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RESEARCH AND DEVELOPMENT SYSTEMS IN RURAL SETTINGS: BACKGROUND OF THE PROJECT

Amilcar O. Herrera

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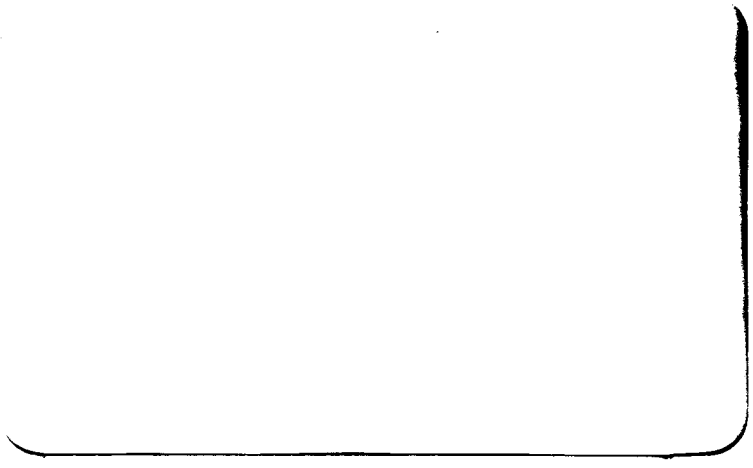

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This paper is being circulated in a pre-publication form to elicit comments from readers and generate dialogue on the subject at this stage of the research.

I. THE PROBLEM

THE CHANGING CONCEPT OF DEVELOPMENT

The Traditional Approach to Development

Although the general concept of development that prevailed almost unchallenged in the world until a few years ago has its roots in the eighteenth century,[1] its concrete present form emerged to a great extent on the conditions of post-Second World War Europe.[2] Adapted to the developing countries, the problem of development seemed relatively easy, at least from a conceptual point of view: it consists essentially of repeating the path followed in the past by the now developed countries. In practice this rich and complex evolution is reduced to a process of industrialization and economic growth. In a certain sense, and in another context, "development is industrialization" and Lenin's dictum "Communism is electricity" reflect the same nineteenth-century mechanistic view of progress. In this conception of development, cultural, social, and economic differences were almost completely neglected. The specific characteristics of the poor societies were mainly valued — despite the lip service paid to their "cultural achievements" — in relation to their relevance to the prevailing conception of progress. To the extent that those cultural specificities posed obstacles to the Western-style transformation of those societies, they were considered a sign of backwardness and were destined to change. In other words, cultural differences were implicitly assimilated to the stages of economic development.

In the last few years the conception of the Western model as being practically the only model of "progressive" societies has undergone

radical changes, and an approach to development is emerging. One of the most important of the elements of changes is the fact that for the first time since the Industrial Revolution the Western world has started to have serious doubts about the soundness and rationality of its own way of development. The foundations of those doubts are well known, so there is no need to treat them here in detail. Two quotations — one from the Third World and one from the industrialized countries — will be enough to show their essential content. According to F.E. Cardoso,

> It is this contradiction — possibly for the first time in history — between a concrete possibility and a performance so distant from the satisfaction of the needs of all that explains the existence of a malaise even in the industrialized world, which turns every gratification into sin. *Everyone knows that the utopia of our century is materially possible.* It is not rooted only in desires, but exists as a possibility in things: if the "logic" of these does not achieve realization, it is because the desires (and interests) of some minorities do not allow it.[3]

In the words of Ignacy Sachs,

> . . . after the anti-novel and counter culture zero growth. These are three symptoms, each quite different, of the re-examination of values by a society in search of new ideological responses to problems which have remained insoluble despite the spectacular progress of material growth, or which have arisen as a result of that progress: the generalized malaise of the young, the persistency of poverty, the aggression against the environment, the frustration of the Third World which today is wondering whether the very concept of development, founded upon efficiency, should not be replaced by that of liberation, centered on social justice and the creation of a new man.[4]

In short, the traditional approach to development — despite an enormous consumption of natural resources that has confronted humanity with the danger of exceeding the carrying capacity of its physical environment — has failed to solve even the material problems on which it is supposedly centred.

The central element in the search for a new approach to development is the realization that underdeveloped countries cannot repeat the path followed in the past by the now developed countries, because the historical conditions are totally different. During the Industrial

Revolution the Western countries had no competitors in the world; they were the centre of economic, military, and scientific power, and so they could shape international trade, and to a great extent the national economies of the peripheral countries, according to their needs. They could export whatever manufactured goods they produced, and, protected when needed by their political and military power, they had easy access to the raw materials of the rest of the world. It is obvious that this situation cannot be re-created today for the benefit of the developing world.

Besides those general conditions there are also now some specific constraints that challenge the viability of the traditional scheme of development. In the first place, under this scheme the developing countries have to adopt the same capital-intensive technologies that predominate in the industrialized countries. Even for many of these countries, with their high rate of multiplication of capital and low rate of population growth, it is not an easy task to maintain full employment. For the underdeveloped countries, with low rates of capital accumulation, a high rate of demographic growth, and 70 or 80 per cent of the population still in the pre-industrial traditional sector, the problem is virtually hopeless. It is interesting to remember that during the Industrial Revolution a considerable part of the population of the Western European countries had to migrate to other continents — particularly America — due to the incapacity of their productive systems to provide enough employment. However, the technologies used at the time were more labour-intensive than those prevailing today, and the rate of population growth was significantly lower than that of the present developing countries.

In the second place, the problem of the availability of resources deserves a special consideration. According to the most reliable forecasts, around the beginning of the next century the population of the earth will be approximately 7 billion, with more than 5.5 billion belonging to the underdeveloped countries. By the most optimistic assessments, the world population might stabilize at about 10 billion during the first half of the twenty-first century.

If this huge population is going to have the same type and volume of consumption that the average industrialized country has today — not to refer to the level of consumption they would probably have thirty years from now — the pressures on the natural resources of the earth would be tremendous. It is not so much a problem of the possible ultimate physical limit of those resources, but that of the generation of the enormous capital required to develop such sources of conventional resources in the next thirty or forty years. Besides, even taking into account that some of the basic natural resources are located mostly in underdeveloped countries, the developed world — due to its superior economic and technological capacity — will still have a clear advantage in the competition for the traditional sources of raw materials for many years to come.

Another point related to the material constraints is that environmental considerations will make it increasingly difficult to reach the rate of growth in the exploitation of non-renewable resources that would be required to raise the level of living of the whole world to the standards that are still now foreseen by the advanced countries. It is now impossible to predict the exact form those environmental restrictions will take, but they will surely impose some limitations on the unrestricted exploitation of natural raw materials.

But even assuming that the socio-political obstacles can be overcome, and that enough resources can be developed, it will still be practically impossible for most of the developing countries to reach the level of living of the industrialized countries — in terms of the same type of consumption — in the foreseeable future. It is obvious that even assuming rates of growth of the economy considerably higher than those observed historically, there is practically no chance for the developing countries to catch up with the industrialized world in terms of overall consumption.[5]

There are also positive arguments to justify the search for a new ideal of development. To repeat the Western model — despite the many positive aspects it contains — would mean to maintain the same situation

of social and international inequality, wasteful use of resources, deterioration of the natural environment, and growing alienation that confronts Western culture today. It would be to copy a model, when its creators are in search of a better one. Finally, the Third World countries have cultural characteristics that are worth preserving; they are the common heritage of mankind, and, using an ecological analogy, they constitute the genetic reservoir of future cultural options.

The New Approach to Development

The distinctive element of the new approach to development, as compared with the "traditional" one, is that it is centred in concrete human beings; in other words, the well-being of individuals will not be the by-product of general economic growth — whose version for the under-developed countries is the "trickle down" effect — but a specific target whose attainment will condition the whole social and economic organization of the country.

According to this approach, development will be centred around the concept of "basic needs." There are many definitions of this concept but it is basically the recognition that each human being, simply because of his existence, has the inalienable right to the satisfaction of certain needs which are essential for a complete and active incorporation into his culture. Some of those basic needs — as food, shelter, health, and education — are relatively invariant through time and cultures, and are easy to identify. Other needs, however, associated with consumption, or of a more spiritual nature, are more difficult to define. Historically they have changed with each society and with time. New needs are generated by the evolution of cultures, by new forms of social organization, and by technological change. In judging which of those needs are really "basic," and their relative priority, a large dose of subjectivity, or social bias, is inevitable.

The only way out of this dilemma — determining which are the legitimate social needs for the majority of the population and not only for an economic or intellectual élite — is to establish mechanisms of

participation to ensure that all social decisions really represent the will and aspirations of the populace.

This emphasis on popular participation in the new approach to development has other reasons, besides the determination of social needs. The creation of new societies in the developing countries, within their own cultural characteristics, requires the creative effort of the whole community. No real social change can take place unless it has the support of the majority of the population, and this support will be given only if people feel that they can participate in the process.

The three elements we have identified — not to repeat the path of the developed countries, to make the satisfaction of the needs of the people the specific objective of development, and to ensure as much popular participation as possible — are not enough to give a complete picture of the content and meaning of the new approach to development. History shows, however, that this is not an exception. All social changes in the past have started with a nucleus of very simple and basic objectives; the extent to which those objectives are attained, and the operative forms they take, are determined essentially by the characteristics of the process of change itself. In other words, and this is not new, the ends are largely a function of the means.

In the case of the new approach to development, the mechanism of change is centred around the concept of "self-reliance." A brief analysis of its origin and content will give some indications as to whether or not it is the appropriate means to achieve the simple objectives we were referring to. Self-reliance, in simple terms,

> is to be understood at the national level of each developing country as the will to build up the capacity for autonomous decision-making and implementation in all aspects of the development process including science and technology. This approach to self-reliance is reflected internationally as opposition to all forms of dependency. It calls for changing the mode of incorporation of the developing countries in the international, political, economic and cultural systems.[6]

Consequently, self-reliance is basically the recognition that the main

responsibility to solve the problems of underdevelopment lies in the developing countries themselves. If it is accepted, furthermore, that the developing countries, for the reasons already given, cannot copy the type of society of the industrialized countries, it is clear that they will have to rely mainly on their own resources, human as well as material. To follow a path to development different from the one followed in the past by the now advanced countries means that they will have to initiate a process on which there is no previous historical experience. They will have to confront new problems because socio-political conditions have changed, and also because the relationship between knowledge, technology, resources, and population had very little resemblance with those prevailing in the past. In these conditions, it is obvious that the developing countries will have to look for solutions in the effort, imagination, and creative capacity of their own societies.

Finally, development, progress, or evolution — whatever we may choose to call it — is not simply a techno-economic phenomenon: it is also, and mainly, a process through which a society continuously creates and reasserts its own identity. The cultural heritage of a society is an obstacle to development only when this is seen as the passive and indiscriminate acceptance of an exogenous conception of the world. However, when development is conceived basically as an endogenous transformation in which external experience is not imposed but voluntarily and selectively incorporated, the specific cultural characteristics of developing countries could be, instead of obstacles, the dynamic nucleus of the process of change.

Collective self-reliance is only the natural extension of the concept of self-reliance. In the first place it is the awareness that, sharing basically the same problems, regional co-operation could be the best way to enlarge the basis of human and natural resources required for development. Secondly, but no less important, co-operation for a conception of development that is not centred on economic growth but on human beings considered in all their dimensions — material, cultural, spiritual — could be the first step in the creation of a more equitable

world order.

In conclusion, self-reliance is not, as it has been sometimes said, an unrealistic, romantic conception, destined to fade away when confronted with the "hard facts." It is the natural, unavoidable strategy of development stemming precisely from the acceptance, at last, of the hard facts.

TECHNOLOGY AND DEVELOPMENT

The search for a new road to development has led to the realization that it implies also a careful reconsideration of the way technology is massively and indiscriminately imported by the poor countries from the Western world. The basis for this position is worth a brief analysis.

Although there is a general agreement on the determinant role that technology plays in the modern world, it is not an easy task to define technology precisely. Until a few decades ago technology was simply defined as the "science of industrial and mechanical arts"; it was seen basically associated with the system of material production, and so it was connected almost exclusively with the material aspects of culture. In the last two decades this position has greatly changed. According to L. Winner, "technology in its various manifestations is a significant part of the human world. Its structure, processes and alterations enter into and become part of the structures, processes and alterations of human consciousness, society and politics."[7] For J. Ellul, technology "is the totality of methods rationally arrived at and having absolute efficiency in every field of human activity."[8] It can be said that in every society technology can be defined as the set of material tools, knowledge, and skills used to satisfy all needs of the community, and to ensure the control upon its physical environment. It conditions the "what to do" and "how to do" of a society.

This conception of technology as a central element of culture — not only of its material manifestations — means that transference of

technology implies transference of cultural forms. What makes this transference specially effective is its subtlety, the fact that the information it carries is not explicit, and acts on the receiving society by modifying its productive, organizational, social, and consumption patterns, even before its overall implications are fully realized. In A. Reddy's words, "technology can be considered to resemble genetic material which carries the code of the society which conceived and nurtured it and which, given a favourable milieu, tries to replicate that society."[9]

The main characteristic of the transfer of social information through technology in modern times is that it is a "one-way" channel of communication — from the industrialized countries to the rest of the world — with practically no reciprocal action in the opposite direction. The specific mechanisms of this one-way transference can be better understood by a closer look at the way both parts of the world generate technology.

The Generation of Technology

The first point we have to consider is how the present R and D systems of the advanced countries determine the orientation and content of the research connected with their social problems from the point of view of the specific technologies required to solve them. As it is known, some developed countries have very well-defined institutional structures for establishing the direction and content of the scientific effort in relation to their main objectives of development. In other countries such formal arrangement is almost completely lacking, and the R and D system works more or less independently of the formal structure of national planning. In both cases, however, the efficiency of the R and D systems, in terms of their contribution to the general objectives of their countries, is more or less the same. Of course, this statement does not represent a value judgement on the intrinsic desirability of the direction of development: it only expresses the fact that the R and D systems of the developed countries respond efficiently to the implicit demand of their societies.

The explanation of this fact is very simple, and we are going to examine it briefly only because it is often forgotten in the analysis of the problems of the developing countries.

The determination of the adequacy of a technology to a given society is a problem with many variables, only a few of them being strictly technological. Most of these belong to the fields of economics, sociology, and social psychology, and form what might be called a set of assumptions or paradigms that constitute the frame of reference of the R and D systems. Some of them for the advanced countries can be stated as follows: the scarce factor of production is labour, so the more capital-intensive technology is the better; it is necessary to stimulate consumption by producing as many varieties of goods to satisfy the same needs as possible; the dynamics of the economy depend to a great measure upon a rapid circulation of goods, so a relatively fast rate of obsolescence is desirable; a considerable part of the population has its basic needs more than fulfilled, so its consumption can only be stimulated by the production of more and more sophisticated goods, irrespective of their real social value; it is a highly competitive economy in which innovations are essential to survival, and they have to be stimulated even when they waste resources, in the sense that they result in the production of more complex and expensive goods that add nothing, or very little, to the rational satisfaction of the needs to which they are directed; natural resources or their substitutes, with a very few exceptions, are available in unlimited amounts.

These are only a few examples of the set of assumptions that direct the effort of the R and D systems of the developed countries of the capitalist world. They are the expression of the most basic characteristics of those societies and are seldom explicitly stated as they have become assimilated by every member of the R and D systems. This is the reason why any scientist or technologist of the developed world, whatever his personal social position or political ideology, when faced with a technological problem rejects automatically, almost unconsciously, any solution which does not conform with the accepted assumptions.

In the developing countries the process of generation or introduction of technologies is more complex, and its understanding requires consideration of some features of the internal structure of those societies and of their relationships with the developed world.

The evolution of the R and D system of the developing countries shows a marked parallelism with the growth of industrialization. Before the beginning or the acceleration of this process, when the economy was based almost exclusively on the exportation of raw materials and the importation of manufactured goods from the industrialized countries, there was very little scientific activity and msot of it was basic research connected with the disciplines which had some social demand, such as medicine in the most advanced of the developing countries. As industrialization started with the replacement of easily manufactured products, very little local R and D was needed. As industrialization advances, however, more complex goods have to be produced in areas where technology changes rapidly because of R and D carried out in developed countries. The inability of local R and D to carry out original technological research, or even to adopt intelligently technologies developed abroad, was a contributory factor in declining international competitivity and in the stagnation of agriculture and livestock production.

It was necessary to create local R and D systems capable of efficient interaction with the productive sector. This was done by applying the same imitative criteria that were used to induce industrialization. R and D systems were then created with the same structure and on the same general principles of those in existence in the advanced countries. It was assumed that once a "modern" scientific system — in the sense of themes of research, quality of personnel, equipment, etc. — came into existence, it would become in due time naturally connected with the productive system through the classical chain of basic, applied, and development research.

As is well known now, those expectations were not fulfilled. Despite the advice and material help of international institutions and

scientific centres of the advanced countries, the R and D systems of the underdeveloped countries proved incapable of generating any significant amount of indigenous technology. Even in the field of adaptation, which looked more promising in recent years, they are only able to introduce minor modifications to adapt a final product or process to local raw materials or to make a better use of the particular combination of factors of the country involved. As for the study and solution of the basic problems of the traditional sectors of those societies, their contribution has been negligible.

The causes of the failure of the R and D systems of the developing countries to contribute to the solution of the problems of their societies are obviously very complex, and include socio-economic and political as well as technological factors. For the sake of clarity, however, we will concentrate on those elements of the problem most directly connected with the R and D systems. As a basis for our analysis, we will adopt the following criteria and definitions:

a. We will accept as basic fact that most developing countries are dual societies, composed of a modern and a traditional sector. The modern or, more appropriately, the rich sector comprises between 10 and 30 per cent of the population, has an average income per capita ten to twenty times higher than the traditional sector, and has the cultural habits and patterns of consumption of the middle and upper classes of the advanced countries. The traditional sector consists in most countries of the vast majority of the population, lives mostly on a subsistence economy, and has cultural patterns still largely based on those prevailing in the past. In the last decades mass media communications have started to change its cultural habits, without improving its material situation.

   According to many social scientists, particularly those from Latin America, the relationship of the traditional sector with the modern sector is one of dependency which closely resembles the relationship between developed and developing countries.[10] The traditional sector produces the raw materials that are exported or required as inputs by the modern sector. Most of the benefits of international

trade are invested in the modern sector which, added to the great wage difference between urban and rural sectors, tends to continuously widen the economic gap between the two sectors.*

b. We will consider technology broadly divided into two types: modern, or scientific, technology; and traditional technology based on empirical knowledge. This distinction is important, because about half of humanity, and a great majority of the population of underdeveloped countries, uses traditional technology to solve most of the problems of the subsistence economy in which they live. From the point of view of their structural connection with society, the two types of technology present radical differences. The scientific technology is generated by a clearly differentiated institutional framework that consists of everything from the institutions specifically devoted to scientific and technological research to public and private organizations that produce goods and services. This complex and loose organization is what we call the R and D system of a country. The traditional technology, on the other hand, lacks any institutional arrangement, and is based on empirical knowledge, which in some way is generated and dispersed through the whole community.

   It is obvious that this sharp division between traditional and scientific technologies is somewhat artificial. In modern societies there are technologies in use which include some elements of empirical knowledge. Conversely, in the traditional sector of society there is some penetration of scientific technologies, mainly in some basic services such as health, transportation, and communication. For the purpose of our analysis, however, these exceptions do not alter the overall picture.

c. For the study of the behaviour of the R and D systems, we define as the problem area of a society the set of problems that can be

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* We use the terms "dual society" and "modern" and "traditional" sectors only for descriptive purposes and due to the lack of a better terminology. The two sectors are really complementary parts of a unique society, as they are structurally interdependent. The rapid growth of the modern sector has been possible due to the transference of the capital generated in the traditional sector.

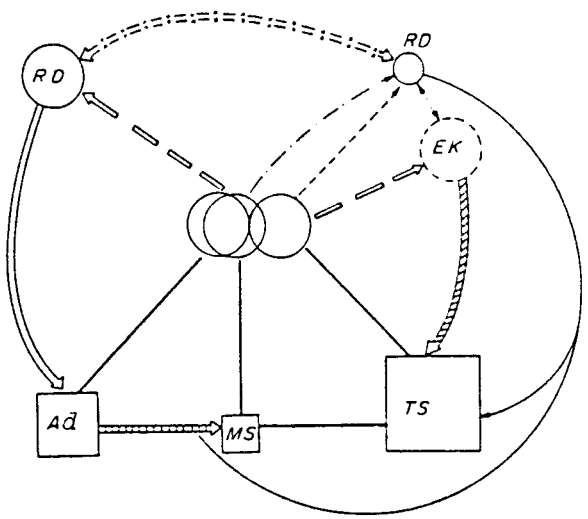
solved by the application of technologies, either scientific or empirical.

To define what really constitutes a problem is often a very elusive question, as the same social situation can be considered differently, depending on the ideological position of the observer. In relation to the first part of this analysis, in which we are mainly concerned with the behaviour of the R and D systems under present conditions, we consider only those problems that exert actual demand on the sources of technological solutions.

Demand and Supply of Technology

Figure 1 is a very simplified representation of the mechanism for generation of technologies as they work today, and its relationship with society. It refers to the whole world, but can be applied with little modification to any particular underdeveloped country.

The boxes at the bottom of the diagram represent the sectors in which we have divided world society: advanced countries (Ad), and the modern (MS) and traditional sector (TS) of the underdeveloped countries. The sizes of the boxes are approximately proportional to the size of the population included in each of these. The circles at the centre are



RD: R and D systems
EK: empirical knowledge
Ad: advanced countries
MS: the modern sector of underdeveloped countries
TS: the traditional sector of underdeveloped countries

FIG. 1. A Simplified Representation of the Mechanism for the Generation of Technologies

dimensionless and depict the relationship between the problem areas of the three sectors; the amount of overlap reflects, in general terms, how much they have in common. The circles at the upper part of the diagram represent the sources of technological solutions: the R and D systems (RD) of the developed and developing countries, and empirical knowledge (EK). The sizes of the R and D circles express their relative importance, although not in exact quantitative terms, as reflected by investment, personnel, etc. The broken arrows indicate the demand upon the sources of technology. The full arrows depict the "flux" of technological solutions; their width represents the relative importance of the directions of circulation. Finally, the "dash-and-point" lines reflect the interconnections between the sources of technology.

The diagram can be clearly divided into two parts: the left-hand side represents the relationships from the point of view of circulation of technology between the advanced countries and the modern sectors of the developing countries; the right-hand side depicts the situation of the traditional sector of the underdeveloped countries. We will first analyse the left-hand side of the diagram.

Most of the features shown in this part of the diagram are well known, so we will consider only those that are more relevant to our purpose. The characteristic which determines the overall pattern of the flux of technology is the overlap of the problem areas of the two sectors under consideration. The rich sector of the underdeveloped countries, having the same cultural trends and values of the developed countries, has the same patterns of consumption and, hence, exerts a similar type of demand on the productive and R and D systems.

As about 98 per cent of the R and D capacity of the world is concentrated in the developed countries, it is obvious that the overwhelming majority of the technological solutions for the area of common problems was to come from the R and D systems of those countries. Moreover, the overlapping of technological problems is continuously enhanced by a feedback mechanism created by the way in which technology circulates in the whole system.

This mechanism is based on the fact, sometimes overlooked in the representations of the R and D systems, that the productive structure of the developing countries is not directly connected with the technological systems of the advanced countries. Of the many technical solutions explored by the R and D systems of these countries, only those that are accepted by their internal markets are finally introduced in the developing countries. In other words, the society of the industrialized countries operates as a filter through which the production of their R and D system has to pass before reaching the underdeveloped countries. The result — as the advanced countries move rapidly towards a welfare society based on the consumption of increasingly sophisticated goods — is that the R and D systems of the developing countries are confronted with a technology that changes so rapidly that it makes it very difficult for them even to be up-to-date with information and practically impossible to influence its direction.

Another effect of this mechanism of circulation of technology is that the industrial systems of the developing countries tend to concentrate on the production of increasingly expensive and sophisticated goods, thus diverting human and material resources from backward parts of society.

The overall effect of this mechanism of generation of technology is to accentuate the dual character of the developing countries. The modern sector tends to be more and more integrated with the advanced countries — at least from the point of view of cultural habits and patterns of consumption — widening the gap with the traditional sector, even if the latter has some marginal improvement in its living conditions.

The above considerations also help to clarify the problems of adaptation of technology in the underdeveloped countries. In recent years, due to the evident failure of their attempts to create R and D systems capable of generating indigenous technologies, the attention of many developing countries has turned to the control and adaptation of imported technology. In a few countries some progress has been made in the selection of the technologies to be imported, but with very little success in the field

of adaptation, and this is due to very understandable reasons.

The central problem can be very simply stated: adaptation to what? As we have seen, the overwhelming majority of imported technologies are devoted to satisfy the demand of the rich sector of the society. As this demand is similar to that of the advanced countries, it is difficult to see how the weak R and D systems of the developing countries could compete with the scientific and technological structures of the industrialized countries to produce different goods to satisfy the *same* needs. Even if it were possible, by enormously increasing the R and D investments in the backward countries, it would be very hard to justify from the point of view of its social cost.

As for the production of those goods using more labour-intensive technologies so as to be more in accordance with the factor endowment of the developing countries, the problem is extremely difficult to solve. In the first place, to devise such technologies, to produce more or less the same goods that are now imported, requires an R and D system of a capacity comparable to those of the advanced countries. Secondly, and no less important, in the market conditions of the rich sector of the developing countries the entrepreneurs compete among themselves on the same basis as in developed countries: producing increasingly more up-to-date and sophisticated goods, marketing the prestige of a particular internationally renowned brand, etc. In this situation, even if they wished otherwise (which is highly doubtful, as they have a vested interest in the conservation of the system), they can only survive by adapting the latest technologies produced in the advanced countries, so as to be able to put the new products rapidly on the market.

The above considerations are enough to understand what happens in the right-hand side of the diagram. The most important feature of the traditional sector is that it comprises more than half the total population of the world, including about 70 per cent of the population of the underdeveloped countries. If the importance of a problem can be in some way measured by the number of people it affects, then the

problems of this part of society in science and technology, as well as in any other field of human activity, are the most important that we are confronted with.

All the characteristics of the traditional sector in relation to technology stem from the basic fact that its problem area, as we have defined it, has very little in common with that of the modern sector. The most relevant features of the traditional sector are too well known to require detailed description: it still depends greatly on a subsistence economy — despite the fact that it is the producer of the raw materials on which the growth of the rich sector is based — and is therefore subordinated to the market integrated by the modern sector. Most important of all, it lives for the most part in a state of utter material misery. Its central problem, therefore, is to satisfy the very basic needs of everyday life.

The technologies used by the traditional sector are based greatly on empirical knowledge, which is transmitted basically by verbal tradition and is the result of centuries of struggle to survive. This knowledge is composed of a great amount of useful information on the physical environment and on the ways to use it to provide for the essential needs of life. Its lack of a scientific base, however, makes the technology it generates essentially static, with very little capacity for reaction in the face of rapid changes.

As we have already seen, the connection of the traditional sector with the sources of modern technology is extremely weak. The technological solutions produced or adopted by the modern sector of the economy are generally not suited to the particular conditions of the traditional sector, and, besides, this sector lacks the economic capacity to accede to them.

The relationship between the three sources of technology also reflects the overall situation. The R and D systems of the developing countries are strongly interrelated with the R and D systems of the advanced countries — mainly through basic research — and make their contribution,

however small it might be, to the generation of the scientific knowledge that constitutes the base of modern technology. On the other hand, the body of empirical knowledge of the traditional sector has practically no connection with the R and D systems of the modern parts of society. It is not considered, in general, an object of scientific enquiry.

By comparing how both parts of the world generate technology, it is easy to understand why the developing countries have not been able to solve — even in those fields where the political will does exist — the most pressing problems of their societies. In the developing countries the R and D systems have evolved with the modern sector of the economy, and are closely connected to the R and D systems of the advanced countries. Their paradigmatic determinants are very similar to those of the developed societies, and this similarity is continuously enhanced by the process just described.

In the traditional sector, on the other hand, the problem area is different from that of the modern sector, and consequently the assumptions of the R and D systems cannot be applied to the solution of its problem. It is an essentially non-explored area and there is no set of paradigms which could form the basic framework to direct the efforts of the R and D systems. Without that frame of reference, hunger or illiteracy, for instance, are not problems from a scientific point of view; they are only facts. They become scientific or technological problems only when their social, economic, and psycho-social parameters and variables are unambiguously defined. The consequence, which is widely known, is that the traditional sector exerts very little demand on the R and D system of the underdeveloped countries.

This statement does not contradict the fact that the R and D system performs some research on the problems of the traditional sector that results in the introduction of a few modern technologies. The important point, however, is that in most cases, the research is made on the implicit assumption that the criteria applied to the modern sector are also valid for the traditional sector. This necessarily results in a piecemeal approach that induces the introduction of some "modern"

technologies, without taking into account the overall social effects. The mechanization of agriculture, increasing unemployment and driving millions of peasants to the misery of the city slums without much improving crop yields, and the build-up in extremely poor countries of expensive Western-style universities, which can absorb only the privileged minority of the population to receive a training entirely disconnected from the real needs of their countries, are but two examples of a widespread phenomenon.

THE NEW APPROACH TO THE GENERATION AND TRANSFERENCE OF TECHNOLOGY

Appropriate Technology

The realization that the indiscriminate transference of technology from the industrialized countries is not an adequate solution for the developing countries is not new (as is shown by the creation by M. Gandhi of the Khadi and Village Industries) but it started to acquire the widespread character it has today in the early 1970s. The best-known names for this new conception of technology — *intermediate and appropriate* — made their appearance at that time. The first one was proposed by Schumacher in the mid-1960s. It refers to a technology that requires less capital investment in the place of work than the ones currently in use. It should be also small-scale, decentralized, with rural relevance, based on local resources, and of simple operation and maintenance. *Appropriate technology* was used by Indian planners in the early 1960s with a meaning, in practice, very similar to the one attached by Schumacher to intermediate technology.

From that modest beginning, and above all in the wake of the new-born concern for the environment, the terminology associated with the "new technology" has greatly multiplied, sometimes adding confusion more than clarification to the underlying concepts. In a meeting organized by UNEP, the terms in use were classified according to the field in which the main emphasis lies, with the following results.

— Terms with predominantly economic goals: intermediate technology;

appropriate technology; self-help technology; progressive technology.

- Terms with predominantly environmental goals: biotechnics; ecologically based technology; soft technology; alternative technology; resource-conserving technology; new alchemy; low-waste and no-waste technology; environmentally sound technology.
- Terms with predominantly social goals: liberatory technology; people's technology; convivial technology; radical technology; community technology.
- Terms with equal emphasis on environmental and social goals: soft technology II; alternative technology II; utopian technology; white technology.
- Terms with equal emphasis on economic and environmental goals: careful technology; human technology; equilibrium technology.
- Terms with equal emphasis on economic and social goals: alternative technology III; inequality reduction technology.
- "Open" terms: appropriate technology II; rational technology; alternative technology IV.

According to the same report,

> Unfortunately, some of the terms have never been clearly defined; and others may have been defined in one way, but used in another and understood yet in another way. Further, the intended scope of the various terms is quite different — while some envisage the achievement of fairly limited transitional objectives, others with an utopian grandeur seek to fulfil all conceivable goals and thus "never put a foot wrong."[11]

The literature on the subject has also expanded to such an extent that even a brief revision would be outside the possibilities of this report. Part of that literature refers to the conceptual approach, another part to specific applications (we will refer later to those contributions) and a considerable portion finally adds very little to the clarification of the issues involved.[12]

As this project deals specifically with the endogenous generation of technologies for rural areas — and consequently falls in the subject area under discussion — it is important to define clearly the terms we are going to use. This is not so much in this case a conceptual

requirement, as a need to avoid the confusions and misunderstandings that often arise due to a super-abundant and sometimes contradictory terminology.

In the first place, when qualifying the technologies to be generated by the project we will use the term *appropriate*. Its best definition is probably: "Appropriate Technology is technology which is most suitably adapted to the conditions of a given situation."[13] Although slightly tautological, this definition expresses exactly the way in which the term is used in this report. In connection with the new approach to development referred to above, it can be complemented with the definition given by Reddy:

> Appropriate technologies can be defined as those technologies which advance the socioeconomic objectives of development, the latter being viewed as a process which is primarily directed towards:
> 1. The satisfaction of basic human needs (starting with the needs of the neediest, viz., the urban and rural poor);
> 2. Endogenous self-reliance through social participation and control;
> 3. Harmony with the environment to ensure the long-term sustainability of this development process.[14]

The advantages of those definitions over many others in use, or proposed, are the following:

a. They do not predefine the type of technology to be used, that is to say, they do not give "recipes" about the specific characteristics they should have. It is almost universally said, for instance, that the technologies for the developing countries should be labour-intensive. It is true that in a country with structural problems of underemployment the overall technological development should increase employment; but this does not mean that every technology should be labour-intensive.

   Taking into account the overall socio-economic conditions, it could well be that for the benefit of the people some technologies should be capital-intensive. As we shall see later, the characteristics that a given technology should have can only emerge from the very process of generating it.

b. Although somewhat redundant, it is important to emphasize that this

conception of appropriate technology does not mean the rejection of all existing technologies. If a technology suits the requirements of a given situation, it does not matter whether it is modern, Western, or "traditional." When we refer to *endogenous* generation of technology, we are referring basically to the process through which the characteristics that the technology should have are determined. The endogenous is the process of definition and not necessarily the origin of the technology itself (see step 5 on page 65).

c. Appropriate technologies are not "second-class" technologies in the sense of being "inferior" to the ones used in the rich countries. A technology can only be qualified as a function of its adequacy to the solution of a given problem, and this has been the obvious criterion used all through history. This is the reason why the use of the term "appropriate" for the technologies specifically devised for developing countries is redundant, and consequently, as experience shows, misleading. It would be much better to say that the developing countries have decided to select the technologies adequate to their needs, cultural habits, possibilities, and aspirations, instead of importing indiscriminately technologies adequate to somebody else's need and conditions.

Finally, appropriate technologies need as much scientific input as the so-called advanced technologies. To quote Reddy again:

> Invariably, appropriate technologies have been confused with low or primitive technologies. This is because, too often, the advanced character of a technology has unfortunately been judged with the trivial criterion of scale of production, whereas in fact it should be determined by the extent of the scientific and engineering thinking that goes into the research and development.
>
> Alternative technologies . . . must be developed from as sound a base of fundamental science and basic engineering as is required by western technology. The importance of this viewpoint must be seen in the context of well-meaning but dangerous advice that developing countries should not invest in basic research. If such advice is acted upon, the result would be highly detrimental to the development of alternative technologies.[15]

Local Knowledge

We prefer to use the term "local" instead of "traditional" because the knowledge of any social group is composed of a mix of traditional knowledge — in the sense basically of old, of unknown origin — and "modern" knowledge, in a chronological sense, stemming from the need to adapt continuously to changing ecological and socio-economic conditions.[16] One of the principles insisted upon in the generation of appropriate technologies is the use of such local knowledge, most of it embodied in technologies.

For many scientists and economists this principle appears as a novelty, and, to say the least, is of very doubtful usefulness. They forget that in the most advanced countries of the Western world, besides science-based technology, a lot of "traditional" technology is being used. In almost every field of economic activity — building (the brick was in use in the most ancient cities of the Indus Valley), carpentry, metallurgy, textile industry, ceramics, liquors, cooking, etc. — technologies based on traditional empirical knowledge coexist with the most sophisticated science-based technologies. We must remember that common people have had to solve their problems in their own way much before modern science was born.

In the rural areas of developing countries the utilization of local empirical knowledge is more important still than in the modern sectors of those countries, or than in the advanced societies. This is particularly clear in the case of ecological conditions, which are so important for economies based mainly on agricultural production. Most underdeveloped countries are located in tropical or subtropical areas, in natural environments that have been scarcely studied by modern R and D systems. The local population, on the other hand, have had to develop through a long experience methods and technologies of production compatible with the physical environment, as a condition of survival. The analysis of those technologies, and of knowledge contained in them, is the best short-cut to know environmental conditions which otherwise would take a long time to understand.[17]

Besides the knowledge of the environment, rural communities have developed technologies and knowledge that can be utilized by the R and D systems. To give an example, we can take the preservation of food, an extremely important problem for countries with poor transportation, particularly in the tropical regions. In many rural areas, people preserve meat for long periods by exposing it to the solar heat under certain conditions they know through long experience. The central idea in this technology is the utilization of solar radiation, a cheap and always available source of energy. This idea, coupled with modern science to improve the process from the biological, sanitary, nutritional, and economic points of view, could help to solve one of the important problems of the rural areas.

The case of the jungle could be another example. The plans to colonize the Amazonian basin have been received with deep concern by the environmentalists of the advanced countries. The interesting point is that to utilize the jungle for economic development seems to mean to destroy it. Apparently the European tradition of crop farming and stock raising in terms of closed and cleared areas, which renders the destruction of the forest, is accepted as the only practical way for the economic utilization of the land. However, is it really the only rational approach? Why not consider the jungle a virgin natural renewable resource, with enormous potential possibilities of economic exploitation without completely destroying it?

This approach to the problem is much more in accordance with the set of basic assumptions we had stated above — utilization of local resources, rational management of the environment, etc. — than the classical one. To explore its possibilities, almost the only knowledge we have to start with is the one accumulated through many generations of people living in close contact with the jungle, or with similar environments. Complemented and enlarged by the scientific study of the biological, economic, environmental, and social implication of the occupation of the jungle, it can give rise to a completely new concept of rational utilization. These are just two examples to which innumerable others can be added.

The utilization of local knowledge is not an easy task because in most cases it is not the problem of simply adopting the traditional specific technologies being used but one of extracting the original ideas they might contain and studying them, applying the resources of modern science. The most important local contribution would probably be, *more than in concrete specific technologies, in new approaches to the solution of old problems, that may stimulate scientific research in hitherto unexplored directions*. Besides the methodological difficulties, this approach requires an unprejudiced and open-minded attitude — not one of the outstanding characteristics of the R and D systems in connection with traditional knowledge.

Local Participation

The need for popular participation in development programmes in general is increasingly recognized by many organizations all over the world, including the UN. A typical expression of this attitude is a recent FAO declaration: "First priority will be given to the promotion of programmes for the involvement of rural people in the development process through their own organizations."[18]

The recognition of the importance of people's participation in development programmes is based not only on an ideological position — the admittance that people have the right to participate in their own development — but also, and mainly, on pragmatic and operational considerations. It has been shown time and time again that many development plans in every field have failed because the opinion of the people involved was not taken into account. This is a problem not only of the developing countries — specially in the rural areas — but also of the advanced countries, as shown, for instance, by the results of much housing development carried out in these countries in the last decades. Those programmes — resulting in the construction of groups of big multi-storey "functional" buildings — were based on architects' theoretical considerations as to the preferences and needs of the people. Now, those "modern" housing compounds are recognized as one of the causes of the alienation that leads to juvenile delinquency, drug

addiction, etc., because they constitute an environment not suited for the normal development of a human community. As a reaction, in the new housing schemes increasing attention is now being paid to the opinion of people that presumably will inhabit them.

This happens despite the fact that in the advanced countries, and in the modern, or rich, sector of developing countries, people have a degree of participation in generation of the technologies that will affect them. This participation is implemented through a complex indirect mechanism that normally ensures the acceptability of new technologies even before they reach the potential users. For instance, no enterprise will try to commercialize a new product, unless a careful market survey has been performed. Besides, the scientists and technicians who produce the technologies belong to the same milieu as the consumers, so they share their preferences and aspirations; applying the terminology we used when referring to the R and D systems, they share the same set of paradigms.

In the industrial enterprises it is also increasingly accepted that the workers would be given some degree of participation in management and technological decisions. This applies not only to socialist economies — Yugoslavia is an outstanding example — but also to capitalist countries, where many experiments on workers' participation are under way.

In the rural areas of developing countries, on the other hand, those mechanisms of participation are almost completely lacking; moreover, the scientists and technicians of the R and D systems belong to a different economic and cultural milieu, so they lack an adequate frame of reference as to which type of technology is best suited for the needs and conditions of the rural people.

The need for the participation of the peasants to develop technologies for the rural areas is evident considering what we have said about local knowledge. The local population is the depositary of traditional empirical knowledge — including, besides the environment and concrete technological solutions, the socio-economic and cultural characteristics

of the community — which can only be transmitted through an active interchange between scientists and the local people.

One of the hypotheses basic to the project is that

> the technological problems that can be identified as obstacles to the development of backward rural sectors of poor countries can only be understood in their true dimensions *by taking as a starting point* the socio-economic processes and conflicts in which each social group is involved; that is, by recognizing that such problems are but one of the aspects of a "problem situation."[19]

As is well known, in many cases the solution of a technological problem depends more on issues of political, social, and economic power than on scientific research. The failure to recognize this fact has led many well-meaning scientific institutions to solve the wrong problem, in the sense of devising a technological solution that does not fit the conditions of the "problem situation."

When it happens that to solve a technological difficulty is useless because the root of the problem lies elsewhere, the scientific team has two alternatives: (i) to point at the root of the problem, making clear that no technological solution will have any sense unless those other elements are corrected; (ii) to look for an alternative path — in which technological problems can be a component — that can bypass the socio-economic or political obstacles. The point is that the "problem situation" cannot be adequately identified without the participation of the local people, as the power problems are normally "ignored" in the higher echelons of decision making. Through direct contact with the peasants it is possible to identify problems of power — even inside the peasant community — that cannot be perceived by a research institution working in the "conventional" way.

One of the obstacles that peasants have to identify and pose clearly their problems is their ignorance of the possibilities and limitations of modern science. Participation in the process of creation of technologies will help them to overcome that obstacle, and to incorporate an awareness of science as a normal element of their lives, as

is the case in the richer parts of the world. Moreover, it is an important objective that the technologies should be produced, as much as possible, by the local people with local resources. The participation of the local population in the process of creation of the technologies will contribute to generating the skills required for their use and production.

However, and despite the growing literature on the value of local knowledge and participation, there is still a great resistance to the participation of the peasants in development plans and in the generation of technology. M. Howes, after showing that the rural people have inventive capacity, says it is

> pertinent to enquire into the reasons why even those who appear favourably disposed towards an extended role for indigenous knowledge do not advocate or even consider ways in which the existing propensity to experiment might provide the basis for direct participation in the process of creating new knowledge on the part of the indigenous population.[20]

The main reasons that are given for the hesitation in fully accepting peasant participation — generally by persons who have not really worked *with* the peasants, although they might have worked *for* the peasants — are: (i) peasants are conservative and tend to reject anything new; (ii) peasants are ignorant and cannot understand modern knowledge and approaches; (iii) participation is a political problem, and in most developing countries power relations are not appropriate to implement it. We can briefly analyse those objections.

As is well known, one of the most difficult aspects of the introduction of new technologies in rural poor areas is to induce people to accept them. This is not because they are specially "conservative," but mainly because people generally tend to reject changes in their ways of living and doing things unless they have participated in some way in their generation. As we have already seen, in the advanced countries there is a degree of indirect participation that normally ensures the acceptability of new technologies. However, historical experience shows that those mechanisms frequently fail, and new technologies are

rejected when they reach the market for reasons that are not more "rational" — perhaps less so, as we will show immediately — than the ones that induce the rural poor to reject innovations introduced from outside.

When the reasons for the rejection of specific technologies by the rural people have been seriously studied, it has been found that normally the rejection is based on solid rational ground. In most cases the resistance to adopt new technologies is based on the fact

> that the adoption of technological innovations cannot be taken in isolation from other factors such as land tenure, social organization and cultural values. The literature on the subject provides many examples of cases where "rational" innovations have been rejected by farmers because of one, or a combination, of these various factors, and not because of any "irrational behaviour" or an abstract "traditionalism" which some authors purport to find among peasants.[21]

As for the "ignorance" of the peasants, the point is not how cultivated they are from the point of view of general education, but how much they know about the specific productive activities in which they are involved. On this matter it is obvious that they have a clear advantage over most of the urban workers (whether white or blue collar). The latter participate normally in a very small segment of the process of production, and have very little idea of the implications of even their own work. The former, on the contrary, have to know the whole cycle of production and are, for the most part, entrepreneurs and labour simultaneously. In a recent paper on economic rationality, A. Luckaszewitcz reaches the conclusion that there is more rationality in the behaviour of traditional households than in the economic behaviour of modern man.[22]

The experience of scientists working in close connection with the peasants confirms also the capacity of the latter to provide useful information and collaboration. In a report of a committee of the International Council of Scientific Unions it is concluded:

> The studies demonstrate that farmers are able to provide lucid and concise information on environmental difficulties and that,

> when related to objective circumstances of agricultural production in the area, the data appear to represent rational assessments of real difficulties.[23]

T.B.G. Egziahber working with Ethiopian peasants to identify their problems reaches similar conclusions even more forcefully:

> Early in the discussions with the farmers' Committee, it was discovered that they would very easily distinguish between the problems for which there are ready answers, but remain problems because of economic weakness . . . and those for which there are not ready answers. . . . The latter category is the concern of R and D systems, the former is not. The farmers with an unbelievable exactness which would discredit those scientists who hold peasants ignorant identified the problem areas where the scientists would, at least theoretically, play a role.[24]

A very important point to take into consideration is that the possibilities of the peasants to discuss their problems depend to a great extent on the attitude of the scientists. A basic principle is that any scientific or technological knowledge can always be explained — at least in its relevant consequences — in terms and concepts that a peasant can understand. Another problem connected with the attitude of the scientist is that, in some instances, while apparently trying to understand the local conception of a problem, he is in practice testing local knowledge against his own preconception of how the problem could be best solved.[25] As a consequence, if the approach of the peasants differs from the one preconceived by the scientist, he will be automatically convinced that the local people are ignorant of their own problems. In conclusion, for a fruitful interaction between local people and scientists, the latter should: (i) make a sincere effort to communicate their knowledge to the peasants using a language that the peasants can understand; (ii) have an open-minded attitude to the possibility of the peasants contributing with useful and even original ideas to the solution of their own problems.

Local participation, to be most effective, requires a certain degree of organization of the community. All rural communities have some elements of organization whether formal or informal. One of the objectives of the socio-economic study of the community should be to identify those

mechanisms of organization, and to determine which type is best suited to implement participation in the development of technologies. It could happen also that the introduction of the new activity is in itself a stimulus to develop new forms of organization specially adapted to its objectives.

Finally, the problem of the institutional possibility of participation has been often confused by not making the obvious and necessary distinction between "political participation" *stricto sensu*, and participation in a concrete limited field of economic and social activity. The former, understood in a wide sense, is a problem of political, social, and economic power and in most countries cannot be truly implemented without radical changes in the structure of power. The latter is looked upon as a technical problem rather than as a political one: it is considered really a collaboration between scientists and common people to find solutions to problems related with development.

It can be said that participation, even in a limited field of social activity, has sooner or later political implications. This is probably true but it has to be remembered, however, that practically in no society can political participation be assessed in terms of all or nothing. There are always some degrees of freedom, and the limits can only be determined in practice. The philosophy of no action, based on the assumption that no progress can be achieved until the whole social structure is changed, is one of the best ways to preserve that structure, by not allowing people to acquire confidence in their own capacity to overcome their problems, and so to identify the real obstacles to their social and economic progress.

WORLD ACTIVITIES IN APPROPRIATE TECHNOLOGY

As is well known, to evaluate what is being done in the world in the field of appropriate technology is an extremely difficult task. There is a reasonably extensive literature on the theoretical aspects — what

is, or what should be, appropriate technology; its economic, social, and cultural implications; the possible contribution of traditional knowledge; etc. — but very little on the activities of the groups engaged in the generation and implementation of those types of technology. The main reasons for this state of affairs are the following: (i) many of the groups involved in the production of appropriate technologies are new, and so they feel that their results are not yet worth publishing; (ii) for many of the relatively small informal groups, it is difficult to find a regular outlet for the publication of their results — which are for the most part preliminary — so they distribute them in mimeographed form, with very reduced circulation; (iii) the organizations of the regular R and D systems engaged in the production of appropriate technologies only publish results when they feel that they represent a more or less original contribution to a given technological field. In these cases, they say very little about the process or methodology applied to generate the technologies.

In this section we will try to evaluate, in general terms, what is being done in the world in the area of appropriate technologies, basically from the point of view of the methodology applied to generate them. Our purpose is not to give a complete picture of the "state of the art" but to determine to what extent the proposed project can make a valuable contribution to the field. The bibliography we have been able to examine gives only a sample of the activities being carried out, but we believe that the sample is representative enough for our purpose.

Organizations Working on Appropriate Technology

The number of organizations engaged in appropriate technology activities has increased steadily in recent years. Several international and national institutions have prepared lists of such organizations, with a very brief description of their activities, in most cases reduced to the specific fields of research in which they are engaged. Some of the best known of those lists have been prepared by the following institutions: UNEP, *Institutions and Individuals Active in Environmen-*

tally Sound and Appropriate Technologies (Nairobi, May 1978); Canadian Hunger Foundation and Brace Research Institution, *A Handbook on Appropriate Technology, C4: Groups Involved in Appropriate Technology Development* (Ottawa, 1976); ILO, *Technologies for Basic Needs: Institutions Dealing with Appropriate Technologies* (Geneva, 1978). Other organizations that have also published lists are the Commonwealth Secretariat (UK); TRANET (Transnational Network for Appropriate Technologies, USA); ITDG (Intermediate Technology Development Group Limited, London); and the National Science Foundation (USA).

The number of organizations varies greatly in the different directories. For example the ILO gives 22; the Canadian Hunger Foundation, 81; and UNEP, the most inclusive, gives 696, of which 443 are located in the developed countries and 253 in the Third World.

Despite the impressive number of organizations registered, those lists and descriptions are not enough to give a clear idea of the real activity in the field of appropriate technology, for the following reasons: (a) Most organizations are included only on the basis of an explicit declaration of interest in appropriate technologies. A cursory examination of the lists is enough to verify that for most of the groups included, to work on appropriate technologies means just to have the purpose to produce technologies useful to local conditions, but without any substantive change in the "conventional" research. Due to the ambiguity of the concept "appropriate technology" and its growing "popularity," many organizations, for the mere fact that they are interested in rural problems, consider themselves active in the field of appropriate technologies. (b) A great number of the organizations are not engaged in the generation of appropriate technologies but only in some related activities — information, diffusion or extension, education, credit to farmers, etc. (c) Many of the organizations listed do not have enough scientific *potential* for the generation and implementation of appropriate technology, because they are small, informal groups, without connections with the R and D systems. (d) The majority of the organizations listed are located in the developed countries, and most of them work on technologies related

with their problems. In many cases they consider that the technologies they produce are appropriate for the developing countries just because they are "simple," promote self-sufficiency at the household level, or use non-conventional sources of energy, although their cost and required inputs are beyond the reach of the poor sector of the Third World countries.

A good example of the heterogeneity of the lists is given by the UNEP directory, which includes "organizations which have some amount of experience and expertise in their staff, whose names appear repeatedly on lists as referrals, and which engage in research" and "organizations for which only an address and an occasional attribute has been supplied, activities and publications are unknown."

Although, as we have already said, the information about the specific criteria applied by the groups actually engaged in the production of appropriate technologies is scanty, it is enough for our purpose when complemented by the above-mentioned lists. The information registered in the latter is for the most part given by the organizations themselves, and the glaring absence of some items or subject is also, as we shall see later, a valuable piece of information.

The Approach and Methodology of the Organizations Working in Appropriate Technology

To analyse the action of the organizations dealing with appropriate technologies in relation to the objectives and methodology of the project, we start from the assumption that the generation of those technologies cannot be based solely on the "intention" of producing a solution adequate for the rural people, without modifications in the research approach used normally by the R and D systems:

> Appropriate technology is not a unique entity, but really an approach. Certainly science and technology enter into its composition, but in truth the subjective elements in its creation are more determinative of its nature. We need to know the place and time, the nature of the operations in which technology has to intervene, but most of all we need to take

account of the spirit and the aspirations of the rural people themselves.[26]

In the preceding sections we have discussed the main elements that in our view should enter into that approach. They are the following:

a. A careful study of what we have called the "problem situation," that is, the dynamic socio-economic elements in which a technological problem is always immersed. This is different from the *static* socio-economic studies that are normally performed in rural areas and which very seldom identify the real conflictive problems.[27]
b. Study of the local knowledge and technologies. In the latter, trying to identify the approaches and ideas they contain.
c. Participation of the local population in all the stages of the process of the generation of the technologies.
d. Applications of a methodology of research that allows the final formulation of the frame of reference, or set of paradigms, we have referred to previously. Without this condition, it would be very difficult to ensure the adequacy of the technologies and their coherence (see Methodology for Research, p. 59).
e. Direct participation of organizations belonging to the "regular" R and D system of the country, or strong operative links with it. This is an important requisite, because, due to their variety and magnitude, the problems of the developing countries cannot be solved by isolated groups, however much goodwill they might have.

To assess to what extent those elements of the approach to development of appropriate technologies are present, we will divide the organizations in the following categories:

1. Informal organizations: these are organizations which do not belong to the R and D systems of the *countries involved*, or are not closely connected with them.
2. Organizations belonging to the R and D systems of the country involved.
3. Specific projects: some R and D organizations, although not normally involved in the production of appropriate technologies, sometimes organize or intervene in projects which have, as one of

the main objectives, to generate technologies suited to the local conditions (whether they call them appropriate or not). We consider these projects as "temporary" organizations.

It is sometimes difficult to decide to which category a given organization belongs, due in part to the difficulty of determining exactly what the R and D system of a country really consists of. However, as we are dealing with general types of organizations rather than with specific groups, the classification is adequate enough for our purpose.

Informal organizations: We include in this category the informal organizations established in the developing countries, and all organizations based in developed countries and operating in the Third World, whether they are connected or not with the R and D systems of *their* countries of origin. We shall examine first briefly the organizations based in developed countries.

Probably the best-known organizations involved in appropriate technology activities in the developed countries are: Intermediate Technology Development Group (ITDG), UK; Volunteers in Technical Assistance (VITA), USA; Brace Research Institute (BRI), Canada; and The Canadian Hunger Foundation.

The ITDG was set up in 1966. Its orientation is to promote low-cost intermediate technology for rural areas. It works through voluntary panels of British-based academics and other interested parties. The panels covering such subject areas as chemical engineering, water resources, and construction respond to requests from developing countries for technical assistance and take technical initiatives on problems which they consider important. In some cases, specialists are sent to developing countries to do research and testing in the field.

A good deal of ITDG work has been concentrated in English-speaking Africa, where field-work has been done in a number of areas, specially in construction, technology, management, village water requirements, and agricultural equipment. Virtually all field-work was carried out

by British scientists, with variable linkage to local R and D institutions.

This general trend has changed somewhat in the last two or three years, and better links with local institutions have been established. An overseas unit was created in Nigeria to identify opportunities for the local manufacture of small equipment and to undertake research into the economic and technical feasibility of such equipment. An Industrial Liaison Unit tries to adapt industrial technologies available in the United Kingdom for small-scale projects in developing countries.

One of the important activities of ITDG is the dissemination of information, which is carried out mainly through its *Journal of Appropriate Technology*.

VITA is an association of about 6,000 volunteer businessmen, scientists, and engineers engaged in technology transfer in response to requests from developing countries. It has published *Village Technology Handbook*, in which a number of plans related to the development of appropriate technology have been included.

At the beginning of its action — confined to some Central American countries — VITA had practically no contact with local R and D institutions, but more recently it has established closer links with some organizations of Third World countries.

The Canadian Hunger Foundation is a non-profit-making, non-governmental organization engaged in giving assistance to developing countries through the support of self-help projects in the field of agriculture, forestry, fisheries, and nutrition. The Appropriate Technology Programme has been in operation since the early 1970s, carrying out projects in several countries, in which it has applied and tested some of the concepts and philosophy of appropriate technology. It has published, jointly with the Brace Research Institute, a *Handbook on Appropriate Technology*.

The Brace Research Institute (McGill University) performs research to

develop economic methods of water desalination, irrigation, and other means of making arid land available and economically useful for agricultural purposes. Emphasis is on small-scale devices suitable for application in individual communities and agricultural holdings, with particular attention being given to the social and technical needs of people living in arid areas. The Institute has also a wide range of publications dealing with specific appropriate technologies.

There are other organizations of that type in the developed countries — some of them working in more restricted fields like interchange and dissemination of information — but their approaches do not differ substantially from the ones just described. Most of the 443 organizations listed in the UNEP directory work in fields of little interest for developing countries — it includes everything from manufacturers of windmills to promoters of systems to convert automobiles to the use of propane or methane as fuel.

Although the organizations belonging to the group really interested in the problems of the developing countries might make some useful contributions, the shortcomings of their activities are evident. In many cases, the R and D groups of the developed countries tend to believe that the technologies for the poor societies have to be generated in the industrialized countries, because of the superior scientific capacity of the latter. As a consequence, the solutions proposed tend often to reflect more the conception of the advanced countries as to the type of development more convenient for the poor countries, than the real needs as aspirations of the societies involved. In most cases there is an almost complete lack of field socio-economic studies and, obviously, very little contact with the local population.

The number of informal groups located in the developing countries seems to be fairly large, but it is almost impossible to determine it with accuracy, the main reason being that, due to their very nature, they publish very little in any kind of regular journal. Of the 253 Third World organizations listed in the UNEP directory, at least 30 to 40 per cent can be included in this category.

Probably the most interesting informal organizations working in the world at present are the Village Technology Unit of BUTSI in Indonesia and the NDS in Nepal.

About 3,000 (the figure for 1976) university graduates work for two years as volunteer village-level generalist development workers in villages all over Indonesia under BUTSI, the Indonesia Board for Volunteer Service. A further 45,000 university students are doing six months of similar work as part of their curricula under the Indonesia National Study Service Scheme (KKN).

In early 1974 BUTSI created a Village Technology Unit in response to the increasing requests from volunteers for advice and assistance for the practical problems they face in their village development work. Its staff is composed mainly of ex-volunteers, with two years of experience of village-level development work. The unit is now serving both BUTSI and KKN.

The unit responds to the demands of the villagers as conveyed to it through BUTSI and KKN volunteers by looking for village-technology ideas that exist in other parts of Indonesia or in other countries, by testing and sometimes adapting these ideas, and by disseminating information on them. The main vehicle for disseminating this information is a series of booklets, each containing pictorial information with a minimum of text.

In Nepal, each year several hundred degree-level students spend a year in village-level development work as an educational requirement under the NDS, and this number will increase to approximately 3,000 per year when the service requirement is moved down to the diploma level of higher education.

The NDS produces booklets in a "Village Improvement" series to help NDS participants in their village development work. The village technology work of the NDS is much more limited than that of BUTSI, and there is not a special village technology section.[28]

There are other informal organizations whose aim is not so much to help the peasants by providing them with information about existing technologies or by giving them technical advice as to induce them to find solutions through the use of their own capacity and resources.[29]

An example of this approach is The Sarvodaya Shramadana Movement in Sri Lanka. For this organization "development" is the awakening of man's physical, intellectual, spiritual, social, and economic well-being as an integrated whole. The members of the group assist the villagers only at their request. They do not give advice but work together with the peasants to identify the most important "felt needs" that can be solved by their own effort. After this identification, members of the group help the peasants to organize themselves to tackle the project. The main objective of the Movement is to demonstrate to the peasants that some of the solutions to their problems lie in their own hands.

The Project for Water Storage and Irrigation in Dogon Villages uses an approach that has many similarities with the one applied by the Sarvodaya Shramadana Movement. The main concern of the group is not modernization but rather the organic development of the traditional society. In helping the peasants to solve some of their problems — construction mainly of water granaries and small reservoirs — the members of the group work with the villagers, consulting them, sharing with them their calculations, asking their advice, and incorporating as much as possible of traditional Dogon technology into their work.

Many other informal organizations work along the lines of the two types just described, but there is very little information about their activities. There is another type of informal organization that works more or less with the same approach of what we call formal organizations. The first type, however, is the most interesting one for our purpose.

The most important characteristic of the informal organizations of the first type is that they work in close contact with the peasants, which implies a high degree of participation of the latter. Due to this

contact, those organizations have also a good first-hand knowledge of the characteristics and problems of the villages, even when they do not perform the systematic socio-economic studies which require the participation of experienced social scientists. Their main drawback — from our point of view — is that, as they are not operationally linked with the R and D institutions, their capacity to generate technologies is greatly reduced, although sometimes they are efficient in the introduction of *known* technologies.

In our view, the most important contribution of those groups lies in the near future. Most of their members are young people — students in the case of both BUTSI in Indonesia and NDS in Nepal — and a certain proportion of them will become researchers in due time. Their first-hand knowledge of the peasant community and their sympathetic understanding of their problems will surely help the R and D organizations to reorient their approach to the generation of appropriate technologies.

Formal organizations: Taking as a basis the UNEP directory, there are probably about 150-170 organizations of the type we classify as "formal" (belonging to the R and D systems or with direct operational links with them). Many of them are little more than names — at least from the point of view of public knowledge — as their "activities and publications are unknown." There remains a core of perhaps about 50-70 organizations — some of them belonging to well-known R and D institutions — from which there is some information about their activities in the general field of appropriate technology.

Those figures are obviously very rough approximations, as most probably there are institutions working in appropriate technology that are not listed, either because the information was not available or because they consider that activity a normal non-differentiated part of their work. On the other hand, it is also probable that some of the organizations listed have had only occasional activities in the field but do not consider it a regular part of their normal work.

Even for the "hard core" of formal organizations, it is difficult, for

the reasons already given, to find detailed information on the elements of the process of generation of technologies we are interested in. It is possible, however, on the basis of a study carried out recently by Dr. A.K. Reddy of ASTRA, Indian Institute of Science, and through an analysis of the general information available to us, to arrive at a reasonably accurate picture as to what extent those components of the process of generation of technologies are taken into account.[30]

The base of Dr. Reddy's study is a sample of ten of the best-known organizations working in appropriate technologies in the Third World.* A questionnaire was sent to the selected organizations, including questions such as their degree and type of contact with the potential users of their results, their concept of appropriate technology, the sectors of the population for which the technologies are produced, whether or not the groups include social scientists, how the socio-political and social constraints that the technologies have to satisfy are defined, etc. With the results of the questionnaire, and his personal knowledge of the field, Dr. Reddy had prepared a preliminary assessment of the appropriate technology institutions.

Given the great importance that the evaluation has for our work, we will transcribe the parts of the conclusions more relevant for our purpose (italics are ours):

> It is obvious that the term "appropriate technology" has different meanings to different institutions. To some, e.g., KIST, it means serving industrialists; to others, e.g., IRRI,

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* The organizations included in the sample are: AATC (Appropriate Agricultural Technology Cell), Dacca, Bangladesh; ASTRA (Cell for the Application of Science and Technology to Rural Areas, Indian Institute of Science), Bangalore, India; ATDO (Appropriate Technology Development Organization), Islamabad, Pakistan; ESIR (Council of Scientific and Industrial Research), Delhi, India; DTC (Development Technology Centre, Institute of Technology), Bandung, Indonesia; EAIRO (East African Industrial Research Organization), Nairobi, Kenya; ESCAP-RCTT (Economic and Social Commission for Asia and the Pacific-Regional Centre for Technology Transfer), Bangalore, India; IRRI (International Rice Research Institute), Manila, Philippines; KIST (Institute of Science and Technology), Seoul, Korea; Technology Consultancy Centre, University of Science and Technology, Kumasi, Ghana.

it means catering to the middle strata of farmers whilst ignoring the poorest. *Not too often does the definition include an emphasis on basic needs, starting from the needs of the neediest.*

Further, the concept of appropriate technology is *generally restricted to production practices; it rarely extends to the appropriateness of products.* Once again, this is because of the lack of a basic-needs emphasis.

The activities of the listed institutions seem to span the entire range of basic needs. However, there seems to be comparatively more emphasis on alternative energy sources, particularly windmills. Appropriate energy technologies are of course vital, and if this emphasis has been derived from a scrutiny of the felt needs of the urban and rural poor, then it is quite justified. *Unfortunately, it is difficult to avoid the suspicion that the emphasis is a carry-over from the interests of appropriate technology groups in the developed countries, and a result of the presence of a large number of expatriates working on appropriate technology in the developing countries.*

In contrast to this preoccupation with energy, there is a quite inadequate emphasis on appropriate technologies which can generate employment in the rural areas, e.g., those based on agro-processing.

It seems that most small groups (many of which are voluntary and manned by expatriates) are in direct contact with the urban and rural poor — hence, the strength of these groups in technology dissemination. *In contrast, very few of the larger establishments of education, science and technology have this vital contact, for example, in the form of field stations or extension centres* — this shortcoming is responsible for the relatively poorer performance of these institutions at technology dissemination.

Very few of the institutions and organizations dealing with the development of appropriate technology have the sociological expertise (either in-house or available through collaboration) to define the felt needs of the target groups, e.g., the urban and rural poor. Even when there is an appreciation of the difference between felt and perceived needs, the *identification of the felt needs is invariably done by scientists and technologists working as amateur sociologists.*

Similarly, *most of these institutions are inadequately equipped with economic and sociological expertise to define the constraints which must be satisfied by a technical solution.* There is little need for such expertise in dealing with western technology, because the constraints invariably percolate to the R and D laboratories and the technologists in them through market forces, but in the case of appropriate technologies, *the prospective beneficiaries cannot articulate their demands through the market, and therefore there is no alternative to*

including the definition of these non-technical constraints as an integral part of the innovation process. In fact, the innovation process — its first step being the formulation of the R and D objective — cannot even commence until the constraints are specified.

Most appropriate technology institutions *do not make explicit the precise economic, social and environmental constraints they seek to satisfy in their innovations.*

With regard to exposing technological options to beneficiaries so that their perceived needs become feasible and realistic, it seems that most institutions get "hung up" on a few "pet" solutions, without exploring the full gamut of possibilities. This is particularly the case with institutions which are also generating technologies, for they tend to become attached to, and develop "vested interests" in, the solutions which they themselves have generated.

From Dr. Reddy's evaluation the following conclusions emerge clearly:

a. Most of the organizations do not carry out the socio-economic studies to determine the economic, social, and environmental constraints they seek to satisfy in their innovations. The almost complete lack of involvement by social scientists means that they are unable to perform even the conventional more or less static socio-economic studies that practically everyone agrees that — at least theoretically — should be done.

b. The fact that the organizations deal more with process than products, that most of them do not have field stations or extension centres, and that a great proportion of the technologies to be introduced have been generated in the research institutions previous to their engagement in field work or adopted under the influence of centres in the developing countries, means that the role of local participation is very small even in the stage of identification of needs, not to speak of participation in the whole process of development of the technologies.

c. For the same reasons given in point b above it is clear that although there can be some input from local technologies and some adaptations and upgrading of them, there are not systematic studies of local technologies and knowledge.

d. The way most of the technologies are selected means that there is not a systematic methodology of research, starting from the needs

identified by the socio-economic studies and carried on in a logical sequence to define the type of technology required without preconceptions as to its specific character (see Methodology for Research, p. 59).

The above conclusions are confirmed, in general terms, by the brief descriptions of the organizations included in the list of directories already mentioned. Most organizations — including those that have started to work very recently in the field of appropriate technology — give a list of the specific technologies being developed, with the same bias pointed out by A.K. Reddy in his study. This seems to indicate that many technologies were selected without field-work to identify the needs, or according only with the opinion of the scientists and technologists as to the real needs of the people.

Another feature of the description of the organizations is that there are very few references to participation of the local people in any stage of the whole process of generation of technology or to the systematic study of local technologies and knowledge. This does not mean that the organizations are entirely indifferent to these aspects of the process of generation of technologies, but clearly indicates that they are not elements that specifically differentiate their approach from the one applied in the institutions that perform technological research in the conventional way.

Specific projects: There have been several development projects in recent years which have included, among their various objectives, the attempt to generate technologies appropriate for the local needs. As these projects are multidisciplinary — in the sense that they have to deal with a multiplicity of the socio-economic elements of the region selected — they should provide, at least theoretically, a good frame of reference for the generation of appropriate technologies. This characteristic makes specially interesting the study of the action of the R and D institutions involved in the work.

As in the case of the organizations engaged in activities connected with

appropriate technologies, the main problem in carrying out the analysis is the scarcity of detailed information. Most of the material published refers either to the general approach and objectives of the projects or to specific results obtained in some fields or disciplines. Very seldom is there an external evaluation of the projects which could give some insight into the results of the approach applied in the specific case of the generation of technologies.

Fortunately, there are a few projects in which we have been able to obtain enough information to evaluate the results, or at least the methodology used, from the point of view of our approach. We have selected three projects — one in India and two in Mexico — which we believe are representative of the general trend in this field because (i) they belong to two countries that are specially conscious of the problems of development in their rural areas and have two of the most advanced R and D systems of the Third World; (ii) one of the projects — Puebla in Mexico — is, for its intended objectives and volume of operation, among the most important of the world.

India

Agricultural Development Project (ADP): Although this project could be considered performed by an informal group — it does not seem to have any connection with the regular R and D system — we treat it here because the organization showed good technical competence, and the results are very illustrative.[31]

ADP was set up in an area of 45.8 square kilometres comprising nine villages. Its objective was to help the poorer farmers to attain a better standard of living by increasing agricultural production.

From the technological point of view, the sequence of actions was the following:

a. The main obstacle identified for an increase of agricultural production was the lack of an assured supply of water. ADP decided to exploit ground water and encouraged the farmers to deepen the

existing wells and to dig new ones for irrigation. Water-bearing strata were located with modern geophysical equipment.

b. Having solved the problem of water, the next step was the introduction of high-yielding varieties of seeds (HYV). This required the introduction of chemical fertilizers.

c. The HYV seeds and the use of fertilizer required deep ploughing, accurate row widths, and proper plant spacing in order to achieve maximum output. As a result it was necessary to hire agricultural machinery, mainly tractors.

d. A water conservation plan was introduced.

The extension work was based on a personal knowledge of farmers in the area. The positive results obtained by those farmers encouraged others to join the project. This led ADP to work with farmers identified as "progressive" — i.e., those who had adopted ADP ideas.

In the third stage of the project — the hiring of machinery — only the farmers with larger holdings (over eight hectares) approached the ADP staff. The fourth phase — the water conservation plan — required the consensus of the leaders of the communities, as they seemed the only people able to enforce the programme. In the discussions with the leaders the poorer farmers tended to be ignored, and so their specific problems were not taken into account.

In conclusion, the project succeeded in increasing yields and introducing modern equipment; however, it failed in its primary objective of improving the well-being of the poorer farmers. Moreover, the project made the achievement of this objective more difficult, by contributing to the concentration of resources in the hands of relatively few farmers.

In the approach applied by ADP, the following characteristics can be detected: (i) no socio-economic study was made before implementing the project; (ii) although there was contact with the peasants, it was selective and all but failed to include the poorer farmers, who were the supposed beneficiaries of the projects; (iii) the selection of the

peasants to be favoured by the project was really made by the technologies introduced. No attempt was made to find technologies more adequate to the socio-economic conditions of the region.

Mexico

Puebla Project (Plan Puebla): The Puebla Project is one of the most interesting that have been carried out in the world, firstly, because of its scope, and, secondly, because it was started as a conventional green revolution type of development approach but was corrected in mid-course to try to adapt it to the real conditions of the region.

The project started in 1967 as an initiative of the Rockfeller Foundation, with the participation of the Centro Internacional para el Mejoramiento del Maíz y Trigo (CIMMYT) and the Colegio de Post-Graduados de Chapingo. It was conceived to tackle two problems: the danger of a scarcity of food at a global level, and the prevalence of low income and deficient nutrition in most of the rural population of the country.

The region selected was rather homogeneous from a socio-economic point of view: the predominant activity was subsistence agriculture, and 75 per cent of the farmers had plots of less than three hectares. For most of the peasants the production of their plots was not enough to provide their basic needs, so they had to supplement their income by working as hired labour.

The project was started as a pilot plan, with the following objectives: (i) to increase the yield of the corn crops of the poor farmers; (ii) to develop and experiment the technologies required for that purpose; (iii) to set up a training programme for the peasants, so they could apply the new technologies. The final objective was to convert the region into a big corn producer, able to satisfy the demand of Puebla state. Implicit in those objectives was the conversion of the peasants into farmers, according to the model of the developed countries.

The established strategy required the introduction of new technologies, basically: (a) high-yield corn varieties; (b) optimal practices of production; (c) agronomic information for farmers and agrarian leaders; (d) adequate infrastructure to ensure the availability of inputs, including credits, and access to the national market.

During this part of the project the research activities were concentrated on agronomical problems and were performed in selected plots of the area to get the acceptance of the peasants through the "demonstration effect."

The technologies developed implied an increased cost in seeds and fertilizers, and consequently, more credit support. Moreover, the technical package did not take into account the economic rationality of the peasants and their knowledge of the environment and agricultural practices. As a result, in 1969, the date at which the plan was to be fully implemented, only about half of the peasants accepted it. In 1972 only 20 per cent of the programmed plots were incorporated in the project. One of the effects of this phase of the project was to stimulate the "social polarization" of the communities. Most of the peasants that accepted the plan were the richer ones and, consequently, the social inequality increased.

From 1969 the approach of the project started to be changed, trying to adapt it to the local conditions. In 1972 a new technological package had been developed which included 16 different systems of corn production, each one with two alternatives: one for "unlimited capital," and the other for "limited capital." The labour required a minimum of new inputs and of modifications of the traditional system of production.

During this second phase of the project, some of the traditional technologies were studied and included in the package, and the elements of risk — so vital for the peasants — neglected in the first phase were also contemplated, mainly through the gradual introduction of the new technologies. A new system of bank loans, more flexible, was also implemented.

As a result of the change of strategy, the Puebla Project was more successful in its second phase, as demonstrated by the increase in the number of poor peasants that accepted. However, the success was only partial, for the following reasons: (a) most of the peasants could not apply the whole package, so the yields did not reach the desired level; (b) the increase in income resulting from higher yields was not enough to liberate the peasants from the need to work as hired labour, so defeating one of the basic objectives of the plan. For the poorer peasants to accept the whole package would mean to *diminish* their income. It is revealing to note that the average size of the plot of the participant peasants was 3.42 hectares, while the average size for the non-participants was 2.42 hectares.

The *social* result of the plan has been to increase the inequality inside the communities. A recent study shows that the original inequalities have been accentuated and that the dependency of the poor peasants on their work as hired labour has been replaced by a dependency on the richer sector of the community.[33]

From the brief description above, it is evident that the Puebla Project showed an uncommon flexibility to try to adapt to the needs of the peasants and a great scientific competence. The main reason for its failure to accomplish totally its quantitative objectives, and for the undesirable social effects produced, can be attributed to the lack of an in-depth socio-economic study of the peasant community involved. The project started by considering the peasant simply as a producer, only limited by physical environmental conditions. It failed to see the peasant as a social actor, immersed in a "problem situation" whose components are not only technical or environmental. This reductionist conception hindered also — despite the proven goodwill of the staff of the project — the participation of the peasants, as it was reduced in practice to the limited field of the technical problems.

Chontalpa Project: The Chontalpa project was originally conceived as a regional development plan to create a diversified agriculture providing employment for the 5,000 families of the area.[34] With the

support of the BID (Banco Interamericano de Desarrollo) a plan of integral agrarian reform was elaborated.

The project was devised to produce radical ecological, economic, and social changes. 50,000 hectares of forest were destroyed, eliminating the main resource of the local population. With the construction of the Raudales dam and other infrastructure works, the conditions were created for the salination of the coastal lagoons and of the underground waters. However, those undesirable effects were to be compensated, according to the planners, with a substantial increase of agricultural production (mainly rice, cacao, corn, and hule evea). A small area was to be reserved for cattle raising, so as to provide for local needs.

The spatial distribution of the population was changed by the construction of 22 new villages, in which about 40,000 persons now live. This concentration of the population allowed the provision of at least a minimum of basic services, such as electricity, water, school, health, and public administration. Another objective envisaged by the project was the training of the peasants for an active participation in the implementation and direction of the plan.

The original plan was later modified. The initial purpose of creating a zone of diversified agriculture was abandoned, due to the lack of governmental credit. As an alternative it was decided to devote half of the area to cattle raising and the other half to sugar cane.

A major deviation from the original plan was that local participation was not implemented. The technologies introduced — besides requiring the use of expensive mechanical equipment and chemical inputs — did not take into account the peasants' knowledge of the climatic and environmental conditions of the area. The technical and economic results of the introduced technologies were poor, and finally the peasants rejected them and preferred to come back to their traditional practices in their own plots. As for the work in the communal plots — entirely determined by the authorities of the plan and by the bank —

the peasants resisted the established schedules. Despite the existence of legal instruments that oblige the peasants to work a minimum of 140 days a year in the communal plots, they seldom work more than 90 to 110 days.

Some of the peasants had privileged access to higher-income positions in the administration of the communal lands or in government organizations. This, together with their own income, allowed them to form a new social class, increasing the inequality in the region.

It is still too early for a final economic evaluation of the Chontalpa project, but the perspectives are not encouraging. It is clear that the lack of participation of the peasants in the implementation of the plan and in the selection of the technologies adopted is one of the main elements contributing to the present difficulties.[35]

The projects briefly analysed show a common pattern in their achievements and failures. All of them had good scientific and technological backing, from the point of view of professional competence. However, in all cases the technologies introduced were rejected, or were not accessible to the poorer peasants, who constitute the majority of the population. As a consequence, the projects failed in their most important declared objective.

The reasons for the failures seem to be clear: (i) a lack of in-depth socio-economic study and, in general, poor or no input of social sciences; (ii) lack of participation of the peasants, so their knowledge of the environment and of their own economic and social rationality was not taken into account; (iii) as a result of points (i) and (ii), the technologies introduced were not adequate for the general characteristics of the region. It should be pointed out that, despite its failures, the Puebla Project, where there was a sincere effort to incorporate the knowledge of the peasants, was the most successful of the three on which we have an evaluation. Unfortunately, the change of direction of the project was too late and too partial.

Not surprisingly, the methodological shortcomings detected in the organizations that were in charge of the projects are the same that we have already identified as a general characteristic of the formal organizations engaged in appropriate technology.

CONCLUSION

The revision of the activities carried out by the organizations dealing with appropriate technology all over the world is enough to arrive at some preliminary conclusions, as to their approach to generate or introduce the technologies. The frame of reference we have used for the analysis is the elements of an approach or methodology that is implicit in the literature on the subject.

The most important finding is that — from the point of view of the approach applied — there is a basic difference between the informal and formal organizations.* The former — those who do not belong or do not have a close operational connection to the R and D system of the country involved — are able to create good links with the local population, and so have a first-hand knowledge of the characteristics and problems of the peasant communities. As a result they have been rather successful at the introduction of *known* technologies, or at stimulating the local population to tackle the problems that can be solved using their own resources, material as well as human. By their action they have been able to show that in the peasant communities there is a rich reservoir of initiative, ingenuity, and knowledge that can be tapped, provided that the common people are allowed to participate in the solution of their own problems.

On the other hand, those organizations are unable to generate technologies, or to adapt to local conditions technologies with some degree of sophistication, due to their lack of high-level scientific and

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* We refer here to the informal organizations *based* on Third World countries.

technological support.

The formal organizations — or at least the most important of them — have the expertise to generate new technologies or to adapt to local conditions technologies developed in other parts of the world, including the advanced countries. Their main drawback is that they tend to follow the "conventional" approach to research, with little or not participation of the local population, and very scarce input of social sciences.

Obviously, the difference between the two types of organizations is not so sharp as it could appear from this brief characterization. Some informal organizations have some scientific backing, and the input of social sciences of the formal organizations is variable. However, all the available information shows that the general picture is valid.

The main result of this situation is that up to now it has not been possible to make a realistic evaluation of the real significance of local participation — including study of the local knowledge and technologies — in the generation of appropriate technologies. Although all the evidence seems to indicate that the lack of people's participation is the main cause of the failures of development projects that include the introduction of new technologies, it is obvious that, unless all the elements of the methodology proposed are included in a single project, our knowledge of the problem will be based, to a considerable extent, on subjective evaluations. This is clear from a revision of the current literature on the subject.

Another important point is that the evaluation of the results of projects that have tried to generate or introduce appropriate technologies in rural areas has been made *ex post facto* by people not involved in the project, and therefore without a detailed knowledge of the methodology applied. We do not know of a single case in which an effective mechanism of evaluation has been introduced in the project itself, so as to be able to make a final assessment — based on an in-depth analysis of the methodology applied — of the causes of its successes and failures.

The project proposal included in the next chapter of this report is an attempt to contribute to filling the gap pointed out above, by setting up groups of researchers in several countries of the Third World, to try to develop appropriate technologies applying systematically all the elements of the proposed methodology (see pp. 49 and 50). A mechanism for monitoring and evaluation is incorporated into each group so as to be able to make a detailed assessment of the results of the exercise. The project is really "research on how to make research," and the expected result is a contribution to a perfected methodology of research to develop appropriate technologies that can be useful to the R and D organization of the developing countries.

II. THE PROJECT

BACKGROUND OF THE PROJECT

In December 1975 the IDRC convened a meeting in Dar es Salaam, Tanzania, to discuss the problem of how developing countries could best use their scientific research capabilities to solve the technological problems of rural development. The participants came from eight developing countries and most of them were involved with research on this problem in their own societies. The starting point for their discussions was a background paper prepared by this author, which analysed the existing situation and which suggested a new approach and traditional knowledge to generate technologies of greatest benefit to the rural poor.

The Tanzania meeting provided a useful opportunity for an exchange of views between the participants but it was unable to define the details of an international collaborative project on this theme. Subsequently the author visited most of the groups who had participated in the Tanzania meeting and, following discussions with these and other interested groups, prepared a new paper. This paper contained an outline of a possible international collaborative project which would unite groups in several countries that were trying to find new ways of harnessing their R and D systems to solve the technological problems of rural development.

This paper was considered by the Council of the United Nations University and accepted, in principle, as the basis of a programme which would be supported by the UN University. It was also used as a background document for a second meeting convened by the IDRC and hosted by

the Ethiopian Science and Technology Commission, which took place in Nazreth from 2 to 7 April, 1977. Participants from seven developing countries attended this meeting and formulated a research proposal to the two sponsoring institutions.

OBJECTIVES OF THE PROJECT

The central objective of the project is to integrate the modern R and D system with the experience and knowledge of the traditional societies in order to tackle the technological problems of rural development.

Specifically the project will develop a methodology for:

a. The generation of technologies for use by the rural poor through a process that involves their interaction with research groups.
b. The utilization of the capabilities and knowledge of the traditional societies, linking these to the R and D systems to optimize the benefits for the rural poor.
c. An assessment of the strategy utilized by the participating research groups to develop technologies for the rural areas, and a comparative analysis of these strategies in different socio-economic situations.

To this purpose the project will:

- bring together a number of research groups committed to the above objectives, to apply a common methodology of research for generating technologies for rural development.
- design a monitoring and evaluation system that can be used to assess the effectiveness of the proposed approach in achieving these objectives.

THE METHODOLOGY OF THE PROJECT

According to point (b) above the overall methodology of the project is divided into two specific methodologies: *a methodology for research,*

and a *methodology for monitoring the project and evaluating its results.*

The Methodology for Research

In what follows we will describe briefly the main stages of the proposed methodology. It is obvious that these steps do not constitute a strict sequence, as they will greatly overlap in time. The main task — to build up a set of comprehensive, valid assumptions or paradigms — constitutes a dialectic process. A few initial assumptions will form the framework for the definition of technologies, but the experience acquired in their formulation and application will be used to modify, enlarge, or complete the assumptions.

The steps of the methodology are as follows.

STEP 1: The general socio-economic characteristics of the selected region should be evaluated, in order to understand the dynamic social elements in which a technological problem is always immersed. The approach of the study is based on the principle that

> the technological problems that can be identified as obstacles to the development of backward rural sectors of poor countries can only be understood in their true dimensions, *by taking as a starting point* the socio-economic processes and conflicts in which each social group is involved, that is, by recognizing that such problems are but one of the aspects of a "problem situation."[36]

As is well known, in many cases the solution of a technological problem depends more on issues of political, social, and economic power than on scientific research. The failure to recognize this fact has led many well-meaning scientific institutions to solve the wrong problem, in the sense of devising a technological solution that does not fit the conditions of the "problem situation." One of the reasons for these mistakes is that the organizations involved tend to forget that the problem situation cannot be adequately identified without the participation of the local people, as the power problems are normally "ignored" in the higher echelons of decision making. Through direct

contact with the peasants it is possible to identify problems of power — even inside the peasant community — that cannot be perceived by a research institution working in the "conventional" way. The final result of this stage should be the selection of the technological problems on which research should be concentrated (fig. 2).

The first step of the process is to identify the poor sector of the population. As is well known, in many projects intended for improving the lot of the poorer sectors of the community, the final result was

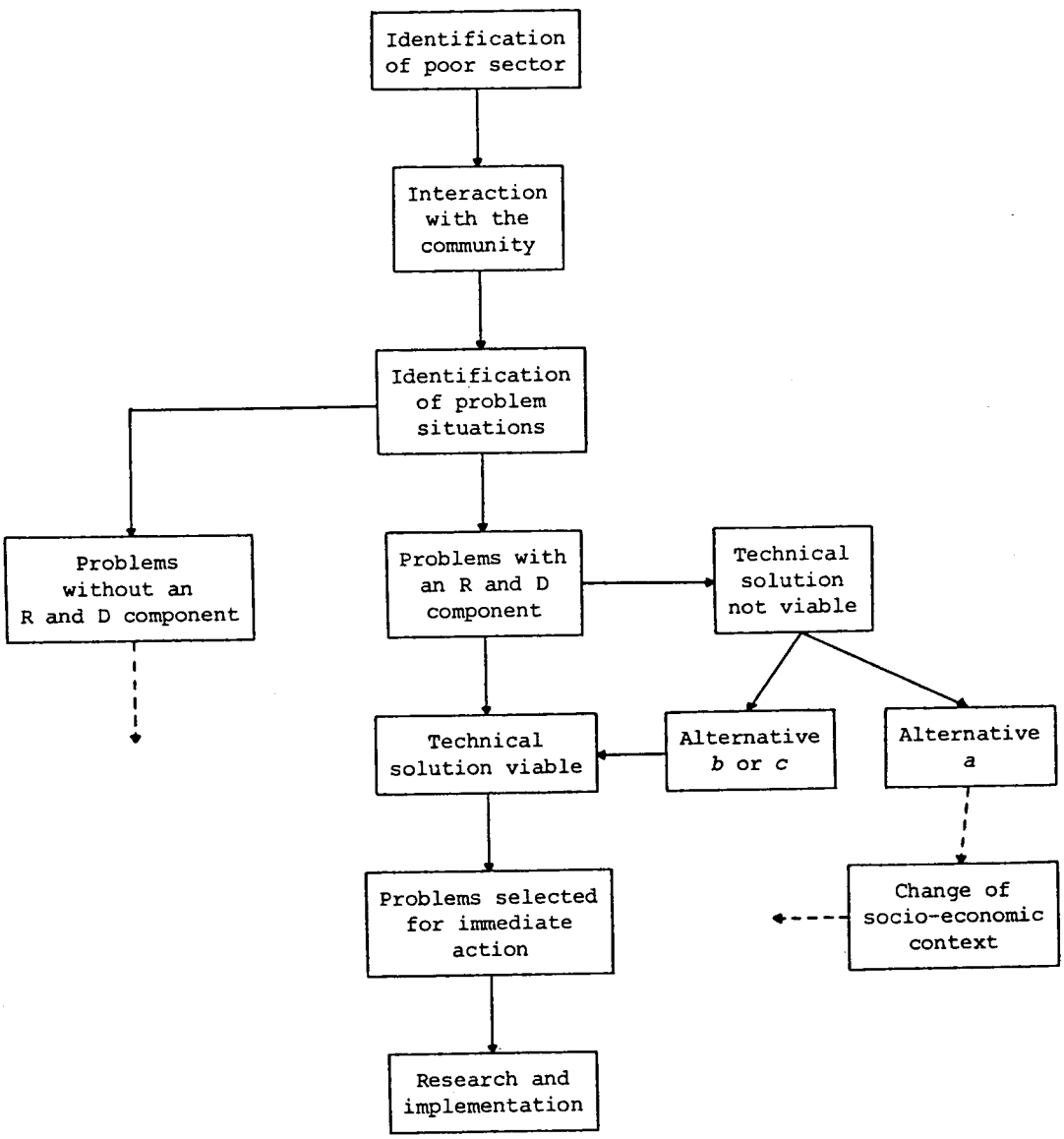

FIG. 2. The Methods of Selecting Problems for Research and Action

just the opposite: due to the lack of adequate socio-economic studies and local participation, the projects mostly benefited the richer sector of the peasants.[37]

Through the interaction with the peasants the problems of the community will be identified. It is important to remember that in any community there is a whole hierarchy of problem situations. The first one is what can be called The Problem Situation: it arises as a consequence of the type of insertion of the community in a global socio-economic and political system at the national level. In most cases the type of problems posed at this level cannot be solved by technological means. Typical examples of this kind of problem are those related to the structure of land property that can only be solved through a radical land reform, or the price changes of exportable products determined by international trade.

At a lower level in the hierarchy problems appear that, although related to the overall problem situation, vary widely in their degree of control by the socio-economic and political context. The problems identified here are broadly divisible into two classes: those without an R and D component and those with an R and D component. The former are not the concern of the R and D systems and consequently are left out of the picture. An example of the first kind of problem — frequent in the rural areas of Mexico, for instance — is the case where more appropriate technologies do not substantially improve the peasant's condition, because the middlemen and money-lenders take all or most of the added profits.

The problems with an R and D component are divisible into two categories: those in which the technical solution is not viable at the time owing to socio-economic or political constraints, and those for which a technical solution is viable. In the first category three alternatives are possible: (i) to leave the problem aside until a change in the socio-economic conditions allows them to tackle the technological component; (ii) to find a technological alternative to bypass the socio-economic constraints; (iii) to use the solution of the

technological problem to overcome the socio-economic constraints. An example based on the MAYA report on the henequen-growing region of the Yucatan, Mexico, can be used to illustrate the three alternatives which we are referring to.[38]

Henequen is cultivated for its fibre, which is extracted by mechanical means. As a by-product of the process a large amount of bagasse (solid waste) is obtained. The bagasse can be spread in a layer of a thickness of about 35 centimetres and used as high-fertility artificial soil to grow vegetables. However, a great deal of research is still needed to control pests and plant diseases, as there is not enough experience with the behaviour of this artificial soil in relation to those factors. The peasants, however, do not want to support the research because, owing to the fact that the vegetable market is monopolized in the region, they have problems in selling their small present production; they feel they will be unable to market an output several times larger, despite the fact that there is still a sizeable unsatisfied regional demand.

In this case the three alternatives mentioned can be exemplified as follows: (i) To wait until the market conditions change. This is the alternative adopted by the peasants at present. (ii) A technological alternative to bypass the market constraint could be to carry out research to identify some other crop which is suitable for the artificial soil and which has an open market. (iii) To solve the technological problem in the expectation that increased production will oblige the local authorities to reconsider the situation of the market or destroy the monopoly by the intervention of other economic interests. This option obviously involves a calculated risk.

Among the problems with a viable technological solution, some or all will be selected by the peasants and researchers for immediate action. The selection will be based on the peasants' priorities and on the possibilities of the R and D system. The next stage will be research and implementation of the solutions.

The central point in relation to the socio-economic study is that if

there has been effective interaction with the peasants, the results obtained through the process just described should be essentially coincident with the interpretation of the socio-economic analysis. On the other hand, the preliminary results of the socio-economic analysis play an important role in helping the scientists to understand the problems of the community, to identify the poor sector, and to appreciate the importance of the technological factors involved in the problems. At the same time the information gathered in the continuous interaction with the peasants serves to correct and enrich the socio-economic study.

STEP 2: This part of the work is concerned with the determination of the functions that the required technology is expected to fulfil.

The first step is one required in any scientific research into a new area — to ask the very basic questions referring to the specific technological field selected: What is the purpose of the technology? What need or needs must it satisfy? Who will really benefit from the solution? These are only a few of the many questions to be answered. What we want to emphasize is that it is necessary to start by rejecting, as far as possible, any preconception or prejudice about the nature of the multiple needs (social, economic, psycho-social) it has to satisfy.

It seems obvious that this kind of question is always asked when a technology is being developed. The real point is that in the customary work of the R and D systems the answers are generally obvious, for reasons already examined: the scientist is working in problems that belong to his own economic, social, and cultural sector, so he has the tendency to apply the same criteria to a completely different environment. He frequently assumes that he has to satisfy the same needs, but on a lower level, due to limitations posed by the local economic conditions.

A typical example of the mistakes to which this approach can lead is posed by the housing problem. Technologists tend to believe that, given the precarious situation of the peasants, they will be content with any house that offers them a reasonable degree of climatic

protection and a minimum of modern sanitary conditions. The result is that in many cases, to the disappointment of the well-meaning technologists, the peasants prefer to live in their own poor dwelling rather than in the supposedly better new ones. The cause is that a house, besides giving climatic and sanitary protection, has several other roles to fulfil: social, economic, cultural, and psycho-social. If these elements are not taken into consideration, the final product could be unacceptable to the people, even if it were much better from our point of view than the one being currently used.

Besides the analysis of the strictly technological elements, the following points would also be studied in this phase of the work:

a. Areas of activity of the community implied in the technology being considered.
b. Forms of organization of the community around the specific activities being considered.
c. Natural resources involved in the technological solution under study.
d. Ecological implications of the technology being developed.

STEP 3: This part consists of an analysis of the solutions that the local community has traditionally given to the problems identified (see pp. 31-35). In this part of the study, the four items included in point (b) above should also be analysed, but in close relation to the traditional technologies being used.

A final point that should be kept in mind is that this analysis does not imply that local technologies or ideas *necessarily* have to be incorporated into the one being developed. In some instances, it will be found that no idea worth being used is embodied in the traditional technologies. In these cases, a completely new solution has to be generated.

STEP 4: A general survey of the natural resources of the area should be carried out. A very important point to keep in mind here is the concept that natural resources are generated by the combination of some natural object with science and technology; there are not natural

resources in an absolute sense. This elementary concept is frequently ignored in developing countries, and there is the tendency to consider natural resources as those taken as such by the industrialized countries. So the research must include not only the natural resources already used, but also those that can have potential application for the problem area being studied.

STEP 5: With the information gathered above a set of assumptions or paradigms will be derived, which will be the frame of reference for the final step of developing the required technology. The set of assumptions — which will contain scientific, technological, economic, social, psycho-social, and anthropological information — will define a "technological space."

In finally building the technology, all possible solutions that fit the technological space should be considered. As is well known, from a certain body of scientific knowledge many technological solutions to a given problem can be devised. The existence of an adequate frame of reference allows the exploration of a multiplicity of possible paths and the selection of the one best suited to the particular situation. Another result of this procedure is to give coherence to technologies pertaining to different fields of activity.

It is obvious that once the set of paradigms has been completed, in some cases the required technology will already exist, and it may simply be a question of adaptation and introduction into the area. In other cases, it may be a problem of combining existing technological elements in a different way. Finally, in other cases it will be necessary to devise an entirely new technology. In most instances, however, it will probably be a problem of combining some of these alternatives.

It should be emphasized, finally, that in this methodology endogenous generation of technology refers to the process through which the characteristics that the technology should have are determined. The *endogenous* is the process of definition and not necessarily the tech-

nology itself, which can be imported, provided it is appropriate. In this way the transfer of technology becomes an integral part of the process of generation of technology.

The Methodology of Monitoring and Evaluation

The methodology refers to the monitoring of the progress of the participating groups, with respect to the following:

a. Links of the R and D units involved with the rural milieu. Effects of those links on the process of generation of technologies.
b. Effects of those links on the local population.
c. Effects of the connection with the rural milieu on the R and D system.
d. Acceptability and dissemination of generated technologies.
e. Contribution to the development of a new set of paradigms for the R and D system.

Each of the above items could be evaluated through the use of several variables and parameters. In what follows some of the most relevant ones are identified, and guidelines are given as to how they can be measured and evaluated.

To apply the proposed methodology of evaluation, however, two qualifications must be borne in mind. First, the fact that the exercise represents a considerable departure from established strategies of research necessarily means that the methods of evaluation to be used must also, to a considerable extent, be regarded as novel and experimental, and therefore they themselves are subject to revision in the light of experience. In other words, the people responsible for evaluation will learn in much the same way as the scientists and the peasants who participate in the programme. Secondly, it must be recognized that the particular skills required for evaluation of certain parts of the activities will vary with the subject chosen. For these reasons, it would be a mistake to attempt to establish a rigid framework of evaluation in advance, since this may rapidly turn into a straight-jacket restricting, rather than facilitating, the kind of understanding

which is desired.

Another important point to keep in mind is the necessity to distinguish those phenomena which are familiar, and where existing methods of measurements are available, from those where a more exploratory and qualitative approach to evaluation will have to be adopted. Within the latter category, it should also be possible to differentiate those phenomena which may potentially be amenable to quantification (and hence to "formal" comparison) from those which will have to be treated in a qualitative way, even when they are much more fully understood than is presently the case.

Links of the R and D Units with the Rural Milieu

The central problem in connecting the R and D system with the rural milieu is to ensure an adequate degree of participation on the part of the local populace. An effective link with the rural areas obviously involves other elements besides peasant participation, such as connections with other institutions working in the area — scientific organizations, government services, local planning bodies, etc. — but most groups involved in the generation or introduction of technologies are normally connected with them. Another essential element is an adequate knowledge of the socio-economic environment of the area, and this aspect is contemplated in the proposed methodology of research.

In the poor rural areas mechanisms of participation are almost completely lacking and have to be established. This does not merely mean that some local people must participate in certain aspects of research itself. It means that ways have to be devised by which the local people become interested in the whole process of the generation of technology and become motivated to contribute with their experience as much as possible. The contact between scientists and the local population starts at the stage of the data collection for the socio-economic evaluation of the community. At this stage the type of data collected — whether primary or secondary — could have an important effect on the real degree of understanding of the local milieu. The

availability of secondary sources may be expected to vary considerably from one country to another and this could lead to variations in the extent to which projects collect data from and rely upon primary sources, and this, in itself, is likely to be an important variable, since the greater the amount of time spent directly in contact with the peasants themselves, the greater the possibility that false assumptions about them will be broken down and understanding of their problems increased.

However, given the detailed type of data required for this phase of the project, a considerable part of the information will have to be obtained through field-work. The data should be collected by the scientists themselves, but the exercise would need to be set up by a social scientist and an economist, and provisions would need to be made for pilot studies, lasting for a few weeks, at the end of which problems would be discussed and refined procedures devised. The person or persons responsible for the evaluation would be consulted in the course of this process, in order to ensure that the data collected would provide an adequate basis for the "before and after" study but would not seek to influence the approach to be adopted beyond this point, since this and the influence which is exercised upon subsequent development would be one of the critical variables to be considered in the final evaluation exercise. The social scientists directly involved in monitoring would be required to record their methodology in detail and to provide an account of how it was modified in the light of experience.

Evaluation of participation: The method of evaluation of participation of the local peasants can be grouped into four categories: (i) measurement of inputs, (ii) mechanisms and dynamics of participation, (iii) direct effects of participation, (iv) indirect effects of participation.

a. Measurements of inputs: The measurement of participation in physical terms would be part of an exercise designed by the evaluator, to record the time expended in different activities during the project.

The first step will be to determine the composition of the group actually doing the research and to collect basic data on each individual involved. This would be a simple and standardized exercise, with information gathered under categories such as age, sex, position, educational background, and previous experience of work in rural areas. Time budget schedules would be prepared for each individual, according to the particular needs and conditions of the project. The schedule should be simple, with activities being recorded under categories such as time spent inside and outside the community, time spent travelling, interviewing, writing up interviews, etc. The precise set of relevant categories would need to be determined in the light of particular project circumstances and will be refined and modified after an initial period of pilot testing.

Complementary to those exercises, it would be convenient to set up a procedure for recording expenditures which do not come from the official budget.

b. Mechanisms and dynamics of participation: Procedures for identifying and measuring inputs are well established and the results can be readily quantified in most cases. Concerning the evaluation of the nature and extent of the links generated between scientists and the local population, and the real degree of interest and commitment of the latter, this is clearly not the case, and a more tentative and qualitative approach must be adopted.

Evaluation of participation by the local people will be done on the basis of a record of the events that take place in the interaction between scientists and the community, which could be categorized according to the type of activity, including the following:

- definition of the objectives of the project,
- identification of problems and needs,
- selection of methodology,
- selection of procedures,
- selection and procurement of material,
- data collection,

- analysis of data,
- drawing conclusions,
- testing of the acceptance of the technology,
- diffusion of the technology,
- training.

The skills that the evaluator should inculcate into some members of the team for this task will be those of a good secretary taking minutes of a meeting. Since much of this is evidence regarding the extent to which genuine participation is, in fact, taking place, it will be important in the first instance, simply to obtain a factual record of who says what and of the action (or lack of action) which ensues. Once this process is under way, it should become possible for the evaluator to identify specific patterns of interaction, and to start to identify who is participating and under what circumstances. This might in turn provide the basis for more systematic enquiries contrasting the circumstances of villagers playing or not playing an active role. This exercise could be strengthened if individual scientists could be encouraged to keep brief diaries of their personal contact with villagers in addition to their time budgets. The type of data to be collected here would include: who initiated the contact (a high incidence of villagers' "initiation" being a likely correlate of a high degree of participation), the type of problems which villagers raise, the nature of their response to problems raised by the scientist, and type of suggestions that the villagers themselves make.

Another method of obtaining information by the type of monitoring described above is the sense of identity generated by the project between the two groups. This is consistent with the underlying philosophy of the project, which holds that appropriate technologies for the rural poor will most likely arise from a situation where distinctions and contradictions between the peasants and scientists are broken down.

The prccedure here would be to collect baseline data and to compare them with the situation at the end of the project; data would most

probably be collected by interview and observation. Questionnaires could be devised to assess the perception of one group by the other and be repeated to assess the extent of change over time, and the nature and development of a number of aspects of intergroup behaviour could be recorded.

c. *Direct effects of participation:* As one of the effects of participation it could be expected that the villagers will contribute ideas and personal work to the whole process of generation and dissemination of technologies. This contribution could be systematically analysed as follows:

1. Determination of the characteristics of the required technology. A careful analysis will allow evaluation of the importance of the local direct contribution through the number and relevance of the ideas contributed.

2. The analysis of the local traditional solution. Traditional technologies are based on empirical knowledge, that cannot always be easily grasped through the study of the technologies themselves. The local population can greatly help the scientists to understand the basic ideas contained in traditional technologies, and this contribution can also be evaluated. One important point to keep in mind here is that the manner in which scientists familiarize themselves with the traditional technological solutions to the problems they are concerned with can have an important bearing in the degree of co-operation to be achieved between the scientist and the villagers. Some scientists will tend to be content simply to ask a few questions about the traditional solutions, whilst others may be prepared to go as far as operating the technologies themselves. It seems likely that the more directly the scientists themselves participate, the greater the probability of identifying those elements of the traditional solution which can most fruitfully be used to develop a better technology.

3. The technological solution finally proposed. The local contribution can be measured using the same approach as in point 1 above.

4. Implementation of the technology. In this stage, the local skill developed in order to apply the technology must be evaluated. Some of the elements to be taken into account, to which others can be added as more experience is gained, are the following:

- The number of people trained during the previous stages.
- The relative weight of the external aid in terms of human resources.
- The extent to which the equipment needed to test and develop innovations is supplied by the peasants themselves.
- The extent to which the villagers take responsibility for testing the innovation, and the importance of the modifications that are introduced as a result.

A most important point in the evaluation of the four items listed above is that it should be carried out taking into account the information gathered in the two previously described phases of the evaluation of participation (measurement of inputs and mechanisms and dynamics of participation). The methodology suggested for carrying out this exercise is the following:

1. Taking the final results (determination of the characteristics the technology should have, the analysis of the local solution, and so on) to make a tentative list of the items contributed by the local population and their relative importance, using some form of numerical or qualitative scale. This can be done by the scientists themselves, with the help of the evaluator.

2. On the basis of the information gathered in the two previous phases of the evaluation of participation, to trace the origin of the ideas, its mechanism of generation as a result of the interaction between scientists and peasants. This will allow them to determine not only the origin of the ideas, but also to what extent the ones contributed by the scientists have been influenced by their contact with the villagers, and vice versa.

3. With the results of the analysis described in point 2 above, the original list must be refined and accompanied by a description of how

the ideas originated and evolved.

d. Indirect effects of participation: The participation in the generation of a given technology could help the local population to understand the nature of its problems, and the importance of science to solve them. Consequently, they could suggest new lines of work, and new ideas to be tested for solutions of problems not originally included in the project. This is an important element to evaluate, as one of the main objectives of the project is to determine to what extent a dynamic link between the R and D system and the local milieu can be established. The methodology to evaluate this element could be the same as proposed for the evaluation of the direct effects of participation.

Effects of the Links with the R and D System on the Local Population

The establishment of links between the R and D units and the local population will be reflected on the effect that they may have in different aspects of the community life. This aspect of the evaluation will be carried out within the framework provided by the socio-economic study.

Effects of the Link with the Rural Milieu on the R and D System

To achieve an effective contact of the scientist with the local problems, it is necessary to do as much of the research as possible in the region. At the same time, a fluid communication has to be maintained with the rest of the R and D system so as to ensure:

1. That the scientist working in the region does not become isolated from the rest of the scientific community. It should be noted that from an operational point of view, it is the scientific system that functions, and an isolated scientist tends to rapidly lose his productivity. For this reason, one of the problems studied in the organization of science is the determination of the "critical size" of an R and D unit; that is, the minimum size of a group necessary for

each of its members to attain maximum productivity.

2. That demand for research from the project that, by its nature, cannot be locally satisfied can be easily transferred to other parts of the system, generating a continuous flow of research.

3. That the scientists consider the research being carried out as an integral part of their activities, and not as a marginal one; that the scientists do not consider this kind of research as second class.

The study has to evaluate to what extent the above requirements are satisfied by the different approaches used. The main elements to be measured are stated below.

The generation and flow of research: The following items can easily be measured as they result in concrete actions of the type normally registered or evaluated by the R and D systems.

a. *Research generated at the basic, applied, and development level, as a consequence of the specific demand of the project:* This can be easily measured, as it constitutes an integral part of the project.

b. *Research indirectly generated by the project:* When a new area of research is interesting enough, it frequently induces research in related subjects in the same institution where the project is being carried out, or in other centres working in related areas. These effects can also be measured, since they normally result in contacts among the scientists and institutions working in similar or related fields, publications or communications, etc.

c. *New areas of research generated:* The research induced in points (a) and (b) could be an extension of either subjects of research already in existence or relatively new ones. It would be interesting to differentiate between them, as new areas of research will tend to reinforce the commitment of the system to the new direction.

Catalytic effect: Besides generating research, a project can stimulate the formation of other groups to apply the same or similar methodologies. It would be easy to identify those groups and to assess to what extent their methodology has been influenced by the one applied in the project.

One element to be evaluated will be some possible educational implications, such as new courses and seminars added to existing educational programmes, participation of the researchers and of the peasants involved in the project in local educational activities, etc.

Effect on the decision-making level of the R and D system or on other planning institutions concerned with economic and social development: Certain decisions could be taken, at a higher or different level than the one of the participating units, as a direct consequence of the activities of the groups. This influence can be manifested in many ways: special support for the groups, official evaluation of results, inclusion of this type of activity as a specific item in the planning process, and so forth. All this can be measured or evaluated.

Effects on the scientists: The procedures adopted here should not present serious difficulties although the categories under which data might be collected will probably vary somewhat from one project to another, and therefore cannot be specified in detail in advance.

Criteria should be developed to discriminate between contacts which do and do not seem likely to generate further activity, with the general outlook of the project as a whole. This can be done by the evaluator, being refined later after experience has been gained. A member of the team should be asked to record and qualify — based on the established criteria — all contacts with other members of the scientific community. When he himself is not involved in the contact, he will receive the required information from the scientists involved.

The data so collected provides an indication of what has happened in absolute terms, but gives no indication of the relative shift in

people's attitude and motivations during the period of operation of the project or of the extent to which any changes which may have arisen may be attributed to the project itself.

The first step could be, for example, to make a baseline survey designed to assess scientific attitudes towards the role of science in rural development. This could take two forms. Firstly, a sample of scientists from different institutions could be interviewed using a standard schedule designed to test their knowledge and perception of rural problems. Secondly, scientific publications could be examined in order to determine the general level of interest in rural issues. At the end of the project, or at intervals during it, the same publications could be examined to see if there was any perceptible shift in emphasis. At the same time, the scientists could be re-interviewed, and divided into categories according to whether they were aware or not of the work of the project. The problem would then be to determine whether the "aware" group showed a greater shift of interest in outlook than those who were "unaware."

The extent of change in attitude is, of course, a difficult thing to measure, but Roger's analysis of the process leading to an innovation could be adapted for this purpose. Roger outlines five stages, namely: awareness, interest, evaluation, testing, and adoption, and it is easy to see that those stages could be also applied to the process under examination. The feeling that something is wrong with present scientific research and the knowledge that alternatives are available could be equated with "awareness," the taking of active steps to find out more of what is being done about the problem by other people as "interest," and so on. If it is discovered that the extent of change is greater among the scientists who were aware of the project than among those who were not, then it will be apparent that the methodology adopted is seen as an appropriate vehicle for the sort of change desired. If, however, there is no significant difference between the two categories, then it would seem that the methodology is not seen as better than, but conceivably as inferior to, alternative strategies directed towards similar ends.

Acceptability and Dissemination of the Generated Technology

The dissemination of the resulting technologies constitutes a whole process in which some of the intervening elements — socio-political, vested interest, etc. — can be evaluated. However, these are obviously beyond the scope of the project, which is mainly concerned with the specific role of the R and D system. Moreover, the process of dissemination of a new technology, until one is reasonably certain that it has achieved wide acceptance, can take several years.

For these reasons, the final stage of the project should be the assessment of the technology to determine its merits, in absolute terms as well as by comparison with current technologies, so as to be able to design a strategy of dissemination, taking into account the possible obstacles. However, this does not mean that if the technology produces material impacts on the rural milieu, this is to be ignored. It should be assessed, and ideally for all the projects if need be, as a follow-up later on.

The assessment should include the following items.

Actual acceptance of the technology: This part of the assessment refers to the acceptance of the technology in the place or region where the actual work has been performed. The main point is to assess to what extent the participation of the local people has influenced its attitude towards the new technology, and which are the practical results from the point of view of its application and performance. Most of the information needed will come from that gathered during the previous stages of evaluation of participation. In the final stage, that of the field testing of the technology, a special set-up could be prepared by the evaluator to complement the information already available.

Appropriateness of the technology: This phase of the assessment refers to the intrinsic merits of the technology in absolute terms and in comparison with current technologies. The evaluation will be made in terms of the implications that the technology could have upon some

aspects of community life, in terms of the specific issues that are included in the initial socio-economic study. Among the elements to include are:

- accessibility of the technology to the lower-income groups;
- effects on the satisfaction of basic needs (direct and indirect);
- effects on employment;
- effects on the generation and distribution of income;
- psycho-social adequacy;
- effects on social participation: possibility of control by the local people;
- natural resources: utilization of local resources as compared with current technologies;
- human resources: utilization of local human resources;
- energy implications: whether it is necessary to increase or decrease the regional or national dependence on external energy sources;
- environmental effects.

On the basis of the analysis outlined above, it will be possible to design a strategy for the dissemination of the new technology, taking into account the characteristics of the overall socio-economic setting.

Contribution to the Development of a New Set of Paradigms or Assumptions to Generate Technologies in the Same or a Related Field

The development of a new frame of reference to generate technologies is one of the main objectives of the project, and so it has to be carefully evaluated.

At the stage of the definition of the technology required, there will be a set of explicit assumptions to define the "technological space" referred to previously. However, many of the assumptions that determine the characteristics of the required technology will remain implicit during the whole process, and others will appear during the final stage of testing and modifications.

The procedure to build up the complete set of paradigms requires the

participation of all scientists involved in the project, including the evaluator, in the detailed analysis of all the steps that have led to the finally accepted technology. As has been said, the paradigms are not only technological but include psycho-social, social, and economic elements; the revision of the material gathered during the evaluation of participation will greatly help to identify assumptions that have remained implicit, although they have influenced the type of technology produced.

The evaluator could help in this part of the work, by preparing a schedule to systematize the analysis. It should be kept in mind, however, that here the most important element of success is the scientist's intimate knowledge of the whole process of generation of the technology.

International Evaluation

The final evaluation exercise will involve bringing together data from all the projects into an international framework of comparison. This would ideally involve the leaders of the scientific groups, the co-ordinators of the project, and the group evaluators.

During the course of the project, evaluators will have begun to detect logical connections between procedures adopted and consequences arising in the various phases of activity, and this will provide an opportunity to formalize and test hypotheses in a comparative matrix. The extent to which such an exercise might be expected to generate concrete conclusions would, however, be very much a function of the degree of standardization achieved in the collection of data in individual projects. This in turn, indicates the importance of generating an additional "layer" of activity during the course of the programme itself, whereby evaluators could feed back experience on different parts of the monitoring to a central co-ordinator who would then be able to devise standard schedules for use in all cases. For instance, it will be desirable to standardize procedures for the way in which scientists record their interactions with villagers, in both an

individual and collective context. Strict comparability may be difficult to obtain, but it may be possible at least to ensure that certain basic data were collected in all cases. Similar principles could be applied to the problem of evaluating impact upon the scientific community, and to other areas under investigation, and would be of enormous value if tempered by the counterbalancing concern not to do violence to the inevitable and equally significant particularities resulting from the generation of different technologies in different environments.

One of the goals of the final analysis is to evaluate the relative merits of different strategies of research. A tentative procedure will first look at individual projects to see if any consistent pattern may be detected behind the eventual permutation of variables adopted. If such a pattern does emerge — if it appears that choices between alternative possibilities have been taken in accordance with a coherent set of principles — then different strategies can be set up as "ideal types" and potentially compared. If a number of such types could be identified in a comparison between the various countries involved, this would provide the basis for a comparison of relative rates of return. If data were sufficiently comprehensive, it might be possible to go on and evaluate approaches to individual phases and types of activity. The evaluation exercise could also attempt to identify what sorts of technologies lend themselves more readily to the methodology and what sorts of starting points are necessary in order to have a reasonable chance of success.

The exercise comparing different possible strategies of research will be greatly enriched by the analysis of past experiences in the introduction of technologies in the rural areas, in which completely different strategies from those used in the project have been applied.

Another part of the final exercise will be the analysis and evaluation of the methodology of monitoring itself. Its aim should be to detect the kind of data, and the methodology to gather it, that proves most relevant to evaluate the effectiveness of the different stages in the

process of generating technologies. This could lead to a flexible and simplified schedule which could greatly help institutions engaged in technological research in rural areas to monitor and evaluate their own work.

The above refers only to the most basic kind of information that can be extracted from the final exercise, but a careful examination will most likely reveal many other possibilities. To get all the possible benefits of the analysis a plan to carry it out should be elaborated early in the project, in order to help the evaluators gather the type of data from which the maximum possible amount of information can be obtained.

NOTES

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2. P. Streeten, "Development: What Have We Learned?," IAE/PES Round Table (Warsaw, June 1978), pp. 20-23.

3. F.E. Cardoso, "Towards Another Development," *Another Development*, ed. Marc Nerfin, Dag Hammarkjold Foundation (Upsala, March 1977), p. 27.

4. I. Sachs, *Environment and Styles of Development, Outer Limits and Human Needs*, Dag Hammarskjold Foundation (Uppsala, 1976), p. 41.

5. See for instance A.O. Herrera et al., "Catastrophe or New Society: A Latin American World Model," *IDRC-064C* (Ottawa, 1976), pp. 103-6.

6. Pugwash Symposium, *The Role of Self-Reliance in Alternative Strategies for Development* (Dar es Salaam, 2-6 June 1977).

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8. J. Ellul, *The Technological Society* (New York: Alfred A. Knopf, 1964).

9. A.K. Reddy, "Background and Concept of Appropriate Technology" (paper presented at the Appropriate Technology Workshop, Karnaka State Council for Science and Technology, India, April 1978).

10. See among others F.H. Cardoso and E. y Faleto, *Dependencia y Desarrollo en América Latina* (Mexico: Siglo XXI, 1971); C. Furtado, *Development and Underdevelopment* (Berkeley, Calif.: University of California Press, 1964); O. Sunkel and E. Fuenzalida, "The Transnationalization of Capitalism and National Development," Institute of Development Studies, University of Sussex (1977).

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12. For the conceptual approach see for instance A. Reddy, "Problems in the Generation and Diffusion of Appropriate Technologies," International Economic Association Conference on Economic Choices of Technology in Developing Countries (Tehran, 18-23 September 1976); UNEP (Nairobi) op. cit., note 11; D. Dickson, *The Politics of Alternative Technology* (New York: Universe Books, 1975); *A Handbook on Appropriate Technology*, Canadian Hunger Foundation and Brace Research Institute (Ottawa, 1976), pp. A1-A7.

13. Canadian Hunger Foundation and Brace Research Institute, op. cit., note 12, p. A1.

14. A.K. Reddy, "National Sub-Regional and Regional Appropriate Technology Institutions: A Preliminary Assessment," Expert Meeting on International Action for Appropriate Technology (Geneva, 5-9 December 1977), p. 1.

15. A.K. Reddy, op. cit., note 12, p. 11.

16. A.W. Johnson, "Individuality and Experimentation in Traditional Agriculture," *Human Ecology*, 1, no. 2 (September 1972); C.B. Knight, *Economy and Change* (New York: Academic Press Inc., 1974); M. Howes "The Uses of Indigenous Technical Knowledge in Development," Workshop on Indigenous Technical Knowledge, Institute of Development Studies, University of Sussex (April 1978); R.L. Sampson, *The Motor Pump: A Case Study of Innovation and Development*, Oxford Economic Papers, vol. 21, no. 1 (March 1969).

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21. R. Stavenhagen, "Basic-Need Peasants and Strategy for Rural Development," in *Another Development: Approaches and Strategies,* Dag Hammarskjold Foundation (Uppsala, Sweden, 1977), A43. See also, among others, R. Traitler, "People's Participation in Development," in *Structures of Captivity and Lines of Liberation* (Montreux, 1974); A.O. Herrera, "Social Determinants of Science Policy in Latin America," *Science, Technology and Development,* edited by Charles Cooper (London: Frank Cass, 1973), p. 25.

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36. Maya, A.C., op. cit., note 19, p. 2.

37. See, for instance, P.J. Cunnington, op. cit., note 31; E.M. Szekely, op. cit., note 35; D. Barking, op. cit., note 34.

38. *Reporte sobre la Zona Henequenera,* Maya, A.C. (Mexico, 1978).