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9. ABSTRACT

Intermediate technology has several distinctive characteristics: low-cost inputs, intensive use of abundant factors of production, simplicity of inputs and outputs, low-cost outputs, smallness of scale, commercially viable, compatible with local environment, geographically dispersed, and adaptive to changing conditions. This paper defines and discusses intermediate technology; describes some applications of it in the Philippines, Indonesia, and Sri Lanka; and discusses the role of international assistance in supporting the adoption of intermediate technology. Philippine applications discussed include the "Jeepney" industry, the IRRI machinery development program, the Kaunlaran industrial shop, zero tillage concept, the Institute of Small Scale Industries, and the Regional Adaptive Technology Centers, Mindanao State University. Indonesian applications include the work at the Institute of Technology at Bandung, the Farm Machinery Testing Program of the Department of Agriculture, the Institute of Agriculture at Bogor, the bio-gas conversion project at the Gajah Mada Institute, and the "Butsi" or domestic peace corps program of the government. In Sri Lanka, projects include industrial cooperatives organized by the Ministry of Planning and Employment, involving blacksmithing, metalworking, pottery, pharmaceuticals, the Farm Mechanization Training Center, and the Somisiri Rice Huller Manufactory. As for international assistance, A.I.D. should probably take the lead in establishing a clearinghouse for dissemination of information on appropriate technology. It should also consider a review of its current activities to determine the "appropriateness" of the technologies called for by those activities.

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INTERMEDIATE TECHNOLOGY: AN INFORMAL SURVEY

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THIS IS AN EDUCATIONAL EXERCISE AND DOES NOT NECESSARILY REPRESENT THE VIEWPOINT OF THE SENIOR SEMINAR IN FOREIGN POLICY OR OF THE DEPARTMENT OF STATE

INTERMEDIATE TECHNOLOGY: AN INFORMAL SURVEY

Case Study by PETER W. ASKIN

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PART I

INTRODUCTION

> "The substance of man cannot be measured by Gross National Product. Perhaps it cannot be measured at all." (Schumacher, p.20)

> "Poor countries slip, and are pushed into the adoption of production methods and consumption standards which destroy the possibilities of self-reliance and self-help. The results are unintentional neocolonialism and hopelessness." (Schumacher, p. 195)

Until a few years ago, the concept of intermediate or appropriate technology was but a ripple in the backwaters of development theory and practice. Even then it was usually discussed within the context of other issues. The concept now goes well beyond these issues. Interest in intermediate technology has burgeoned, and as a concept it is now entering the mainstream of the litany and literature of development. Not a few think it should be the main focus of development activities. Terminology has become a serious problem in understanding the concept. The definitional problem will be discussed in some detail later, but at this point, it is necessary to state that the terms intermediate or appropriate technology are used interchangeably throughout the text of this paper, unless otherwise noted.

Why the sudden interest in intermediate technology? There appear to be a number of reasons. Developed and developing countries alike are becoming frustrated over the realization that aggregate-economic growth theories and foreign aid programs with massive transfers of capital since the end of World War II have done little for the masses of people who constitute the world's poor. World levels of food production are not adequate to remove the specter of mass hunger; unemployment exceeds thirty percent in many of the poorer countries and threatens to go higher; the tide of rural to urban migration has not been turned; and population growth threatens to wipe out the advances that have been made.

The second set of factors that have contributed to the relatively sudden popularity of intermediate or appropriate technology flow from an increasing disillusionment with some of the results of large-scale industrialization and modernization. The concept of intermediate or appropriate technology has great appeal in the industrialized countries to those who long romantically for the simplicities of a bygone era they never knew, or who are alarmed by the ramifications of the limits of growth theories, the rapid depletion of nonrenewable resources and the threats of environmental destruction. In the developing countries, the concept converges with the resurgence of nationalism, ethnicity and the desire to preserve traditional cultural values, as well as a frustration with the results of Western-inspired development programs.

There is yet a third set of factors which is probably more germane. From disappointment with the results of conventional development wisdom has come the growing belief that (1) economic progress in many of the poorer countries has been frustrated or retarded by attempts to transfer and utilize inappropriate "Western" technologies and (2) that more appropriate alternatives can and must be found.

Dr. E. F. Schumacher, in his book Small is Beautiful....perhaps was more responsible than anyone in capturing most of the above factors at their confluence, channeling them into a concept and popularizing that concept into a movement. Ralph Nader reportedly carries a dog-eared copy of Schumacher's book wherever he goes. A 1976 U.S. Presidential Candidate, Governor Brown of California, is also a Schumacher fan and has established an intermediate technology position on his staff.

The literature on the subject is vast, groping and growing; yet there is a dearth of well-documented experience concerning applications of the concept. The principles, even the definitions, underlying the concept are unclear and unestablished. It is not clear from any level of analysis exactly how intermediate technology is to be universally employed as a development strategy in solving the problems of the world's poor. A few disclaimers, therefore, are in order. This paper attempts only a limited and informal survey of the subject. It describes some of the major definitional and conceptual problems that have emerged. It addresses but does not attempt to resolve the more controversial issues surrounding intermediate technology. Mainly the paper attempts to assess on the basis of a limited field survey, how the concept of intermediate technology is viewed by policy makers, planners, practioners, innovators, etc. in some developing countries and to describe the major applications of intermediate technology activities in the countries surveyed. Lastly, the paper attempts to arrive at some conclusions concerning the role of international agencies in assisting the development and dissemination of intermediate technology.

The latter is relevant to all United States agencies involved in external assistance. In the Secretary of State's address (delivered by Ambassador Moynihan) to the Seventh Special Session of the United Nations General Assembly last September, he stated:

> "Developing countries need not only new funds but also new technology. Yet the mechanisms for the transfer of new technology and for its local development are limited, and are seldom at the sole command of national governments, and the technologies of industrial countries must often be adapted to local economic and social conditions. New institutions and new approaches are therefore required."

It is particularly relevant for the Agency for International Development (A.I.D.) in that last year the U.S. Congress amended the Foreign Assistance Act to include a section on "Intermediate Technology" and to require A.I.D. to greatly expand its efforts in this field.

Intermediate or appropriate technology is an exciting idea which, theoretically, holds out a great deal of promise to the poorer nations of the world. It is also a rebellion--a rebellion against neo-classicial economics and against much of the conventional development wisdom of the last twenty-five years. As such, it has provided to date far more questions than answers. It also runs the risk of becoming a development fad or a panacea. It is definitely in danger of being over-attended, over-conceptualized by the development experts of the West and under-attended by some developing countries. Nevertheless, the concept of intermediate or appropriate technology has focussed attention on some important questions. It has made technology a major development issue and has served to sharpen the debate on the larger issues of employment versus production and growth versus equity. It points up how little is known about the relationship of technology to growth and of the development process itself.

PART II

THE CONCEPT

> "There is nothing in the experience of the last twenty-five years to suggest that modern technology, as we know it, can really help us to alleviate world poverty, not to mention the problem of unemployment which already reaches levels like thirty per cent in many so-called developing countries, and now threatens to become endemic also in many of the rich countries." (Schumacher, Small is Beautiful, p. 148).

> "We know that labor is there, waiting to be applied. The brains are there. It is possible that the motivation is there also. What is needed is the technology. Not sophisticated technology emobdied in heavy capital; not primitive technology, but something in-between -- tools and machines -- appropriate to the situation in the particular country at that time." (Hon. Clarence D. Long, Representative of the State of Maryland, Hearings before Committee on International Relations, 94th Congress, First Session on the Foreign Assistance Act. p. 336)

A. Some Definitional Problems

Terminology is definitely a stumbling block to the analysis and understanding of the concept of intermediate or appropriate technology. It has been alternately referred to as appropriate technology, low-cost technology, labor-intensive technology, capital-savings technology, alternate technology, self-help technology, village-level technology, progressive technology, indigenous technology, peoples' technology, light-engineering technology, adaptive technology, light-capital technology and soft technology. There are probably more, and more to come.

For the most part these terms are used interchangeably in the literature, but at times they become almost slogans, deliberately chosen it would appear to connote a particular bias or ideology or to emphasize a particular set of economic or social variables. For example, the terms labor-intensive or capital-savings technology (regardless of country origin) emphasize the employment factor in technological choice. Indigenous, peoples', or village-level technology focus on the local development, modification and adaptation of technology--normally technology that derives directly from traditional tools and methods. Alternate and soft technology tend (but not always) to embrace more ecological and environmental considerations such as alternate and renewable sources of energy and the environmental impact of technologies. Adaptive technology generally means the modification of an existing technology--normally the scaling down of large, sophisticated machines and processes to smaller, cheaper and simpler products and methods.

Intermediate Technology (a term that is falling out of favor) on the other hand refers, at least in the Schumacher sense, to new products and processes which in scale, simplicity, accessibility and productivity lie somewhere between existing primitive and advanced

technologies but which are closer to the former than the latter on the spectrum of possibilities. The term intermediate technology has fallen from grace because it is thought to convey images of a static and "second-best" technology. Actually there is little evidence in the literature to support this belief and almost none was found in a survey of three developing countries.

Appropriate technology has been defined somewhat differently. One author (Morawetz) defines it "as the set of technologies which make optimum use of available resources in a given environment. For each process or project, it is the technology which maximizes social welfare if factors and products are shadow priced." A.I.D. has adopted a tentative definition which states it simply as "technology which enables developing countries to provide goods and services for their people in a manner which is compatible with LDC conditions." One definition that seems to make as much sense as any comes from Indonesia in which technology in general was looked upon as falling into three distinct categories--traditional, intermediate, and advanced Western technology. Appropriate technology was then defined as that which uses a combination of these three.

It will serve no major purpose to prolong this semantical ping-pong. Most authors have settled on the use of the term appropriate technology, or the simultaneous use of both appropriate and intermediate, but no one seems entirely comfortable with this compromise, probably because it begs so many questions. One can only speculate that some of the uncertainty and debate over concept and application flow directly from the lack of precision in terms and definition.

B. Towards A Conceptual Framework

It would be nice at this point to lay out clearly and briefly the conceptual framework for intermediate or appropriate technology as background to a discussion of some of its applications. Unfortunately, one doesn't seem to exist in any ready and recognizable form. Part of the problem of course is the potential scope of the subject. Conceivably, few forms of economic and social activity are excluded. Theoretically, the concept can be applied to the productive as well as to the non-productive sectors, to consumption patterns and to social services as well as to the production of goods, to health delivery systems as well as to the mechanization of agriculture. Another part of the problem is that the subject is so closely related to other major issues and processes. In one sense, it goes to the heart of the development process itself and challenges current theories of development and economic growth. The concept flows directly from the major development problems of unemployment, regional imbalances, income distribution inequities and the relation of technology to growth. On a more philosophic plane, it represents a search for a more rational lifestyle, a *modus vivendi* for man with his environment.

In an attempt to provide some further insights into the concept, the author has chosen to approach the conceptual framework problem from five different but related angles--first, a somewhat philosophic view; second, the economic issues; thirdly, the question of technological choice; fourth, some application issues; and last, by an attempt to extract some conclusions concerning characteristics and criteria.

1. The "Schumacher School"

On a broad plane, the concept of intermediate technology with Dr. Schumacher as its chief prophet, is in a sense a rebellion against

neo-classical economics. A recent Newsweek review of Schumacher's book stated: "Schumacher's message is deceptively simple:

> the economic system should serve man, man should not serve the system. Modern economists, he maintains, have established material growth--in the form of the gross national product--as the chief measure of social progress. As a result, economics has become a psuedo-science in the service of a pseudo-philosophy--materialism--in which greed and envy are justified through the uncritical worship of continuous and unlimited growth." (Newsweek, March 22, 1976, "Thinking Small", p. 14)

Schumacher advocates the Buddhists' "Middle Way" and contends that man can better meet his needs by scaling down his wants. This must happen, he notes, because man cannot continue to use up nonrenewable resources at the present rate and survive. In economic and technological terms then, the "Middle Way" is finding the right development path "between materialist heedlessness and traditional immobility". In the search for the right development path, finding the "appropriate scale" of things becomes all important. He applies this to the scale of organizations as well as to the scale of machines, to consumption patterns as well as to production methods. He admits that this concept cannot be universally applied, but argues that it is ideal for fulfilling the needs of the poor. To Schumacher, it does not mean going back to outdated methods, but rather forward into new technological territories. The task, he states is to develop appropriate technologies which will create literally millions of new workplaces. In short, he is advocating Ghandhi's principle of production by the masses, not mass production.

Schumacher elaborates on this in a hypothetical example. He speaks of a $100 technology (actually he used pounds sterling) in terms of investment per workplace. The hypothetical cost of a workplace using traditional technology would be about $1.00 while the workplace investment in utilizing Western technology would be about $1,000. The gap is enormous and the latter technology crowds out the former. What is needed, Schumacher contends, is a $100 technology (or $100 investment per workplace); one that is "immensely more productive than the indigenous technology, but immensely...cheaper than the sophisticated, highly capital-intensive technology of modern industry." These technologies, Schumacher states "must be cheap enough for jobs to be provided in very large numbers and simple enough to be used and maintained by rural and small town populations without sophisticated technical or organizational skills and with very low incomes. It follows that equipment of this kind will have to be provided largely from indigenous resources and employed largely to meet local needs". (Stewart, p. 108)

Following are two brief case examples which illustrate this approach to intermediate or appropriate technology:

Example One: Metal Bending Machine (AFRICA)

The problem posed to the Intermediate Technology Development GROUP (I.T.D.G.) in London was to find a simple tool by which African village craftsmen (blacksmiths and metal workers) could bend metal around the wooden wheels of new ox-carts. The least expensive modern piece of machinery to do this cost in the neighborhood of 700 British pounds and required an electric drive. The I.T.D.G. knew that European forefathers had a simple machine to do this which had fallen

into obscurity. They finally found such a machine in a French village. They redesigned and upgraded it. It is simple and can be made and used by any village blacksmith. It costs seven British pounds to produce and is all hand-powered.

Example Two: The Egg-Tray (ZAMBIA)

The I.T.D.G. found a situation in Zambia where egg producers were in despair because the supply of imported egg crates had given out. No one in Zambia knew how to make them. The need was for a million trays a year. A multinational company reported that the smallest egg-tray making machine turns out one million trays per month. The company also reported that it would be uneconomic to make a smaller machine. The I.T.D.G., working with the Royal School of Arts and a small manufacturer in Scotland, redesigned the egg-tray (into a much better one) and designed a prototype machine to produce it. The machine is now being used in a number of African countries.

This kind of intermediate technological generation is going on in a number of countries in Africa and Asia, more examples of which will be discussed later. These above examples illustrate several different aspects of the concept: One is that it was stimulated by outsiders. The target group was small-scale, low-income craftsmen and farmers. In one case an older, discarded technology was rediscovered and through modern sector knowledge was redesigned, upgraded and put into effective use at low cost. In the other case, the same result was achieved by developing a completely new (in scale) technology.

The Schumacher School, while not ignoring the economic questions, refuses to be imprisoned by the rigors of quantitative economic analysis; most of which Schumacher dismisses as pre-conceived notions translated into foregone conclusions. This School also tends to limit the concept of intermediate technology to the non-modern or traditional sector and with the belief that unless this sector begins to grow, any hope in the modern sector is illusory. At the heart of this conceptualization is the belief that the right path is the dynamic approach to development which treats technology as the central issue. This in turn will open up avenues of constructive action which the static, econometric approach fails to recognize.

2. The Economic Debate

The Schumacher level of conceptualization does not satisfy most economists. However, they are often badly split in their own attempts at conceptualization and analysis of appropriate technology. Space does not permit a full discussion of the economic debate but the following (largely drawn from Sarah Jackson's work) represents a useful summary of the main arguments:

a) The Arguments in Favor

- Capital is scarce relative to labor which is in direct contrast to the countries developing and exporting the technology. Therefore, the capital requirements for providing full employment via these technologies is simply beyond the reach of the poor countries; also they cannot afford the corollary levels of investment in infrastructure, market and market support systems demanded by higher technologies.

- Labor, for the poor countries is the abundant resource. Therefore, appropriate technologies would use more of the abundant resources for each unit of output.

- The large-scale nature of production of capital-intensive technologies cannot be achieved or fully utilized in poorer countries because of the small size of their markets.

- Appropriate technologies can better take advantage of traditional economic activities and make fullest use of existing organizational, management and entrepreneurial talents.

- Smaller-scale permits more geographic dispersion and wider links with the rest of the economy.

- More appropriate technologies will permit more jobs from the limited capital available. This in turn will spread the benefits more quickly and will spark more demand for marketable products.

- Appropriate technologies are more likely to stimulate the traditional sectors by developing backward linkages with agriculture and other feeder industries. Large-scale production using capital-intensive technology, on the other hand, tends to displace traditional sector economic activities.

- Western technologies tend to ignore the raw materials of the countries in which they are introduced, because they have been developed for a different climate and environment. This not only adds to their cost but may make them totally inappropriate for local conditions.

- Technologies which make maximum use of poor countries' resources would produce higher rather than lower rates of growth and better distribution of income, and would permit them to compete (under laws of comparative advantage) more equally in world markets.

The counter-arguments are based mainly on the rapid growth through accelerated industrialization theory of development. In other words, in order to raise their rate of growth over time, poor countries must create their own industrial sector as soon as possible.

b. <u>The Arguments Against</u>:

- Capital-intensive investments maximize total output in the shortest time. Returns on capital are usually greatest when capital is combined with the most efficient Western technologies. Therefore, they generate the greatest savings for necessary future investment and thus continued economic growth.

- Labor-intensive industries take longer to produce a given output and tie up scarce working capital longer.

- Labor is not as abundant or as cheap as it looks and entrepreneurial talent is not as abundant as it seems in developing countries. Wage rates are often artifically high. This is generally the labor required for industry. Cheap labor, where it exists, may not be suitable for efficient production even with small-scale technologies. Labor-intensive industries require more complex management skills which are in short supply. Therefore, available entrepreneurial talent should be used where it will yield the greatest return.

- Capital-intensive industries generate downstream employment generation which more than offset the fewer workplaces of the industry in question.

- Many industries are not economically divisible because they must produce for an compete in wide domestic and international markets. Quality

control and precision in production become critical and cannot be achieved in smaller-scale, labor-intensive and geographically-dispersed production processes.

- Decentralized, small-scale industries are not conducive to creating the necessary environment to form a critical mass of competitive innovation.

- Western technology can be transferred more easily to poorer countries than developing brand new, and possibly more appropriate techniques.

- The prestige value of developing a modern capital-intensive industrial sector cannot be underestimated. It also provides labor and management with skills that eventually will be needed in a modern economy and exposes them to modern work values of precision and efficiency.

The economic debate seems to center on one basic question--whether maximum production through the use of Western technologies or the fullest utilization of available resources is the best path to economic growth? The question is in some respects a challenge to basic economic theory at both the macro and micro levels. The quick-growth theory has not solved the problems of massive unemployment and inequitable income distribution. On the other hand, increasing labor-intensive activities may reduce overall output which many countries cannot afford to have happen. Thus the developing countries are confronted with a production versus employment dilemma.

At the micro-level, the theory goes, variations in capital-labor ratios are the standard responses to variations in factor prices. Output is always maximized when the productivity of the one scarce factor (capital) is maximized (by technology and other efficiences). Further, as long as the marginal productivity of labor (the abundant factor) is positive, every increase in employment will increase the productivity of capital. Therefore, increasing employment will increase output. The trouble is practice has not followed theory. Case after case has been cited of labor-rich countries following capital intensive methods. Why haven't these countries,or particular businesses, selected mixes of production factors more consistent with their factor endowments and comparative advantage? Is it because the productivity of labor is negative? Is it due to the absence of labor-intensive alternatives? Is it due to inappropriate conditions of choice, e.g., lack of information, distorted factor prices (and thereby wrong-headed government economic policies), tied-aid, etc.? Or can it be attributed to planners' and entrepreneurs' irrational preferences for sophisticated technology and methods of production? There are few conclusive answers to these questions. Some evidence has been found to support the conclusion that all these factors have an adverse influence on technological choice at various times. Certainly, in terms of the theory, developing countries operate in an imperfect world of competition. Information does not flow freely so available choices are not always known. The factors of production are not mobile. Entrepreneurs and other decision makers may become enamoured with the more sophisticated equipment or processes. Import policies, licensing practices, etc., may indeed make capital goods irresistably cheap.

Factor price distortions are believed by many economists to play the largest role in bringing about production mixes contrary to a country's factor endowment. In fact, some contend that unless factor price distortions are removed, appropriate technologies will not and cannot emerge.

What causes factor price distortions? If government economic policies are wrong in terms of a country's factor endowment, this will create a gap between market prices and the real or social costs of production factors. For example, if through government policies interest rates are kept artificially low, if capital imports are encouraged by low import tariffs, if foreign exchange is overvalued, and if foreign aid and investment are plentiful, the price of capital becomes cheap relative to its inherent scarcity. Also government policies regarding wage laws can distort factor prices. Labor may become overpriced relative to its abundance by artifically high minimum wages, fringe benefits, hiring and firing policies, etc., or wages may not distinguish sufficiently between skilled and unskilled, or between skills in high and low demand. These distortions, therefore, give the wrong signals to the planner and the entrepreneur and lead them into the wrong factor mixes and technological choices.

What are the solutions? The standard responses of course are: (1) reform government policies, or (2) shadow price the factors of production to determine their real or "social" costs and make the technological decisions on that basis. Neither solution seems that easy or terribly realistic. It takes massive persuasion and political will to carry out a full package of policy reforms. The government's development planner can shadow price production factors and make recommendations accordingly. This may or may not influence the technology chosen for government-financed or government-controlled projects. It is difficult, however, to see how this technique will influence or affect the private entrepreneur who, regardless of the shadow price argument, must still pay the market price for his production inputs. Conceivably, shadow prices could be used as indicators that government policies are wrong, e.g., they could be used to establish more rational import policies. They could also be used in a situation where government has established a centralized mechanism for screening or improving the import of capital goods. In the final analysis, the tradeoffs will be made on the basis of how a country perceives its development priorities and carries out its development strategy.

3. The Question of Technological Choice

By this time, it is apparent that in one sense there is nothing basically new in the philosophy underlying intermediate or appropriate technology or in the arguments against it. The industrial and agricultural development of Europe and the United States were based on innovative and incremental approaches to technology--largely in response to factor (labor) scarcities. China, Japan, and even India are to some degree more recent examples. The basic difference is that today there is, theoretically, a more pronounced choice among three basic alternatives: (1) utilization or transfer of existing technologies (ranging from traditional to the more advanced Western technologies), (2) adaptation and modification of these existing technologies, and (3) invention of new ones. Each choice has its own set of issues and problems.

Staying with existing traditional technology may mean continued low levels of output without the generation of additional employment. On the other hand, the international transfer of existing Western technology to developing countries is made difficult in many cases by what has been referred to as a "communications gap" and a "suitability gap". Contributing to the "communications gap" are such factors as the high costs of transfer, international restrictions and the exercise of monopoly power. Even if these obstacles are overcome, most "Western" technology has been developed to suit developed country factor endowments, and seldom will be "appropriate" in all respects.

Generation of new technology can be stimulated in at least two ways. One is simply to cut the country off from imports--a la the Chinese model--thus forcing entrepreneurs and engineers to be inventive and innovative. Another is an extensive local research and development effort, for example, through the establishment of Appropriate Technology Centers (ATC's). In the first case, it is thought that if factor prices are not right, there will be little incentive to innovate unless it is forced or done for reasons of challenge or patriotism. In the second case, research tends to be isolated from producers and the problems areas. As will be shown later, this becomes a key issue at the application stage. There is, however, a surprising number of national and international appropriate technolgoy centers already established and functioning.

The third general alternative is of course technological adaptation. To many, this offers the most promising area for the development of more appropriate technological choices. It would seem to follow that a country must be semi-industrialized in order to fully exploit this process. In other words, it would require a cadre of entrepreneurs and trained engineers to identify the potential for adaptation and at least a light engineering or small capital goods production capacity to follow through. It is possible that other factors such as production costs relative to sales price, absence of factor distortions, the existence of competiton, high tariffs on imports, are also important incentives in the adaptation process.

The element of choice is basic to the concept of appropriate technology. Opinions differ on how much choice actually exists for developing countries. Some feel there is a fairly wide shelf from which to choose and therefore they favor the alternatives of transfer and adaptation. Others are convinced that the shelf of choices for a particular product in a particular country situation is in reality quite narrow or even non-existent. They emphasize the generation of new technologies. The Schumacher School certainly backs the latter view. The problem, as has been suggested, is that very little is known about the processes of generating new technologies, and therefore, the adaptation alternative seems to have the best track record.

4. Some Theoretical Applications

Earlier it was stated that the concept of intermediate or appropriate technology could embrace almost any form of economic and social activity. Theoretically, this is true, but it is by no means proved by practical experience. The literature suggests a wide variety of current and possible applications, the full impact of which remains to be documented and assessed. Space does not permit even a partial listing but they include almost every sector. Following are just a few examples.

In agriculture: improved hand tools and equipment such as hoes, weeders, shellers, wheel barrows. Small-scale animal-drawn or motor-driven equipment such as--steel-tipped plows, harrows, power tillers, harvesters and threshers, irrigation pumps, which increase productivity over traditional tools and methods.

In rural industry: improved small-scale equipment and methods for making small-scale metal products such as farm implements, spare parts, cooking utensils and other home products. Simple food processing equipment and methods such as vegetable oil pressing, processing of food grains and vegetable fibres. Cottage industries such as spinning, pottery making, paper making, wood working, leather working, etc.

In urban industry: simplifying modern technology or redesigning traditional technology in such manufacturing activities as farm equipment, metal products, chemicals, sugar refining, cement and brick making, shoes and leather goods production, glassware production, pharmaceuticals, food processing, food preserving, wood and paper products, ceramics, even in oil refining and car manufacturing (e.g. the Jeepney and the Fiera).

In transportation, water-works and construction: more efficient but labor-intensive methods of road building, ship-building, irrigation systems, water filtration (home and city), low-cost house construction, etc.

In the service sectors: low-cost health delivery systems, educational methods, and water purification and sanitation systems; also, developing simple and low-cost information dissemination systems, as well as simplified marketing and distribution systems for a range of commercial goods.

In the energy sector: developing wind and solar-powered equipment for home and farm water use and small-scale irrigation systems, grain drying, etc. Developing methane gas converters (powered by animal dung) for home cooking, lighting and refrigeration.

Even a summary list like the above points up a major application issue--is intermediate or appropriate technology applicable primarily to the traditional or non-modern sector? The question is important in fashioning criteria for appropriateness and determining research and other allocations in the development and dissemination of appropriate technology. As conceptualized by the "Schumacher School", it seems to pertain almost exclusively to the traditional sector. Under the economic debate, the concept is widened and, in fact, the debate strongly suggests a bias for the modern sector. For example, the factor price issue pertains much more to the modern than to the traditional sector. The problem is compounded by the fact that the line between the traditional and modern sectors is not that clearly marked, and to the extent that it is, it is constantly changing.

The question also can be looked at in terms of where the greatest need exists. As we have seen, appropriate technology springs from the need to increase employment and to decrease income disparities. Between the two sectors, these needs are much greater in the traditional sector and the type of response to the need is likely to be different than in the modern sector. The problem in the modern sector is often that the production processes have been organized on too sophisticated and large a scale, thus leading to idle capacity and wastage of capital. The response then is to lower productive capacity, save capital and where possible increase the labor inputs. This is generally accomplished by modifying downward Western technology rather than creating new technologies. Modification, however, does not necessarily increase employment. The problem in the traditional sector is somewhat opposite, i.e., the production is organized around technologies that are too primitive and too inefficient to increase incomes, stimulate business and industrial activity and generate employment. Depending on the product, this calls for either major adaptation of Western technologies or more likely, the need to generate completely new ones.

There are other points at issue. Assuming limited financial resources, there will be competition between the two sectors in the allocation of resources for the development and dissemination of appropriate technology. Whether an adaptive or new technology approach is taken, the process is expensive. Innovation and inventors are present in all countries but the supply is limited. Therefore, it will be

important to decide which sector (or products) should receive the emphasis. Another point is that if income is increased in the traditional sector, it is likely to be at the expense of the modern sector. Or conversely, and perhaps more importantly, care must be taken that in developing more appropriate modern sector technologies, it does not further destroy jobs and markets in the traditional sector.

There is no simple answer to the question of whether intermediate or appropriate technology is primarily applicable to the traditional sector. The usual answer of course is that it is applicable to both sectors. It is also clear that most of the conceptualization and application efforts to date do in fact give primary emphasis to the traditional sector, partly because it is easier to work in this sector and also because the needs are more obvious. It could be that much more is known about the "tinkering" process to make primitive products more efficient than the process of scaling down and simplifying larger and more sophisticated techniques. This suggests that perhaps one of the greatest weaknesses in current approaches to appropriate technology questions is the attempt to apply the concept uniformly to both sectors. It is possible that each sector requires a substantially different approach beginning with the objectives and on through the conceptualization and application stages.

5. Characteristics and Criteria

It goes without saying that the foregoing discussion falls far short of a clear and consistent conceptual framework for intermediate or appropriate technology. From it, however, one can draw a few conclusions regarding the nature, characteristics and criteria of appropriate technology.

It seems relatively clear that the overall objective of appropriate technology for the developing countries is to achieve a state of technological independence. This does not imply a state of scientific self-sufficiency or technological isolation. More correctly it implies the development of local resources (labor, entrepreneurs, materials, research capacities, supporting systems etc.) to the point that developing countries can make their own technological choices consistent with local resource availabilities and national goals such as increasing income, output, employment and basic services. In this context, the major characteristics and criteria by which appropriate technology seems to be recognized and applied include the following:

a. Low cost inputs:

- low capital cost per work place
- low capital costs per unit of output

b. Intensive use of the abundant factors of production:

- labor
- local materials
- entrepreneurs

c. Simplicity of inputs and outputs in their:

- manufacture
- operation

- maintenance and repair

- organization and need for support systems.

d. Low cost outputs that:

- are accessible and affordable by low income groups,and

- fulfill basic needs.

e. Small in scale relative to capital-intensive and advanced technological activities.

f. Economically efficient and commercially viable.

g. Compatible with local political, economic, social, cultural and physical environment.

h. Encourages indigenous innovation, self-help and participation in the process (i.e., growth from below).

i. Geographically dispersed.

j. Dynamic, progressive and adaptable to changing conditions and requirements.

Most of these factors have been discussed in some detail earlier. A few points, however, need to be stressed. First, the above characteristics and criteria represent an optimum. In practice, they may not all be present in every type of appropriate technology. The second point, not often brought out in the literature, is that in most cases, appropriate technology is highly location-specific. This characteristic immensely complicates the task of drawing a conceptual framework and mounting any broad projects or programs to develop and disseminate appropriate technology. It particuarly complicates the task of organizing realistic and effective international assistance. The final point is that, despite the heavy emphasis on traditional sector needs, the response to these needs requires the use of modern scientific and engineering knowledge and skills, as well as innovation and imagination. The challenge is whether technicians trained in the modern sector can adjust their thinking and skills to extract the best from the new and the best from the old in developing something in-between which is more appropriate for the utilization of local resources and conditions.

PART III

LDC ATTITUDES AND APPLICATIONS

> "When bulldozers were sent to Asian nations to replace shovels, we turned their values and their culture upside down," says Carl Madden, a top economist at the U.S. Chamber of Commerce. "I agree with Schumacher that the rich nations must walk softly through the rice fields." ("Thinking Small", Newsweek, p. 14)

Most of the theorizing about appropriate technology has occurred in the industrialized countries and among international development experts, although a few of the more worthwhile contributions to the literature have been made by practitioners in the developing countries. Very little attention has been paid to date, however, on how the concept of intermediate or appropriate technology is viewed by the developing countries themselves, e.g., by planners, policy makers, industrialists, small entrepreneurs, inventors, educators, as well as by the target of this technology--the low income groups. In other words, how do these groups look at appropriate technology as a development strategy? Is it responsive to their national, sector and local priorities? What are the problems and conflicts associated with it? How is appropriate technology stimulated and supported? Where are the nuclei of ongoing intermediate and appropriate technology activities? How do developing country officials and innovators view the role of international assistance in developing and disseminating appropriate technology?

These and related questions were the subject of a very limited survey conducted by the author in three developing countries. The purpose here is to describe the results of this survey and to relate these results to the concept and later to the role of international assistance. But first, a couple of caveats are in order.

The countries surveyed were the Philippines, Indonesia and Sri Lanka--also a brief visit was made to the Technology Development Institute (TDI) of the East-West Center in Honolulu to discuss its activities in the field of appropriate technology. The survey focussed on the rural sector in each of these countries. This was the result of time limitations and the author's conviction that in terms of need this is the sector most relevant to the general concept and to the role of international assistance. It excludes, therefore, most activities pertaining to small and medium-scale urban-based industries and to the service sectors, as well as to alternate sources of energy.

A. The Philippines

1. Some Background Notes

The Philippines have made great economic strides since their break with the colonial pattern of trade and investment of thirty years ago. Since that time industry has been built up through a process of import substitution of primary and consumer goods. The process was fuelled and financed to a large extent by a lively market for traditional agricultural exports. Industrial growth slowed down in the 1960's, however, as easy export markets ran out and the country attempted to shift into the secondary phase of import substitution, i.e., capital and producer goods. Additional growth from this point was purchased at the price of increased inefficiency and was accompanied by rising numbers of un and underemployed and

worsening family and regional income distribution. The economic causes appear to be the constraining effect of continued import substitution programs and the slow growth of the rural sector.

The rural sector in particular has not been able to provide sufficient productive employment opportunities, despite the agricultural productivity improvements that have occurred since 1965. This has led to "premature" rural-to-urban migration and aggravation of the urban unemployment problem. The situation in the rural sector can be summarized as follows:

- considerably higher infant mortality and lower literacy rates than the urban areas.
- paucity of hospital beds and care outside of Manila.
- adequate water supply in only one-half of rural homes.
- electricity available in only 10 percent of rural homes.
- rural incomes are one-third those of Manila and about one-half those of other urban areas.
- low agricultural yields.
- extensive unemployment, especially in the non-agricultural parts of the rural sector.
- widespread malnutrition.

The task, it seems, is to mobilize and energize the rural sector to increase output, income, employment and basic services, while at the same time orienting the industrial sector away from import substitution (to keep it from feeding off the rural sector) and towards exports. The geographic dispersal and ruralizing of industry as well as technological choices will play important roles in this two-sector strategy.

2. Attitudes Towards Appropriate Technology

In general, a surprising degree of awareness and understanding of the basic elements and issues of appropriate technology were found in discussions with officials, practitioners, farmers and small businessmen in the Philippines. Part of this is attributed to the influence of the International Rice Research Institute (I.R.R.I.) located at Los Banos, which has been one of the pioneers of appropriate technology for rice cultivation in Asia. Also the history and evolution of the Jeepney industry has given Filipinos another concrete example of how appropriate technology can work. The survey also revealed a lack of any real sensitivity to some of the terminology or conceptual issues discussed earlier. Under any number of terms and definitions, the "2nd best issue" seems to be a non-issue in the Philippines. At the same time, there is a very narrow base of appropriate technology research and applications. With the exception of the Jeepney industry, current applications seem to be confined largely to agricultural mechanization and isolated research and development efforts in the urban-based industrial sector which have not yet been translated into action programs.

Perhaps a more accurate observation would be that the Philippines is in a state of transition with respect to intermediate and appropriate technology. There are several indicators of this. Recently the concept of "appropriately-scaled technology" was injected into the mid-term appraisal of the Four-Year Development Plan, with the idea that the next steps would be to initiate research and formulate programs. Some research is already in progress at several branches of the University of the Philippines, particularly at Los Banos and at the Small-Scale Industries Institute located in Quezon City and at Mindinao University.

In addition, the GOP has created a Farm Systems Development Corporation with responsibility for researching, testing and evaluating various farm systems and technologies. To date, the emphasis has been placed on small-scale irrigation systems and on small-scale farm machinery. The recently initiated cooperative movement is in many ways an application of appropriate technology concepts. Organized vertically down to the "barrio" level, the "coop" movement is designed to provide, farmers, among other things, small-scale irrigation systems, small-scale machinery and rice processing equipment and a "technology package". Some of the equipment, in time, will be produced by the cooperatives themselves.

Another example of changing emphasis on the part of the Government is the increase in government-sponsored credit programs for the purchase of small-scale farm machinery, particularly the small power tillers and threshers. The GOP, with World Bank and other loans, has extended low-cost credit for the purchase of farm machinery in order to increase production. Most of this machinery has tended to be large Western four-wheel tractors and similar equipment imported from the West and from Japan. Recently, however, emphasis has shifted to the small two-wheel tractors manufactured locally or imported from Japan. This shift was given an added push last year when hoof and mouth disease began to deplete the Carabao (water buffalo) population. This decrease of the Carabao population had serious economic and political ramifications. It left many farmers at the mercy of the "custom cultivators" or with the alternative of using human-power to pull ploughs and other animal-drawn equipment through the rice fields. This occurred in several areas and was unacceptable politically and socially. Most farmers, when credit is available, seem to prefer the small power tiller to the Carabao, even though the tiller may provide more power and capacity than are needed for two-to-five hectare farms. When several farmers were asked why they aspire to own the power tiller, the usual response was "because the Carabao is too much work. It requires one person at least five hours per day to provide the necessary care and feeding." This raises an important point. Farmers, in addition to wanting to increase output, also want some of the drudgery taken out of their primitive farming methods. This is a factor not always taken into account by the theorists, engineers and economists in the debate over intermediate and appropriate technology issues.

It should also be mentioned that part (10 - 15%) of a World Bank loan is dedicated to providing investment and working capital to small rural entrepreneurs who wish to manufacture small-scale farm equipment. Thus far, the program has been limited to lending for the manufacture of power tillers, power threshers and batch rice dryers. This appears to be a good, if very limited, beginning in the stimulation of small rural industries.

One final note on attitudes. Most officials surveyed were well-disposed towards the concept of appropriate technology as a development strategy for the Philippines. Not all, however, were satisfied with the current approaches. The most controversial issues concerned farm mechanization. Many felt that more efforts should be made to

develop improved animal-drawn equipment rather than small mechanized equipment. The main reasons given were that better animal-drawn equipment would be more economically accessible to small farmers, more attuned to the scale of small farm operations and more in concert with existing infrastructure and the existing social/cultural environment. To some extent, this official attitude seemed to mask a deep sympathy for the small farmer and traditional culture, and a fear that the small farmer would not be able to resist the prestige of buying new equipment, whether he needed it or not. A deeper insight into Philippine attitudes can be gained from looking closely at some of the current applications. In general, however, the Philippines appear ready for a wider application of the concept. No marked sensitivities or general resistance were found. What is needed is a sharper focus at the planning and operational levels and a more coordinated push by Government institutions.

3. Major Activities and Applications

Despite the lack of planning and programs, there are several significant on-going appropriate technology activities in progress in the Philippines. Some are purely research and experimental, others have a rather long history of application. The following are some representative examples.

a. The "Jeepney" Industry.

No survey of appropriate technology in the Philippines would be complete without at least mentioning the "Jeepney" industry, as the history of this industry embodies most of the essentials of the appropriate or intermediate technology concept. It is purely indigenous and was a going concern long before the terms intermediate or appropriate technology became popular.

The Jeepney industry was born of the great need for public transportation and an abundance of cheap, locally available war surplus materials that existed after World War II. After the war, millions of dollars of excess army property was available in and to the Philippines, including Jeeps and Jeep spare parts. It was almost natural then that a local adaptation of the army Jeep vehicle evolved. It started in small shops with crude versions. It is now a $20 million a year business. Jeepneys are made in over 100 shops, large and small, throughout the country. It is estimated that Jeepneys comprise almost 50% of the vehicles in the Philippines. Now various models, sizes and shapes are available, many brightly painted, decorated and with titles or names. They have become an intimate and colorful part of the Philippine culture and they provide much of the country's public and private conveyance system, particularly in the rural areas.

The complete body and all sheet metal parts are made locally in small and medium-sized shops. The engines and gears are generally imported as surplus or excess property items, but increasingly engine and transmission parts are produced locally by the larger shops. A large automotive component industry has sprung up around Jeepney production. The sheet metal work is done by presses in the larger shops and by simple metal bending and metal-forming machines in the shops of smaller producers. The entire industry is highly labor intensive. Some producers have modernized their production methods but most are still using essentially the same simple tools and techniques of twenty years ago. Current costs vary depending on the model and whether new or reconditioned surplus engines are used. Average retail costs range between $1500 and $2500.

The success of the Jeepney industry in the Philippines can be traced to three main factors:

- the low-cost of surplus engines and suspension systems.

- the widespread availability of local materials and spare parts.

- it fits the requirement, i.e., the demand for a low-cost, durable vehicle that will survive the rugged country roads and terrain of the Philippines. The evolution of the Jeepney industry provides some valuable lessons for the proponents of intermediate or appropriate technology. For example, it illustrates that:

  a) the product must be demand-oriented, simple, functional and durable.

  b) local materials must be in abundance and their supply assured.

  c) the product must be something that local, small town artisans can copy, i.e., a sample or prototype is generally needed in the beginning.

  d) some standardization of spare parts must be achieved.

b. <u>The I.R.R.I. Machinery Development Program</u>

The work of the Agricultural Engineering Department, under the leadership of Dr. Amir Kahn, and as part of the International Rice Research Institute (I.R.R.I.) at Los Banos, is based on a rather simple theory. Most modern imported mechanization technologies are inappropriate for application to tropical agriculture. There are essentially only two categories of modern farm machinery - Western farm machinery which has been developed primarily for dry land farming and the agricultural machinery that has been developed in Japan which, while smaller in scale and suitable for wetland rice production, has become highly sophisticated and too complex and uneconomic for most tropical rice farmers in other Asian countries. The introduction of new rice varieties has brought on the need for technologies that are simple and inexpensive, yet much faster and more efficient than the traditional technologies. In other words, double and triple cropping has increased the need for faster and more efficient land preparation, fertilization and post-harvest processing.

The second premise is that traditional, primitive technologies, including animal-drawn equipment have evolved over hundreds even thousands of years and that there is not a sufficient margin of improvement left in most of this equipment to make a significant enough impact on increased productivity and output to influence most farmers to adopt the improvements. Therefore, the decision was made to concentrate, for the most part, on the lower scales of mechanization. This decision also embodies another basic conviction, which is that the farmer in addition to looking for ways to increase his capital/labor-output ratio is also looking for ways to remove some of the drudgery of farm work. Experience with the adaptation of imported machines to fit these needs has not worked out. What has been lacking is demand-oriented product designs which can take advantage of and stimulate locally available metal-working technology. Therefore, the emphasis was placed on simple mechanized tillers and threshers. However, the development of new designs and prototypes is expensive and often outside the engineering expertise available in any quantity in most developing countries. In the developed countries this market identification and design role is played by industry. In the developing countries, the small to medium-sized metal working firms and manufacturers are the logical producers of small-scale

equipment but they lack the design knowhow. Therefore, the design role, for a time, must devolve on national and international institutions such as the Farm-Machinery Development Program at I.R.R.I.

Based upon this theory and with A.I.D. as its largest sponsor, I.R.R.I. has designed or adapted thirty-five to forty pieces of small-scale hardware considered suitable for various small-farm applications in the rice growing regions of the world. Following is a partial listing:

- rotary harrow for small tractors
- four-wheel 15 hp riding tractor
- 8 - 14 hp tiller
- single and multi hopper seeders
- anhydrous ammonia applicator
- rotary power weeder
- contact herbicide applicator
- drum-type paddy thresher
- axial flow thresher
- manually operated grain cleaner
- test tube miller
- grain moisture meter
- heated sand parboiler
- batch rice dryer with oil burner
- low lift bellow pump
- solar energy collector
- differential slip tiller
- four-wheel 15 hp riding tractor
- deep placement granular and liquid fertilizer applicators
- stripper harvester
- table-type paddy thresher
- rotary power grain cleaner
- oscillating screen-air cleaner
- adaptation of Engleberg rice milling machine
- rice hull furnace for drying paddy
- vertical axis windmill

The above projects are in various stages of development. The manual grain cleaner, the windmill and the solar collector are still experimental. However, six designs have been put into commercial production in the Philippines and in a few other countries. These are worthy of further note.

The 5 - 7 hp tiller is probably the most popular and successful of the I.R.R.I.-developed small-scale machines. It is not an original technology but a simpler model of the two-wheel tractors developed in the U.S., Japan and elsewhere over the last several years. Its engine, chains, sprockets, bearings and seals must be imported. The remainder was designed to be produced by small metal working shops in most Asian countries. It comes with an array of attachments (e.g., lowland cage wheels, upland wheels, rubber lug wheels, comb harrow, trailer, plow, slasher blades, ridging blades, rotary grass cutter and a centrifugal pump). Twenty companies are now producing this tiller in the Philippines. Over 7000 units have been produced throughout Asia. I.R.R.I. is now working on a slightly larger version with steering clutches, which was a drawback of the smaller machine.

The axial flow thresher has become moderately popular after two earlier versions failed miserably. It weighs approximately 1000 pounds and requires a 7 hp engine to power it. Its main advantages are: mobility (pulled to the field by carabao, small hand tractor or jeep or truck), multi-crop capability (rice paddy, sorghum, soy beans, etc.) and flexibility and efficiency (threshes one ton of paddy per hour). It requires a three to four man crew to operate. Its main disadvantages seem to be that it is expensive (about $US 2000), and its capacity is quite a bit beyond the needs of the average 2 - 5 hectare rice farmer. It is estimated that it requires at least 15 hectares to make it pay. If a farmer can afford to buy it, however, he can amortize the cost fairly quickly by doing custom threshing. It is also potentially ideal for "coop" ownership.

The rotary power weeder is a three-row, engine-powered machine of light-weight construction for easy turning at the end of the rows. The weeder was designed at I.R.R.I. but it is produced almost exclusively in Japan. It has a lightweight, high-speed one hp engine that is difficult to duplicate in other countries. It is also not too economical for operations under 6 hectares. The development of a good manually-operated rotary weeder would work best. Thus far, one has not been developed at I.R.R.I.

The tractor extendible lug wheel is an I.R.R.I.-designed set of steel lugs attached to the rear wheels of a four-wheel tractor to prevent it from becoming bogged down in wet rice fields. The lugs can be extended easily to give more traction and mobility. It has become popular with custom tractor operators.

The batch dryer is another of I.R.R.I.'s post-harvest processing innovations. Drying of paddy is a serious problem in most Asian countries and the cause of considerable lost production as it directly affects spoilage or results in a high level of "brokens" during the milling process due to improper hardening and moisture content. Farm-level dryers are popular in Japan but are too expensive to import and too difficult to fabricate in most developing countries. The I.R.R.I. dryer is more simple, consisting of a grain bin with a perforated floor, a blow, fan and a kerosene burner. It can dry one ton of paddy (16% to 26% wet) in five or six hours. The dryer is being produced by six companies in the Philippines and production has also started in Taiwan. I.R.R.I., however, has developed two modifications of the original prototype--a wooden grain bin which can be built by farmers and a furnace to heat the dryer which uses rice hulls as furnace fuel. All these items are being produced and sold by small metal working shops in the Philippines.

While the results of the I.R.R.I. Machinery Development Program are somewhat controversial in appropriate technology circles, its general approach to the problem is interesting and somewhat unique. The approach consists of the following distinct elements and steps.

a) Study the economics of mechanization, identify the major areas of potential new designs and identify the reasons why commercialization of small-scale machinery had not taken place earlier.

b) Design new small-scale equipment or improvements in existing equipment.

c) Interest local small firms in manufacturing the equipment from I.R.R.I. - furnished designs. This proved to be a major problem. Poor response was received to general advertisements in local newspapers. It was discovered that small firms were not familiar with working from engineering designs and were reluctant to invest in the prototype unless they had assured orders. This bottleneck was broken by giving the designs to the manufacturer in return for the production of a few demonstration machines.

d) Field test the first manufactured prototype and suggest manufacturing improvements and modifications before authorizing the manufacture of the rest of the initial prototypes.

e) Encourage and assist the manufacturer in selling the first prototypes to farmers by furnishing technical assistance, test results, promotion leaflets, and instruction manuals, as a further means of stimulating interest in commercial production and obtaining additional field test data.

f. Encourage manufacturers to incorporate their own ideas for design changes and adapt the machines to their own production facilities to give them competitive advantage.

I.R.R.I. has extended this basic approach to nine other Asian countries, namely Pakistan, Thailand, Indonesia and Sri Lanka, Malaysia, Taiwan, Korea and Vietnam (before April, 1975). This "outreach" program is basically done through sub-contract arrangements with public and private institutions or firms in these countries and by furnishing designs, prototypes and a limited amount of financial assistance. Production of initial prototypes apparently has taken place in all of these countries, but has not yet developed into any significant commercialization, except in Taiwan.

The I.R.R.I. machines are not without their critics. The major criticism and opposition to date centers around the following contentions:

a) the I.R.R.I. machines, especially the power tiller and axial flow thresher, provide more power and capacity than the average farmer needs and are, therefore, uneconomical. They should be made to a smaller scale or some of them abandoned in favor of hand-powered or animal drawn equipment.

c) The I.R.R.I. machines displace labor in labor-abundant countries.

d) The I.R.R.I. program is not an indigenous enterprise since it depended heavily on outsiders to initiate and sustain it.

e) The I.R.R.I. machines are not commercially viable without an initial subsidy.

f) The I.R.R.I. machines have not made a significant impact on increased output or increased net farm income.

In summary, a serious shortcoming of the I.R.R.I. experience has been the lack of impact studies built into the design, development and commercialization stages. Without these the validity of the above arguments and counter-arguments cannot be evaluated intelligently.

3. The Kaunlaran Industrial Shop

The survey included a visit to a small rural manufacturer of the I.R.R.I.-designed machines, the Kaunlaran Industrial Shop (K.I.S.) located at Calamba, Laguna, R.P. The owner - manager of KIS was formerly a skilled craftsman in I.R.R.I.'s Agricultural Engineering Department. In 1973, he started his own machine shop, under a shade tree, with three employees and a limited amount of "scrounged capital". His original capitalization was the Philippine peso equivalent of about $500. He now has paid-in capital in excess of $25,000 equivalent and subscribed-capital of almost $100,000. KIS now employs eighty-three workers in three locations. Plans call for an expansion in 1976, provided Government-sponsored loans are available. It is interesting to note that about 50% of KIS's skilled employees were recruited from "Jeepney" shops. KIS has produced and sold most of the major and more popular I.R.R.I.-designed equipment (about 60 units in 1975), but up to now it has emphasized the axial-flow power thresher. In 1976, KIS plans to increase its production of power tillers and batch dryers.

The Kaunlaran Thresher has undergone several modifications over the original I.R.R.I. design, e.g., a fifth louver has been added to the axial flow to make it more efficient. It has been modified in some models to enable it to be moved about the field by animal power. The thresher sells for the equivalent of about U.S. $2,000, while the tiller and dryer will sell in the $800-$1000 (U.S.) range. These prices are competitive with larger dealers and, KIS believes, are affordable by small farmers with access to Government-sponsored credit. All three machines contain roughly 15% to 20% of imported components, while the remaining components are made in the KIS shop from locally available raw materials.

The KIS owner and manager regards the following as the main reasons for his success. One is the fact that the I.R.R.I. engineers and technicians worked closely with him and his employees during the initial development and expansion stages. Second, that he personally supervises the quality control aspects of production, and third, that he has chosen demand-oriented products which he is willing to back up with guarantees and post-sale service. Working closely with the farmers has increased their confidence in him and also has led to several useful in-the-shop modifications and improvements.

4. The Zero Tillage Concept

A small experiment is underway in the Central Luzon area of the Philippines which could be considered a unique application of intermediate technology. It combines the most advanced seed technology available, water control and intensive use of farm management and farm labor, while using almost exclusively hand-powered equipment.

In brief, the system involves taking a small acreage of from one to two hectares and sub-dividing it into from 70 to 100 small plots. Each plot is then farmed intensively and separately. High yielding varieties are used but the cultural practices differ from the norm. For example, seeds are presoaked and then germinated in the dark. The seedlings are treated with a zinc oxide solution to increase their absorption of nutrients. In transplanting, the seedlings are spaced less intensely than normal and in east-to-west rows to increase exposure to solar radiation. In addition, fertilizer and pesticide applications are made weekly (7 times during the growing season compared to 2 or 3 applications under normal practices). Harvesting occurs earlier to avoid losses from field shattering. The rice is harvested close to the ground and removed from the field the same day. The next day a new crop is planted between the rows of the old crop. The harvested rice is dried by electric lamps one day and milled by a hand-powered rice mill the next day. The rice produced brings premium prices in the Japanese restaurant trade in Manila.

Four crops are produced on each plot each year (compared to two previously) with a labor input four times that of traditional crops. From land preparation through harvest, no mechanical or animal-powered equipment is used. Equipment includes a hand-pulled plow, hand-pushed rotary weeder, backpack sprayer, a harvesting scythe, foot pedal thresher and hand winnnower. The concept has caused considerable excitement in the Philippines. The system depends heavily on two things--discipline or intensive farm management almost 365 days a year and precise water control. The question is whether the majority of Philippine farmers are willing to subject themselves to more work rather than less? Most agree that the answer is "probably not" but other experiments are underway which, while using the same principles, attempt to reduce the man-days of farm management down to a more realistic level, e.g. around 320-330 man-days. It will take several crop cycles to determine to what extent these efforts will prove successful and attractive to other farmers. The experiment illustrates another facet of intermediate technology, the best of the new and the best of the old, and it has caused some of the small-scale mechanization proponents to do some serious rethinking.

5. The Institute of Small Scale Industries.

At the academic level, one of the major research efforts is occurring at the University of the Philippines' Institute of Small Scale Industries (I.S.S.I.), located at Quezon City, I.S.S.I. has been in operation for almost ten years. It has been assisted over the years by the Royal Dutch Government and is dedicated to upgrading small industry in the Philippines through training, research and extension services. It

is now engaged in a "state-of-the-arts" survey of ten selected industries as a preliminary step to establishing transfer of technology programs. These programs are being assisted financially by Canada's International Development Research Centre (I.D.R.C.). The surveys are aimed at determining the level of technology in use in each of the ten industries, including recommendations for the most profitable technology for a given industry. This along with training of entrepreneurs, managers and foremen of small industry, is combined with the identification and design of more appropriate adaptive technology for each industry. The purpose is to increase the income of the small entrepreneur and to prepare him for making the technological choice most appropriate for his industry, and also to stimulate local innovation. Foreign experts are brought in to assist with the training and to advise selected industries. I.S.S.I. has made several "laboratory" innovations. For example, three presses have been adapted or newly designed: an old drill press has been adapted for modern small shop uses, a new design for a pneumatic press has been put into operation, and an impact press has been newly designed. The purpose of these is to demonstrate to entrepreneurs what can be done by innovation.

The biggest problem facing small industry in the Philippines is the erratic flow of raw materials and financing. In I.S.S.I.'s view, this is a more serious problem than the lack of more appropriate technologies. Cooperatives are one way to help alleviate these problems, but stronger Government policies are also needed in the marketing and distribution of the raw materials on which small industries depend. Sufficient credit at reasonable interest rates has not been available to small entrepreneurs in the Philippines. More is being allocated than before but the amount is quite limited and the process is slow.

6. Regional Adaptive Technology Centers (RATC's).

Mindanao State University is one of four non-metropolitan Asian Universities participating with the East-West Center of Honolulu in a program designed to develop Regional Adaptive Technology Centers. The other universities are Yeungnam University, Korea; Hasanuddin University, Indonesia and Khon Kaen University in Thailand. The purpose of these centers is to provide community-related research, consulting, training, technological adaptation, and industrial extension for small industries within the community served by the Center. Mindanao State University first concentrated on the local brassware industry. These programs began in 1974. Some have advanced more than others, but in concept they represent an important development in the field of intermediate technology. Previous international assistance has tended to concentrate on upgrading national and international-level institutes without upgrading and developing linkages with local and regional institutions. The latter are in the best position to identify problem areas, carryout adaptation and disseminate information to rural target groups. India, apparently, has carried this concept to a relatively advanced stage. The RATC concept is one that merits more attention by international assistance agencies and national governments if they are serious about developing and disseminating intermediate or appropriate technology. RATC's will be discussed in more detail at a later point in this paper.

7. Problems and Research Priorities

Following are some of the major problem areas observed in the Philippines where research and application seem most needed. The list is restricted primarily to the rural sector.

a) Small-Scale Farm Machinery: The results of the I.R.R.I.-designed farm Machinery Development Program are impressive but not conclusive. More research is needed to determine better responses to a number of questions and problems. There is some doubt as to whether

I.R.R.I. has hit the right scale of some of its equipment. The tendency in second generation development will be to go for a slightly larger scale, where the real requirement may be in the other direction. A closer look also needs to be taken at a mix of hand, animal and gas-powered equipment. In terms of rice production, perhaps the biggest payoff will be in the post-harvest handling and processing of rice. Losses at these stages due to inefficient methods and technologies can vary from 15-30% due to improper harvesting, drying, cleaning and milling. Past responses to the drying, cleaning and milling problems have tended towards importation of large rice processing complexes. Many of these have not worked out because the technology has not been appropriate. Continued research needs to be done on the batch dryer and on solar drying, which is the subject of a current experiment at the University of the Philippines at Los Banos.

One of the chief problems with the I.R.R.I. equipment is that there are no thorough impact studies available. In other words, after almost ten years of development, experiment and application, precious little is known about the impact of some of this equipment on employment, farm income and production. Secondly, I.R.R.I. bases its product development program on the principle of "commercial viability". The principle has merit, yet the process appears to be heavily subsidized from inception on through the purchase of equipment by the farmer and subsidized credit for the small manufacturer. Some subsidization is inevitable and probably desirable but the question of how much should be looked at more closely.

b) Irrigation is an area where innovation in small-scale methods could pay enormous benefits. In the Philippines there is a need for many more small dams and reservoirs in the rain-fed areas in order to convert these to areas of constant water supply. Within the irrigated areas, there is a requirement for an efficient, inexpensive variable-depth immersion pump for small-scale irrigation systems. Also, it would appear that for provinces such as Nueva Ecija wind-powered pumps could be utilized. Preliminary research indicates that chemically treated membranes derived from fibrous vegetable matter could make excellent and inexpensive water proof liners for irrigation ditches and small canals.

c) Fish farming. In previous years, fish raised in the rice paddys were the source of additional subsistence or cash-crops. In the Philippines, fish have disappeared from the paddys. Many believe that this has been caused by the use of fertilizers and pesticides. Research is needed to more precisely determine the causes and find a solution.

B. Indonesia

1. Some Background Notes

With a population of about 140 million people, Indonesia is the fifth largest country in the world. A per capita income of about $100 (measured in 1973 prices) also makes it one of the world's poorest countries. Open and disguised unemployment and a continuation of massive rural-to-urban migration are some of its most serious problems. Yet, Indonesia is rich in oil and natural resources with vast unexploited lands. It has shown a steady growth rate over the last few years in both the agricultural and industrial sectors but it is not yet self-sufficient in rice production, which is a rather alarming fact given the estimates that its total population will increase by 100 million people over the next twenty-five years. This also has great significance in terms of political/social balances and its dual development goals of growth and equity.

The Government of Indonesia (GOI) has not been unaware of these problems. Agricultural development, employment, improved income distribution and population control have been primary development objectives for the past several years. However, there seems to be an excessive capital-intensive bias in the economy which may have contributed to some of these distortions. Several factors have contributed to this bias. Its rich natural resource bases has attracted foreign investment and with its capital-intensive technology. Oil and other primary product exports have also brought in the foreign exchange earnings by which Indonesia could afford to import capital goods. Substantial foreign aid, with its own orientation towards advanced Western technology, also may have contributed to a capital-intensive economy. There is evidence that Indonesia is now "rethinking" some of its development strategy and is beginning to question the wholesale importation of Western technology. In fact the labor displacement issue has become so sensitive, there is danger that policy decisions may shift to the other extreme. Indonesia has not yet found a comfortable path to the dual goals of growth and equity and has not yet come to grips with the question of technological choice and its impact on employment.

2. Attitudes Towards Appropriate Technology

In a country as diverse as Indonesia, it would be unrealistic to think that a complete and totally accurate picture of attitudes towards something as far ranging as appropriate technology could be gathered with limited time and travel. At best, this approach can only yield a few indicators and sketches, which in this survey are confined largely to the rural sector.

In the rural areas, particularly on Java, it is important to understan that farm holdings are very small, with the majority less than one hectare and many as small as one-half hectare. This will not support a family even on a subsistence level. Thus, a farmer's income comes from many sources. The farmer and his wife and his children are also laborers in other farmers' fields much of the time. It is estimated that as much as seventy percent (70%) of rice production is done by hired labor. Java probably has the most intensive rice production in the world. As many as 950 women are involved in one way or another in the harvesting and post-harvesting of one hectare of rice. Hundreds of harvesters thus share in the rice crop. This process has been referred to as "shared poverty". While it is a way to distribute wealth (or poverty), it causes many problems for the farmer whose crop is being harvested. Large losses in production are incurred because of trampling, droppage, shattering, and stealing. Farmers have resorted to various ways to cut these losses such as selling the rice crop to middlemen before the harvest. The middlemen then control the harvest and do not have the same degree of social pressure to use so many harvesters.

Small-scale technology could and has reduced these losses but at a price. A dramatic example of the impact of new technology on employment in rural Indonesia concerns the introduction of rice hullers as opposed to the traditional handpounding of rice by women. It is estimated that the rice huller, while increasing output (some estimate 5 or 6%) has displaced about 125 million woman days of labor annually, which represents $50 million dollars in wages a year. Another illustration concerns the introduction of the new high yielding rice varieties of the Green Revolution. These varieties shatter more easily than the traditional crops, which are harvested by women using the "ani-ani" knife. The knife is hand-held and used to cut one stalk (panacle) at a time. The stalks are bundled together and carried from the field. The villagers know that a sickle should be used on the new varieties but many are reluctant to do so for fear of the economic and social consequences. Those that do, automatically displace a great deal of rural labor.

These are but a few examples of how even simple technology can affect the economic and social relationship of a country like Indonesia. The labor displacement issue is highly sensitive and affects most attitudes towards any kind of rural technology that departs significantly from the traditional. It particularly affects attitudes towards the introduction of small-scale I.R.R.I.-type farm machinery. Unfortunately, the I.R.R.I. equipment has become synonomous with appropriate technology among many Indonesians. For this reason, Indonesia recently declined to participate formally and fully in I.R.R.I.'s "outreach" program. This represents a setback in terms of understanding its concept and application. As will be seen later, however, Indonesia is now participating in this program on a "semi-formal" basis. Also for the same reasons, most of the imported small-scale Japanese tractors and other farm equipment have failed commercially in Indonesia. Many officials flatly predict that the I.R.R.I. and similar Japanese machines will have no future in Java. This is not a unanimous or universal attitude, however. The chief reason for the debate is that, despite the abundance of labor in rural areas, there appear to be labor shortages during the peak periods of land preparation and harvest. This has been caused in part by the new seed varieties and increased uses of fertilizer which permit double-cropping but require quick land preparation between harvest of the first crop and the planting of the second. It is also caused by a declining water buffalo (kerbau) population.

In this debate, one sees the constant dilemma between growth and equity, employment and output, and the lack of any research that would put the issue to rest one way or another.From studies that have been done, however, there seems to be little doubt that the use on Java of such small-scale equipment as the power tiller and the power thresher is definitely labor displacing. One study indicated that without commensurate increases in production, employment losses for each 5-7 hp. power tiller used at a three-fourths utilization rate were 128 man-days per year when displacing a water buffalo, and 688 man-days per year when displacing manual methods (contrary to the Philippines, manual labor has been used as extensively as animals in land preparation). When is it efficient for a farmer to own a small tractor? One study estimates that in rice farming a farmer with a "padi tractor" should own about seven hectares and have effective control over 20 hectares, i.e., by leasing additional land or leasing the use of the tractor. This amount of hectarage does not fit the pattern of average holdings on Java. It also gives weight to the argument that the newer technology, even small-scale equipment, may impact adversely on the lowest income groups.

Attitudes towards small-scale equipment change drastically when related to the trans-migration areas. These area will be settled by Javanese families. The average-sized holdings will be from three to five hectares. Considering the amount of clearing that will be necessary, plus the harder soil and the problem with alang alang, (a pernicious jungle growth) this is more than a farm family can handle with hand labor and traditional tools. It is probably more than can be handled with animal-powered equipment. Hence, the interest in appropriate technology and small-scale mechanized equipment for these areas.

In summary, the general attitudes in Indonesia towards technology are somewhat confused and diverse. The country is only now beginning to correct what has been a strong capital-intensive bias. Attitudes towards intermediate or appropriate technology vary from apathy to misunderstanding to a high degree of awareness. Those most knowledgeable believe that the problem is not one involving concept but rather confusion in how to go about making the right technological choices. There is a favorable disposition towards international assistance but few ideas

exist as to specifically how this assistance should be directed. It is clear that the labor displacement issue is ultra-sensitive and for this reason appropriate technology efforts must be approached with great care. There is also a concern for the conflict between technology and the environment and a strong feeling that appropriate technology activities must be indigenized to the extent possible in order to avoid conflict with cultural traditions.

3. Major Activities and Applications

A productive survey of appropriate technology activities and needs in Indonesia would take many weeks if not months. The following represents at best the barest of samples.

a) The Institute of Technology at Bandung

On a conceptual level, the Development Technology Center (DTC) at the Institute of Technology at Bandung (ITB) is probably the major catalyst for intermediate or appropriate technology efforts in Indonesia. The DTC is three years old. It has an able Director and is staffed by highly trained and motivated people. As part of a national institution, the DTC looks at appropriate technology in a broad sense, as an avenue for "better living" for rural peoples and is, therefore, interested in a broad range of technological improvements and adaptations. The DTC has laid out three stages for its appropriate technology activities. The first stage which DTC refers to as "software" is the identification, training and motivation of select groups of rural entrepreneurs. In addition, the DTC attempts to provide technical assistance to rural entrepreneurs to complement a fairly sizeable and accessible Government-sponsored credit program for small-scale enterprise. To date, over one hundred entrepreneurs have been assisted, mostly from the Bandung area. The DTC is attempting to involve the entire banking community as well as several Government ministries in this effort.

The next stage will be to set up an information center, or a clearing house system to get at the dissemination side of appropriate technology which the DTC sees as the priority problem. Assisted by international experts, the DTC hopes to establish important links with most of the international institutions and to establish downward linkages with regional institutions in Indonesia. As a further stage, the DTC also plans to get into the development, testing and adaptation of appropriate hardware in such areas as food processing, food preservation and storage, clean water systems and pumping equipment, waste utilization, energy generation (solar, wind, hydro, bio-gas), and low-cost construction of bridges, housing and irrigation works. Some specific projects either active or contemplated are a coconut dryer, more hygenic processing of "tempe" (fermented soybean cake), a solar water distillation unit (adapted from a Brace Institute design), adaptation of the "Sofretes" water pump, a bio-gas digester (at Lembang), solar water heaters, dryers and refrigerators, and a windmill pump. Also as part of the hardware development stage, the DTC hopes to set up three experimental field stations--one will be in a fishing village, the second will be in an isolated agricultural village (accessible only by boat) and the other will be in a village that is in transition from agriculture to handicrafts and small industry. Mobile shops will be available to serve these stations. In this way, the DTC hopes to accomplish realistic testing, development and demonstration, but more importantly, to involve the villagers in each of these locations as participants in the process.

The ITB-DTC has made a valiant start in the appropriate technology field. It has established good linkages with the Government and with international institutions but is under-staffed and under-funded for the goals it has set. While it is in a good position to influence Government

policy, its greatest challenge will be to serve as a model and catalyst for the several regional centers of technology in Indonesia. This network will not be easy to establish given the tremendous distances and communication problems of Indonesia.

2. Farm Machinery Testing Program

The Sub-Directorate of Mechanization of the Food Crops Division of the Department of Agriculture located at Pasar Minggu (a few miles from Jakarta) is practically the only Government agency involved in testing small-scale farm equipment. It is serving as a sub-contractors for I.R.R.I but not as part of a full and formal I.R.R.I. "outreach" program. It takes the basic approach that agricultural production, particularly in rice, soybeans and peanuts, must be increased substantially. This, therefore, calls for an intensification program in terms of irrigation, land preparation, fertilizers, insecticides and improved seed varieties, which in turn requires selective mechanization in carefully determined areas. The program is very sensitive to the labor displacement problem and for the most part it selects areas where the average holdings are five hectares or above, where the animal population is small, and near big cities where farm labor tends to be scarce. In addition to the increased production objective, the program also is dedicated to taking some of the drudgery out of farming.

Tests are conducted by the Extension Service on farmers' land. This includes big machines for plantation production and small-scale equipment (up to 15 horse-power) for smaller holdings. The program also tests some hand-powered equipment such as hand-held sprayers but this does not seem to be a major emphasis of the program. The tests are also coordinated with the Ministry of Industry to determine if spare parts can be manufactured in Indonesia. The small-scale farm equipment tested thus far has involved I.R.R.I.-designed machines and imported Japanese equipment. The Food Crops Division has no equipment design capability similar to that of I.R.R.I., although it has experimented with the local manufacture of these machines with one or two small entrepreneurs on a sub-contract basis. Apparently this has failed to generate much commercialization because the small manufacturer in Indonesia lacks the kind of credit that allows him flexibility in taking risks.

The results thus far of the Farm Machinery test have been limited. The staff is convinced that there is a large demand for small-scale farm equipment due to peak period labor shortages and a decline in the water buffalo population. One small roto-tiller of the type imported from Japan has been adapted, improved and is being marketed in Indonesia. A locally-adapted irrigation pump has proved successful and has contributed to an increase in production in the test areas. Unfortunately, not much testing and adaptation seems to be in progress in the transmigration areas, which offer the best potential for small-scale equipment and are relatively free of the labor displacement issue. It also appears to be missing the great mass of low income farmers with holdings of one hectare or less.

3. The Institute of Agriculture at Bogor (IPB)

The IPB is one of the main agricultural experiment stations of Indonesia at which there is a small Institute of Technology and Mechanization. The Institute has conducted some limited experiments in design and adaptation of both traditional and modern farm equipment. The basic concept is somewhat unique and interesting. Intermediate technology is seen as improved versions of traditional technology while appropriate technology is one that combines traditional, intermediate and advanced technologies. Earlier efforts to concentrate solely on intermediate technology failed and were abandoned in favor of a more

mixed approach. Experiments thus far have included testing and adaptation of a soybean extruder, tractors of various sizes, a seed planter, and a coconut cleaner. Like the Sub-Directorate of Farm Mechanization, the emphasis is on selective and gradual mechanization.

The IPB has established arrangements with the Tool Foundation (Netherlands). IPB also wished to establish an arrangement with the East-West Center at Honolulu but lacked the necessary funds. Very few working relationships with the Institute of Technology at Bandung or other Indonesian institutions were apparent.

4. Other Activities and Applications

The balance of the appropriate technology effort in Indonesia appears to be relatively minor and scattered. In all fairness, this may be the fault of the time and geographic limitations of the surve In any event, the following are the other major activities that came to the author's attention:

a) British Assisted Renovation of Irrigation Works

Two British teams have organized a village-level program for the renovation of irrigation works in East and Central Java. Many of the tertiary and lesser irrigation canals and headgates in these areas have fallen into disrepair. The British teams have devised a system for cleaning and restoring these canals using local materials and village labor. The headgates are being made by village blacksmiths and metal workers using simple tools and methods. It is expected that this kind of a project will have a significant impact on agricultural production at a relatively low cost.

b) Bio-Gas Conversion

There is a small Ford Foundation project at the Gajah Mada Institute in Jogjakarta. A similar program is underway on Bali, and as mentioned earlier, at Lembang. Like most of these projects, they are still experimental and have not been advanced to the point that they can be commercialized successfully.

c) The "Butsi" Program

"Butsi" is the Indonesian equivalent of a domestic peace corps which like VITA of the United States operates a village technology unit. Its main purpose is to demonstrate to villagers how they can make simple low-cost improvements in their daily lives through better water and sanitary facilities, better agricultural methods, etc.

d) Small-Scale Rural Industrial Credit Program

The Bank of Indonesia has approved the equivalent of $120 million in GOI funds to assist small-scale rural entrepreneurs with working and investment capital. Almost any kind of small-scale industry is eligible, and up to 10,000 rupiahs can be loaned for working capital. The sector breakdown of loans approved to date is: Agriculture-19%; Industry-28%; Trades-32% and transportation-14%. In terms of appropriate technology, the missing ingredients in this credit program have been technical assistance and supervised technological transfer to accompany the financial assistance. This may be partially remedied by a proposed complementary World Bank technical assistance loan under which cadres of foreign experts could be financed.

5. Major Research Priorities

The range of possible applied research activities in the area of

appropriate technology in Indonesia is extensive, given a continuation of the Government's current development objectives concerning income distribution and employment generation. The following are only a few of these possibilities--

a) better hoe - the locally produced hoe tends to last only a few months. Those imported from Europe last a couple of years. A better hoe could be produced by small manufacturers if shown a better technology.

b) cold box - for keeping fish for fish farming in the wetland rich areas.

c) better extruder for soybeans and other nutritional products--something in between the large inefficient machine now being used and the more primitive methods.

d) locally produced low-lift irrigation pump. Also there is a need for small turbines to produce hydroelectric power on a small scale. It is reported that there is not one Indonesian irrigation economist in the country.

e) machine-developed building materials, e.g., bamboo designs or wood and cement mixtures.

f) shipbuilding. There is a large demand and need for more small to medium-sized water craft for transportation of cargo and people between the islands. A better technology is needed to increase the production, efficiency and safety of water-craft without inordinate displacement of labor. Labor displacement apparently is already occurring among the fishing fleets where motor-powered trawlers are replacing sail-powered vessels. There has been a decline in the number of fishermen, a decline in the income of sail-boat fishermen and an overall increase in the annual catch. There is also a need for a simple ship-to-shore communications system.

g) revival of the blacksmiths trade which is dying out due to competition by large foundries and metal working firms. Previous outside help in this area has been unsuccessful.

h) small-scale post-harvest rice and grain processing equipment, especially equipment for threshing, drying and storing. It is not clear if the I.R.R.I.-designed equipment would be appropriate without significant adaptation. The pedal or hand thresher would seem ideal for parts of Indonesia but even this simple technology may displace too much labor. Better village-level storage is a must.

i) development of a trans-migration research and application package. Some ad hoc research and application has been done for the trans-migration areas but a more integrated "package" approach should be considered. This could include everything from hand tools to bio-gas converters. It is especially true of the proper mix among hand-powered, animal-powered and engine-powered equipment. One suggestion is that cattle be furnished the trans-migration settlers as a source of food, animal power and one way to control alang-alang. It is certainly clear that much of the small-to-medium-scale agricultural equipment is more suitable to the trans-migration areas than to densely-settled Java. Research could also be done on an all-purpose vehicle for these areas, similar to the Jeepney and the Fiera of the Philippines.

j) "zero-tillage" or intense cropping concept of rice cultivation now under observation in the Philippines, may have great utility for the rice growing regions of Java where land holdings are so small.

k) Regional adaptive training centers offer one of the best areas in which to expand. The development and diffussion of appropriate technology in Indonesia is one of the areas in which international assistance could be most effective. In addition to increased financial support, an information network needs to be established among these institutions, and between them and national and international-level organizations. Some of the more specific needs expressed to the author were:

- a country inventory of on-going appropriate technology activities.
- an in-country information and "clearing house" system to promote the concept and diffuse existing information.
- a fund to finance high risk starts among innovators and small-rural entrepreneurs.
- outside assistance with designs and systems to develop a critical mass of understanding and awareness of the possibilities and potential of appropriate technology.

C. Sri Lanka

1. Background Notes

Sri Lanka is currently faced with a stagnant declining economy and high levels of unemployment. This has come about over a period of years and is principally due to declining markets and prices for its primary export products (tea, rubber, coconuts), increased costs of imports and population growth caused basically by decreased infant mortality and death rates. During better years in which exports were booming, Sri Lanka established a high level of social welfare services which allows most of the population wide access to medical services, education and even subsidized food allowances. The problem is that the country has attempted to maintain this standard of living in the face of declining national income. For the past several years per capita income growth has not quite kept up with the annual birth rate of approximately 2.5%, foreign exchange reserves have fallen, imports have been curtailed and unemployment has risen over 20% and Sri Lanka is now heavily dependent on foreign assistance.

Food accounts for almost half of Sri Lanka's annual imports but agriculture is clearly Sri Lanka's most important sector. It accounts for more than one-third of the Gross Domestic Product and well over half of the national employment (as much as 80% when calculating agriculture's indirect impact on employment). Tea, rubber and coconuts are the country's chief foreign exchange earners and are raised under plantation conditions. These plantations recently have been taken over by the State. Rice is the principal domestic food crop followed by manioc, kurakkan, corn, sorghum and soybeans. The country is rather sharply divided into a northern dry zone and the southern wet zone. Three-fifths of the area under cultivation is family farms that range from one-half to two and one-half acres in size. The rural areas are served by comparatively good roads and toehr communications and social services. Sri Lanka has been spared the massive rural to urban migration problems of other countries. Yet unemployment is highest in the rural areas.

The industrial sector is divided basically into four categories: large private factory industries producing mostly consumer goods; medium to large public industries producing intermediate goods (iron, steel, refined petroleum products, chemicals, etc); small private industrial activities such as power looms, coir and coir products, handicrafts and cottage industries; and small to medium-scale public industries and industrial cooperatives producing a wide range

of products such as paper, leather, ceramics, oils and fats, plywood, cement, sugar, textiles, tires, tubes, hardware, small-scale machinery, rice milling and so on. There has been an increase in public industrial activity over the past few years as these enterprises have had the most access to scarce foreign exchange.

Sri Lanka, historically, has been heavily oriented towards imports. As the foreign exchange squeeze developed, import substitution was encouraged but without regard to efficiency, comparative advantage or employment effects. This encouraged capital-intensive industries that required large imports of raw materials, components and Western technology, thus placing an increased strain on foreign exchange reserves in the face of declining exports and mounting unemployment.

Government policy for the past few years has been directed towards restructuring this industrial pattern by emphasizing low capital-intensity products located to the extent possible in rural areas; by the establishment of public industries in order to produce domestically basic inputs for other industries; and by orienting the rest of the industrial sector towards exports that reflect Sri Lanka's comparative advantage. Sri Lanka has moved slowly in these directions over the past few years. Imports are controlled centrally under a licensing arrangement. It also provides a point for "screening" technological choices. Several light engineering cooperatives have been established. A State Hardware Corporation has been put into operation. Incentives have been established for increased exports, e.g., import licenses are granted more quickly to those industries that have potential for earning foreign exchange. It will take several years, however, for Sri Lanka to overcome its most serious economic problems.

2. Attitudes Towards Appropriate Technology

Sri Lanka's development planning efforts are well oriented in the direction of appropriate technology. Much of the national planning documentation could be chapters in an appropriate technology textbook. In fact, it appears that intermediate or appropriate technology was in progress in Ceylon long before anyone invented the current terminology. The author was told that early versions of the two wheel tractor had been developed on a small scale in Ceylon some twenty years ago. The point is that there is by and large a high degree of understanding and awareness of appropriate technology concepts among a large number of public and private sector Ceylonese, many of whom are able to intellectualize the concept as well or better than Western theorists and practitioners.

Appropriate technology, import substitution, conservation of foreign exchange, indigenization of technology, employment generation self-help and national pride are almost synonomous in the minds of many Ceylonese. Opinion is divided, however, on how to go about implementing the concept. There is a definite sensitivity to the "foreign expert" who along with Western-oriented Ceylonese planners and entrepreneurs are sometimes blamed for overselling and importing Western-technology in the past and for not looking inward at Sri Lanka's own resources and factor endowments. Aid agencies are chastised for not being more flexible in their aid-giving approaches (e.g., program versus project aid) and for insisting that "foreign experts" must do the studies, etc. It would appear that this generally widespread orientation towards appropriate or intermediate technology is the product of several factors. One, it seems to come naturally to many Ceylonese, almost as an extension of the culture. Second, the high literacy, access to education facilities and relative ease of communications undoubtedly have also helped in the spread of technological

information. Lastly, the foreign exchange crisis and drastic reduction of imports, and alarming levels of unemployment have all been catlysts in developing a "let's make it ourselves" attitude. A major shortcoming to date, however, appears to have been the time necessary to translate attitudes and plans into actual output-oriented programs. Part of the problem lies in interagency communication and policy coordination.

Dr. Schumacher has visited Ceylon many times and has developed a rather large group of supporters and admirers. Several Ceylonese are internationally recognized authorities in the field of appropriate technology and are frequent participants in appropriate technology symposia. Most of the attitudinal and conceptual approaches to appropriate technology in Sri Lanka conform closely to the Schumacher model. One wonders which came first--the Schumacher school or the Ceylonese model. One difference is that the Ceylonese model is more heavily flavored with ideology (anti-imperialist, anti-materialist, anti-foreign-expert and anti-Western technology rhetoric). This is not a critical statement. It simply emphasizes some of the sensitivities and the fact that many Ceylonese look at the concept of intermediate or appropriate technology not in simple economic terms, or solely in terms of the conflict between employment and output but rather in humanistic terms and as a practical extension and application of Buddhist teachings.

3. Major Activities and Applications

The majority of appropriate technology activities observed pertained to the rural sector but were representative of what appear to be a wider range of experimentation and application going on in other sectors. Following are the major applications of which some first hand knowledge was gained.

a) The Ministry of Planning and Employment

This Ministry is a major nucleus for conceptualizing, planning, organizing and to some extent operating several kinds of appropriate technology activities, or "peoples technology" as they were referred to in the Ministry. These activities are briefly described below.

1) Blacksmiths

The Ministry's first program was to organize village blacksmiths into light industrial cooperatives. At least 45 of these were claimed to have been established in 14 districts involving over 12,000 blacksmiths. The main features of the program are that the worker is not separated from his workplace, that he has the prospect of owning his own business in his lifetime, and that he is initially provided with inputs (raw materials, tools, etc) and market outlets "without the intervention of middlemen". Technical assistance was furnished by Government and volunteer university graduates. These cooperatives are turning out simple tools and implements which were previously imported. It has also revived a craft which was slowly dying because of imports and larger-scale domestic competition.

2) Medium-Scale Industrial Cooperatives

Medium-Scale Industrial Cooperatives were the next type of cooperative to be organized beyond the blacksmiths and small-scale metal workers. The fundamental reason for organizing these two levels of cooperatives is to achieve import substitution in the agricultural sector, where even simple tools and implements are being imported. The Medium-Scale Industrial Cooperatives are cooperatives of small machine shops, welding shops, and foundries in various

districts. The Cooperative is provided with a technical center for quality control and systematic production of small-scale agricultural equipment. Each technical center is equipped with a heat treatment plant, metrication center, an assembly area, and a central stores and sales area. It was reported that eight of these Medium-Scale Industrial Cooperatives are operating in Sri Lanka.

One such cooperative was visited near Colombo in the small town of Nugegoda. This Cooperative employed about thirty people and was concentrating on the manufacture of a small two-wheel tractor. The target is to produce 20 tractor units per month in each location. The first units were sold in late 1975 and since then production has been averaging about 10 to 15 units per month at each center at a cost of about 4,500 rupiahs each (about U.S. $600). The engine, wheel belt, bearings, sheet metal and drive chain are all imported. The remainder of the machine is made in Sri Lanka. There is little quality control but thus far there have been few complaints and the farmers have access to the regional technical centers for major repairs and adjustments.

The demand for two-wheel tractors was estimated at 4000 to 6000 per year. Yet the full production of these cooperatives would only be a little over 1000 per year. There appear to be several reasons for this discrepancy. As mentioned earlier, there is a national controversy over the two-wheel tractor. One faction, the Ministry of Planning and Employment and others, favor the local production of the I.R.R.I.-type tractor to fill the entire demand. Another faction, mainly in the Ministry of Agriculture, favors the more sophisticated Japanese two-wheel tractor of which about 1200 are imported annually. Their argument is that the imported model is better, more maneuverable in the field, and is what most farmers want. A second factor in the low production of the local version is the flow of raw materials due to foreign exchange shortages and import restrictions. However, a shortage of steel imports and scrap metal resulted in a novel and innovative project a short time ago. A small group of skilled metal workers broke up two ships anchored in Sri Lankan harbors for scrap. Plans are to buy obsolete ships and do more of this in place of importing the steel.

3) Pottery and Pharmaceuticals

The Ministry has established other programs to organize the country's pottery, ceramic and pharmaceutical industries. Clay pots were actually being imported while this ancient craft was dying in Sri Lanka. These potterers cooperatives were furnished up-dated tools and kilns and were given technical and financial assistance. Likewise an effort is being made to organize the "native doctors" and pharmacists. The latter is part of a multi-agency effort to establish in Sri Lanka intermediate processing of herbs into pharmaceuticals and teach "native doctors" and pharmacists how to administer these medicines. This is an interesting scheme, apparently based somewhat on the Chinese "barefoot doctor" model and some basic economics. Sri Lanka grows many herbs and roots that are used in the pharmaceutical industry in the West. Herb medicine has been practiced by "native doctors" in Sri Lanka for centuries. Up until recently these herbs were exported to Europe where they were processed into modern pharmaceuticals, some of which were shipped back to Sri Lanka at high prices for consumption in the modern sector. Herbs are still exported in order to earn foreign exchange but increasingly intermediate-level pharmaceuticals are made in Sri Lanka for domestic consumption. The author observed one herb that native doctors prescribe in raw form for sore throats. These same herbs are now processed in Sri Lanka into a liquid cough medicine called Valmelix.

b) The Industrial Development Board

The Industrial Development Board (IDB) is part of the Ministry of Industries and Scientific Affairs. It's function is the promotion and development of small-scale industries. One of its major functions is the development of machinery and organization of the local manufacture of machinery for the small-scale sector. It also conducts several experimental projects. Under the latter category, projects of interest include--the development of a high quality banana fiberboard, coir dust board, bricks made from rice husks and fuel briquettes from peat, and quality hand-made paper. The IDB also will give further technical assistance to the fledgling small-scale straw board co-operative industries that have been started in eight locations, to small manioc starch plants, eight small safety match plants, coconut and palmyra jaggery, and roofing tile plants.

The machinery development program has concentrated on such things as the two wheel tractor and tractor trailer, a single roller cotton gin, a bench lathe and a methane gas generator. The bench lathe has been fully developed as has the methane gas converter. Special credit programs are planned to demonstrate and popularize the gas converter for use by private individuals. The IDB is also involved in the manufacture of small engine-driven and bullock-driven sugar cane crushers. For the future, the IDB will initiate research and experimentation on a hand-operated sugar crusher, dipping machine for leather goods, wood turning lathe, fretsaw and a hand corn sheller.

Another important part of IDB's programs is its small-scale across-the-board industrial credit program. The IDB can now make loans to small entrepreneurs of up to 250,000 rupees.

c) The Farm Machinery Research Center (FMRC)

The FMRC is located at Maha Illuppallama in the North Central province. This is part of the Engineering Research and Development Division of the Department of Agriculture and is the only organization in Sri Lanka that does farm machinery research. This includes machinery design, testing and evaluation, including field trials and evaluation of the effects of mechanization. The FMRC was set up in 1968 to evaluate the large and varied amounts of farm machinery that had been imported into the country since the end of World War II without regard to its suitability for local agricultural conditions. The FMRC's work is done in conjunction with the Agricultural Implements Factory located at Welsira, which will be discussed later.

The FMRC has conducted research on a wide range of farm implements but has given preference to seeding and threshing equipment. More emphasis has been put on adaptation of foreign equipment than on new design. Results thus far among mechanized equipment evaluated seem to favor engine-powered threshers and adaptation of imported Japanese two-wheel engine-powered tractors. The FMRC has tested a pedal thresher and two or three versions of wetland and upland hand seeders. They appear to be the most suitable for Sri Lanka's agriculture. A simple hand weeder has been modified and put into mass production.

d) The Agricultural Implements Factor

The Agricultural Implements factory at Welsira (a short distance from Colombo) is the production side of the Ministry of Agriculture's farm machinery development program. If FMRC tests and adaptations prove favorable, the Implements Factory then produces

the equipment according to estimated demand. This factory has turned out an impressive array of small-scale equipment, but in relatively small quantities. Following is a partial listing of items being produced at Welsira: tractor cage wheels, ridger points, chick feeders, winnowers, galvinized water tanks (400 gallon capacity), galvinized buckets, egg trays, poultry feeders, wheel barrows, ploughs and plough shares, animal cages, bee boxes, incubators, paddy bins, grass cutting knives, axial flow threshers, hand-pushed seeders (four types) and weeders, and a hand-operated centrifuge pump for extracting honey.

The Welsira factory is also building prototypes of the I.R.R.I.-type coaxial thresher and a simple grain cleaner. One of the more interesting adaptations is the development of a foot pedal thresher modeled after the Chinese and Indian models. It is also building a modified I.R.R.I. axial flow thresher which, it is claimed, represents several improvements over the I.R.R.I. design. It is estimated that there is a potential demand for about 12,000 power threshers in Ceylon. There is also a high demand for several thousand foot pedal threshers which can be adapted to an engine power source, e.g., by a pulley off the two-wheel tractor. The Welsira factory has given equal attention to hand-powered equipment. It is now producing second and third generation hand-powered weeders and seeders. In each of these the greatest attention was given to simplifying the design and substituting local materials for those that must be imported, e.g., wood for steel. When demand for these items reaches a certain level, production is turned over to the private sector.

Even in hand tools, however, there are difficulties in achieving import substitution. One of the best examples is the mammoty, a large, rather heavy, short-handled hoe, which many small farmers use for a variety of tasks including tillage. The size and shapes vary within the country, depending on customs and soil conditions. At one time these were all imported from Europe. Now none are imported and the farmers are unhappy with the local versions. It doesn't last as long and doesn't have the same feel and balance. The same thing is occurring with the two-wheel power tiller. The local versions (I.R.R.I. design and Landmaster varieties) are not as popular as two or three models of Japanese tractors. The main reason seems to be maneuverability. The Japanese models have steering clutches; the I.R.R.I. type does not. There may be a prestige factor at work also. There is pride in owning the fancier model and farmers like the chance to show it off when hauling produce and family to market.

e. <u>The Farm Mechanization Training Center (FMTC)</u>

The FMTC, which also is part of the Ministry of Agriculture, was established in 1971 near Anuradhapura under a cooperative agreement between Sri Lanka and the Federal Republic of Germany. The German assistance has involved the complete equipping of the Center with modern tools, machinery and training materials, as well as furnishing a team of German experts for technical training, advisory and extension services. The Center is surrounded by a hundred acres which are used for field trials and crop production. The main purpose of the Center is to offer technical training at a variety of levels on farm mechanization. Training programs of varying lengths are conducted for farmers, agricultural students, public and private repair shops on farm machinery functions, maintenance, repair and the economics of farm machinery. Depending on the group, special training is offered on two-wheel tractors, four-wheel tractors, water and irrigation pumps, pesticide and fertilizer sprayers, welding, forging, lathe operations, diesel engine repair, transmission repair, etc. In this manner, the FMTC complements the work of The Farm Machinery Research Center and the Agricultural Implements Factory in the area of small-scale farm mechanization. The agricultural extension agent plays an

important role in tying these activities together at the farm level. An additional spin-off of the FMTC is the creation of semi-skilled craftsmen and mechanics for the rural area.

f) The Somisiri Huller Manufactory

The Somisiri Rice Huller Manufactory is one of twenty or more small-to-medium-sized manufacturers of small-scale farm equipment. Somisiri began in 1942 with the manufacture of a rice huller. The original huller has gone through several modifications since that time and the company now produces other farm equipment, including the small two-wheel tractor. It also makes parts and components on a sub-contract basis for one or more of the Medium-Scale Industrial Co-operatives which are making and assembling small-scale farm equipment.

If Somisiri is typical of other small-to-medium shops in Sri Lanka, the country has an excellent base from which to build a dynamic and innovative small-scale industrial sector. Typical of the Somisiri operation is the fact that it is currently working on a technology by which a small diesel engine could be manufactured in Sri Lanka. Somisiri is now the only manufacturer of gear wheels in the country. Several years ago, after a long search, the owner of Somisiri discovered the gear wheel technology he had been looking for. It was found in a small two-man shop in a remote rural area of the British Isles. It was easily adapted to the Somisiri operation in Sri Lanka and the company has been producing quality gear wheels since. This same innovative drive is what has prompted the search and experimentation for a locally-produced small gas combustion engine. Somisiri is convinced that it can be done and that Sri Lanka cannot develop its full potential in appropriate technology until it can produce its own gasoline power source since all adaption of mechanized equipment now must be built around imported engines and other difficult to make components. In addition to profit, and the thrill of innovation and discovery, there is an obvious national pride at work among innovators like those at Somisiri.

g) Summary

The foregoing represents only the barest sketch of what is going on in Sri Lanka in the fields of intermediate or appropriate technology. If a complete inventory could be made of all on-going research and applications efforts, it is the author's belief that it would add up to a surprisingly full and comprehensive picture. Despite its previous history of mindless importation of inappropriate technology up to 1968, there is now a relatively wide-spread sensitivity to the concept of appropriate technology and its importance for Sri Lanka. There appear to be several reasons for this. First is the foreign exchange squeeze which has developed an import substitution consciousness. This attitude even pervades larger-scale and more capital intensive activities. For example, a modern rice milling complex is being built in Anaradhapura with the help of the UN's Foreign Agricultural Organization (FAO). Although it is being built of largely imported materials, plans are already underway to substitute local materials and to interest local manufacturers in making as many components as possible before replicating this rice milling complex in twelve other locations. The second major reason is that Sri Lanka is blessed with what appears to be a great number of highly trained, gifted and innovative planners, technicians, and entrepreneurs who understand the concept of appropriate technology thoroughly and who are attempting to do something about it. A major problem may be the lack of coordination in policy formulation and execution. With so much of the organization and operation of the economy in the hands of Government institutions, there is room for conflict and duplication.

The case of the two-wheel tractor (i.e., produce locally or import) is a good example of this. The author was told this policy conflict between import licensing on the one hand and the stimulation of local small scale industry on the other exists in other product areas.

Sri Lanka offers a productive area for further research and study. This is not to suggest that it become a laboratory for the world, but considerable further research needs to be conducted in the area of appropriate technology for application in Sri Lanka and for possible application elsewhere. One of the areas in which further research is required in Sri Lanka is in the agricultural areas scheduled for irrigation. With the diversion of the Mahaweli River, thousands of acres of dry land will come under irrigation. This will make it possible to use an ancient "tank" system of irrigation and restore rice and other production to bottom lands. In order to diversify agriculture and increase production, the Ministry of Agriculture is attempting to introduce "hillside" farming into several mountainous and semi-mountainous areas. This is a form of farming that does not belong to Sri Lanka's ancient past and, therefore, an entire new and "appropriate" technology must be developed for it. This includes water control, equipment, land preparation as well as the appropriate seed and soil technology.

In the farm sector, the Government seems committed to mechanization as a means of increasing production. Current research emphasizes the smallest scale of mechanization. This is a reaction against the inappropriate equipment that was imported into Sri Lanka between 1944 and 1968. It also stems from a conviction, fairly pervasive, that improvements in animal-powered equipment are not the answer. To the extent that Sri Lanka cannot produce its own appropriately-scaled equipment, the dilemma is often seen as a choice between "shiploads of rice or shiploads of two-wheel tractors". More than once the author heard statements such as "the person who objects most to mechanization comes from the West." Also, among innovators and practitioners, there is a feeling, like some in the Philippines, that animal-powered equipment is about as good as it can be made and that if one tinkers with it too much, its technological balance will be upset and it will become even less efficient.

In Sri Lanka, like several other countries, there is a trend toward greater mechanization without a solid data base concerning the impact of small-scale equipment on increased production, farm income and employment in the rural sector. This, along with rural industrialization and information dissemination, is probably one of the most urgent research priorities in the field of intermediate or appropriate technology. Within this context, land preparation and post-harvesting appear to be the most important areas to which more attention should be devoted. Another area for research and possible international assistance is in the area of organizing production systems. Many Ceylonese believe that a sufficient design and innovative capability exists but that help is needed in organizing production more efficiently. This includes assistance with small plant layout, organizing production and assembly systems, and sources of supply.

PART IV

ON THE ROLE OF INTERNATIONAL ASSISTANCE

> "Appropriate or Relevant or Intermediate Technology with Dr. E. F. Schumacher as its prophet may draw many disciples from among the privileged both in the rich and the poor world. There is nothing surprising in this trend as it is the way things do happen. However, if Appropriate Technology becomes a preserve of the few and if it turns out to be another elitist exercise to which the poor have no access, all your endeavours will end in disappointment and frustration. Therefore, I strongly believe that all Appropriate Technology programmes should be directly related to concrete development actions. The beneficiaries should have direct access from the problem-identification stage to problem-solving experience so that the programme becomes their own." (H. Ariyaratne, "Appropriate Technology", The Ceylon Daily News, March 24, 1976, p. 4).

A. The AID Mandate

In 1973 Congress, by amending the Foreign Assistance Act of 1961 radically changed the directions of United States economic development assistance and concentrated it in three principal areas--food and nutrition, population and health and education and human resources development. Congress also intended that to the extent possible assistance in these areas be directed at reaching the poor majority of the populations of the developing countries. This mandate is contained in Sections 102 through 106 of the Foreign Assistance Act. In 1975 Congress added Section 107 which provides that:

> "Of the funds made available to carry out this Chapter for the fiscal years 1976, 1977 and 1978, a total of $20,000,000 may be used for activities in the field of intermediate technology, through grants in support of an expanded and coordinated private effort to promote the development and dissemination of technologies appropriate for developing countries. AID shall prepare a detailed proposal to carry out this section and shall keep the Senate Foreign Relations Committee and the House International Relations Committee fully and currently informed concerning the development of the proposal...".

From a review of Congressional Hearings, it is clear that Congress expects AID to go far beyond the language of Section 107. In particular, Congress would like to see established an International Institute of Intermediate Technology. The implication is that this Institute would be in the U.S. private sector with authority to influence AID policies and programs concerning intermediate technology. It is also clear that Congress expects AID to support national institutes of intermediate technology within the developing countries, some of which already exist. Congress is concerned that if intermediate technology is not rapidly institutionalized in the developing countries, the concept will not gain momemtum.

AID is both a newcomer and an oldtimer in the field of appropriate technology. AID and its predecessors have fostered intermediate and appropriate technology kinds of activities around the world since at least the days of Point IV. Small demonstration projects, self-help school construction, small business development, village technology, labor-intensive activities, and popular participation all have been and still are integral parts of AID policies and programs. The small-scale farm machinery development program at I.R.R.I. is sponsored by AID. AID has not, up to this point, focused these activities under the banner of intermediate or appropriate technology, and, in this respect, AID is a newcomer.

Over the past ten years, a surprising number of public and private Appropriate Technology Centers (ATC's) have been established in the industralized and developing countries. These ATC's generally fall into three categories: governmental and government-related agencies, universities and non-profit institutions. Following is a list of some of the main technology centers established to date:

* Intermediate Technology Development Group Ltd. (London);
* Brace Research Institute (Ste Anne de Bellevue, Canada);
* Appropriate Technology Cell (New Delhi);
* Planning Research and Action Division (Lucknow, India);
* Appropriate Technology Development Unit (Varanasi, India);
* Industrial Development Division, Engineering Experiment Station (Georgia Tech, Atlanta, Georgia, USA);
* Volunteers in Technical Assistance (Mt. Rainier, United States);
* Division of Microprojects (Eindohoven, Netherlands);
* Appropriate Technology Centre (Islamabad, Pakistan); and
* Technology Consultancy Centre, University of Science and Technology (Kumasi, Ghana).

This rapid proliferation of national and international institutions dedicated to the development and dissemination of intermediate or appropriate technology is encouraging but it does raise questions concerning duplication of effort and investment. At present there is no division of labor or information or other networks that can tie these institutional efforts together so that research results and other information can be widely shared.

AID is now conducting a comprehensive "state of the art" survey of the entire field of appropriate technology, including discussions with the U.S. private sector in preparation for responding to Cohgress. Although AID has a clear mandate and ample financing authority for an action program, its task is not an easy one. The field of possibilities is immense but there are as many unanswered questions. Opinions vary considerably as to how, at what levels, and in which sectors, appropriate technology should be developed. Therefore, AID must choose its course carefully, least appropriate technology becomes a development cliche, a superficial or redundant effort, or even disruptive to the developing countries.

B. A Few Reminders

It is not the purpose of this paper to present a detailed outline of an appropriate technology assistance strategy for AID or other international assistance agencies. This is left to others who are far more able and knowledgeable. It might be helpful, however, to summarize a few basic insights--call them reminders--developed in the course of preparing this paper which do seem to limit, constrain or otherwise influence, the role of international assistance in the development and dissemination of appropriate technology. They have been prepared with the AID Mandate in mind but could be equally applicable to other assistance programs. The points are by no means inclusive, and some may appear to hammer unnecessarily on the obvious. They are covered in some detail in order to illustrate and support the basic thrust of this paper which is that the nature and characteristics of the concept of appropriate technology severely limit and constrain the role of international assistance. This is not to state that this role is unimportant; it does imply that it must be approached with a degree of caution, and more modestly, imaginatively, and differently than traditional forms of assistance.

1. The Objectives. It is well recognized that conventional development theory has not delivered for over one-half of the world's population..." the poor majority". The theory that rapid industrialization and expansion of the modern sector, utilizing capital-intensive technologies, would cause the traditional sector to shrink and become absorbed by the modern sector has not come about for most of the developing countries. In fact, the disparities between the two sectors have increased in most cases. If technology is not the central issue in this dilemma, it certainly plays an important role. Traditional sector technology has not been able to provide an increase in production orincomes. Much of the modern sector technology has been imported without modification and has been unusable or inappropriate. In other words, there has been a lack of suitable alternatives to these extremes. The result, due only in part to the lack of suitable alternatives, has been low production, low income, rural-to-urban migration and lack of basic services, particularly in the rural areas.

The short-term objective of appropriate technology, therefore, is to fill this technological gap in carefully selected key problem areas. The longer run objective should be the technological independence of the developing countries to the degree that they can make their own technological choices based on their resource endowment and perceived priorities. In terms of international assistance, this means at the outset a progressive passing of initiative and decision making to the developing countries.

2. "We all need humility in the face of what we do not understand." This statement, taken from the dictionary definition of humility, seems to be a particularly apt reminder for those concerned with appropriate technology. Perhaps it should end there out of risk of sermonizing or constructing platitudes. It might be well to be reminded, however, that past development assistance programs have had something to do with the transfer of inappropriate technologies to the developing countries. Developing country planners and international development experts, for the most part, have been trained in the industrialized countries. They have been strongly steeped in and oriented towards advanced Western technology. This has injected a capital-intensive bias into many development assistance strategies, programs and projects.

A basic premise of appropriate technology is that modern sector knowledge can be applied to develop technologies which are infinitely better than primitive methods but which are greatly reduced in cost, scale and sophistication compared to that existing in the

advanced Western societies. It is rather sobering and humbling to ask if Western-trained and Western-oriented economists, engineers and other technicians can suddenly do an about face and apply their knowledge and skills to the small and the simple? The answer is not self-evident. A positive answer begins to form when we are willing to learn from the past and face the future with a certain modesty and a great deal of imagination.

3. Technology is not neutral. Technology has been compared to tourism in that it carries its own culture with it whereever it goes. This may be a slight overstatement but it illustrates an important point which is that technology is often biased. For example, the Green Revolution, while achieving some dramatic results on the production side, was biased in its technology. Success for the farmer depended on access to water, fertilizers and pesticides; for those without them there was no Green Revolution. Moreover, the Green Revolution has created an increased demand for mechanization, both on and off the farm. This too requires access to credit and often displaces labor. Mechanization in turn tends to create consolidation of land holdings, which can further skew the income distribution pattern in the absence of alternatives. Appropriate technology introduced into the modern sector can have the effect of displacing markets and jobs in the traditional sector. In fairness, it should also be stated that enrichment of the traditional sector probably has to be at the expense of the modern sector. Technology also introduces its own requirements for different support systems. It changes the infrastructure requirements, training requirements and marketing systems, just to mention a few.

The basic point is that technology, at any level, can create second and third generation problems that were not foreseen, not thought of and not desired, some of which wipe out the initial gains or compound the original problem. There will always be trade-offs but a better job could be done in forecasting second and third generation problems so that, to the extent possible, these trade-offs can be made deliberately before the fact rather than forced by unplanned, unforeseen results after the fact. There is no guarantee that appropriate technology is immune from these risks and dangers. After all, inappropriate technologies were probably once thought to be appropriate. The trade-off dilemma of course must be sorted out by the developing countries themselves. International assistance agencies can contribute to sound decisions in this respect by more thorough research and analysis of new ideas and by assisting with developing better information gathering and distribution systems.

4. Appropriate technology is highly location specific. There is no such thing as an intermediate or appropriate technology for the third world, or the fourth world, or perhaps even for one country. This sounds like a truism. Yet this element seems to be overlooked or down-played in the literature and in some current applications. It has great significance for how international assistance is structured and how effective it can and will be.

There are at least three major reasons for the location specificity of appropriate technology, some of which are more obvious than others. The first and most obvious reason is found in the differences that exist in conditions from one country to another or from one region to another. The basic problems may be very similar but the solutions required are often very different. These differences include political, economic, social and cultural patterns, resource bases, agricultural practices, topography, soil conditions, population densities, infrastructure, level of development, etc. The two-wheel tractor may be appropriate for the five-hectare Central Luzon rice farmer but completely inappropriate for the one-half hectare Javanese rice cultivator.

Less obvious is the factor of national or local pride among appropriate technology innovators and entrepreneurs. While it is difficult to document, there seems to be a tendency to make some modification, however minor, in technology developed elsewhere. This tendency was observed in all three countries visited. Part of this is due to a cautious attitude or the desire to do exhaustive tests and trials before introducing a foreign technology. There is also a bureaucratic desire to justify the effort. Entrepreneurs like to make some modifications in order to identify the product with their enterprise. Whatever the other reasons, one of the purposes behind much of the tinkering and modifying seems to be finding ways to impart a national or indigenous character to the technology. This means that in addition to being technically appropriate, the technology must also reflect the sociocultural setting. The Jeepney industry in the Philippines is the best example that comes to mind.

The location-specific nature of appropriate technology vastly complicates, limits, and perhaps alters the traditional forms of international assistance. Except in products involving solar energy, wind power, bio-gas conversion and development of combustion engines, the location-specific nature of appropriate technology forces the fragmentation of activities particularly at the product design and commercialization stages into a series of "micro-projects" for a region or a country. This means that the research, planning, participation and decision making must take place in or near the problem area. It may also mean that this type of effort does not lend itself easily to the familiar forms of program and project assistance. The emphasis on use of local resources certainly changes the nature of the inputs and the way projects are designed and managed. It places a much greater reliance on local institutions in the developing countries, many of which are ill-prepared for the task. To the extent that outside assistance is required, it calls for a greater number and variety of technical specialists working for extended periods of time at grass roots levels. Therefore, while appropriate technology may lower the foreign exchange requirements for international assistance, it could raise and change considerably the foreign personnel requirements. In other words, labor-intensive programs may require labor-intensive international assistance. If this is true, the question is whether AID, and similar agencies, are willing to reverse past and current trends towards fewer rather than greater numbers of direct-hire and contract technicians? The alternative is for AID to be simply the conduit for financing this work through other institutions. Regardless of the option chosen, the real payoff is not likely to come from a United States university laboratory. It will come from imaginative and innovative people, indigenous and foreign, working in the developing countries, close to the problem.

5. Commercial Viability. Another important consideration for developing countries and international assistance agencies involved in appropriate technology efforts is the question of commercial viability. There are those that argue that many of the "village level" intermediate technology activities in progress are a waste of time and money because they are not "commercially viable." This is a question closely related to the above discussion of location-specificity and the process of "indigenization" which is discussed later.

The question of commerical viability is central to the economics of appropriate technology. There are those (see Kahn) that argue that the commercialization of appropriate technology, simultaneous with its design and development, is a prerequisite to its success and favorable impact on such problems as unemployment, low production and rural-to-urban migration. In other words, these socioeconomic benefits will accrue only when technology caters to the demands of the local population. Appropriate technology, therefore, must be demand-oriented and capable of local (mostly rural) manufacture and marketing: Proponents contend that in the rural areas of developing countries there is an effective demand for modern

sector products. The problem is that these products, which are now made in the modern sector or are imported, are too expensive and too sophisticated for rural inhabitants. What needs to be done is to redesign a whole series of high demand, high utility products such as flashlights, sewing machines, cooking utensils, tools, appliances, farm implements, gas lanterns, simple vehicles and conveyances, etc., into simpler and lower-cost products capable of being made and manufactured in rural centers by small entrepreneurs for purchase by rural inhabitants. In this way, rural employment is increased, rural income goes up, rural-to-urban migration decreases and living standards are bettered. This is seen as a far more effective means of developing and promoting appropriate technology than tinkering with improvements in traditional technology, which must be subsidized and are probably not commercially viable over a long period. The commercial viability approach assumes that the original design, development and commercialization stages also must be subsidized by the public sector. In industrialized countries, this function is carried out by the R & D elements of industry. No such capability exists among small to medium-sized rural manufacturers and, therefore, this must be done by international or national institutions. This would be accompanied by industrial extension services until the product is established commercially.

The commercial viability criterion has one principal advantage. Within a rural context, it provides a relatively simple means of determining priorities, geographic dispersal of small industry and allocations of resources for the development and dissemination of appropriate technologies. In other words, it allows market forces to make most of the determinations and builds a dynamic and progressive element into the introduction of new technologies. The major disadvantage may be that the technologies involved will become biased towards those with means and bypass in terms of benefits the lowest income groups. Also it is not clear what this approach would do to traditional or marginally-improved traditional technologies and those that make their meager income from them.

Except for the last issue, it does appear on balance that the commercial viability principle must be an inescapable and indispensable element in the formulation of appropriate technology strategies and programs. It is somewhat inconceivable that it could be otherwise in countries operating under some form and degree of a "free market" system. Where possible, close examination should be made to determine if this same principle can be applied to upgrading traditional methods of production and the commercialization of traditional products. In any event, there will have to be a relatively heavy investment of time and patience, if not money, in which international assistance agencies must be prepared for some frustration and failures on the road to successes.

6. Technology is Only Part of the Picture. The literature and the litany of appropriate technology is becoming so vast and popularized that there is a danger it will become a science unto itself and isolated from many other related factors that bear on the development process. Developing countries and international agencies need to guard against falling into this trap. While it is true that not enough is yet known of appropriate technology *per se*, even less is known of its relationship to other development issues.

The first level of relationship is that of appropriate technology to national development goals, policies and priorities. These goals and the trade-offs implied will have a strong influence on the success of appropriate technology efforts. For example, increased agricultural production, increased employment in the rural areas, energy conservation, import substitution, and reduced income inequities are all goals that can be served, theoretically, by appropriate technology. Each, however, requires a different response and produces a different effect. The concept of

appropriate technology also is inextricably linked to economic policies, entrepreneurial attitudes and business practices. The factor price issue, foreign exchange and interest rates, tax policies, labor legislation, licensing regulations and import policies are only a few illustrations of this interaction and interdependence.

But appropriate technology cannot exist by economics alone. This is perhaps more true of the traditional sector than the modern sector but it applies to both. Cultural values, traditional practices and social customs are important variables in the equation. There are at least two reasons why more Javanese farmers do not harvest rice with a simple sickle rather than the slower ani-ani knife. One is related to myth, and the other is related to strong social pressures to maintain a traditional, labor-intensive, crop-sharing method of harvest. Somewhat conversely, many Ceylonese farmers prefer a more expensive Japanese two-wheel tractor to the less expensive locally-made model because the imported model has more features on it which not only make it easier to handle in the field but make it more prestigious to drive around the village.

Several more such examples could be found or cited to illustrate the interdependence of appropriate technology with a host of other issues and factors. Like most other development approaches and concepts, appropriate technology involves a series of linkages that must be understood and accounted for before putting it into practice. This truth casts some doubt over Schumacher's statement that "technology should be treated as the central development issue." If there was ever a development concept that required a multi-dimensional, multi-disciplinary approach, it is appropriate technology.

7. The Process of "Indigenization". The dictionary defines indigenous as "born, developing, growing, or produced naturally in a region or a country." In a sense, this expresses both the essence and the challenge of intermediate or appropriate technology. In other words, how can new and more appropriate technology be introduced from the outside in a manner that allows it to take root and grow naturally within a local environment? How can international assistance be structured so as to stimulate local initiative and innovation without stifling or destroying it? To these questions there are no facile answers. It is a delicate and fragile process calling for the utmost sensitivity, imagination and patience. Without presuming to write a prescription, it would seem that the process of indigenizing technology must include or at least take into consideration many of the following factors:

a. The concept and practice of intermediate or appropriate technology must be accepted and expressed as an important part of national policy and national develoment goals.

b. There must be a demand or felt need for the technology and the products produced by it. In other words, it must be able to stimulate commercially viable enterprises leading to sought after socioeconomic benefits.

c. The basic research concerning the relationship of the technology to the local and national environment must be completed. To the extent possible, this research should be done by indigenous personnel in the locale in which the technology will be used.

d. The technology must be based on the maximum use of local resources (manpower and materials). Import requirements should be kept to a minimum and constitute a small percentage of the inputs required.

e. The inputs to and the outputs from the technology (production process) should be relatively low cost and accessible by a large share of the local population.

f. The organizational and support requirements should be commensurate in scale, simplicity, cost and maintenance requirements with the technology.

g. The technology should stimulate other local enterprises, e.g. retail outlets, the manufacture of spare parts and accessories, agribusiness, etc.

h. There should be opportunity for involvement by the users and beneficiaries of the technology from the inception of the activity. To the extent that outside expertise is needed at the research, design, development, production and marketing stages, strong provision should be made to train indigenous personnel at each stage. This would include technical skill training as well as management training for entrepreneurs.

i. Also provision should be made for continuing access to backstop and problem-solving services, e.g., industrial extension services, associations, small-scale industry institutes, regional technology centers, etc.

j. The technology introduced should not have an adverse impact on existing traditional enterprises or labor markets. Preliminary research should identify the number of workplaces the new technology will create and/or displace.

k. Factor price distortions should be identified and removed if possible as well as similar disincentives and obstacles to the viability of the technology. The marketing system should be adequate to assure a steady flow of production inputs and delivery of the production outputs. This may also call for the establishment of standardization policies and mechanisms to assure adequate quality control and avoid second and third generation problems.

l. The technology must be allowed to grow and develop at its own "natural" pace.

m. Its successes or failures should be judged by indigenous standards, not those of outsiders. In most cases, however, market forces and commercial viability will provide the yardstick.

n. The technology introduced should be flexible enough to accommodate further innovations and adaptations to allow for progressive improvements and transition to better alternatives.

It is recognized that the foregoing is but a crude and superficial treatment of a complex process. It is a process about which a good deal more can be written and about which a great deal more needs to be learned. It is hoped, however, that it serves to illustrate several key points concerning the concept of intermediate or appropriate technology: (1) that it is a fragile and delicate concept that can be shattered easily by overattention and clumsy, presumptive approaches, (2) that the role of international assistance is limited and constrained by this factor and the increased dependence on local participation at several levels and linkages, and (3) that the process involves substantial and long-term investments of time, patience and restraint, elements which international assistance programs often have had much less of than capital.

8. The Need for Impact Studies. Perhaps one of the greatest obstacles to better understanding and acceptance of the concept of appropriate technology as a development strategy is the lack of data concerning the impact it has had or is having on production, income patterns and employment. For example, part of the controversy surrounding the suitability of the IRRI-designed equipment stems from the fact that sufficient methods

for measuring impact were not built into the activity from the design and development stages. This evaluation is absolutely vital for intelligent decision making and dissemination of the technology as well as for minimizing second generation problems. It was not clear in any of the three countries visited exactly what impact the two-wheel tractor is having on these three important problem areas. One good study has been done in Indonesia on the labor requirements for hand-powered, animal-powered and engine-powered tillage (see Morris). Although this study is limited to a few geographic areas, it does give a relatively clear picture of the labor-using and labor-displacing qualities of these three common types of rice cultivation. More such studies need to be made. This would be a fruitful area for international assistance and international agencies should insist that methods of measurement be built into any appropriate technology research and application activities in which they cooperate.

C. Some Thoughts on Priorities

The field of appropriate technology is so vast and the range of possibilities is so extensive there is a danger that international efforts will become anarchical, redundant, or reduced to scattered and feckless tinkering unless some sense of focus and priorities is introduced into the process. Despite previous discussion concerning the limited role of international assistance, there are several ways in which the international agencies can assist in organizing and focusing the appropriate technology movement. A few of the major ones will be touched on briefly.

1. International coordination is perhaps the first order of business. As was seen earlier, there are already a surprising number of appropriate technology activities sponsored by developed as well as developing countries already underway. Those described earlier represent only a fraction of the total. With only a few exceptions, each is doing its own thing. While this is consistent with the location-specific nature of appropriate technology, it could lead to unnecessary duplication and reinvention of wheels. Some better mechanisms are needed to establish an international appropriate technology center or network, to which other international, regional, national and sub-national institutions would not only have access, but from which these institutions would receive information on a regular basis. This would serve to encourage and stimulate national efforts and provide a basis for assessing impact and progress, as well as identifying problems. This international appropriate technology center would not necessarily conduct research for international application. This is probably better left to private and public specialized international institutes, and national and sub-national centers in the developing countries, as well as to universities and foundations.

2. Traditional versus modern sector is another issue involving priorities. Several facets of the issue have been pointed out earlier. International agencies probably need to decide whether they are going to support appropriate technology activities in both the modern and the traditional sectors or confine their efforts to just one. There has been an unconcealed bias in this paper in favor of concentrating appropriate technology primarily, if not exclusively, in the traditional sector, with emphasis on the rural areas. There are basically three reasons for this bias. They are: (a) not enough is known about appropriate technology and there are not enough resources available to mount full-scale efforts in both sectors, (b) appropriate technology is aimed at helping the lowest income groups and while they are to be found in both sectors, in urban as well as rural areas, the greatest need exists in the traditional sector, and (c) appropriate technology appears more suitable for application in the traditional sector, especially when new technologies are required rather than just adaptations. This focus seems especially suited to

agencies like AID where development assistance programs are aimed almost exclusively at the lowest income groups.

The above discussion clearly suggests that in terms of appropriate technology the two sectors cannot be approached similarly. Much of the appropriate technology literature does not make this distinction. The author would like to carry the point even further and suggest that completely separate appropriate technology assistance strategies need to be developed for each sector. If nothing else, this might help to clarify some of the confusion that now exists.

3. Inventories and profiles are especially urgent facets of the informational issue. As one of the first steps in constructing an international informational network, inventories, or at least profiles, could be constructed of the on-going or contemplated appropriate technology activities in each developing country. This would also include key innovators and institutions. This is an area in which international assistance could be very helpful but it would have to be approached carefully and with the full knowledge and cooperation of the developing countries involved. Depending on how each country sees its own priorities, this could be done on a more limited basis, e.g., for only one sector, or the energy area, irrigation, or the construction field, etc. In any event, some such information gathering seems absolutely vital in mounting appropriate technology programs.

4. International Regional Institutes play an important role in the appropriate technology sphere. There are now several of these international centers in Asia, Latin America and Africa. These institutions have been devoted primarily to developing better seed technologies and cropping practices. Some have added "hardware" or farm equipment development programs to the basic seed research. The I.R.R.I. Farm Machinery Development Program, described earlier, is one of the better examples. Similar efforts are in progress at the Tropical International Institute of Agriculture (IITA) in Nigeria. The author had the opportunity to discuss the program at IITA with one of the Institute's engineers. IITA takes a "farming systems" approach to appropriate technology. They have titled the farm systems approach "minimum toilage" to complement the crop work which is built on a "maximum cropping" concept. Most of the equipment is hand-powered with a few small engine-powered two-wheel tractors for the heavier work.

More of these kinds of efforts are needed, especially when joined with specialized crop research. These Institutes have the advantage of being oriented to a specific crop or crops and of being located in the areas in which the crops are grown. They can provide a locus of basic research and the training of indigenous personnel. Their role, while important, is limited by two factors: (a) in terms of the basic research, design and development of appropriate technology, they are restricted to the conditions existing within the immediate area of the research station; not all of the research, therefore, is applicable and transferable to other regions and countries, and (b) design and innovative personnel are usually expatriates which limits to some extent their ability to participate effectively in the "indigenization" process. Nevertheless, these international institutes are an extremely important link in the chain.

5. National Technology Institutes and the Regional Adaptive Training Centers are the next key links in the chain as they form the important interfaces with international assistance agencies and international research institutes on the one hand, and developing country activities and policies on the other. The national technology institutes are in a good position to promote, stimulate, evaluate, guide and coordinate research and application. These institutions are among those closest to the problem areas and target populations. India has already established a

separate complex of national and regional appropriate technology centers. Indonesia has a national technology institute which functions at both the national and regional levels. In Sri Lanka, these functions are performed by the university and several research centers within the Ministries of Industry and Agriculture.

In many countries, past development efforts have been focused on the establishment and strengthening of national institutes of technology and have neglected the parallel development of the provincial and regional centers. Consequently, the latter lag far behind in their ability to make a contribution to the development and dissemination of appropriate technology. Linkages have not been formed between national and regional centers in terms of information and personnel exchange. The regional centers have not been sufficiently mandated or equipped to perform community-related research and application. Yet, in terms of the location specific principle and the process of indigenization they could play the most vital role. The East-West Center in Honolulu, has been engaged for the past few years in assisting the development of four regional adaptive training centers located in the non-metropolitan areas of four Asian countries. The concept is sound but needs far more support than it has enjoyed in most countries.

6. AID priorities in appropriate technology is a question with which the Agency is now faced. Should it concentrate its resources on support of general level efforts, e.g., across-the-board research, or should it limit its activities to selected areas in order to achieve more immediate impact? These are not easy questions to answer. A full and complete answer to this question will not be attempted in this paper, but since this paper was motivated primarily by the Agency's new congressional mandate on intermediate technology, it is only appropriate that it end with a few general thoughts on how AID might structure some of its priorities in this field, keeping in mind the foregoing discussion and the general set of reminders put forth in the preceding section.

-- AID should probably take the lead in establishing an international appropriate technology information center and network to provide, in effect, a clearing house for and dissemination point for the vast amount of appropriate technology information that has been developed and that will be developed over the next few years.

-- With the above as the exception, AID should probably opt for a concentrated focus on appropriate technology. This focus should be limited to the traditional sector, and within that context, assistance should be focused primarily, if not exclusively in the rural areas. Narrowing the focus a bit further, it should be directed at the farm, village and rural market town levels in terms of food production, food processing, basic crafts and skills, and, in sum, the rural manufacture of a selective range of high demand, high utility products that could be made by rural industry for the primary consumption of rural inhabitants. This has the advantage of trying to raise food production on the one hand and absorb more surplus rural labor on the other. It is also recognized that it is far more complex than it looks, which is probably one of the reasons it has been so neglected.

-- AID can support this focus in several ways and at several levels, for example:

- institution building in establishing and strengthening the policy, technical and administrative capability of national technology institutes and regional adaptive training centers.

- support of specific research at the international, national and regional levels. The following are only a few possibilities:

. the process by which innovation and inventive activity is stimulated;

. methods of technological information dissemination in the developing countries;

. methods of training rural entrepreneurs;

. market assessments, i.e., estimating the demand for new technologies and new products for the rural areas;

. the pros and cons of small-scale mechanization;

. small-scale food processing;

. specific design development and commercialization of low-cost, high demand, high utility products and the technologies (the entire production process) to produce them;

. the construction of national inventories and/or profiles of current appropriate technology activities, the key institutions and innovators involved in order to get a comprehensive picture, country-by-country of the state of the art and also to establish some baseline data against which future progress can be measured.

As a final thought, AID should consider a review of its current project activities to determine the "appropriateness" of the technologies and techniques called for by these activities, either directly or indirectly. If no other purpose is served, it would provide a useful way to involve a good share of the Agency in understanding the concept of appropriate technology, and it may even lead to some useful insights, if not discoveries.

INTERVIEWS

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Wijewardene, Ray, Engineer, International Institute of Tropical Agriculture, Ibadan, Nigeria. (Interviewed in Colombo, Sri Lanka).

Zimmerly, Garnett, Director, USAID/Philippines, Manila.

BIBLIOGRAPHY

Adelman, Irma, and Morris, Cynthia T., Economic Growth and Equity in Developing Countries, Stanford University Press, Stanford, 1973.

AID - Appropriate Technologies for International Development--Preliminary Survey of Research Activities, Office of Science and Technology, AID, Washington, D.C., 1972. 60 pp. TA/OST 72-11 (PB 212 288).

AID - "Implementation of 'New Directions' In Development Assistance." Report to the Committee on International Relations on Implementation of Legislative Reforms in the Foreign Assistance Act of 1973, Washington, D.C., U.S. Government Printing Office, 1975.

AID - Technology and Economics in International Development, Washington, D.C., Office of Science and Technology, Agency for International Development, May 1972.

Anonymous, "Thinking Small", Newsweek, March 22, 1976, pp. 14.

Ariyaratne, H., "Appropriate Technology," The Ceylon Daily News, March 24, 1976, pp. 4.

Bautista, F., and Wickham, T.H., The Tractor and the Carabao: A Socio-economic Study of Power Source for Land Preparation in Nueva Ecija International Rice Research Institue, Los Banos, Laguna,Philippines, 1974.

Bell, Cline, "The Acquisition of Agricultural Technology: Its Determinants and Effects," The Journal of Development Studies, No. 9, October 1972, pp. 123-160.

Brown, Lester R., Seeds of Change, Praeger Publishers, New York, 1970.

Bruton, Henry J., "Economic Development and Labor Use: A Review," in E.O. Edwards (ed.), Employment in Developing Nations, Colombia University Press, New York, 1974, pp. 49-67.

Cabanos, Phil, "Jeepney Manufacturing in the Philippines: A Model for Developing the Agricultural Machinery Industry", Agricultural Mechanization in Asia, Autumn 1975.

Cooper, Charles, "Science, Technology and Production in the Underdeveloped Countries: An Introduction", The Journal of Development Studies, No. 9, October 1972, pp. 1-18.

Duff, B., Output, Employment and Mechanization in Philippine Agriculture, International Rice Research Institute, Los Banos, Laguna, Philippines, December 1974.

Eckhaus, R.S., "Making the Optimal Choice of Technology", in Gerald M. Meier (ed.), Leading Issues in Economic Development: Studies in International Poverty, 2nd Edition, Oxford University Press, New York, 1970, pp. 345-348.

Edwards, Edgar O. (ed.), Employment in Developing Nations, Colombia University Press, New York, 1974, pp. 428.

------, "Employment in Developing Countries", Employment in Developing Nations, Columbia University Press, New York, 1974, pp.1-44.

Fei, J.C.H., and Ranis, Gustav, "A Model of Growth and Employment in the Open Dualistic Economy: The Cases of Korea and Taiwan", Yale University, New Haven, 1974, (draft).

Gamble, Alton F., An Accelerated Cooperatives Development Program for Nueva Ecija, Office of Agricultural Development, U.S. Agency for International Development, December 1975.

German Foundation for Developing Countries - Development and Dissemination of Appropriate Technologies in Rural Areas, International Workshop, July 17-28, 1972, Kumasi, Ghana, Seminar Centre for Economic and Social Development, German Foundation for Developing Countries, 1972, pp. 211.

Gotsch, Carl - "Economics, Institutions and Employment Generation in Rural Areas", in E.O. Edwards (ed.), Employment in Developing Nations, Colombia University Press, New York, 1974, pp. 133-160.

------, "Technical Change and Distribution of Income in Rural Areas", American Journal of Agricultural Economics, No. 54, May 1972, pp. 326.

International Rice Research Institute, Agricultural Machinery Development Program, Terminal Report, Laguna, Philippines, May 21, 1975.

Inkeles, Alex, and Smith, David H., Becoming Modern: Industrial Change in Six Developing Countries, Harvard University Press, Cambridge, 1974.

I.L.O., The Work of the Intermediate Technology Development Group in Africa, by E.F. Schumacher, Geneva, pp. 20. ALSO: International Labor Review, Vol. 106, No. 1, July 1972.

------, Sharing In Development: A Program of Employment, Equity and Growth for the Philippines, Geneva International Labor Office, 1974.

------, Matching Employment Opportunities and Expectations: A Programme of Action for Ceylon, (a WEB Report), Geneva International Labor Office, 1971.

------, Appropriate Technology, Employment and Income Growth, Prepared by the ILO at the invitation of UN ACAST, 15th Session, Geneva, November 15-26, 1971, pp. 34.

Jackson, Sarah, Economically Appropriate Technologies for Developing Countries, Overseas Development Council, Washington, D.C., 1972, pp.38.

Kahn, Amir U., "Appropriate Technology and Development Assistance", Unpublished Manuscript, Los Banos, Philippines, January 1975.

------, "Appropriate Technologies: Do We Transfer, Adapt, or Develop?", in E.O. Edwards (ed.), Employment in Developing Nations, Colombia University Press, New York, 1974, pp. 223-233.

------, Mechanization Technology For Tropical Agriculture, Paper No. 74-01, International Rice Research Institute, Los Banos, Laguna, Philippines, Paper presented at OECD Seminar, September, 1974.

Kelley, Alan C.; Williamson, Jeffrey; and Chatham, Russell J., Dualistic Economic Development, University of Chicago, Chicago, 1972.

Kissinger, Henry A., "Global Consensus and Economic Development", The Secretary of State, Department of State, Washington, D.C., September 1, 1975.

MacPherson, George, and Jackson, Dudley, "Village Technology for Rural Development: Agricultural Innovation in Tanzania", Reprint Series No. 413, University of Cambridge, Department of Applied Economics, Reprinted in International Labour Review, No. 3, February 1975, pp. 105-126.

Marsden, Keith, "Progressive Technologies for Developing Countries", International Labor Review, Vol. 101, No. 5, May 1970, pp. 475-502. ALSO: W. Galenson (ed.), Essays on Employment, ILO, Geneva, 1971, pp. 113-140.

McRobie, George, and Carr, Marilyn, "Mass Production or Production By The Masses: Technology a Critical Choice for Developing Countries", Manuscript, Intermediate Technology Development Group, Ltd., Parnell House, London, November 1975.

Mendis, D.L.O., "Appropriate Technology: Underdevelopment and Over-Development", Economic Review, I, Peoples Bank, Sri Lanka, May 1975.

------, "Planning the Industrial Revolution in Sri Lanka", Occasional Paper, No. 4, O.E.C.D. Development Centre, January 1975.

Merrill, William C., "The Impact of Agricultural Mechanization on Employment and Food Production", Occasional Paper, No. 1, Technical Assistance Bureau, U.S. Agency for International Development, Washington, D.C., September 1975.

Mishan, E.J., Technology and Growth: The Price We Pay, Praeger Publishers, New York, 1970.

Morawetz, David, "Employment Implications of Industrialization in Developing Countries: A Survey", The Economic Journal, September 1974, pp. 491-530.

Morris, Richard, The Potential Impact of Mechanical Land Preparation in the Indonesian Small-Holder Rice Producing Sector, (unpublished manuscript), International Rice Research Institute, Bogar, Indonesia, September, 1975.

O.E.C.D., Choice and Adaptation of Technology in Developing Countries: An Overview of Major Policy Issues, Paris, O.E.C.D., 1974.

O.E.C.D. Development Centre, "Low-Cost Technology--An Inquiry Into Outstanding Policy Issues", Interim Report of the study sessions held in Paris, September 17-20, 1974, Paris: O.E.C.D. Development Centre, January 1975.

------, "Research and Related Activities of the Development Centre in 1975", Paris: O.E.C.D. Development Centre, May 15, 1975.

Owens, Edgar, and Shaw, Robert, Development Reconsidered, D.C. Heath and Company, Lexington, Massachusetts, 1972.

Pickett, James; D.J.C. Forsyth and N.S. McBain, "The Choice of Technology, Economic Efficiency and Employment in Developing Countries", in E.O. Edwards (ed.) Employment in Developing Nations, Columbia University Press, New York, 1974, pp. 209-221.

Ranis, Gustav, Technology Choice, Employment and Growth, Economic Growth Center, Center Discussion Paper No. 97, Yale University, New Haven, Connecticut, 1970, pp. 23.

Sen, Amartya, Employment,Technology and Development, Clarendon Press, Oxford, England, 1975.

Schumacher, E.F., Small is Beautiful: Economics as if People Mattered, Harper and Row, New York, 1973.

Sinaga, Rudolph, and Collier, William, Social and Regional Implications of Agricultural Development Policy, Paper presented at the South East Asian Agricultural Economics Association Meeting at Balihpapan, Indonesia, November 3-4, 1975.

Stewart, Frances, "Choice of Techniques in Developing Countries", The Journal of Development Studies, Vol. 9, No. 1, October 1972, pp.99-121.

------, Technology and Employment in Less Developed Countries, Prepared for the Ford Foundation Seminar on Technology and Employment, March 21-24, 1973, pp. 119.

------, "Technology and Employment in LDCs", in E.O. Edwards (ed.), Employment in Developing Nations, Columbia University Press, New York, 1974, pp. 83-129

Timmer, C. Peter; Thomas, John Woodward; Wells, Louis T., Jr.; and Morawetz, David, The Choice of Technology in Developing Countries: Some Cautionary Tales, Center for International Affairs, Harvard University, Cambridge, Massachusetts, 1975.

United States House of Representatives, 94th Congress, 1st Session, Hearings of the Committee on International Relations on the International Development and Food Assistance Act of 1975, U.S. Government Printing Office, Washington, D.C., July 21, 1975, pp. 329-340.

United States Senate, 94th Congress, 1st Session, Hearings Before the Sub-Committee on Foreign Relations... to Amend the Foreign Assistance Act of 1961, U.S. Government Printing Office, Washington, D.C., 1975.

Usui, M., Choice and Adaptation of Technology in Developing Countries: An Overview of Major Policy Issues, Review of the Discussions held at the Study Sessions organized by the OECD Development Centre, Paris, November 7-9, 1972, OECD, Paris, 1974, pp. 240.

Wells, Louis T., Jr., "Economic Man and Engineering Man: Choice of Technology in a Low-Wage Country", in Timmer, C. Peter et al., The Choice of Technology in Developing Countries. Some Cautionary Tales. Center for International Affairs, Harvard University, Cambridge, Massachusetts, 1975.

White, Lawrence J., (ed.), Technology, Employment, and Development, Princeton University Press, Princeton, New Jersey, 1974.

Winston, Gordon C., "Factor Substitution, ex ante and ex post", Journal of Development Economics, Vol. 1, No. 2, September 1974, pp. 145-163.