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07162

Distr.
LIMITED

ID/WG.233/14
30 September 1976

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Meeting of Selected Heads
of Research Institutes

Vienna, 18 - 22 October 1976

APPROPRIATE TECHNOLOGY RESEARCH AT THE GEORGIA INSTITUTE OF TECHNOLOGY AND THE SMALL INDUSTRY DEVELOPMENT NETWORK [1/]

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id.76-5322

CONTENTS

I. THE GEORGIA INSTITUTE OF TECHNOLOGY

The Georgia Institute of Technology (Georgia Tech), like a number of other organizations, has been active in the appropriate technology field for many years. The involvement of Georgia Tech in this field was an evolutionary activity stemming from the underdeveloped nature of the State of Georgia and the unique structure of Georgia Tech.

The State of Georgia, once predominantly agricultural in nature, has now evolved into an industrial state with about 30% of the labor force engaged in manufacturing. Concurrently, agricultural employment has declined to about 5% of the labor force although agricultural productivity has remained high.

However, the per capita income in Georgia, while increasing dramatically over the last four decades, continues to lag the U.S. per capita income figures. While the per capita income gap of approximately $500 (in 1975) is slowly being reduced, Georgia still is one of the poorer states of the United States, and this has caused Georgia Tech to become involved in stimulating the economic growth of the state.

Georgia Tech is a large scientific and engineering higher education institution with a wide variety of undergraduate and graduate programs. In addition, the Engineering Experiment Station at Georgia Tech is a 500-person applied research institute attached to the Georgia Institute of Technology. It is the Engineering Experiment Station which has been given the task of accelerating the economic growth of the state.

In particular, the Economic Development Laboratory of the Engineering Experiment Station has concerned itself with many aspects of economic development.

Qualifications of the Economic Development Laboratory

The Economic Development Laboratory (EDL) at Georgia Tech has provided a broad spectrum of economic development services within the United States for 20 years and internationally for 12 years. EDL has more than 300 person-years of economic development experience within its staff. Over the past 20 years, EDL has provided problem-solving technical and management assistance to more than 4,000 establishments, has produced over 650 published analytical and evaluative research reports and over 200 unpublished reports on various economic deve. pment aspects, and has irectly assisted n the creation of tens of thousands of jobs in commerce and industry in the U.S. and abroad.

In the past year, 13 international development projects have been undertaken by EDL in 10 countries. Under USAID 211(d) and other funding, Georgia Tech has established a closely knit continuing network with eight developing country organizations with small industry development interests and capabilities. These eight nations are located in the Far East, Africa, and South America.

The EDL at Georgia Tech is staffed by full-time research professionals. Consequently, this staff is free to travel at all times (unlike a research facility dependent on academic faculty who are tied to teaching schedules). This availability provides the Laboratory with a quick response capability and insures that schedules will be maintained and that report and other deadlines will be met.

EDL is one of eight laboratories which make up the Engineering Experiment Station at Georgia Tech. The Engineering Experiment Station is a client-oriented applied research organization carrying out investigations in engineering science and economic development for government and industrial sponsors. The Station has a prestigious 500-person staff and a long history of pragmatic domestic and internation.l activities, inc ding research, training, technology transfer, and development. Occupying seven buildings, the Station has extensive laboratories, fixed and mobile equipment, a machine shop, experimental facilities, prototype design and fabrication areas, and all of the analytical and computer hardware and software associated with an outstanding applied research institute. In addition to the main library on the Georgia Tech campus, the Station personnel have access to a number of other information sources, including EDL's Basic Data and International Development Data Centers and an on-line data base linkage with other computer information centers which provides more than 14 million citations in the network.

II. THE SMALL INDUSTRY DEVELOPMENT NETWORK

Georgia Tech personnel early realized the need for counterpart organizations in the developing countries and sought to link with organizations which are motivated to assist small and medium scale industry develop and expand.

Formal agreements to cooperate with institutions on programs of mutual interest now exist with eight other public and private organizations. They are:

1. Fundacao Educacional do Sul de Santa Catarina (FESSC)
   Tubarao, Santa Catarina, Brazil
2. Centro de Desarrollo Industrial del Ecuador (CENDES)
   Quito, Ecuador
3. University of Science and Technology
   Kumasi, Ghana
4. Institute of Technology Bandung
   Bandung, Indonesia
5. Kenya Industrial Estates, Ltd.
   Nairobi, Kenya
6. Soong Jun University
   Seoul, Korea
7. University of Ife
   Ile-Ife, Nigeria
8. Institute for Small-Scale Industries
   University of the Philippines
   Quezon City, Philippines

These organizations and Georgia Tech are closely linked in a communication, assistance, information, and personnel exchange program.

A number of these organizations have been active in appropriate technology research. Many of the examples cited in Chapter IV are a result of the counterpart activity and the network interaction.

Further linking these organizations (and 1,500 others) is the Small Industry Development Network Newsletter, which is issued quarterly. The network organizations are contributors to this newsletter.

III. SOME EXAMPLES OF APPROPRIATE TECHNOLOGY

The following examples of appropriate technology represent only a small part of the examples which could be cited as originating at Georgia Tech or the network organizations or which have been observed during the course of Tech's international development activities.

Figure I. One of the many labor-intensive processes in a rural bamboo fishing pole factory in Korea is shown here. The sections of bamboo are rotated manually by the operator, using his right hand, while thread is wound on both ends of each section by his left hand.

Fig. I

Figure II. The Soong Jun University and Georgia Tech team suggested that the operator sit at a work surface and that the bamboo section be rotated by foot movement. Management developed this method, utilizing the foot treadle of a sewing machine to rotate the section, freeing both hands of the operator for the thread winding operation.

Fig. II

Figure III. Subsequently, the factory manager installed a small electric motor on the work surface to rotate the bamboo section, showing initiative and adaptability. These improvements increased the productivity in this operation about 250%, eliminating a bottleneck in the factory operations and contributing to a doubling of the fish pole production in the plant.

Fig. III

Figure IV. Korean metalworking companies, such as foundries, frequently need a low-cost immersion pyrometer to determine the heat of molten metal. This simple pyrometer is a bi-metallic strip with a stainless steel jacket and a meter calibrated to read temperature. Designed at Georgia Tech, it cost about $20 to assemble.

By comparison, the commercially available units cost several hundred dollars in Korea.

Fig. IV

Figure V. In Ghana, a process developed by the University of Science and Technology, a Georgia Tech counterpart institution, utilizes local resources -- plantain skins and cassava starch -- to produce a highly successful paper glue.

Fig. V

Figure VI. In Ghana, the University of Science and Technology has been active in the design and construction of village water pumps. The University, utilizing available materials, designed and built a welded pipe pump, which has performed well under field conditions. This pump is being produced to order by the University.

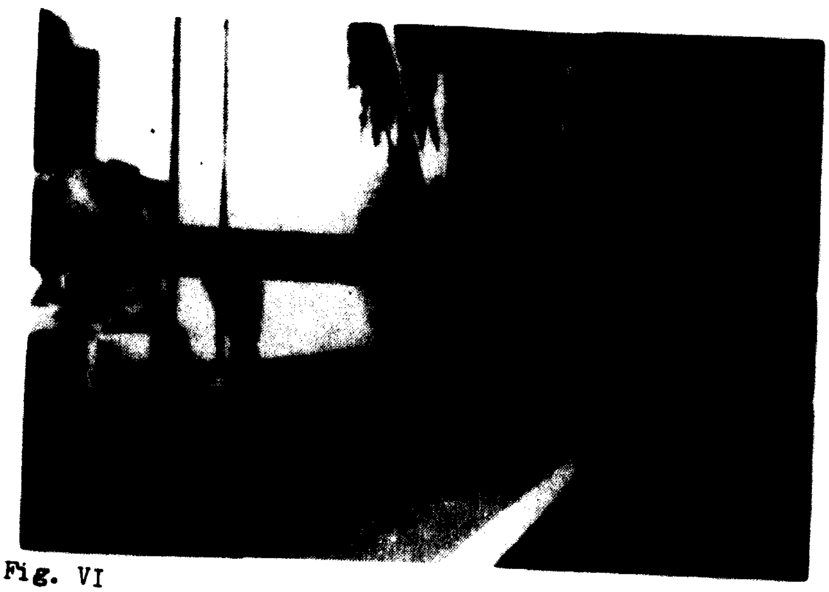

Fig. VI

Figure VII. The "cheegay," a backpack, the traditional way of carrying tools in rural Korea. Heavy loads are carried long distances.

Fig. VII

VIII. A modified "cheegay" designed and built at the Economic Development Laboratory at Georgia Tech. Retaining the cultural pattern of back-packing, the wheel assembly supports approximately 75% of the load, greatly reducing physical effort.

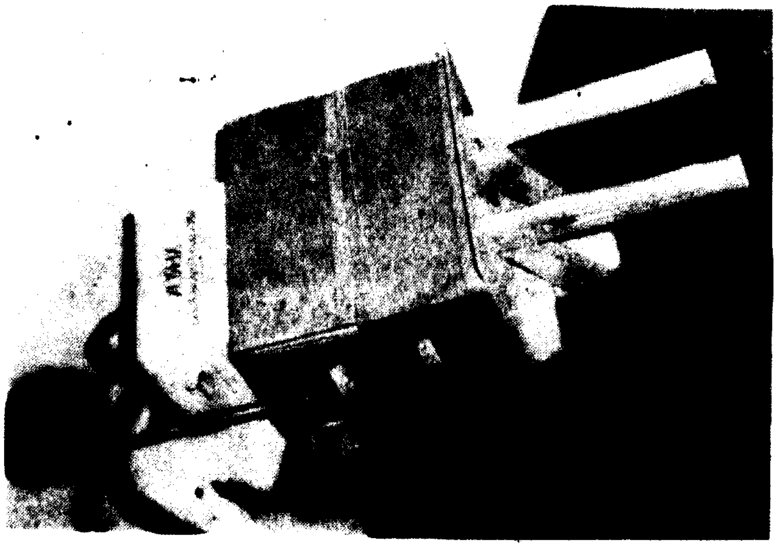

Fig. VIII

Figure IX. In the past, peanut shells from the large Georgia peanut crop have traditionally been burned in open incinerators, adding to air pollution. This pyrolytic converter, developed at Georgia Tech, in a controlled combustion process, converts peanut shells and other agricultural wastes into charcoal, gas, and oil, which can be utilized as fuels.

Fig. IX

Figure X. This 50-ton-a-day commercial unit processes waste wood and sawdust at a Georgia woodworking plant into activated charcoal and oil. This U.S. appropriate technology can be easily converted to a more labor-intensive, less capital-intensive process for developing countries.

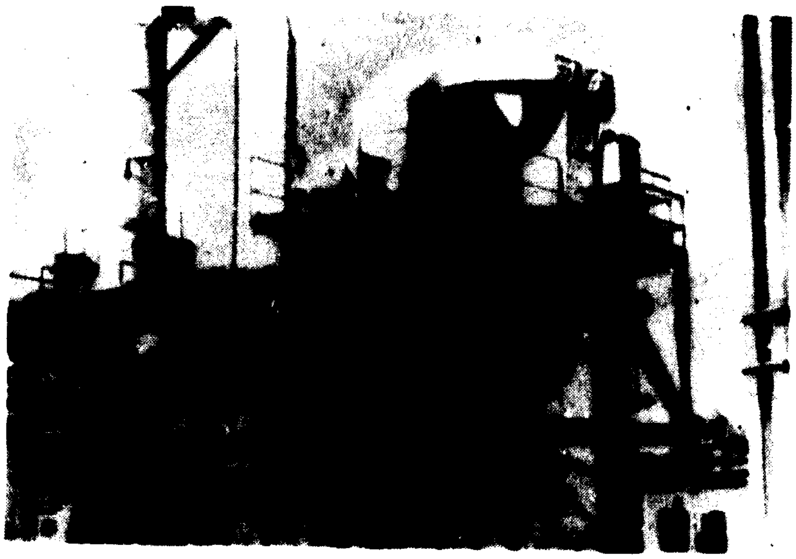

Fig. X

Figure XI. A south Georgia peanut farmer was interested in solar drying of peanuts. Personnel of the Economic Development Laboratory designed and helped build this appropriate installation. Tar paper on the ground serves as the heat-absorbing material. A polyethylene cover on a wooden frame provides a solar "tunnel." Air at 75° to 85° enters in the foreground.

Solar energy has heated the air to 115° by the time it reaches a blower, which forces it into peanut drying carts. This intermediate technology installation cut the energy costs attendant to peanut drying in half for this farmer, and paid for itself several times over in the first year.

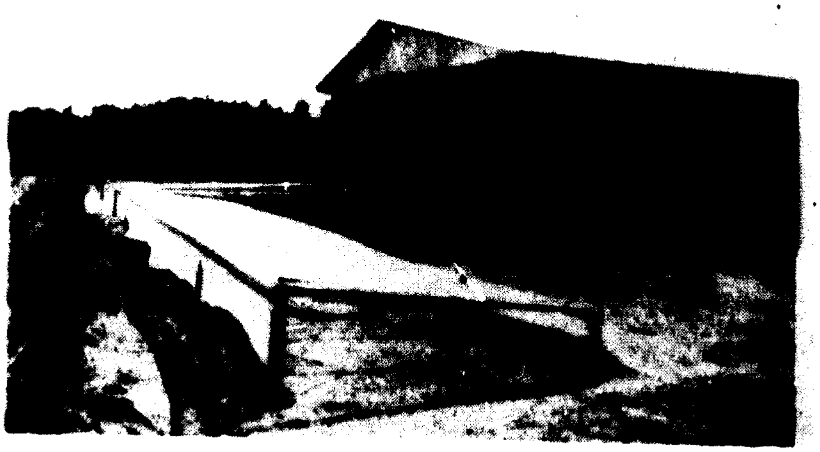

Fig. XI

Figure XII. A highly effective fixed segment mirror concentrator at Georgia Tech focuses solar energy on a pipe located in the focal line, producing air at 500° to 600°F. This heat is stored in rocks for use in heating and air conditioning the laboratories in the building.

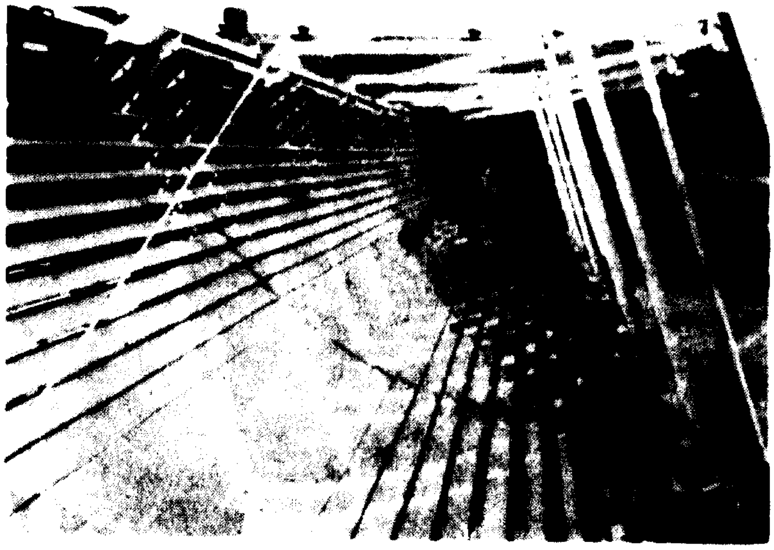

Fig. XII

Figure XIII. A low-cost tensile strength tester was designed by Georgia Tech, and a prototype was built in the laboratories of Soong Jun University. Relatively uncomplicated, it provides an adequate approximation of tensile strength for the small industries, and has the virtue of costing only $150.

The metal sample to be tested is clamped at the right, and as the weight is moved out on the calibrated arm, the sample breaks when its tensile strength limit is reached. The position of the weight at the breaking point provides a reading from which tensile strength can be calculated.

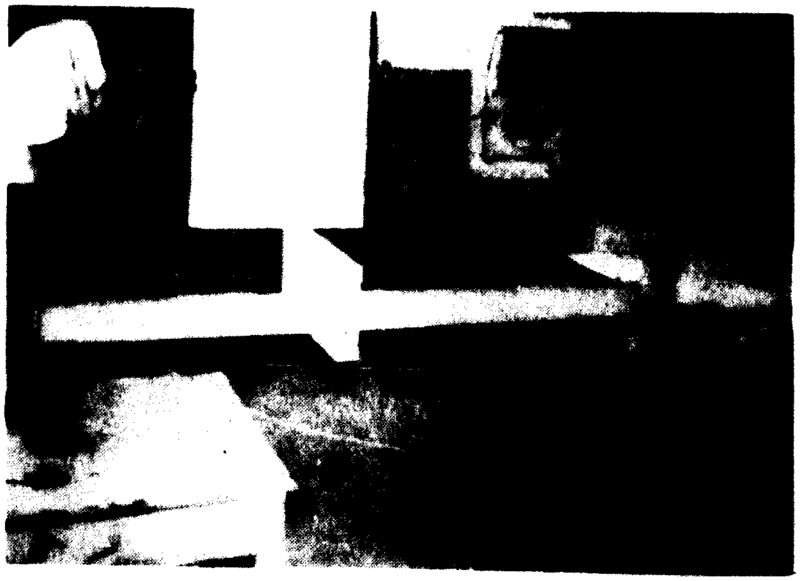

Fig. XIII

Figure XIV. Two pieces of intermediate technology are shown at the Rural Industrial Development Center in Machakos, Kenya. The wheelbarrow is made completely from local resources and available material, and eliminates the need to expend foreign exchange for imported wheelbarrows. The manually operated corn sheller on the left is appropriate for those rural areas where no forms of power are available.

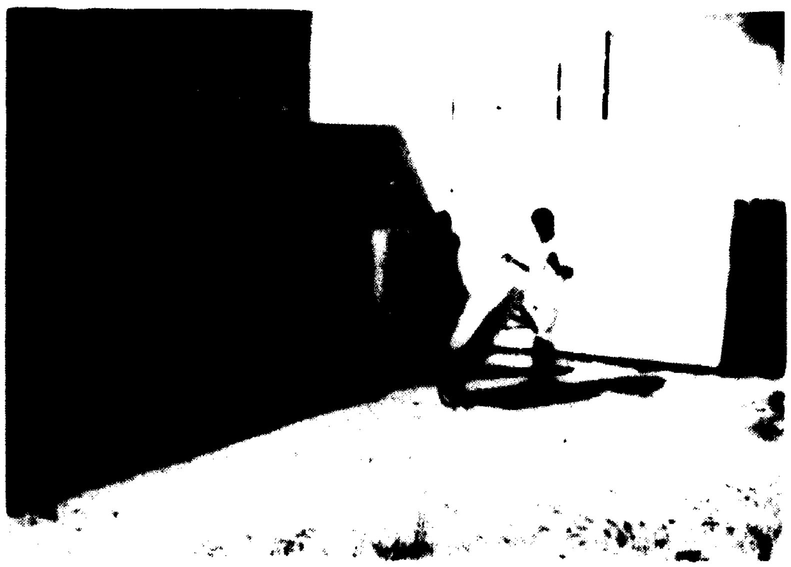

Fig. XIV

Figure XV. Another characteristic of intermediate technology is the use of competitive substitute materials. A tire retreading equipment manufacturer in Georgia was having breakage and tolerance problems with its metal casings and turned to Georgia Tech for problem-solving assistance.

After study of the problem, the Economic Development Laboratory recommended a material substitution and began building a fiberglass prototype.

Fig. XV

Figure XVI. The fiberglass casing was competitive in cost with the metal casing and did not have the breakage and tolerance problems. In addition, it was lighter, more pleasing in appearance, and handling devices could be more easily attached to it. The company switched over to the production of fiberglass casings.

Fig. XVI

IV. OBSERVATIONS ABOUT APPROPRIATE TECHNOLOGY

Appropriate technology is a major area of interest of EDL. Long before the present focus on appropriate technology existed, it was obvious that the selection of appropriate technologies was being made in many places of the world, in industry, in the cities and villages, and in the agricultural areas.

However, the present concentration on appropriate technology, by systematizing the approach can provide better solutions than the scattered and isolated approaches taken heretofore.

As a result of Georgia Tech's efforts at appropriate technology solutions over the last 20 years, some conclusions have been drawn.

The Characteristics of Appropriate Technology

There are many lists of the characteristics of appropriate technology, prepared by different organizations and individuals, and many differing versions of these characteristics. Those which are generally accepted and which Georgia Tech finds to be generally relevant are:

1. Technology is seldom directly transferable. More often than not it must be adapted to different environmental conditions. As a case in point, the International Rice Research Institute developed rice machinery which has potential for use in many rice-growing countries. However, it was designed for wet-land rice farming and must be modified and adapted for dry-land farming.

2. The various cultural, political, economic, and infrastructure conditions must be considered in suggesting the appropriate technology. For example, a high electric power-using technology would be inappropriate for an area devoid of reliable electric power.

3. To the maximum extent possible, local materials and natural, manpower, and man-made resources should be utilized (foreign imports usually are high in cost and foreign exchange in short supply).

4. Appropriate technology should encourage and foster indigenous initiative and innovation. It is not sufficient to buy technology and know-how

and to transfer and install it without encouraging in the productive system flexibility and a willingness to change with changing markets and other factors.

5. Appropriate technologies must have or develop logistical support systems, such as maintenance services and spare parts availability.

6. Basic to intermediate technology is the concept of cost effectiveness. Hence, most considerations of intermediate technology are concerned with labor-intensive, low-cost elements.

Hardware vs. Software

Much emphasis has been placed on the hardware aspect of appropriate technology in the literature and in prototype demonstrations. Relatively little is said about the software side of appropriate technology.

Intuitively, one recognizes that strategies, tactics, plans, and programs which have all the appropriate technology characteristics could be called software appropriate technology. The problem in doing so seems to lie in the fact that such software approaches are generally not thought of as appropriate technology and not designated as such.

Consider a financial incentive program for small industry which borrows procedures from large industry lending programs and simplifies and adapts them for small industry loans, which utilizes locally dispersed units to authorize loans, which sets collateral requirements at a low level, which stimulates the use of local resources and materials, and which results in low-cost loans for small industry. Such a program would satisfy many of the criteria associated with appropriate technology. However, it is more likely to be described as a financial incentive program than as a software appropriate technology.

Steps in Appropriate Technology Research

1. Problem and Need Identification. The selection of appropriate technology must be preceded by recognition of a problem or a need. In Georgia, for example, the burning of peanut shells in open incinerators was adding to air pollution. This was a recognized problem and the need was to find some way to utilize these shells in a non-polluting manner.

2. Available Alternative Technologies and Resources. Some determination of the technologies which are known and hence available must be made in the light of the available materials and resources.

There are many ways to build a factory chimney and a number of different materials which can be utilized. The Koreans in Yeungdongpo Industrial Estates chose to utilize a locally available material, empty oil drums, for this purpose and it is a cost-effective appropriate technology for that environment.

3. Analysis. Analysis of the various alternative technologies which may be available to solve a recognized problem is essential. The analysis for a developing country must consider educational, social, cultural, economic, infrastructure and political aspects to the maximum extent possible.

Lower labor costs in developing countries greatly influence the choice of technologies, skewing the selection to more labor-intensive alternatives. National plans, with their varying emphases, have a bearing on the selection of appropriate technologies. The level of education and skills of the available manpower resources obviously impacts on technology selection.

These and many other factors must be considered in the analysis phase.

4. Design, Including Adaptation. Technology from the developed world usually requires modification, adaptation or redesign when utilized in the developing countries. This is especially true in the small industry sector.

The IRRI rice machinery, designed for wet-land farming, must be modified for dry-land rice farming. The $5,000 tensile strength tester must be scaled down, sacrificing accuracy or other characteristics to provide a low-cost unit. The tire retreading casing was modified by material substitution.

Design, redesign, modification, or adaptation of technology becomes an extremely important phase of the selection and utilization of appropriate technology.

5. Prototype Development. When modification and adaptation take place, the question must then be asked "Will it work?" To answer this question, it usually is necessary to build a prototype and to analyze its operating characteristics and performance.

Our ounterpart in Korea, So ng Jun University, has built four different prototypes of a "cheegay" on wheels to determine the most appropriate application.

6. Testing, Evaluation, Modification. The prototype then must be subjected to testing and evaluation. Modifications and adaptations, however small they may be, can significantly alter the capabilities and performance of the technology.

Hence, prototypes with built-in modifications or adaptations require field testing and evaluation under real or simulated use conditions. Frequently, such field testing reveals operating problems which may occasion additional modification or adaptation.

7. Replication (Manufacture). When analysis indicates that the prototype has been debugged and appears commercially feasible, the final steps may include the encouragement of manufacture of the prototype in sufficient volume to supply the market needs.

This may involve the creation of a new venture for the specific purpose of manufacturing the appropriate technology, but more usually, it would involve interesting existing manufacturers in adding the prototype as a new product. The manufacturers may in turn adapt and modify the equipment in accordance with the specific needs of their customers.

An example of this process can be seen in the Philippines. A number of existing Philippine manufacturers used and sometimes adapted IRRI rice machinery designs to build more than 16,000 units last year, mostly for the domestic market.

It is, of course, desirable to develop and utilize appropriate technology which may have widespread applicability. This is not always an attainable goal in the industrial sector, where problem solving through appropriate technology is frequently location specific, and process or product specific. In such cases, widespread applications frequently do not exist.

V. SOME APPROPRIATE TECHNOLOGY PROBLEMS AND OPPORTUNITIES FOR COOPERATION

Problems Encountered

1. Developing Country Counterparts. To find eight developing country organizations which were well motivated in the small industry and appropriate technology development fields, a total of 38 organizations in many countries were visited by Georgia Tech. While almost all organizations indicated an interest in these subject areas, only about a quarter of them had done any substantive work prior to the contact.

Some developing countries simply have no viable organization at present with on-going programs in appropriate technology. The lack of development of such organizations constitutes a major problem area.

2. Governmental Indifference to AT. In many cases, developing country governments are not very interested in appropriate technology, especially as it relates to small and medium size industry. Large-scale, more sophisticated plants have more appeal and public relations value to many governments.

This frequently poses a problem in obtaining approval of and funding for appropriate technology programs. Education and promotional campaigns related to the need for AT may be required to overcome governmental indifference.

3. Inadequacy of Delivery Systems. It has been observed that delivery systems for providing appropriate technology in developing countries often are inadequate or non-existent. While AT can be delivered by outside agencies, or through industrial interactions, the need for capable, well funded, appropriate technology organizations in many developing countries is very pressing.

Opportunities for Cooperation in Appropriate Technology

There appear to be a number of opportunities for cooperation between developed and developing country organizations interested in AT. Some of these are listed below.

1. Specialization by Organizations. A number of organizations are presently focusing on AT related to certain sectors (i.e., IRRI on rice machinery, Georgia Tech on small industry problems, Brace Research Institute on solar

energy, etc.). Continued emphasis on specialized areas is producing centers of specialization in AT, which in a cooperative mode can be mutually helpful.

2. Systems Analysis. Much of the effort to date has been location specific AT, aimed at solving a particular identified problem. There is an opportunity for appropriate technology concerned organizations to take a systems analysis approach to agricultural and industry sector problems. This would involve an overall sector approach rather than an individual problem-solving approach. This would result in sector and sub-sector specialized centers.

3. Information Networks. Many present AT centers have excellent data bases, manpower resources and experience. Some blending of these resources into an AT network, capable of responding to information and case study inquiries, seems appropriate.

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