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Programme Document

Research and Development Systems in Rural Settings

Project Meeting Report

Addis Ababa, Ethiopia, April 1977

THE UNITED NATIONS UNIVERSITY

From the CHARTER OF THE UNITED NATIONS UNIVERSITY

ARTICLE I

Purposes and structure

1. The United Nations University shall be an international community of scholars, engaged in research, post-graduate training and dissemination of knowledge in furtherance of the purposes and principles of the Charter of the United Nations. In achieving its stated objectives, it shall function under the joint sponsorship of the United Nations and the United Nations Educational, Scientific and Cultural Organization (hereinafter referred to as UNESCO), through a central programming and co-ordinating body and a network of research and post-graduate training centres and programmes located in the developed and developing countries.

2. The University shall devote its work to research into the pressing global problems of human survival, development and welfare that are the concern of the United Nations and its agencies, with due attention to the social sciences and the humanities as well as natural sciences, pure and applied.

3. The research programmes of the institutions of the University shall include, among other subjects, coexistence between peoples having different cultures, languages and social systems; peaceful relations between States and the maintenance of peace and security; human rights; economic and social change and development; the environment and the proper use of resources; basic scientific research and the application of the results of science and technology in the interests of development; and universal human value related to the improvement of the quality of life.

4. The University shall disseminate the knowledge gained in its activities to the United Nations and its agencies, to scholars and to the public, in order to increase dynamic interaction in the world-wide community of learning and research.

5. The University and all those who work in it shall act in accordance with the spirit of the provisions of the Charter of the United Nations and the Constitution of UNESCO and with the fundamental principles of contemporary international law.

6. The University shall have as a central objective of its research and training centres and programmes the continuing growth of vigorous academic and scientific communities everywhere and particularly in the developing countries, devoted to their vital needs in the fields of learning and resrarch within the framework of the aims assigned to those centres and programmes in the present Charter. It shall endeavour to alleviate the intellectual isolation of persons in such communities in the developing countries which might otherwise become a reason for their moving to developed countries.

7. In its post-graduate training the University shall assist scholars, especially young scholars, to participate in research in order to increase their capability to contribute to the extension, application and diffusion of knowledge. The University may also undertake the training of persons who will serve in international or national technical assistance programmes, particularly in regard to an interdisciplinary approach to the problems with which they will be called upon to deal.

ARTICLE II

Academic freedom and autonomy

1. The University shall enjoy autonomy within the framework of the United Nations. It shall also enjoy the academic freedom required for the achievement of its objectives, with particular reference to the choice of subjects and methods of research and training, the selection of persons and institutions to share in its tasks, and freedom of expression. The University shall decide freely on the use of the financial resources allocated for the execution of its functions. . . .

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RESEARCH AND DEVELOPMENT SYSTEMS IN RURAL SETTINGS

PROJECT MEETING REPORT
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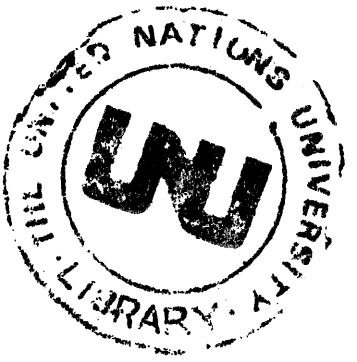

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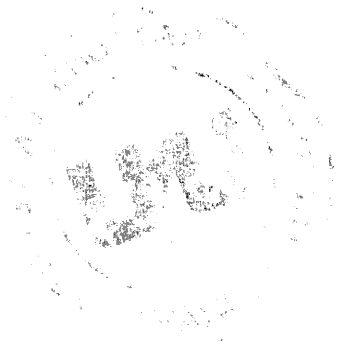

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I. BACKGROUND

1. In December 1975 the International Development Research Centre (IDRC) convened a meeting in Dar-es-Salaam, Tanzania, to discuss 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 Amilcar Herrera. It analyzed the existing situation and suggested a new approach whereby scientists and peasants could work together to combine modern and traditional knowledge in order to generate technologies of greatest benefit to the rural poor.

2. The Tanzania meeting provided a useful opportunity for an exchange of views among the participants, but it was unable to define the details for an international collaborative research project. Subsequently, Dr. Herrera visited most of the groups that participated in the Tanzania meeting and, following discussion with these and other interested groups, prepared a new paper. This paper contained an outline for a possible international collaborative project which would unite groups in several countries that were trying to find new ways to harness their R&D systems to solve the technological problems of rural development.

3. This paper was considered by the Council of the United Nations University and accepted, in principle, as the basis for a project 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 the UN University, and hosted by the Ethiopian Science and Technology Commission, which took place in Addis Ababa, 2–7 April 1977. Participants from seven developing countries attended the meeting and formulated the following research proposal.

II. STATEMENT OF THE PROBLEM

The R&D Systems of Developing Countries

4. The situation that now confronts developing countries in the field of science and technology, after several decades of effort to build up R&D systems appropriate for their needs, is too well known to be mentioned here in detail. For our purpose, it will be enough to point out its main features.

5. Since the beginning of this century and, above all, since after the Second World War, underdeveloped countries have tried to break the chronic stagnation of their economies through the introduction of modern methods of production. The main thrust of this effort has been the generation of a process of industrialization that was based on the well-known mechanism of import substitution. The general pattern adopted was more or less similar in all countries: a first stage in which only the most elementary and simple consumer goods were produced, followed by the production of increasingly sophisticated durable goods, and finally, in some countries, by the building up of an incipient heavy industry.

6. From the point of view of the market, this industrialization was based on the demands of the privileged minorities which constitute between 10 and 20 per cent of the total population in most developing countries, and which hold most of the economic and political power. These minorities are predominantly urban, have an essentially European education, and follow the cultural habits, values, and patterns of consumption of the middle and upper classes in advanced countries. A modern sector of the economy was thus developed in the backward countries, which in some fundamental aspects was closely integrated with the industrialized countries.

7. The rest of the population, mostly rural, was hardly touched by this process of modernization, and remains today more or less in the same state of poverty and backwardness that has been its lot for many generations.

8. The evolution of the R&D systems in developing countries shows a marked parallelism to 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 most of it was basic research connected with those disciplines which were in some social demand, such as medicine in the most advanced of the developing countries. Because industrialization started with the replacement of easily manufactured products, very little local R&D was needed. As industrialization advanced, however, more complex goods had to be produced by methods where technology changed rapidly because of the R&D carried out in developed countries. The inability of local R&D to perform original technological research, or even to adopt intelligently technologies developed abroad, was a contributory factor in the declining international competitivity and in the stagnation of agriculture and of livestock production.

9. It was necessary to create local R&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&D systems were then created with the same structure, and on the same general principles, as those in existence in 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 developmental research.

10. 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&D systems of the underdeveloped countries proved incapable of generating any significant amount of indigenous technology. Even in the field of adaptation, which has 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 better use of the particular combination of factors in the country involved. As for the study and solution of the basic problems of the traditional sectors of their societies, the local systems' contribution has been negligible.

11. The reasons why R&D systems in developing countries failed 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 first on those elements of the problem most directly connected with the R&D systems. As a basis for our analysis, we will adopt the following criteria and definitions.

(a) We will accept as a 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 *per capita* income ten to twenty times higher than the traditional sector, and has the cultural habits and patterns of consumption of the middle and upper classes in advanced countries. The traditional sector comprises in most countries the vast majority of the population, lives mostly on a subsistence economy, and its cultural patterns are still in general based on those that prevailed in the past. In the past decades, the mass communication media have started to change this sector's cultural habits, without improving its material situation.

According to many social scientists, particularly those from Latin America, the relationship of the traditional sector to the modern sector is one of dependency which closely resembles the relationship between developed and developing countries. 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, and this fact, 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" as being broadly divided into two types: modern or scientific technology, and traditional technology based on empirical knowledge. This distinction is important because about half of all humanity, and a great majority of the population of undeveloped countries, use traditional technology to solve most of the problems of the subsistence economy in which they live.

From the point of view of their structural connexion with society, the two types of technology are fundamentally, radically different. The scientific technology is generated by a clearly differentiated institutional framework. The framework has a number of components, ranging from the institutions specifically devoted to scientific and technological research to the public and private organizations that produce goods and services. This complex and loose organization is what we call the R&D system of a country. The traditional technology, on the other hand, lacks any institutional arrangement: it is based on empirical knowledge, which in some way is generated and dispersed to the whole community.

It is obvious that this sharp division between traditional and scientific technologies is somewhat artificial. In modern societies there are "scientific" technologies in use that include some elements of empirical knowledge. Conversely, in the traditional sector of society there is some penetration of scientific technologies, mainly in basic services such as health, transportation, and communication. For the purpose of our

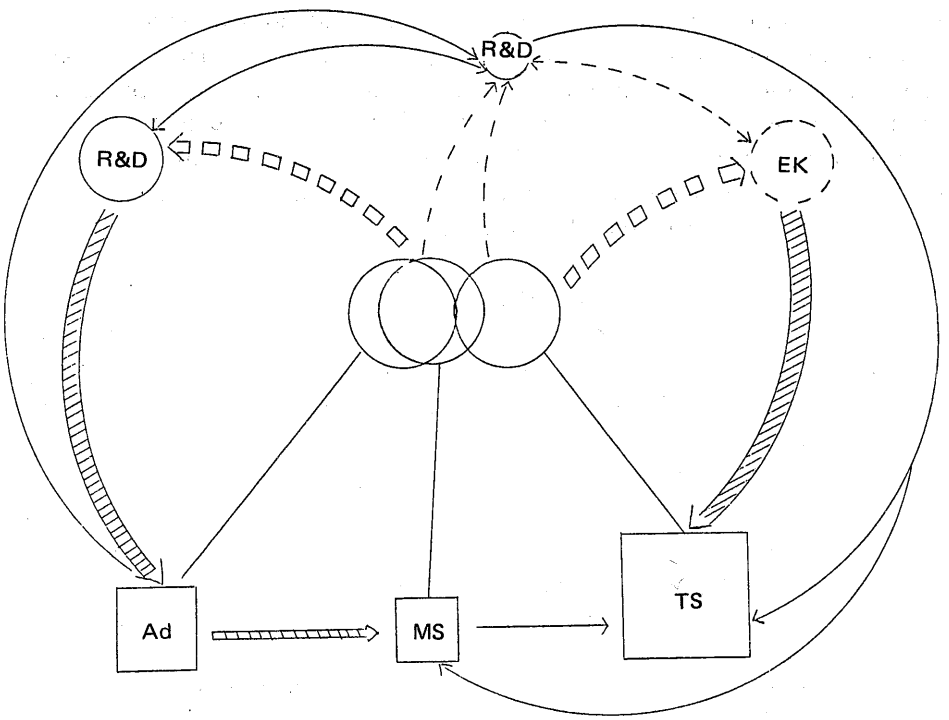
* We use the terms "dual society" and "modern" and "traditional" sectors only for descriptive purposes, and due to the lack of better terminology. The two sectors are in fact complementary parts of each unique society and are structurally interdependent. The rapid growth of the modern sector has been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

analysis, however, these exceptions do not alter the overall picture.

(c) For the study of the behaviour of the R&D systems, we define as the "problem area" of a society the set of problems that can be solved by the application of technologies, either scientific or empirical. However, to clarify what really constitutes a problem is often a very elusive undertaking inasmuch 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&D systems under present conditions, we will consider only those problems that exert actual demand on the sources of technological solutions.

Demand and Supply of Technology

12. The diagram below is a very simplified representation of the mechanism for the generation of technologies as they work today, and of that mechanism's relationships with society. The model is intended as a general "world view", but can be applied with little modification to any particular developing country.



13. The boxes at the bottom of the diagram represent the sectors into which we have divided world society: advanced countries (Ad); and modern (MS) and traditional sectors (TS) of the underdeveloped countries. The sizes of the boxes are approxi-

mately proportional to the size of the population included in each of these sectors. The circles at the centre are 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&D systems (R&D) of the developed and developing countries, and empirical knowledge (EK). The sizes of the R&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 interconnexions between the sources of technology.

14. 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 analyze the left-hand side of the diagram.

15. Most of the features shown in this part of the diagram are well known, so we will consider only those which 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 sectors of the developing countries, having the same cultural trends and values as the developed countries, have the same patterns of consumption and, hence, exert a similar type of demand on the productive and R&D systems.

16. Because about 98 per cent of the R&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 has to come from the R&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.

17. This mechanism is based on the fact, sometimes overlooked in the representations of the R&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&D systems of the latter countries, only those that are accepted by their own internal markets are finally introduced in the developing countries. In other words, the societies of the industrialized countries operate as a "filter" through which the production of their R&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&D systems of the

developing countries are confronted with 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 the direction of the technology.

18. Another effect of this phenomenon is that the industrial systems of 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.

19. 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 makes some marginal improvement in its living conditions. Besides, and this is a most important point, the *character* of the gap is changing. In the not too distant past, the gap was to a certain extent quantitative, in the sense that the more advanced parts of the population of the developing countries were still struggling to attain satisfaction of basic needs, and such was indeed the situation of a large number of the inhabitants in developed countries. The desires of the "advanced" sectors of developing countries were not basically different from the aspirations of the more submerged part of their societies. Now, however, the values and aspirations of the "post-industrial era" are starting to permeate the modern sector of the developing countries. The basic philosophy of this "second industrial revolution" is that the struggle for the essential needs of life is a problem of the past, and that it is necessary to look for new goals and aspirations for the future development of mankind. This crucial difference in outlook between the two parts into which developing countries are divided is starting to introduce a strong qualitative element in the gap that separates members of the same society, widening the division in a new conceptual direction.

20. The above considerations also help to clarify the problems of adaptation of technology in the underdeveloped countries. In the past, due to the evident failure of their attempts to create R&D systems capable of generating indigenous technologies, the attention of many developing countries turned toward controlling and adapting imported technology. In a few countries some progress has been made in the selection of technologies to be imported, but with very little success in the field of adaptation, and this is for very understandable reasons.

21. The central problem can be very simply stated: adaptation to what? As we have seen, the overwhelming majority of imported technologies are devoted to satisfying the demands of the rich sector of a society. As these demands are similar to those made in the advanced countries, it is difficult to see how the weak R&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* demands. Even if it were possible, by enormously increasing the R&D investments in backward countries, it would be very hard to justify such use of technology from the point of view of its social cost.

22. As for the production of those goods by the use of more labour-intensive technologies, thus utilizing the native resources of the developing countries, the problem is extremely difficult. In the first place, to devise such technologies to produce more or less the same goods that are now imported would require R&D systems with a capacity comparable to those of the advanced countries. Secondly, and no less important, in the market conditions of the rich sectors 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 advanced countries in order to market the new products rapidly.

23. The above considerations are enough for an understanding of the left-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, and about 80 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 relation to the fields of science and technology, as well as in any other field of human activity, are the most important that we are confronted with.

24. 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 greatly depends on a subsistence economy – despite the fact that it is the producer of raw materials on which the growth of the rich sector is based – and is therefore practically outside 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.

25. The technologies used by the traditional sector are based very largely on empirical knowledge, which is essentially transmitted by verbal tradition and which is the result of centuries of the struggle to survive. This knowledge comprises a great amount of useful information concerning the physical environment and on ways to use it to provide 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.

26. As we have already seen, the connexion between the traditional sector and 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.

27. The relationship between the three sources of technology also reflects the overall situation. The R&D systems of developing countries are strongly interrelated with the R&D systems of advanced countries – mainly through basic research – and make their contribution, however small it may 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 connexion with the R&D systems of the modern parts of society. It is not considered, in general, an object of scientific enquiry.

Science and Technology and the Gap between the Modern and Traditional Sectors

Development by the Expansion of the Modern Sector

28. How can the gap between the modern and traditional sectors in developing countries be closed, and what is the role of science and technology in this process?

29. The implicit assumption in advanced countries, and in the dominant classes of the developing countries, has been that the mere expansion of the modern sector will finally transform and absorb the traditional sector. However, even a very superficial analysis of recent historical experience, and of the conditions required for that huge expansion of the modern sector, shows that this hypothesis is really untenable. The fundamental reasons can be very simply stated.

30. In the first place, as already noted, the "affluence" of the modern sector is, at the same time, the cause and effect of the backwardness of the rural or traditional sector. The accumulation of capital and the high consumption of the former can only be sustained at the expense of the latter. Unless this unequal relationship is drastically modified, there is no possibility of effectively eliminating the stagnation in rural areas.

31. On the other hand, under the circumstances we have examined very briefly above, the modern sector has had 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 developing 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. Moreover, the technologies of that period were more labour-intensive than those prevailing today, and the rate of population growth was significantly lower than that in the present developing countries.

32. In the second place, the problem of the availability of resources merits 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 living in the underdeveloped countries. By the most optimistic assessments, the world population might stabilize at about 10 billion during the first half of the 21st century.

33. If this huge population is to have the same type and volume of consumption that the average industrialized country has today, not to mention the level of consumption they will probably attain 30 years from now, the pressures on the natural resources of the earth will be tremendous. It is not so much a problem of the ultimate physical exhaustion of those resources – which we believe is too far away to be of any relevance to the foreseeable future – but that of the generation of the enormous capital required to develop such sources of conventional resources in the next 30 to 40 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.

34. Another point also 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.

35. 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. In 1970 the average GNP *per capita* of the advanced countries was about $2,030; for the developing countries it was about $115 for Asia, $170 for Africa, and $445 for Latin America. The GNP of the advanced countries was growing at a rate of more than

6 per cent (1960–70), which means a rate of growth of the GNP *per capita* of about 5 per cent. In the developing countries the GNP was growing at 4 to 5 per cent; considering the growth of the population, that meant a rate of growth of the GNP *per capita* of about 1.5 to 2.5 per cent. It is obvious that, even assuming rates of growth of the economy considerably higher than those observed historically, there is practically no chance for developing countries to catch up with the industrialized world in terms of overall consumption.

The Role of Science in a New Approach to Development

36. We have been referring to the material constraints to development, but a basic question is whether, even if possible, it would be desirable to take the same road followed in the past by the now-developed countries. We believe it would not, as it would lead to the same situation of social and international inequality, wasteful use of resources, destruction of the natural environment, and growing social alienation, that confronts Western culture today.

37. The problem is, then, how to define a new path of development, one that, being materially satisfying and practicable, offers as well satisfaction of the needs and aspirations of the deprived majority of mankind. Here we must remember that, as has been very often pointed out, it is very difficult to identify aspirations in a community. However, the problem changes its character if we consider two different levels: a level of basic general values, and a level of specific needs and social goals which changes with time and with different human groups.

38. If we accept that the fundamental objective of development has to be the creation of a society in which each human being has the opportunity to fully develop his or her potentialities, the first level comprises those values and elements of social organization that are the preconditions to making that basic goal at least possible. The first goal, then, is the reduction of inequalities in such basic needs as nutrition, housing, health, and education; and the final goal should be an essentially egalitarian humanity.

39. Besides the basic needs, which are the most pressing at the moment because without an adequate satisfaction of them no human being can be free in any meaningful sense, there are many other forms of inequality that have to be taken into account. Some of them, such as those based on racial, sexual, or political discrimination, are obviously unjust and should also be reduced and eventually eliminated. There are others, however, stemming from the genetic endowment of individuals or from the cultural values and traditions of different human groups, that are not the result of social oppression, and contribute to the rich diversity of mankind. Using an ecological analogy, these inequalities constitute the genetic reservoir of future cultural options.

40. However, it is frequently very difficult to differentiate between what we can call "legitimate" inequalities, and those that are the result of social oppression sometimes subtle enough to make inequalities appear as real, free options. There is no easy way to escape this dilemma; any external judgement as to what constitutes a legitimate inequality is necessarily highly subjective, in that legitimacy depends on a very complex interrelationship between social, cultural, and psychological elements which are very difficult to evaluate. The only solution to this problem is to generate, through the effective participation of the populace in social decisions, a mechanism that makes impossible, or at least very difficult, the imposition of arbitrary inequalities on individuals and social groups.

41. At the level of specific social needs and aspirations – which is above the level of basic needs and represents the level of cultural options at which a society expresses its essential originality – the necessity for full participation is still greater. By their very nature these options cannot be anticipated; the only way to ensure that they represent a legitimate social expression is by the active and conscious participation of the members of the community at all levels of decision. The lack of this condition of participation is certainly the most important explanatory reason for the present alienation of a great part of mankind; in a certain way, a great many men feel alienated from their own cultural forms, as they participate but little either in their origins or in the contemporary evolution of their society.

42. The problem of how to ensure wide social participation is one of the most difficult of our time. In this work we will refer only to some of its implications in the field of technology, particularly for the developing countries, because, as we have already shown, they are the passive recipients of technological forms originated in quite different social and cultural environments.

Traditional Cultures and Social Change

43. The notion that the development of the backward countries can be solved by simply expanding the modern sector has produced grave disruptive effects in the social fabric of the traditional sector, without significantly improving its material standard of life. The massive immigration of peasants to the cities, which are unable to provide employment for them, is probably the most widely known of those disruptive phenomena.

44. The real problem, however, is not whether by destroying the social structure and cultural values of the developing countries their material conditions of living can be improved, but if there are social forms and values the preservation of which is essential to maintaining the rich cultural diversity of mankind. At a moment when, for the first time in history, humanity is confronting fundamental problems on a planetary scale, the contributions of different cultural visions of the world could prove essential to finding new roads to development, roads more compatible with

the physical and human environment than those currently postulated in the Western world.

45. There is also a direct instrumental value in preserving some of the basic elements of traditional cultures. A different conception of development necessarily means, as we have already stated, a different system of social and cultural values. The only values we have to begin with – besides the general ones of eliminating illegitimate inequalities and ensuring social participation – are the basic traditional values of the societies to be transformed. The task to be undertaken – which is very difficult indeed, but the only one that offers any hope of success – is the transformation of traditional societies by the gradual and non-disruptive introduction of modern scientific knowledge, so as to reach a stage at which the essential material needs of every human being are really satisfied, in a new cultural context where the basic goals of equality and participation are harmoniously blended with the old traditional values.

46. To understand the aim and scope of this path to development, the following two important points have to be considered.

(a) The emphasis is on the rural sector because that sector is the most important in developing countries from the standpoint of population and potential resources. The final result, however, should not simply be to raise the standard of living of the deprived majority of the population, but to transform the whole society, eliminating the present structural dichotomy between "modern" and "traditional" sectors. The transformation of the modern sector would be the natural outcome of changes in the structure of production, pattern of consumption, etc., of rural areas, which would thus modify the relationship between urban and rural sectors radically.

(b) The preservation of basic components of the traditional cultures would be through a process of "natural selection", in which only those elements that are compatible with a society in which every human being can fully develop his potentialities would be maintained. In other words, the goal of the process is not to preserve traditional values for the sake of preservation – which would be against all historical experience – but to start a process of change based on the real specific needs and aspirations of the populace of the developing countries.

47. It is obvious that a process of transformation of the developing societies as we have defined it requires the generation of its own technological solutions. Besides, technology is, in a wide anthropological sense, possibly the most important component of culture. It determines the relationship of a community to its natural environment, and it is the most concrete expression of the community's values. Consequently, one of the main objectives of any process of development by the poor countries should be to reinstall technology as one of the central elements of their own cultural creativity.

48. It is also obvious that such a process of transformation requires deep institutional and social changes which can only be achieved by political means. However, as history has repeatedly proved, the changes in the relations of power inside a society are not enough in themselves to adapt automatically the superstructural elements to the new situation. This is particularly important in the case of the R&D system, because a social change of the magnitude required by the developing countries needs a tremendous amount of scientific and technological knowledge. The R&D systems of modern societies, whether of the advanced or of developing countries, have traditions and criteria to perform and orient research which were developed as a part of the mechanism of progress of the advanced Western societies. This is the main reason, leaving aside the political constraints, why the R&D system has proved so inefficient when confronted with the radically new situation posed by the traditional sector of the underdeveloped countries.

III. OBJECTIVES OF THE PROJECT

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

50. 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 participation with research groups;

(b) the utilization of the indigenous capabilities and knowledge of the traditional societies, linking these to the R&D systems to optimize the benefits for the rural poor; and

(c) the assessment of the strategies utilized by the participating research groups to develop technologies for the rural poor, and a comparative analysis of these strategies in different socio-economic situations.

51. For this purpose the project will:

(a) bring together a number of research groups committed to the above objectives to apply a common methodology of research to generate technologies for rural development;

(b) study past experiences of the introduction of technologies in rural areas, in order to determine the causes of their achievements and failures; and

(c) design an evaluation system that can be used to assess the effectiveness of the proposed approach in achieving these objectives.

52. It is expected that the outcome of the project will help scientists and policy-makers to reorient their approach to the generation of technologies for the rural poor.

IV. A METHODOLOGY FOR THE GENERATION OF TECHNOLOGIES IN DEVELOPING COUNTRIES

Introduction

53. The methodology will presuppose that the type of technology a developing country should use cannot be determined on a simple and *a priori* basis (i.e., labour-intensive, soft, small, simple, intermediate, etc.) or that all existing technologies, whether modern or traditional, have to be rejected. The characteristics that a technology must have in order to be most appropriate to a given problem should emerge naturally from the very process of its creation.

The Assumptions or Paradigms of the R&D Systems

54. The first point we have to consider is how the present R&D systems determine the orientation and content of the research connected with social problems from the point of view of the specific technologies required to solve them. As is known, some developed countries have very well-defined institutional structures to establish the direction and content of scientific efforts in relation to their main objectives of development. In other countries such formal arrangement is almost completely lacking, and the R&D system works more or less independently of the formal structure of the national planning. In both cases, however, the efficiency of the R&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 R&D systems of the developed countries respond efficiently to the implicit demands of their societies.

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

56. To determine the adequacy of a technology to a given society is a problem with

many variables, only a few of them strictly technological. Most of them belong to the fields of economics, sociology, and social psychology, and form what might be called a set of assumptions, or paradigms, which constitute the frame of reference of the R&D system. Some of them for the advanced countries can be stated as follows: the scarce factor in production is labour, thus the more capital-intensive technology 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.

57. These are only a few examples of the set of assumptions that direct the efforts of the R&D systems of developed countries in the capitalist world. They are the expressions of the most basic characteristics of those societies, and are seldom explicity stated as they have become assimilated by every member of the R&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. This is the first filter that sorts out any possible technological solution that can be applied to specific problems of developing countries. The important point here is that without that set of assumptions, or some other equivalent, no technological problem can be stated in meaningful terms.

58. In developing countries, the R&D systems have evolved with the modern sector of the economy, and are closely connected to the R&D systems of the advanced countries. Their paradigmatic determinants are very similar to those of developed societies, and this similarity is continuously enhanced by the process we have already described.

59. 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&D system cannot be applied to solve its problems. 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&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&D system of the underdeveloped countries.

60. This statement does not contradict the fact that the R&D system performs some research on the problems of the traditional sector which results in the introduction of a few modern technologies. The important point is that the research is directed with 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 rural 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 the the country, are but two examples of this widespread phenomenon.

61. The above does not mean that only the traditional sector needs a new set of assumptions to develop its own technology. If the objective is to have an integrated society, the transformation of the rural sector will be accompanied by a gradual complementary evolution of the modern sector, and the final outcome should be a set of assumptions to guide the generation of technology for the whole country. We start from the rural sector because it is the most important one in the developing countries, and its transformation will be the driving force in changing the present structural relationship between the two sectors.

62. In conclusion, what the R&D system of developing countries lacks to direct its research is a set of assumptions embodying a whole new concept of development. This would give the underdeveloped countries, not merely their modern sector but the societies as a whole, a frame of reference for adequately defining the type and character of the technologies required.

The Organization and Working Methods of the R&D Systems

63. The methodology outlined above will require certain modifications or adaptations to conform to the organizational forms and working methods now prevailing in the R&D systems of developing countries. It is very difficult to predict accurately the form of those changes, but they will have to evolve from a process of trial and error based on actual experience.

(a) In the first place – and this is probably the most distinctive element of the proposed methodology – the participation of the local populace has to be ensured throughout the whole process. The main reasons for this are the following.
    (i) The local population is the repository of the traditional empirical knowledge –

which includes, besides concrete technological solutions, the social and cultural characteristics of the community – that can only be transmitted through an active interchange between scientists and the local people. The necessity of ensuring a systematic participation of the population makes it imperative to study carefully the operational forms this interchange should take.

(ii) One of the most difficult problems of the introduction of new technologies to poor rural areas is that of inducing people to accept the innovations. This is not so much because they are "conservative", as is commonly assumed, 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. In the economically advanced societies, this participation is implemented through a complex indirect mechanism that normally ensures the acceptability of new technologies even before they reach the potential users. However, historical experience shows that those mechanisms frequently fail, and new technologies are rejected when they reach the market, for reasons which are no more "rational" than those that lead the rural poor to reject innovations introduced from outside.

(iii) One of the main problems that peasants have to solve, or even to pose clearly, is their almost complete ignorance of the possibilities and limitations of modern science and technology. Participation in the process of creating technologies will help them to overcome that obstacle, and to incorporate science as a normal element of their lives, as is the case in the richer parts of the world.

(iv) The resulting technologies should be produced, as much as possible, by the local people with local resources. The participation of the populace in the whole process of creating technologies should contribute to the generation of the necessary skills for their use and production.

(b) The formulation of the problem areas of the developing countries, in such a way as to make them explicit subjects for scientific and technical enquiry, would require interdisciplinary research of a type somewhat different from that currently being performed today. In most cases, multidisciplinary research is understood as the collaboration of specialists in different scientific fields on a particular project. The planning of river basins, some ecological projects, and urban planning are a few examples. In all these cases, the characteristics of the project have been predetermined, and the specialists are temporarily incorporated into the group to treat the special problems of their specific fields, although with a certain amount of interaction among them. In other words, the research is confined mostly to the stage of development. The new form of interdisciplinary research, which should include the human and social as well as physical sciences, should start at the stage of basic research in which problems and objectives of research are defined. This implies a type of interaction that will require some changes in the forms of organization of the R&D structures.

(c) In all the research groups, the participation of basic scientists should be stimu-

lated as much as possible. When one of the main problems is to find new technological solutions, the basic scientists are the best prepared to see possible new applications of existing basic knowledge. It is always important to remember that accumulated scientific knowledge – more than available technologies – is the source from which many, if not most, of the new solutions emerge.

(d) The research teams working on problems in rural areas should be effectively connected with the main scientific centres of the R&D system. It is not simply a problem of institutional relationship, but of active intellectual interaction. In other words, the research being done has to be an integral part of the main activities of the R&D systems, and not a marginal one. This is the only way for the gradual transformation of the whole society, precipitated by the technological and social change, to be reflected in the orientation and content of the scientific effort of the country. Because most scientific centres are located in urban areas, it is a difficult problem to maintain an adequate connexion with the research teams devoted to the rural areas without weakening their interaction with the local people. In some cases the solution could be to locate research centres in rural areas; in others, the research teams could work in rural areas on a temporary basis. The best solutions, which may well be different for different regions, will evolve with time, as more experience is accumulated.

The Methodology for Research

64. In what follows we will describe briefly the main elements of the methodology. It is obvious that these stages do not constitute a strict time sequence, as they will take place simultaneously. The main task, that of building 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 gained in their building and application will revert to the assumptions to modify, enlarge, or complete them. This is the process that now operates in the advanced countries and allows them to generate "spontaneously" technologies adequate for their needs and aspirations, a process which needs to be generated in the developing countries.

65. The elements of the methodology are the following.

(a) The general socio-economic characteristics of the selected region should be evaluated. The scope of the analysis and the methodology to be applied will depend on the information available about the region, and on the means, backgrounds, and available personnel in each of the groups involved. However, in order to obtain an adequate understanding of the more important things that are going on in the selected community, as well as of the historical process that has led to its present situation, a basic knowledge of the following elements will be necessary:

(i) the nature of the national and regional socio-economic formation in which the community is immersed;
(ii) the forms and mechanisms of articulation of the community with the socio-economic formation in which it is included;
(iii) the social relationships and forms of production inside the community; and
(iv) the economic cycle inside the community, and the form of appropriation of the economic surplus.

(b) As an effort is made by the local population and scientists to analyze the current situation in the community ((a) above) problem areas will be identified, and some of them will be chosen as subject matter for the project.

(c) This part of the work is concerned with determining the functions that the required technology is expected to fulfil. The first step is one required in any scientific research into a new area—asking 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) the technology has to satisfy.

It seems obvious that these kinds of questions are always asked when a technology is being developed. The real point is that in the customary work of the R&D systems the answers are generally obvious, for reasons already examined: the scientist is working on problems pertaining 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 seen in 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 modicum 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 dwellings rather than in the supposedly better new ones. The reason 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 may be unacceptable to the people, even if it is much better from our point of view than the one currently used.

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

(i) the areas of activity of the community implied in the technology being considered;
(ii) the forms of organization of the community around the specific activities being considered;
(iii) the natural resources involved in the technological solution under study; and
(iv) the ecological implications of the technology being developed.

(d) This part consists of analyzing the solutions that the local community has traditionally given to the problems identified. We must remember that common people have had to solve their problems in their own way since long before modern science was born.

This area of the research is a very difficult one, because in most cases it is not a matter of simply adopting the traditional specific technologies being used, but a problem of extracting the original ideas they may contain, and of studying them by applying the resources of modern science. The most important local contribution will probably be, *not so much concrete specific techniques, but suggestive approaches to the solution of old problems which may stimulate scientific research into hitherto unexplored directions.* Besides the methodological difficulties, this approach requires an unprejudiced and open-minded attitude, not one of the remarkable characteristics of the R&D systems in respect of traditional knowledge.

As an example of traditional technology, 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 sun under certain conditions they have learned 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, assisted by 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 in rural areas.

The case of the jungle could be another example. The Brazilian Government's intent to colonize the Amazon basin has 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 technique of crop-farming and stock-raising in closed and cleared areas, a method which destroys the forest, is accepted as the only practical method 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 for economic exploitation, instead of completely destroying it?

This way of approaching the problem is much more in accordance with the set of basic assumptions stated above—utilization of local resources, rational management of the environment, etc. — than the classical one. To explore its possibilities, the only knowledge we have to start with is that accumulated by many generations of people living in close contact with the jungle, or with similar environments. Complemented and enlarged by scientific studies of the biological, economic, environmental, and social implications of the occupation of the jungle, this knowledge may yield a completely new concept of rational utilization.

These are just two examples, to which innumerable others could be added. Most developing countries are located in tropical areas, in natural environments that have been scarcely studied by the R&D systems of the Western countries, and where local knowledge would make an essential contribution to finding new roads to development. In this part of the study, the four items included in (a) above should also be analyzed, 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 that which is being developed. In some instances, it will be found that no idea worth using is embodied in the traditional technologies. In these cases, a completely new solution has to be found.

(e) A general survey of the natural resources of the area should be carried out. A very important point here is this: Natural resources are generated by a combination of some natural object with science and technology; there are no "natural resources" in an absolute sense. This elementary fact is frequently ignored in developing countries, and there is a tendency to consider "natural resources" to be those taken as such by the industrialized countries. So research must include not only the resources already in use, but also those with potential application to the problem area being studied.

(f) With the information gathered in (a) and (d) above, a set of assumptions or paradigms can be derived, which will be the frame of reference for the final step in 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."*

66. 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, including all the requirements the technology must fulfil, allows the exploration of a multiplicity of possible paths,

and the selection of the one best suited to the particular situation.

67. It is obvious that once a set of paradigms has been constructed, in some cases the required technology will already exist, and it may simply be a question of introducing it into the area. In other cases, it may be a problem of combining existing technological elements in a different way. Finally, in many cases, it may be necessary to devise an entirely new technology. However, in most instances, it will probably be a question of combining the three situations.

Methodology of Evaluation

Evaluation of Individual Projects

68. The methodology of the project consists of monitoring the progress of the participating groups, with respect to the following.

(a) Links of the R&D units involved with the rural milieu; effects of those links on the process of generating technologies.
(b) Effects of the links with the R&D units on the local population.
(c) Effects of the connexion with the rural milieu on the R&D system.
(d) Acceptability and dissemination of the generated technologies.
(e) Contribution to the development of a new set of paradigms for the R&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 are identified, and guidelines are given as to how they can be measured and evaluated.

69. 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 are themselves 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 poor 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 straitjacket restricting, rather than facilitating, the kind of understanding which is desired.

70. Another important point to keep in mind is the necessity of distinguishing those phenomena which are familiar, and for which 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 quantifica-

tion (and hence to "formal" comparison) from those which will have to be treated in a qualitative way, even when much more fully understood than at present.

(a) Links of the R&D units with the rural milieu

The central problem in connecting the R&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 connexions 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 considered 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 the research itself. It means that ways have to be devised by which the local people will become interested in the whole process of generating technologies, and hence will be motivated to contribute with their experience as much as possible. The contact between scientists and the local population starts at the stage of collecting data 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. 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 fieldwork. 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 should be consulted in the course of this process, in order to ensure that the data collected provide an adequate basis for the "before and after" study, but should not seek to influence the approach to be adopted beyond this point, since this and the influence which is exercised upon subsequent development will be one of the critical variables to be considered in the final evaluation exercise. The social scientist directly involved in monitoring should be required to record the methodology in detail, and to provide an account of how it was modified in the light of experience.

Evaluation of participation

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

(i) Measurement of inputs

The measurement of participation in physical terms will 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 should 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 should 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 will have to be determined in the light of particular project circumstances and should be refined and modified after an initial period of pilot testing.

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

(ii) 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, 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.

a. Definition of the objectives of the project
b. Identification of problems and needs
c. Selection of methodology
d. Selection of procedures
e. Selection and procurement of material

f. Data collection
g. Analysis of data
h. Drawing conclusions
i. Testing of the acceptance of the technology
j. Diffusion of the technology
k. Training

The skills that the evaluator should inculcate in some members of the team for this task are those of a good secretary taking minutes of a meeting. Since much of the evidence regarding the extent to which genuine participation is, in fact, taking place will emerge in the context of interactions of this kind, it will be important in the first instance simply to obtain a factual record of who says what, and 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 begin to identify who is participating, and under what circumstances. This might in turn provide the basis for more systematic enquiries contrasting the circumstances in which villagers play, or do not play, an active role. This exercise can be made more valuable if individual scientists are encouraged to keep brief diaries of their personal contacts with villagers, in addition to their time budgets. The type of data to be collected here should 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 describe; the nature of their response to problems as analyzed by the scientist; and the type of suggestions that the villagers themselves make. As with other types of data already discussed, one would anticipate an initial period of heavy interaction between scientists and evaluators* during which the categories and procedures of recording could be modified and standardized, followed by a period of little direct contact, when the scientist simply submits the schedules and records to the evaluator. Finally, all this activity should be complemented by the evaluator's own enquiries into the evolving nature of the relationship between the participating groups.

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

The procedure here would be initially to collect baseline data and to compare

* "Scientists" and "evaluators" are used to denote roles, and do not imply special professional qualifications.

the data with that obtained at the end of the project; such data should most probably be collected by interview and observation. Questionnaires could be devised to assess the perception of one group by the other, and then repeated to assess the extent of change over time. The nature and development of a number of aspects of inter-group behaviour could be thus recorded. These would include such revealing behavioural patterns as mode of address, seating arrangements at meetings, and the general nature of the language used for communication between groups, as opposed to that used within them. The extent to which enquiries revealed a movement from distant to relatively close relations in the course of the project would provide a significant indicator of local participation.

(iii) Direct effects of participation

As one of the effects of participation, it can be expected that the villagers will contribute ideas and personal work to the whole process of generation and dissemination of technologies. This contribution can be systematically analyzed as follows.

a. 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.

b. Analysis of the local traditional solution. Traditional technologies are based on empirical knowledge that cannot always be easily grasped through the study of 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 on the degree of co-operation to be achieved between the scientists and the villagers. Some scientists will be content with simply asking a few questions about the traditional solutions; others may be prepared to go so 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. Most important is that when the villagers see that scientists are prepared to take part in work which villagers normally do, it will help to break down the barrier between the two groups, making the peasants more confident of their own ability to make a contribution.

c. The technological solution finally proposed. The local contribution can be measured using the same approach as in a. above.

d. Implementation technology. At 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; and
- the extent to which the villagers take responsibility for testing the innovation, and the importance of the modifications that are introduced as a result.

Methodology

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

a. Integrating the final data (concerning 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.
b. On the basis of the information gathered in the two previous phases of the evaluation of participation, to trace the origin of the ideas and the mechanism of generation as a result of interaction between scientists and peasants. This will permit for a determination of not only the origin of the ideas, but also of to what extent those contributed by the scientists have been influenced by contact with the villagers, and vice versa.
c. With the results of the analysis described in b. above, the original list must be refined, and accompanied by a description of how the ideas originated and evolved.

(iv) Indirect effects of participation

Participation in generating a given technology could help the local population to understand the nature of its problems, and the importance of science in solving them. As a result, the people themselves may suggest new lines of work, and new ideas to be tested for solutions to 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&D system and the local milieu can be established. The methodology for evaluating this element could be the same as that proposed for the evaluation of the direct effects of participation.

(b) Effects of the links with the R&D units on the local population

The establishment of links between the R&D units and the local population will

be reflected in their effects on different aspects of community life. The evaluation of these effects will be carried out within the framework provided by the socio-economic study.

(c) Effects of the connexion with the rural milieu on the R&D system

To achieve an effective contact between the scientist and 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&D system so as to ensure the following.

(i) 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&D unit; that is, the minimum size of a group necessary for each of its members to attain maximum productivity.

(ii) That the research which the project demands – which, by its nature, cannot be locally satisfied – can be easily allocated to other parts of the system, generating a continuous flow of research.

(iii) That many scientists consider the research being carried out as an integral part of their activities, and not as marginal, and that the scientists do not consider this kind of research to be 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 as follows.

(i) The generation and flow of research

The following can easily be measured as they result in concrete actions of the type normally registered or evaluated by the R&D system.

a. Research generated at the basic, applied, and developmental 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 stimulates research in related subjects in the same institution where the project is being carried out, or in other centres working in related areas. This effect can also be measured, since it normally results in contacts among scientists and institutions working in similar or related fields, in publications, or in communications, etc.

c. New areas of research generated. The research just mentioned may be in areas of research already in existence, or in relatively new fields. 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.

(ii) Catalytic effects

Besides generating research, a project can stimulate the formation of other groups to apply the same, or similar methodology. It should be easy to identify such groups, and to assess to what extent their methodology has been influenced by that applied in the project.

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

(iii) Effects on the decision-making lever of the R&D system, or on other planning institutions concerned with economic and social development

Certain decisions could be taken, at a higher or different level from that 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.

(iv) 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 within the general framework of the project as a whole. This can be done by the evaluator, then later refined 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 can obtain the required information from the scientists involved. The data so collected will provide an indication of what has happened in absolute terms, but no indication of the relative shift in people's attitudes and motivations during the period of operation of the project, nor 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 survey could take two forms. First, a sample of scientists from different institutions might be interviewed, using a standard schedule designed to test their

knowledge and perception of rural problems. Second, scientific publications might 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 or not they were aware 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, 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 equated with "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 perceived as better than, and conceivably is seen as inferior to, alternative strategies directed towards similar ends.

(d) Acceptability and dissemination of the generated technologies

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&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 in order to determine its merits, in absolute terms as well as by comparison with current technologies, so as then to be able to design a strategy of dissemination, taking into account 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.

(i) 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 goal is to assess to what extent the participation of the local people has influenced their attitude towards the new technology, and which results are the practical results from the point of view of application and performance. Most of the information needed will come from that gathered during the previous stages of the 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.

(ii) Appropriateness of the technology

This phase of the assessment refers to the intrinsic merits of the new technology in absolute terms, and in comparison with current technologies. The evaluation will consider the impact that the technology might 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:

a. accessibility of the technology to the lower-income groups;
b. effects on the satisfaction of basic needs (direct and indirect);
c. effects on employment;
d. effects on the generation and distribution of income;
e. psycho-social adequacy;
f. effects on social participation: possibility of control by the local people;
g. natural resources: utilization of local resources as compared with current technologies;
h. human resources: utilization of local human resources;
i. energy implications: does it increase or decrease the regional or national dependence on external energy sources; and
j. environmental effects.

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

(e) Contribution to the development of a new set of paradigms or assumptions to generate technologies in the same or related fields

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

At the stage of defining 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 for creating a 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 the most important factor in success is the scientist's intimate knowledge of the whole process of the generation of the technology.

International Evaluation

71. 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.

72. During the course of the project, evaluators will begin to detect logical connexions 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 may be expected to generate concrete conclusions will, 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 can feed back experience on different parts of the monitoring to a central co-ordinator who then is able to devise standard schedules to be used in all cases. For instance, it will be desirable to standardize procedures on how scientists record their interactions with villagers, both in an individual and a collective context. Strict standardization may be difficult to obtain, but it may be possible at least to ensure that certain basic data are 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.

73. 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 can be detected behind the eventual permutation of the variables adopted. If such a pattern does emerge — if it appears

that choices between alternative possibilities have been made 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 comparisons among the various countries involved, this would provide the basis for a comparison of relative rates of return. If the data should be 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 types of technologies lend themselves most readily to the methodology, and what sort of starting points are necessary in order to have a reasonable chance of success.

74. The exercise of comparing different possible strategies of research can be greatly enriched by analyzing past experiences with technologies introduced in rural areas, in which completely different strategies from those used in the project were applied.

75. Another part of the final exercise will be an analysis and evaluation of the methodology of monitoring itself. Its aim should be to detect the kind of data, and the methodology for gathering them, that prove most relevant in evaluating 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.

76. 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.

V. TIMETABLE

77. This proposal for an international network research project will be presented to the International Development Research Centre and the United Nations University. The national research groups intending to participate in the international project will discuss the proposal in their respective countries. National or country research proposals are to be submitted to Dr. Geoffrey Oldham by 15 June 1977, if the national research groups intend to participate in the international project.

78. The national and international proposals will then be submitted to the IDRC Board of Governors for approval in September 1977. If approved, work on the international project could begin soon after.

VI. ORGANIZATION OF THE PROJECT

79. The project will be organized on two levels:
(a) the Country Project Team; and
(b) the International Project Co-ordinating Committee.

(a) Country Project Team

Each participating country team will be headed by a Project Leader and shall be composed of social scientists, natural scientists, and other research staff. The project leader will be responsible for the conduct of the project, which will include its monitoring and evaluation. In addition, a team of evaluators, which will include natural and social scientists, will be drawn from the project team.

Each country team will operate autonomously, but it is expected that the different participating teams will exchange information through the Co-ordinating Committee.

(b) International Project Co-ordinating Committee

The project leaders of the different country participants, with the approval of the sponsoring institution (IDRC/UNU), shall nominate a Project Co-ordinator. He will be in charge of co-ordinating the entire project and will be responsible to the Co-ordinating Committee, composed of all project leaders. They will meet at least four times over the course of the project to monitor and evaluate the progress achieved.

The International Project Co-ordinating Committee will, in general, have the following functions:
(i) to finalize and approve the methodological guidelines for the project;
(ii) to evaluate the work carried out by the different country teams; and
(iii) to establish procedures for synthesizing country or national studies.