to further activities on the biological resources development.

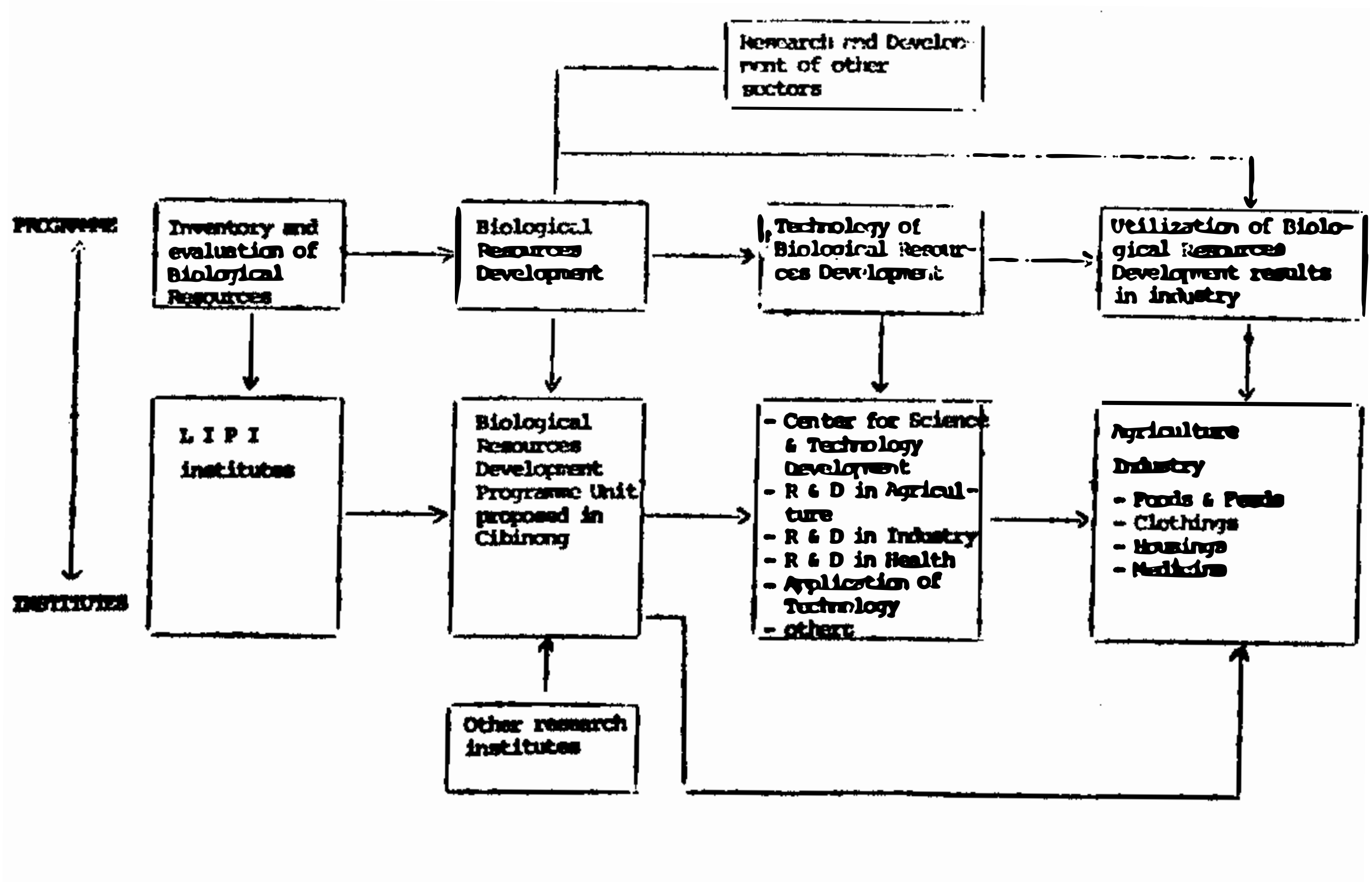
A BRIEF HISTORICAL BACKGROUND OF THE PROGRAMME SITE

The proposed Biological Resources Development Programme will take place in Cibinong, on a piece of land owned by LIPI with a total area of 193,194 ha. LIPI inherited this land from the Ministry of National Research in 1967. Based on the Presidential Decree of the year 1963, this land has been designated to be used by the National Research Center for the development of national laboratories to conduct research that is long term, cross-sectional in nature, and mission-oriented. However, for this purpose there has been a transfer of site, while Cibinong has been left as it is today.

Because of the existing needs to develop biological resources potentials in Indonesia, LIPI has decided to develop the Cibinong site as a centre for the development of biological resources. Considering the activities of BAKOSURTANAL (National Coordinating Body for Surveys and Mapping), that also requires a site to accommodate their buildings since their activities are closely in accordance with the scope of the programme of biological resources development LIPI allowed the construction of a BAKOSURTANAL complex in Cibinong.

At present, in line with the master plan for the programme on the development of biological resources, construction of the housing complex and improvement and new construction of service roads and site drainage have been started. Other activities have been carried out in developing experimental orchards and planting high-quality varieties of fruit trees which have been financed through special Presidential Grants.

ANNEX 1 Interrelationships Between Biological Resources Development Programme and Related Institutions



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ANNEX 2 Manpower Planning (Number of Persons)

Qualification	Year 0: Pre-programme (phase of preparation)	Years 1–2: Stage I, Sub-stage 1 (First Phase)	Years 3–4: Stage I, Sub-stage 2 (Second Phase)	Year 5: Stage I, Sub-stage 3 (Third Phase)	Years 6–10: Stage II (Fourth Phase)
Ph.D	-	5	10	20	25
M.Sc./Sarjana	-	8	17	65	100
Technician	-	13	36	110	219
Administration	-	5	8	10	40
Total	-	31	71	205	390

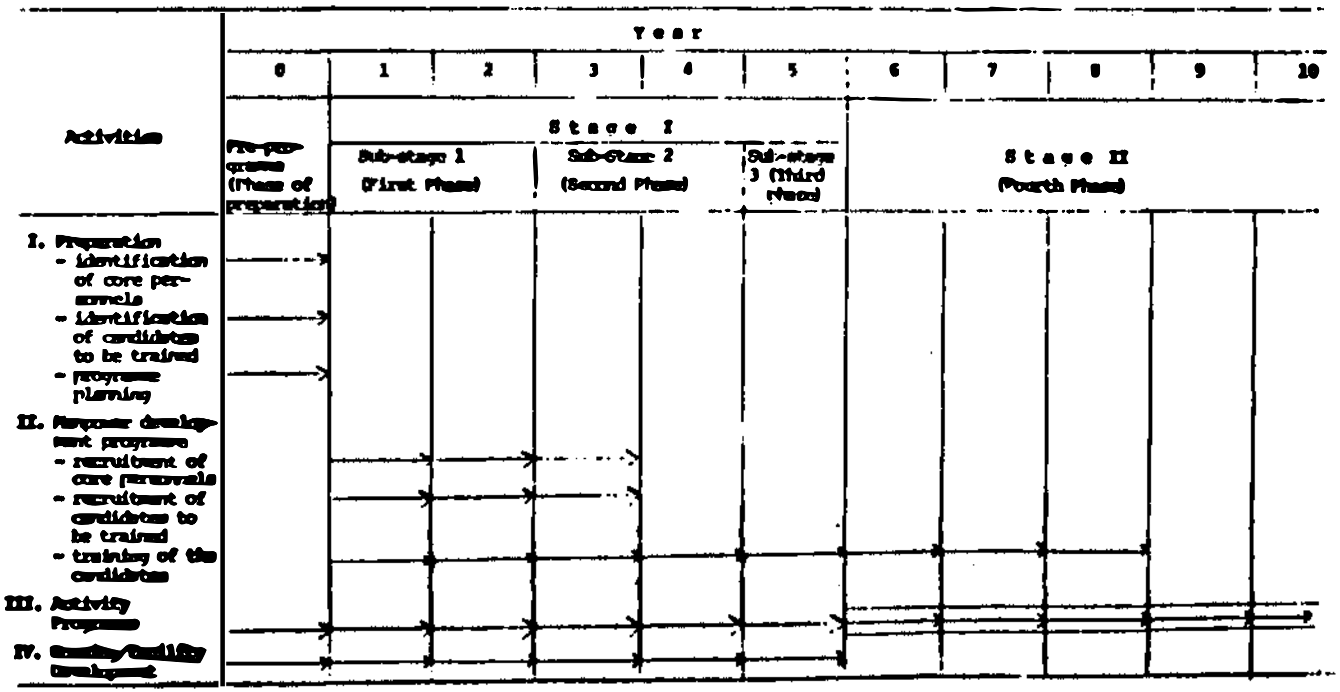
ANNEX 3 Requirement of Manpower in the Programme

No.	Experts	Ph.D.	M.Sc.	Techni-cian	Adminis-tration	Total
1.	Microbiologist					
	- industrial	2	6			
	- food	1	3	20		36
	- agricultural	1	3			
2.	Biotechnologist					
	- food	1	3	10		10
	- non-food	1	3			
3.	Home garden ecologist/ landscape specialists	1	3	20		24
4.	Agronomists	3	9	20		32
5.	Plant breeders	2	6	20		28
6.	Pharmacologists	1	3	5		9
7.	Animal breeders (birds)	1	8	9		18
8.	Parasitologists	1	5	6		12
9.	Physiologists					
	reproduction of fish		2	1		3
	and invertebrates	2	2	1		5
10.	Ichthyologists		10	20		30
11.	Limnologists		3	3		6
12.	Chemists					
	- plant	1	3			
	- analytical	1	3			
	- organic	1	3			
	- biochemist	1	3	56		84
	- food	1	3			
	- agricultural	1	3			
	- physical	1	3			
13.	Engineers					
	- chemical	1	3			
	- electrical		1			
	- mechanical		1	20		32
	- sanitation		2			
	- instrumentation		3			
	- industrial technical		1			
14.	Quality control officers		2	3		5
15.	Statisticians/ computer specialists		1	2		3
16.	Administrators		2	3	40	45
	Total	25	106	219	40	390

ANNEX 4 Requirements in Foreign Experts (in Man-Months)

No.	Experts	Total	Year 1	2	3	4	5
1.	Microbiologists						
	- industrial	12					
	- agricultural	12					
2.	Biotechnologists						
	- non-food	20					
3.	Home garden ecologists/landscape specialists	20					
4.	Animal breeders (birds)	20					
5.	Parasitologists	20					
6.	Physiologists reproduction of fish	20					
7.	Limnologists	20					
8.	Chemists						
	- analytical	23					
	- Biochemists	18					
	Total	185		72	76	29	8

ANNEX 5 Work Plan



ANNEX 6 Scholarships Required for Personnel Training

Qualification	Locality of training	Number of trainees	Duration of training (years)	Budget required (US $ per year)	Total Budget
Ph.D.	Internal	8	5	5.000	200.000
	Abroad	17	5	15.000	1.275.000
M.Sc.	Internal	35	2	5.000	350.000
	Abroad	71	2	15.000	2.130.000
Technician	Internal	73	1	2.500	182.500
	Abroad	146	1	10.000	1.460.000
					5.597.500
				Inflation *)	839.625
				Total	6.437.125

*) Inflation rate is estimated at 15%. Inflation can be minimized if grantees will finish their study term in shorter time.

Some of the budget will be used to train the core personnels at the end of the fifth year.

ANNEX 7 Estimated Budget for the Development of Facilities and Infrastructures of the Programme of the Development of Biological Resources

I. Laboratory and administration buildings

1. Chemistry Laboratory, 3 storeys, 2.100 m^2	
First floor 700 m^2 @ Rp. 213,000.00	= Rp. 149,100,000.00
Second floor 700 m^2 @ Rp. 251,340,00	= Rp. 173,938,000.00
Third floor 700 m^2 @ Rp. 251,340.00	= Rp. 173,938,000.00
	Rp. 496,976,000.00
Laboratory facilities and equipment	
- Equipment, 100% x Rp. 496,976,000.00	= Rp. 496,976,000.00
- Furnitures, Rp. 50,000.00/m^2	= Rp. 100,000,000.00
	Rp. 1,143,952,000.00
2. Microbiology laboratory, 3 storeys, 2,100 m^2	= Rp. 1,143,952,000.00
3. Aquatic laboratory, 3 storeys, 2,100 m^2	= Rp. 1,143,952,000.00
4. Biotechnology laboratory, 3 storeys, 2,100 m^2	= Rp. 1,143,952,000.00
5. Pilot plant, 2,000 m^2	
- Building Rp. 182,000/m^2	= Rp. 364,000,000.00
- Equipment	= Rp. 364,000,000.00
- Furnitures, Rp. 50,000/m^2	= Rp. 100,000,000.00
	Rp. 828,000,000.00
6. Green houses, 2,000 m^2 @ Rp. 182,000.00	= Rp. 364,000,000.00
7. Fish and aquatic resources ponds 20 units @ Rp. 1,800,000.00	= Rp. 36,000,000.00
8. Experimental farm, 100 ha @ Rp.500.00/m^2	= Rp. 500,000,000.00
9. Chicken, duck and small bird coops 20 units @ Rp. 3,750,000.00	= Rp. 75,000,000.00
10. Workshop, 1,600 m^2	
- Building Rp. 182,000.00/m^2	= Rp. 291,200,000.00
- Equipment	= Rp. 291,200,000.00
	Rp. 582,400,000.00
11. Administration buildings, 1000 m^2	
- Building, Rp. 135,000.00/m^2	= Rp. 135,000,000.00
- Furnitures, Rp. 25,000.00/m^2	= Rp. 25,000,000.00
	Rp. 160,000,000.00

ANNEX 7 Continued

II. Housing complex and infrastructures

1. Housing complex

Type A, 2 @ Rp. 28,750,000	= Rp. 57,500,000.00
Type B	= Rp. 26,880,000.00
Apartment, 3 storeys	
- First floor	= Rp. 182,000,000.00
- Second floor	= Rp. 214,000,000.00
- Third floor	= Rp. 214,000,000.00
Electricity	= Rp. 41,000,000.00
Water, other facilities	= Rp. 75,000,000.00
Furnitures	= Rp. 208,770,000.00
	Rp.1,020,070,000.00

2. Other facilities and infrastructures

Sports hall and recreation facilities, 1000 m^2 @ Rp. 162,000.00	= Rp. 162,000,000.00
Health/medical facilities, 100 m^2 @ Rp. 162,000.00	= Rp. 16,200,000.00
Waste processing units, 10,000 m^2 & buildings, 200 m^2 @ Rp. 162,000.00	= Rp. 324,000,000.00
Other equipment	= Rp. 300,000.000.00
Road, 2,000 x 5 m^2 @ Rp. 6,000/m^2	= Rp. 600,000,000.00
Parks	= Rp. 100,000,000.00
Drainage system, 20 km, Rp. 2,000/m	= Rp. 400,000,000.00
Electricity, 78 kva	= Rp. 250,000,000.00
Gas	= Rp. 100,000,000.00
Water cleaner processing unit	= Rp. 300,000,000.00
Telephone system	= Rp. 50,000,000.00
Fences, 18,000 m @ Rp. 25,000.00	= Rp. 450,000,000.00
	Rp.3,052,200,000.00
Sub total	= Rp.4,072,870,000.00
Grand total	= Rp.11,194,078,000.00

ANNEX 8 Summary of Schedule of Physical Facility Development of Biological Resources Programme Development According to Activity Item (in Area Unit, Percentage of Completion, and Million Rupiahs)

Activities	Year										
	0	1	2	3	4	5	6	7	8	9	10
	Pre-programme (phase of preparation)	Stage I					Stage II (Fourth phase)				
		Sub-stage 1 (First Phase)		Sub-stage 2 (Second phase)		Sub-stage 3 (Third-phase)					
- Preparation, design specification, technique, blue print, land processing & schedule	100%										
- Chemistry Laboratory 2.100 m^2									700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5
- Microbiology Lab., 2.100 m^2		700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5							
- Aquatic Laboratory, 2.100 m^2				700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5					
- Biotechnology Lab., 2.100 m^2							700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5	700 m^2 33 1/3% 381.5		
- Pilot plant (2000 m^2)				500 m^2 25% 91	500 m^2 25% 91	500 m^2 25% 91	500 m^2 25% 91				
- Green house						500 m^2 25% 91	500 m^2 25% 91	500 m^2 25% 91	500 m^2 25% 91		
- Aquatic rearing/breeding pond			300 m^2 50% 18	300 m^2 50% 18							

ANNEX 8 Continued

Activities	0	1	2	3	4	5	6	7	8	9	10
- Experimental farm (100 ha)		20 ha 20% 100.0	20 ha 20% 100.0	20 ha 20% 100.0	20 ha 20% 100.0	20 ha 20% 100.0					
- Chicken and other bird coop				10 units 50% 37.5	10 units 50% 37.5						
- Workshop			400 m^2 25% 145.6	400 m^2 25% 145.6	400 m^2 25% 145.6	400 m^2 25% 145.6					
- Administration building				250 m^2 25% 33.75	250 m^2 25% 33.75	250 m^2 25% 33.75	250 m^2 25% 33.75				
- Housing : Type A (2 houses)			1 50% 30.0	1 50% 30.0							
Type B (2 houses)			1 50% 14.0	1 50% 14.0							
Three storey apartment (3.000 m^2)		1.000 m^2 33 1/3% 182.0	1.000 m^2 33 1/3% 215.0	1.000 m^2 33 1/3% 215.0							
- Electricity				41.0 100%							
- Water		75.0 100%									
- Interior decoration & furniture		33 1/3% 70.0	33 1/3% 70.0	33 1/3% 70.0							
- Supporting facilities - sports & recreation (1.000 m^2)			250 m^2 25% 40.5	250 m^2 25% 40.5	250 m^2 25% 40.5	250 m^2 25% 40.5					
- Health, 100 m^2					50 m^2 50% 8.1	50 m^2 50% 8.1					
- Waste processing 200 m^2				50 m^2 25% 81.0	50 m^2 25% 81.0	50 m^2 25% 81.0	50 m^2 25% 81.0				

ANNEX 8 Continued

Activities	0	1	2	3	4	5	6	7	8	9	10
- Service Road (20 km)					4 km 20% 120.0	4 km 20% 120.0	4 km 20% 120.0	4 km 20% 120.0	4 km 20% 120.0		
- Drainage & Landscaping				100 20%	100 20%	100 20%	100 20%	100 20%			
- Electricity (700 kva)			130 kva 16 3/5% 50	130 kva 16 3/5% 50	130 kva 16 3/5% 50	130 kva 16 3/5% 50	130 kva 16 3/5% 50				
- Water cleaner processing unit		500 75	500 75								
- Water & Gas			12 1/2% 31.25	12 1/2% 31.25	12 1/2% 31.25	12 1/2% 31.25	12 1/2% 31.25	12 1/2% 31.25	12 1/2% 31.25	12 1/2% 31.25	
- Telephone system (50 units)				10 20% 10.0	10 20% 10.0	10 20% 10.0	10 20% 10.0	10 20% 10.0			
- Fences			2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0	2.000 m^2 11.1% 50.0
Total		808.5	1.220.85	1.780.6	1.180.20	1.233.7	939.5	683.75	1.055.25	462.75	50.0

Single-Cell Protein (SCP) From Cassava

Indonesian Institute of Sciences

More than 60 percent of the Indonesian population lives on Java, while the island itself represents only 7 percent of the total Indonesian land area. Thus, there is practically no possibility to expand agricultural land on this island. Such an undertaking should take place on the other islands and should also be coupled with the effort to distribute the population more evenly. In this way food production could be increased both by the improvement of food crop cultivation on Java as well as by the expansion of food crop cultivation in the new agricultural areas on the other islands. Moreover, this approach also opens the possibility to boost the production of food crops other than rice, and thus help to reduce the dependency on rice as the staple food.

Whereas the target of an average calorie requirement of 2,100 calories per day for every Indonesian has been met, there remains a significant gap with respect to the protein need: of the 46 g of protein required per person per day, only 39.8 g has been met. Of the latter, only about 6 g comes from animal sources, while the rest comes from plants. Because of its superior amino acids profile, animal protein is better than that of plants. Hence, the production of animal protein should be highly increased. For the present time and near future, the most promising way to close the gap of animal protein deficiency is through the enhancement of poultry husbandry with the help of modern technology. For this purpose a good supply of the proper feed, particularly its protein component, is a necessity.

Cassava is an important tropical food crop, particularly in areas where the soil is relatively poor and in time of food scarcity. This plant is widely and easily cultivated throughout the country in a monoculture of a multiple-cropping system. With the opening of new agricultural lands and transmigration from Java and Bali to the other islands where the soils are generally less fertile and the irrigation systems are less developed, cassava has become one of the major food crops. Considering the relatively low number of people living in these new places, overproduction of cassava often occurred. Because of its high susceptibility to spoilage under humid tropical conditions, preservation of cassava by sun-drying would not help much in keeping it for a long time. Meanwhile, the deterioration process which takes place during its storage may bring about a decrease in its economic value. Obviously, an appropriate technology which could keep cassava for a long time and, preferably, could also increase its economic value would be highly desirable. Converting cassava into single-cell protein (SCP) seems to be one of the answers since under suitable conditions it not only could be preserved for a practically unlimited time but the economic value of the cassava itself is also considerably increased.

To explore the possibility of producing SCP from cassava, study has been initiated at the National Biological Institute to select high-yielding microbial cultures which are capable of utilizing cassava flour or cassava starch (tapioca).

A total of 14 mold and 4 yeast cultures which are amylolytically active have been screened by cultivating a single culture or a combination of a mold and a yeast culture in a liquid basal medium containing 2 percent cassava flour or starch in shaking flasks, and at room temperature (ca. 27°C). These cultures were isolated from various traditional fermented products such as "tempe" (fermented soybean), "kecap" (Indonesian soysauce), "tauco" (Indonesian "miso"), "tapai" (fermented glutinous rice or cassava), and "ragi" (a traditional starter). The reason for utilizing these cultures is that should there be a need to use the SCP for human consumption, psychological constraints for its acceptance could be minimized because these cultures are already consumed.

The cassava flour was prepared by grinding sun-dried chips of peeled cassava roots. Sun-drying peeled cassava root chunks is the most popular preservation method employed by the farmers. Cassava starch or tapioca is widely sold in the markets; it is prepared by water extraction of the starch from fresh cassava root pulp followed by sedimentation and drying.

Results of the study showed that when used as cultures the molds generally were more productive than the yeasts in converting cassava flour as well as cassava starch into biomass. While there was, respectively, two and one mold cultures capable of yielding maximum biomass from cassava flour and cassava starch in 24 hours, there was none for the yeasts. In the case of the mixed cultures, none of them could produce a maximum yield of biomass from either cassava flour or cassava starch in less than 48 hours. In terms of the weight of the biomass, however, higher figures were obtained by a number of the mixed cultures. In all cases the growth of the cultures was characterized by an increase, followed by a decrease in the reducing sugar content, the disappearance of starch content, and the decrease of the pH of the medium. Results of the study also indicated that cassava flour is apparently a better raw material for SCP production than cassava starch. However, more detailed studies of the promising/potential cultures in a fermenter are necessary to confirm results of this study.

APPENDIX I

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