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SRI LANKA ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PART II

PROCEEDINGS

of the

THIRTY FIRST ANNUAL SESSION

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FOR THE
ADVANCEMENT OF SCIENCE

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CONTENTS PART II

INAUGURAL ADDRESS

by

HECTOR KOBBEKADUWA
Minister of Agriculture

Mr. President, the Distinguished Chief Guest, Distinguished Visiting Delegates, the President Elect, Distinguished Scientists, Ladies and Gentlemen,

It is with great pleasure that I accepted this invitation to deliver the inaugural address at the 31st annual sessions of the Sri Lanka Association for the Advancement of Science. I wish to thank the President and the Council for extending this invitation to me and for giving me the opportunity to meet and talk to so many members of the scientific community of Sri Lanka.

Many countries of the third world specially the highly populated countries in the Asian region find themselves today at a critically important phase of economic development. Recent global shortages of food, the international monetary crisis and the escalating prices of food, petroleum products, other important materials and agricultural inputs in the world market have thrown out in very sharp relief the vital need for countries like ours to embark on policies of self reliance and at least to be self sufficient in the production of our basic food needs. Increasing population pressures on land and increasing unemployment make it imperative that we dedicate ourselves to this task. Time is running out and if we are to survive in this race for development we have to harness all our material and human resources to ensure that every acre of our relatively limited resources of cultivable land is productively utilized. It is now a time for clear policies, decisive programmes and speed of implementation.

The problems of unemployment and self sufficiency in food cannot be solved without a major transformation of the

agricultural sector. This transformation in turn cannot be effectively carried out without four cardinal commitments in national policy. The first is the mobilisation and participation of the people for changes in the agrarian sector through political leadership at the highest levels. Secondly the larger fiscal and monetary policies must be aimed at suppporting the indigenous agricultural base. Thirdly the land resources of the country must be under social control and managed and developed for the benefit of those actively engaged in farming the land and finally the agricultural systems must be so designed as to make maximum use of material and human resources that are available within the country.

I do not have to repeat here the progress that has been made in implementing these policy commitments. These are only too well known in this country but I wish to emphasize two important matters of far reaching significance.

In the sphere of land policy the implementation of the land Reform Law No. 1 of 1972 and the ammending Law No. 35 of 1975 are major steps towards the social control of land, which is the most important resource base in an agricultural country. We have moved decisively forwards in the transformation of the agrarian situation in Sri Lanka. The fact that this change was brought about without violance and bloed shed is a great tribute to the discipline and understanding of the people of this country.

The Agricultural Productivity Law has placed the responsibility for planning and implementation of agricultural programmes squarely on the rural farming community. This transfer of the decision making processes to the people directly engaged in farming the gradual termination of bureaucratic control should go a long way towards obtaining full farmer participation in development and also towards opening the door for a release of the creative potentialities that hitherto have been inhibited and dormant in the rural areas.

Policies, Laws and Institutions alone, however, cannot solve the problems of agricultural production. The major task ahead

of us is one of utilizing our land, water and other natural resources in the most productive manner possible and in reaching levels of productivity that would not only be adequate to meet the needs of the nation but would also provide increasing employment and higher standards of living in the rural areas. In achieving these objectives it is axiomatic that the application of science, in all its varied disciplines and technologies, is an integral and indispensable component. However, it would appear to me, that the development of science and technology is not merely one in which a group of scientists carry out research and publish their research findings for use by development planners or one in which research findings are transmitted to the end users in agriculture and industry. It is largely a question of infusing the nation as a whole, especially the youth, with the creative spirit of science. It is one of developing a nation wide appreciation of the value of scientific thinking and action and of evoking a mass consciousness of the fundamental role that science has to play in development. To be effective this approach cannot be cold and sterile, it has to be carried out in the spirit and exitement that accompanies the development of a country and the challenges of pulling a poor nation to prosperity by its boot strings. Science has to be concerned with ethics and values and the scientific tradition in any country gets enriched to the extent that it is involved in these issues.

If I may be permitted to refer to a matter which has been of some concern to me I have observed that many of our scientists are still alienated and isolated from the real spirit of the country. Perhaps the training and orientation that is given in the highly sophisticated laboratories of the developed countries has been partly responsible for this position. This situation can only be corrected by ensuring that the training which is given at the University campuses in Sri Lanka inculcates in all scientists a deeper understanding of the problems and the role of the scientist in economic development. In addition the training institutions abroad have to be carefully selected. Our young men and women have to learn to think in socially relevant terms and be stimulated by the technological demands

of the nation for it is only then that scientific research in a poor nation can become truly meaningful.

It would seem to me that we need to know a great deal more about the nature, extent and potential of our own natural resources and to develop technologies that are within our capacity to implement. We need to exploit our own land, water, biological resources to the maximum and to develop ways of using our own sources of power, wind, water and solar energy. At the same time our scientists should be fully conversant with all the latest advances in science that are taking place elsewhere in the world so that this information could be utilized in developing technologies and of finding solutions to technical problems that would meet the indigenous needs. Our science should develop on an indigenous base and have a character of its own. In short we need to look from in outwards rather than from out inwards. However, a focus on nationalism has certainly to be tempered with a measure of internationalism if the trap of parochialism is to be avoided.

I accepted this invitation to inaugurate these sessions because I believe that the scientists have an indispensable role to play in economic development. I am deeply conscious of the fact that inspired scientific innovations and creative technologies adapted to local conditions can transform the potential for production in many areas of development and in this connection I wish to pay a tribute to the work of our agricultural scientists. In the field of rice breeding we hold a premier place in Asia. In my view the Sri Lanka Association for the Advancement of Science can provide the leadership required in developing in this country the attitudes to science and in fostering the spirit of science that I have referred to earlier in my address. I understand that the Association has a membership of over a 1000 distinguished and highly trained scientists covering nearly all scientific disciplines. If this entire membership could be harnessed to focus on the single theme of economic development and to spread the

message of the creative role of science in economic development it could prove to be a tremendous force for progress. This is not to say that individual scientists are not concerned or involved in thinking and acting in these terms but to indicate that the collective strength of the Association could be a valuable asset to the nation.

May I offer two suggestions:

1. Agriculture and agro-based industries in the rural areas will for many decades ahead continue to be the main sources of employment and income generation. Since the development of this sector would be crucial to the survival of the nation as a whole would it not be too much to ask that the majority of our scientists be concerned with the development of the rural sector as a whole. I think that in one way or another all disciplines are involved in this effort. Would it be possible for the SLAAS to make this theme its focal point of thinking and action over the next few years? Could not a series of projects, seminars, discussion groups, lectures be arranged by the different Sections to deal with different aspects of rural development. Would it be possible, for instance, to organise the next Annual Session of the SLAAS, as already been done in India, around this single theme? I believe that this may also be one of the ways of giving our younger scientists the orientations that are required.

2. In the rural youth of this country we possess the highest potential for creative and innovative effort. If this great reserve of creative energy can be released and harnessed for the development of science and technology in the rural areas it may prove to be a decisive factor in the speed of economic development. Is it possible that the SLAAS could expand its current programmes for the popularisation of science and harness the greater part of its membership for this task? Would it be possible to establish a number of

regional branches of the Association through which this programme can be undertaken.

I have placed before you a few thoughts as they have occured to me. I have done so not in any spirit of criticism but because I sincerely believe that Scientists have a vital role to play in development. We need, at this stage, to harness the best scientific brains in the country to this task.

May I wish the Association all success.

GENERAL PRESIDENT'S ADDRESS

SOME ASPECTS OF AGRICULTURAL DEVELOPMENT IN SRI LANKA

by

ERNEST ABEYRATNE

The question of Agricultural production, primarily food production, in Sri Lanka is today the central topic of concern and debate. Different and controversial views are being expressed. At one extreme there are those, specially the neo-Malthusians and the fanatical supporters of population control, who claim that this country has already reached the limit of its capacity to feed itself. The future to them is one of deep gloom. At the other extreme there are those who claim that with advances in science and the application of these advances in science and technology to agriculture in Sri Lanka, there is no need for any apprehension about the future. As in most controversies both positions have some validity depending on the circumstances in which these are considered. I shall endeavour in the course of this address to place my own point of view on these issues.

The nutritionists and those interested in population/food balances would ask the agricultural planners to indicate in what areas of the country the different food commodities required could be grown, the quantities of each that could be produced and the increases in production that could be achieved over the years to meet the food demands of the expanding population. Such a request presupposes that the base for production has been well established in this country and all that has to be done is to increase productivity and expand the production base using the total conventional apparatus of modern agricultural development. This proposition is not as simple as it looks at first sight. I do not intend to set out here a neat plan in quantitative terms indicating where

and how these targets can be met, but to outline the more important features of the present position with regard to food production in this country and to draw attention to some fundamental factors which I consider important that need to be taken into account in utilizing our potential of land, water and human resources in a productive and sustained manner. I do not intend to enter into a discussion on population control. It is assumed that the twin objectives of food production and population control will be given equally high national priority but I wish to focus attention at this point in our history, where agricultural development has reached a cross road, on the vital need to make a very careful assessment of our long term goals and objectives.

Estimates of food needs for the population in Sri Lanka (in terms of medium projection of population growth rate) at the beginning of the 21st century have been made by the Nutrition Division of the Medical Research Institute. Taking into account the estimated needs of rice, other cereals, pulses, vegetables, fruits, meat, milk and sugar and calculating the extents of land that would be required at current levels of productivity a total estimated extent of around 5½ million cropped acres of land a year would be required. Based on the extent of double cropping or multiple cropping now practised on a part of these lands and assuming that productivity can be doubled in the next 25 years—there is no technical reason why this cannot be done in most regions of the country—the physical extent of land required would be in the region of 2¾ to 3 million acres. Of the total extent of land in Sri Lanka of 16 million acres, it is estimated that around 10 million acres are cultivable. The total extent cultivated at present is around 5 million acres of which approximately 600 000 acres are under tea, 565 000 acres under rubber, and 1.15 million areas under coconut making a total of 2.32 million under plantation crops. The extent under food crops is around 2.25 million acres. There is a potential for development of another 4½ million acres of land most of which is however in the dry zone. In the wet zone specially under cocunut a total of around half a million acres of land can be intensified under food crops.

I am conscious of the fact that the presentation of these figures in this way would appear Utopian and a little unrealistic. This approach was taken only to draw attention to the fact that resources of land, though limited, are adequate in the foreseeable future. The question of how this land can be effectively used is a basic question facing us today.

Any assessment of the current level of development of agriculture in Sri Lanka, specially in the food production sector, has to be placed in the perspective of the agricultural and fiscal policies that have existed during the last 150 years or so and have to be viewed in the background of the consequences that have flowed from the implementation of these policies. The potential for agricultural production has to be considered on the one hand in terms of the extent and quality of the available land, water and human resources, and on the other in the way this potential is exploited through social objectives, the organizational forms that are developed for agricultural production and through the application of science and technology.

This is a vast subject which cannot be dealt with in any detail in the space of the time available. Only the more salient features will be discussed here.

During the entire British period the basic policies in agricultural development were directed towards the development of export crops mainly tea, rubber and coconut and their supporting institutions and to the import of cheap food from the world's markets to meet the domestic requirements of food.

This policy which resulted in a continued import of the major part of the food requirements of the country for nearly 75 years, while it had some social and political benefits, could hardly have been expected to have had a beneficial effect on the rural agricultural sector and the development of a national plan and programme for food production. Investments in the development of land and water resources in the country as a whole where marginal with the exception of the restoration of some irrigation works. Incentives for

the commercial production of food crops other than rice were minimal as cultivators had to compete with cheap imports. Rural agriculture remained stagnant and at a subsistence level of development throughout this period.

From the 1930's onwards policies and programmes directed towards attaining self sufficiency in rice have been gathering momentum. During the last fifty years there has been a big investment in the development of land and water resources for rice cultivation. The major portion of this investment however had been made in the dry zone in the development of major irrigation schemes. Investment in the development of land and water resources and in exploiting the food production potential of the wet zone and the rural areas outside the irrigation schemes had however remained relatively marginal.

The policy of importation of the greater part of our food requirements of the country continued more or less unchanged up to 1971, with the exception of potatoes, the import of which was banned in 1967 and which resulted in a surge of potato production locally. In 1971 a positive shift in policy towards self reliance in food production took place. This policy decision resulted in a ban on the import of a wide range of food commodities which had the potential for being grown in Sri Lanka. This decision coupled with the decision to permit a free market in the sale of the commodities produced locally, provided the necessary incentives to the cultivators and set the stage for a diversification of agriculture in Sri Lanka which had up to now been dominated by the monoculture systems of tea, rubber, coconut and rice. This was the first really serious attempt in the recent history of agricultural development in Sri Lanka to provide a firm basis and a starting point for agricultural development in the rural areas by changing qualitatively the earlier policies. These decisions which were followed by the Land Reform Law No. 1 of 1972, the Agricultural Productivity Law of 1972 and the amendment this year to the land Reform Law under which the company estates were taken

over have placed the major responsibility for food production on the rural sector and have paved the way for a full scale assault on agricultural development in more comprehensive terms. We are in effect at the beginning of a new era in agriculture.

The recent history of food production has been traced here not with a view to criticizing earlier policies but primarily to bring into focus the fact that the development of land and water resources and a productive utilization of land in the rural areas for food production particularly in the wet zone and other areas in the dry zone outside the major colonisation schemes has yet to take place. It would thus be clear that national food production is still in its early stages of development and that the total food production potential has yet to be tapped. The nett result of past policies is that they have created the dilemma of the present situation in that, driven by increasing pressure of population, we are being forced to compress into a few years a development that should have taken place gradually over the last 100 years. Any conclusion that we have reached the limit of our capacity to feed ourselves would in this context be an unrealistic one.

A brief reference to some of the more important features of agriculture in the food production or what is often referred to as the domestic sector would help to make the picture clearer and also throw out in relief some of the problems facing us.

One of the characteristics of agriculture in general and rice production in particular is that it has been very susceptible to variations in weather conditions. Fluctuations from year to year and crop failure due to drought or floods have been recurrent. These disasters have been always put down to natural causes and have been taken for granted as a fact of life. Is this really the full explanation. Could not a part of the damage and the fluctuations from year to year have been reduced or evened out if investments in land development, water conservation and water

control measures had been made over the years particularly in small scale works in the wet zone, where nearly 50 percent of the paddy acreage is located. This aspect will be considered in more detail at a later stage.

Another characteristic of present day agriculture is that a major part of the production of other cereals, pulses and other food crops, for example Maize, Kurakkan, other millets, green gram, black gram, cowpea, cassava and sweet potatoes are produced under conditions of shifting cultivation (Chena cultivation) and in what are virtually semi developed home gardens. The production of these crops had remained more or less static during the period 1947 to 1972 while there was a considerable increase between 1973 and 1974 in response to the ban on imports and the shortages of wheat flour. It sould however be borne in mind that these increases in production have come mostly from chena cultivation. Similarly the increases in production of chillies consequent on the ban on imports of chillies have come mainly from increases in the extents under chena cultivation in the Anuradhapura, Hambantota, Moneragala and other dry zone districts. Even here there is a long way to go. The development of stable systems of farming would increase total production and productivity very considerably.

An important feature of the domestic sector of agriculture in Sri Lanka is that the basic production units consist mainly of small holdings. The 1973 census of agriculture revealed that nearly 80 percent of the total land of approximately 5 million acres in agriculture is covered by small holdings. The extent of 3.89 million acres in small holdings is made up of 1.62 million small holdings with an average holding size of 2.36 acres. Each holding which comprised either of paddy land and upland, or paddy land alone or upland alone is the unit operated by a single individual or family. The number of holdings have increased from 1.16 million in 1962 to 1.62 million in 1973, an increase of half a million holdings. The average size of a holding on the other hand has dropped from 3.31 acres in 1946 to 2.68 acres in 1962 and to 2.36 acres in 1973. In the case of paddy lands only the data from the 1973 census has not yet been officially released. The indications are however that the number of hold-

ings have increased and the size of holding has dropped considerably when compared with the data for 1962 where it was revealed that nearly 85 percent of the holdings were under 2 acres in extent. The trend is unmistakably for more and more families to operate less and less land each. This trend is more marked in the estate areas of the wet zone particularly in the mid country where in some areas the average total holding size has dropped to a quarter acre of highland and half an acre of paddy land.

The generalized picture that emerges of the current state of development of agriculture within the food production sector is one dominated by small individual family holdings in which trends towards further fragmentation are clearly evident as social demands for individual ownership of land remains to be satisfied. Water supply conditions have yet to be stabilized in many regions of the county and stable systemsof farming have yet to develop on the unirrigable uplands. The basic questions that arise for the future development of agricutlure are:- What are the prospects for developing highly productive systems of agriculture in the context of a large multitude of small individual holdings? How is this to be done? How is the food production sector to be integrated with the estate sector with a national system for agricultural dovelopment?

In order to answer this question it would be necessary to identify some basic principles on which the base for food production could be developed in the background of the social objectives of providing employment, a satisfactory income level, a reasonable standard of living and the elimination of poverty in the rural areas. Clearly agriculture and agro based industries located in the rural areas would be the main sources of employment and income generation for many decades ahead. Such a development would obviously have to be achieved within the framework of environmental stability and the long term conservation of land and water resources.

As is well known, Sri Lanka has a wide variation in soil, climatic and water supply conditions. The Land and Water Use Division of the Department has now identified 24 agro-ecological regions in the country, 10 in the wet zone, 9 in the inter-

mediate zone and 5 in the dry zone. Each of these regions has a potential for the production of a different group of crops and each would in addition require different cropping patterns and management systems. 9 out of the 10 main soil groups are encountered within the country. Such a wide range of soils climate and water supply conditions makes possible the cultivation of almost all tropical and sub tropical crops in some part or the other of the island. The island therefore has considerable potential for a diversified and balanced agricultural development. It is not intended to go into details here as this would divert from the main focus of this address. But it is necessary to draw attention to the rich potential that exists and to highlight the scope for a high degree of regional specialisation of crop and livestock enterprises. The food shortages of recent years could really be classified as a shortage of rice and wheat flour. Had the diet been more diversified and had the rich potential for the development and expansion of the local food crops (for example the range of millets such as kurakkan, the tubers, yams and pulses) which fit into specific regions and classes of land also been developed over the last fifty years or so perhaps the position today would not have been so difficult.

In attempting to develop regional specilization and adapted systems of farming suited for systematic crop and livestock production in each region, a number of fundamental factors which would play a determining role in the organization and structure of farming have to be taken into account if the goals set out earlier are to be achieved.

Firstly, all land in this country lies within well defind and clearly demarcated river catchment basins. Apart from some parts of the coastal regions of the country, usually below the 100 feet contour, there are no extensive areas of flat land in the country. The basic land form is that of a ridge and valley type. Secondary and tertiary valleys are generally narrow and rarely more than a mile or so wide. In the dry and intermediate zones the terrain is gently undulating or rolling, while in the mid country the terrain is rolling to hilly and deeply incised. In the up country the terrain is hilly and steep. The fact that most land is sloping

predisposes a greater part of the surfaces of the country to the hazard of soil erosion and projects important consequences for long term stability and the inherent need for the development of soil and water conservation practices.

Secondly, apart from the region covered by the latosols and regosols, which is around 5% of the area of the island, in over 95 percent of the island precipitation exceeds infiltration into soils in most rain storms. Storms of high intensity are relatively frequent in both the wet and dry zones. In practical terms this means that there is run-off of water from the land in most rain storms and since land is not flat the damage that can occur from soil erosion is an ever present reality. The basic need for the effective control and disposal of storm water and the inherant susceptibility of most land in the country to soil erosion make the proper management of land and water an inescapable requirement in any system of land use. Effective soil conservation is therefore vital. Failure to plan for this can lead to serious trouble in the future.

Thirdly, Sri Lanka is dependent on convectional and monsoonal rains for its water supply for agriculture both for irrigation and rainfed cultivation. There are no perennial sources of water and it is a fact of life in this country that irrigation even in the major irrigation works will continue to be dependent on the variability of the monsoons until the desalination of sea water and could seeding for rain can become cheap, regular and wide spread practices. Nevertheless these technological advances are perhaps many decades away and water will continue to be a limiting resource in agricultural production in Sri Lanka. While it would appear paradoxical to suggest that water is a limiting factor in the wet zone, this is in fact so. For instance, experience in paddy cultivation has shown that short periods of drought at critical stages in the crop can have depressing effects on both production and the cultivators incentives to intensifying production. The effective conservation of water and the utilization and management of water are therefore of priority concern and are basic to the development of stable and productive systems

for agricultural production in Sri Lanka. Measures and practices designed to achieve these objectives have necessarily to be applied on relative large units of land. In this context planning and development of water resources have to be carried out in terms of each river basin at the macro level and the micro-catchment (the smallest drainage unit) at the production or farm units level.

Fourthly, within each subsidiary valley, the kinds of crops that can be grown vary according to location within the valley. This is because the soil types in terms of chemical and physical characteristics and soil moisture regimes differ in the bottom lands middle slopes and upper slopes. There are in fact a series of land classes with differing drainage conditions and agricultural potential ranging from the top of the valley to the bottom. Clearly, an effective system of land use which aims at making the best use of the land resources would have to take the existence of these natural land classes into account. The implication of these facts in terms of agricultural systems is that diversification of agriculture is an inevitable consequence of the landscape over most of the country. Such a diversification of land use is inevitable even on relatively small blocks of land. Traditionally the existence of these land classes were recognized in systems of land use that developed prior to colonial times. Rice was located on the bottom lands of the valley and chena crops on the upland slopes. The crop composition of the chenas varied according to position in the slopes as determined by the drainage conditions of the different land classes. In the mid country the mixed gardens of perennial tree crops, nutmegs, cloves, arecanut were usually located on the uplands of relatively low hills and rarely on the steeper slopes of valleys which were left under forest. In addition the focus on land and water use was not on the individual but on the community as a whole. It is interesting to speculate on the form agricultural development would have taken had there been no colonial intervention.

Land classification and the matching of cropping system suitable for each land class is therefore a sine-quo-non for efficient land utilization. This inherant need for diversification poses several questions for the organizational form in which land is

used. The location of a small holding in any position in a valley would permanently fix the income potential of an operator to the potential of that site. Since the income potentials would vary according to position the prosperity of individual farmers would also be dependent on the location of their individual holdings. This would lead in course of time to income differentiation and social conflict. It would appear in fundamental terms that the diversity which occurs even within small blocks of land could best be handled by thinking in terms of total incomes from relatively large units of land and by developing systems whereby incomes are pooled and shared out on some basis. Such an arrangement becomes necessary if full use is to be made of the lands, water and other resources and if equality of incomes is to be maintained.

Fifthly, the valley bottom lands which are normally under paddy cultivation consitute only a relatively small proportion of the total land included in the valley, The percentage of paddy land to the total land in a valley varies according to the region and ranges from 40 - 60 percent in major irrigation schemes, where a part of the uplands are also irrigated, 20 - 30 percent in the minor irrigation schemes, and 25 - 5 per cent or less in the wet zone. It would appear that in a long term programme for agricultural development the paddy land cannot be separated in terms of management and possibly ownership from the adjacent and surrounding uplands. This integration of upland and lowlands into a single system becomes necessary in terms of the need for a maximum use of resources of land and water, in terms of water control and soil conservation. The silent witness of the need for this integration is today the increasing damage that is occurring to paddy lands each season in the wet zone especially in the mid country. The continued separation of paddy lands from the highlands would in course of time lead to a further intensification of the adverse conditions that were created after the establishment of the large plantations on the uplands in the wet zone where the village became hemmed in on the lowlands with no control whatsoever over its water resources.

Taking these five fundamental factors together the conclusion that emerges in regard to the development of viable and productive agricultural systems in Sri Lanka in which maximum use is to be made of the land and water resources is that land and water utilization would have to be managed in terms of large units of land. A small unit of land, for instance an independent small holding either on upland or in a paddy tract or yaya is an organic and integral part of the landscape and cannot be separated from the lands adjacent to it if effective soil conservation, water control and water management is to be achieved. This would mean that planning, organisation and disciplined group action are inherent requirements for obtaining stability and the efficient use of land and water. It is suggested here as a hypothesis, apart from any ideological, political or economic consideration, that the physical features of the landscape and environment in any country also play a determining role in shaping the organisational form of the basic unit for agricultural production. Where the harmony with the environment is broken, the resultant disequilibrium is manifested in soil erosion and increasing hazards from drought and floods. It would appear that under Sri Lanka conditions and in keeping with its social objectives that large scale, organized, labour intensive, collective or cooperative systems as the basic units for agricultural production are better adapted to the requirements of the physical environment than a multitude of independent indisciplined small holdings. These systems would also make possible the integration of the domestic and export sectors into a single system for agricultural production. In addition, the problems of planning and phasing of capital development programmes, the transfer of technology, the organization of agricultural inputs and marketing and the provision and recovery of production credit would be greatly simplified.

It is a popularly held view that Sri Lanka is eternally either in the grip of drought or floods and that nature is rarely kind to us. But is this position really a result of uncontrollable natural causes only? In recent years there has been an increasing recurrence of flash floods and droughts. The damage being done to paddy fields in the wet zone from uncontrolled storm water discharging from the adjoining uplands has been also increasing

in intensity. Could this not be a result of a growing imbalance between the current systems of land use that have developed over the years specially in the wet zone? The facts presented earlier suggest that his variability and damage is in fact at least partly due to such an imbalance and that there is a way out towards stabilizing our agriculture. Clearly the question of developing agriculture in terms of independent holdings would have to be very seriously re-examined. The resolution of this dilemma between the social demands for independently owned and managed small allotments on one hand and the environmental demands for large scale planned, organized and disciplined management on the other presents probably the most serious problems facing the country today. It is abundantly clear that the unchecked prolifiration of small independent holdings and unplanned and uncontrolled use of land and water resources could lead in course of time to a serious breakdown of agriculture production in Sri Lanka.

I am deeply conscious that proposals to develop agriculture in Sri Lanka on the basis of the principles outlined earlier would appear at first sight to be too impracticable and unrealistic. I am also aware of the immense social and practical difficulties in mak ing such a transformation but it is essential that we identify our problems and develop some long term goals and priorities. In the past a planned approach to the management of land and water resources in the wet zone in particular was not possible because of the presence of large estates with small holdings interspersed between them. No water conservation, water control and disposal measures or soil erosion control measures designed to stabilise agricultural production over rela tively large areas of land could have been conceived in this context. Today the position is different. Government policy has been moving in this direction and several fundamental steps have been taken already which will make the transformation of agriculture and the launching of planned and organized programmes for production easier. The land Reform Laws have made for greater national control of land. The Agricultural Productivity Law has provided the organisational framework in terms of the Agricultural Productivity Committees and the Cultivators Committees through which the changes can be

gradually made and productive programmes adapated to environmental needs of each region in the country developed.

This address has so far concerned itself with the need to develop organisational forms for production which are in harmony with the environment. Attention has also been drawn to the fact that soil and water conservation and water management and the stabilization of production should be given a priority rating in any national programme of agricultural development. Attention was also focussed on the conclusion that agricultural production, if it is to be stable, has to be planned and organized in large units. In order to carry out these development programmes a large body of detailed technical information on land classification, soil and water conservation, measures and systems of diversified mixed farming and integrating crop and livestock enterprises suited for the different regions of the country would be needed.

Over the last 50 years or so the attention of agricultural research workers has been directed primarily at improving the productivity of four major crops tea, rubber, coconut and rice. Work on the other crops has been marginal with only a limited investment in staff and other facilities being given to them. Research work on agricultural systems, on soil and water conservation and management, on land classification and utilization had been also limited. The focus has been largely on commodity development and not on systems which were taken for granted. Undoubtedly this development was the result of policies and structures prevailing at the time which in a sense precluded a full scale assault on the development of rural agriculture. The agricultural research was carried out in independent institutes and was highly centralized and commodity oriented. In the light of what has been said earlier there is an urgent need to make a fresh approach to the orientation and organisation of research and to mount a massive programme of agricultural research.

The primary factor that has to be taken into consideration in developing our agricultural research system is the range

of variation in the climatic conditions in this island. Experience has shown, in general terms, that recommendations made for one area of the country are often not applicable in another. The first requirement therefore if agricultural research is to be meaningful, in the national context, is the decentralization of research to major agro-ecological regions and the development of multipurpose regional research stations which would focus not only on individual or a specific range of commodities but also on developing fully the resources of the region for agricultural production. In order to utilize the existing resources for research to a maximum and also ensure a full concentration on all regions of the island, it become inevitable that all the existing Agricultural Research Institutes should be drawn into developing a national programme for research. This would mean that the Tea, Rubber and Coconut Research Institutes would also have to come into the network. An important requirement in this direction is the classification of the island into relatively homogenous agro-ecological regions and sub-regions in terms of temperate, rainfall intensity and distribution, soil types, land forms, water supply etc. The Land and Water Use Division has been working on this for several years and the preliminary classification is now available. Twenty four regions have been identified. It is not proposed that a regional research station be located in each of these regions as some of them are quite small. For the present it would be adequate if the Department of Agriculture established around 6 - 7 regional stations. Two regional stations one in the Northern, one in the Southern dry zone one in the up country region and one in the latosol soil region have already been established. If the Tea, Rubber and Coconut Research Institutes are also included in the national network the basic structure of a national system for agricultural research is already in existence. The problem is largely one of staffing and equipping these stations to carry out the new role that will be assigned to them.

The provision of a regional station however will not meet the entire need for regional research. Within each region there is still variability not only in physical conditions for agricuture but also in the socio-economic conditions

tions of the farmers. The importance of providing research recommendations which can be adopted by farmers within the resources available to them cannot be overstated. This requirement can be met by a further decentralization of the research programmes from the regional research station to the farmers to the farmers fields. Such a programme of carrying out agronomic trials directly in farmers fields is the vital key to an effective system of agricultural research. It has a two way relationship in that practical technical problems faced by the farmers are brought into focus on the one hand and the value of scientific research and new technology is brought home to the farmer on the other. This system of cooperative experimentation between the research worker, the extension worker and the farmer is one of the most effective ways of stabilising scientific systems of farming.

In communicating technical information gathered at the research station to Agricultural Productivity Committees and farmers, two other Institutions have to be closely integrated with the regional research stations, namely, the extension services and farmer training centres. By locating a training centre at the site of a research station, and also by locating at the same point a cadre of highly trained specialists in different subjects for example Water Management, Farm Management and Economics, Crop Production, it would be possible to bring all the components of the information system together and thereby obtain a coordinated focus on the solution of the practical problems of the farmer. This would also help in establishing a technical research and advisory system that would be socially relevent and in harmony with farmers needs. It is anticipated that in course of time this "composite agricultural centre" would become the agro-technical nerve centre for each region. Such a proposal also implies that the activities of the extension services of the different departments and agencies would be coordinated into a national programme which would be towards supporting the Agricultural Productivity Committees in planning and implementing agricultural development programmes within their areas of authority. It is likely however that if the approach to development that

is adopted is in terms of the principles outlined earlier, the present bounderies of Agricultural Productivity Committee may have to be modified in terms of agro-ecological regions, water sheds and catchments.

We have so far considered the question of stabilizing land and water resources and developing organizations for production based on an inter-linked structure of research, extension, training and farmers organizations. It would be necessary before concluding to briefly refer to some technical aspects connected with increasing food production. In achieving these increases in productivity two approaches have to be made.

The first is the development of systems of mixed farming, integrating crops and livestock, which would make the best use of resources and make for improvements in soil fertility and a balanced use of organic and inorganic fertilizers. This development of organized systems of mixed farming is already taking place on many of the Janawasa and Cooperative Farms that have peen recently established. The potential of the wet zone for food production has yet to be fully exploited. Apart from the prospects for associated cropping in coconut lands, which is now widely recognized and has to be fully exploited, there are considerable areas in the low country and mid country in which systems of mixed farming can be developed. The cultivation of local and introduced yams, tubers, vegetables and sugarcane can be considerably expanded and fitted into land classes in the wet and intermediate zones which are not now being utilized or are only partially utilized. In the mid country and the coconut areas of the low country, an intensive programme for developing mixed farms with the central focus on milk production has already commenced. In the dry zone, apart from the Mahaweli Development Project and other major irrigation schemes, the development of systems of rainfed farming should make possible the large scale production of other cereals such as maize, sorghum, kurakkan, meneri etc., pulses, oil seeds, milk, meat and eggs. A potential extent of 3 million acres of land is available for this development. The exploitation of the potential of the tube well regions in the Puttalam, Mannar and Jaffna districts has only just begun.

The second approach to improving productivity is the improvement of the production potential of individual crop and livestock strains through breeding and the development of attendant packages of management practices that would make possible the achievement of the full production potential of the different strains. Sri Lanka scientists have already developed a wide reputation for successful crop breeding, Improved varieties are available in rice, other cereals, pulses, legumes, groundnuts, fibre crops, oil seeds, pasture and fodder crops. In rice breeding in particular Sri Lanka scientists are among the best. A new 4 month variety 90-2 has recently come out at the top of a list of varieties from all rice growing countries tested by the International Rice Institutes at a number of rice growing countries in South and South Eastern Asia. On the livestock side work is in progress for the development of adapted strains of dairy cattle, beef cattle, pigs, goats, sheep and poulty. An intensive program for artificial insemination and the upgiading of dairy cattle in the mid-country, the coconut areas and selected regions in the dry zone has just commenced. It will be seen that the foundation for a take off in food production has been laid already. But this is only a beginning. The programme has to be intensified and greatly expanded to develop new strains better adapted to specific regions of the country. In order to reduce costs of cultivation these strains would have to be inherently resistant to a range of the common diseases and pests, and also incorporate special characteristics such as age of crop, drought resistance, flood tolerance and tolerance to a range of other physical conditions that would enable these varieties to be fitted into specific requirements of the different regions of the country. Such a programme of varietal improvement which is basic to improving productivity has already commenced and could be expected if adequate investments are made in the programme, to have dramatic effects on the potential for food production.

This could be illustrated briefly with a few examples:

1. In terms of rice cultivation 10 edaphic regions with distinctly different rice growing conditions have been

identified. Each of these regions require a specific variety adapted to it and would also require a different package of management practices if future improvements in productivity are to be made. Resistance to disease, pests and other environmental factors will have to be bred into each variety according to the specific requitements of the region. The rice research programme of the Department of Agriculture is now being organized into an integral national programme along these lines. The present high yielding varieties have doubled and in some cases trebled yields per acre in those regions to which they were well adapted. New strains adapted to other regions could be expected to have the same impact.

2. The potential for utilizing rainfall for developing systems of rainfed farming in the dry zone specially in the Yala season could be dramatically changed if very short duration strains of 50 - 60 days of a range of cereals, pulses, and oil seeds could be bred. Such strains are now being developed elsewhere in the world while in Sri Lanka itself 50 —60 day strains of green gram and cowpea have already been bred at Maha Illuppallama. The work in this direction has to be greatly intensified.

3. The potential for expansion in the production of potatoes and the development of a viable programme for potato seed production in Sri Lanka is limited by the prevalence of the diseases, bacterial wilt and late blight over the greater part of the island. There appears to be no way out of this difficulty. But research workers at the International Potato Centre in Peru have isolated potato clones which posses resistance to both these diseases in single clones. New clones have been isolated which are also heat tolerant and which tuberize in 50—60 days at low elevations in the hot season. The development of varieties in Sri Lanka which possess these characteristics could change the whole picture in regard to potato production and make potato a crop that could be grown almost anywhere where soil conditions are suitable.

Spectacular developments are also taking place in developing new varieties of Manioc and Sweet potato at the International

Research Institutes in Colombia and Taiwan respectively. Sri Lanka should be able to draw on these new materials for developing high yielding varieties adapted to local conditions. Similar advances are also possible with the range of indigenous yams and tubers. The question is now one of mounting intensive programmes of research and development with these crops.

Research in the cultivation of soyabeans in Sri Lanka during the last five years has indicated clearly that there is a very high potential for the crop. The incorporation of soyabean into the agricultural systems and into the diet of the people in Sri Lanka could make a significant difference to the nutritional status of the food production programme. A project is now in operation for the development of varieties and cropping systems and food processing techniques.

The intermediate zone of Sri Lanka is well suited to the cultivation of surgarcane as a rainfed crop. The breeding of highly productive rainfed cane varieties and the establishment of adapted systems of cultivation could make a qualitiative change in the local situation relating to the production of sugar and sugar substitutes.

Looking further into the future, advances that are taking place in the biological sciences offer exciting prospects for raising the potential of new crop varieties. For instance, the discovery that some tropical grasses can fix atmospheric nitrogen and the research that is now taking place with cereals has opened up the possibility of developing both natural and synthetic methods for nitrogen fixation directly by cereal crops such as rice, maize, sorghum etc. Such a development would greatly increase productivity and also reduce costs of cultivation. At the same time, it is also becoming possible to bring about improvements in the nutritive value and content of proteins in cereals, legumes and root crops which would radically alter the food-nutrition picture in many countries. There are also indications that it maybe possible to improve bio-conversion of solar energy through the photosynthetic-efficiency and the output of carbohydrate per unit of leaf surface.

The inhibition of photo-respiration would enable this output to be still further enhanced. Improvement in grain and herbage yields are also being obtained by the use of new chemical growth regulators.

In conclusion it would be apparent that Sri Lanka is only at the beginning of its attempt to exploit its potential for food production. The land and water resources are adequate and potential for increasing productivity through the application of advances in science and technology which is still relatively untapped are great. Clearly productivity can be doubled and even trebled. In this respect there is no cause for alarm about the capacity of this country to feed itself in the foreseeable future. On the other hand if we fail to develop systems for the utilization of land and water resources that are in harmony with the environment, the neo-Malthusians may well be proved right.

The basic choice before us is between environmentally unbalanced systems of small holdings, dictated by current social demands, with all the attendant difficulties of servicing and support and the more easily managed, large scale, labour intensive collective or co-orperative systems which are environmentally stable.

CHIEF GUEST'S LECTURE

The Advance of Scientific Agriculture

by

*B. P. PAL, F.R.S.**

I would like to begin by expressing my sense of deep privilege on being invited to be the Chief Guest at this distinguished gathering of scientists and those interested in science. This invitation has made it possible for me to pay my first visit to your famous and beautiful country. I bring with me the warm greetings of the Indian National Science Academy and best wishes for the success of the meeting.

I am conscious that the title of my address, 'The Advance of Scientific Agriculture' is too ambitious and it would need a book—perhaps several books—to do justice to it. I shall therefore only attempt to present to you my impressions of some of the landmarks in the history of agriculture, and to discuss briefly its place in the world of today with some reference to the future possibilities. In doing so, I shall cite mainly the Indian experience not only because that is what I know best, but also because it does present a picture of great changes in agricultural development, in a developing country, which may be of interest, especially to countries in this part of the world.

It is not necessary for me to underline the paramount importance of agriculture which provides food for man and domestic animals and also raw materials required for producing the many things required by civilized man.

The beginnings of agriculture go far back in unrecorded history. Primitive man in the earlier stages was a gatherer of fruits, roots, and other plant products, as well as a hunter of

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animals. He also began to make use of the grains of certain plants which he found growing wild. After some time, we do not know when, early man discovered that he could keep the seeds for the next season and thus he assured of a source of supply of the grains near his dwelling. It was this discovery that made it possible for our nomadic ancestors to settle down in certain favourable regions where, because of the climate, the availability of water, and other resources a settled life was possible. At some stage again, man began to exercise selection regarding the seeds which he gathered for storage. By taking the seeds from the superior plants, primitive man began a very early form of plant breeding. It has been suggested by some—and this can appropriately be recalled this year which is the Women's International Year—that perhaps it was not the man who performed this important act but the women of the household, because she would have had more time for this than the menfolk who would be out hunting most of the time. But, for a very long time, agriculture remained an art and it has only been during the last century or two that it has developed into a technology based on the findings of science. Earlier agriculture was obviously more of a subsistence agriculture, and the type of crop plants that we used were just the opposite of what are required for modern highly productive agriculture. Studies have shown that the pattern of improvement in crop production, by and large, all over the world, reveals a discontinuous rise, this being associated with some major advances in crop husbandry. Only a few centuries ago it was discovered that by growing crops in a rotation, there was a significant increase in the yield per hectare. The next, and very notable landmark was the propounding in 1840, by the German scientist, Leibig, of the famous theory of mineral nutrition of plants which established the role of nitrogen, phosphorus and potassium as the major plant nutrients, as also the role of other elements in plant growth. A little later in the middle of the 19th century, J.B. Laws and J.H. Gilbert of the wellknown Rothamsted Experimental Station in England proved that the supply of nitrogen was essential for the growth of non-legumes. Then in 1866, the German scientists, Hellriegal and Wilfrath established that leguminous crops like the pulses have the ability to fix atmospheric nitrogen with the help of bacteria. It was only in the beginning of the

20th century that the wide-scale use of chemical fertilizers for crop growth began in agriculturally-advanced countries. In the countries which became industrialised, agricultural equipments were also invented for economising the manual labour.

Yet another very important landmark in the progress of agriculture was the rediscovery in 1900 of Mendel's Laws of Heredity which had remained almost unnoticed in the pages of an obscure journal. These laws gave birth to the science of Genetics which has made astonishing strides, and has given the scientists new tools for tailoring plants suitable for the needs of intensive agriculture. Based on the new knowledge of genetics and the considerable advances in plant physiology, a new type of plant architecture has been successfully constructed in the case of rice and wheat—two of the most important food crops of the world. The older, taller varieties of these crops used to lodge i.e. fall down, if heavy fertilization was applied, especially after irrigation whenever there was a high wind. The upper leaves also tended to shade the lower leaves so that the latter could not carry out photosynthesis efficiently. The new type of dwarf plant which was developed, using in the case of wheat the dwarfing genes from the Norin-10 wheat of Japan and, in the case of rice the Dee-Gee-Woo-Gen variety from China, were responsive to heavy application of fertilizer, were resistant to lodging, and the more erect leaves allowed sunlight to reach the lower leaves also. At the present time, endeavours are being made by plant breeders to breed dwarf strains in some other crop plants like barley.

Another phenomenon which has led to very significant results in agriculture is that of hybrid vigour i.e. the greater vigour which results when certain varieties are crossed together. Hybrid vigour was known to early man which he exploited by crossing the horse and the donkey to produce that study but sterile animal, the mule, which was used a great deal in the armies of the past before mechanised transport became general. Generally a male donkey and a female horse were crossed to produce the mule of which it has been said that, "it has no pride of ancestry and no hope of posterity". Although the existence of hybrid vigour in plants was known for a long time, its spectacular use in agriculture was achieved only in the 20th century when the United States

of America went in for hybrid maize on a very large scale. Such hybrids, have since been used in other countries very successfully not only in maize but also in other crops like sorgum and the pearl millet.

Though crossing of different species as distinguished from crossing varieties is often difficult, and in many cases, leads to sterile hybrids, yet there are several instances where such inter-specific crossing has given valuable results. The sugarcane industry of north India is based on crosses made at Coimbatore several decades ago between the noble cane, *Saccharum officinarum* and the wildgrowing *S. spontaneum*. Another remarkable instance of more recent times is the cross between the pearl millet and Napier grass which has yielded hybrids of tremendous productivity.

Many other scientific discoveries are making it possible to produce new varieties using such methods as the artificial transmutation of the gene, by doubling the chromosome number of plants, by the genetic manipulation of the grain quality (an outstanding example of this is the work by Mertz, Bates and Nelson on the opaque-2 gene in maize), the use of tissue and cell culture (including anther culture) for the multiplication of elite individuals in certain economic plants like tea, orchids, etc.

I have referred so far mainly to the achievements in the improvements of the plant itself. But agriculture involves a large number of fields and significant advances have been made in all these as a result of scientific researches. These includes such large and important areas as soil management and fertilizer use, water management including irrigation techniques, plant protection against the hordes of pests and diseases which afflict economic plants, and agronomy, i.e. the synthesis of plant and soil technology to give the most efficient and economic results in the field, multiple cropping being one instance of this. Here I must point out that agriculture embraces animal husbandry also, but in the space of a short lecture it is not possible for me to make more than a passing reference to that vast and importan field.

But whatever results science might offer in particular fields, to be of any practical use there has to be devised, ultimately, a suitable package of practices for the farmer to adopt. This package has to be different for different soil and climate regions, and must in fact be severely tailored to the needs of the particular locality. Carrying the results of research to the farmers involves agricultural education, a well-organised extension service of persons trained in the art of communication, the involvement of economists to guide the overall policies, arrangements for easy credit to the farmers, the provision of numerous other services required by the farmers, and so on. How does one provide an organisation which will deliver the goods and thus sustain the vital, modernized, highly productive agriculture? As every one knows, the agriculture from region to region is different and location-specific, and agricultural technologies developed in other parts of the world by national institutes or international institutes may not normally be expected to be directly and fully applicable to any other country. In view of this, how does one build up within the country the necessary set-up in research, education and extension which will be responsive to the national development goals? We have so looked at things in a general way. Let us now take a specific case, namely, that of India.

Up to the mid-sixties, several international experts thought that India was "a lost cause" from the view-point of achieveing self sufficiency. In fact the Paddock brothers in 1964 predicted that in view of our vast and expanding population and the heretofore inadequate increase in agricultural production, our fate would be similar to that of "sheep going to the slaughter house". But in the five years that followed came after (1967-72) India achieved a doubling of its wheat production; there was also considerable success in the development of varieties and hybrids in some other important food crops like maize sorgum, pearl millet and potatoes. This breakthrough in agricultural production though it did not embrace all the large number of crops that exist in this country, and though it did not cover many areas of the country, was so striking that it was termed by some one as the 'Green Revolution'. A tribute to this achievement in a special report from the Rockfeller Foundation some of whose experts have worked in India, reads as follows:

"The speed with which India's farmers and scientists, with some materials and counsel from the outside, suddenly gave their country the approach to an abundant food supply has never been duplicated on an equal scale any where else in the world, including the agriculturally sphisticated United States".

When the sharp increase in agricultural production became first evident in 1967-68, some people thought that this was merely a flash in the pan, brought out by favourable weather conditions during the year. But production continued to rise and the conclusion became inevitable that the reorganisation of the agricultural structure in India especially in the fields of research, education and extension had begun to pay off. I now propose to examine briefly the major factors which contributed to this remarkable change.

Let us first consider the institutional structure for agricultural research in India. The beginning of agricultural research and education on modern lines in India began during the last decade of the 19th century and the first decade of this century with the establishment of the two major research institutions, namely, the Imperial (now, Indian) Veterinary Research Institute in 1890 and the Imperial (now, Indian) Agricultural Research Institute in 1905. Five colleges of agriculture were also established in the provinces (now, States) at Coimbatore in 1878, Nagpur in 1888, Poona in 1890, Cawnpore in 1906 and Lyallpur in 1909 (the last-named is now in Pakistan). Agriculture was at that time directly administered by the Central Government but about 1920 following the so-called Montford reforms, agriculture was declared as a 'transferred' subject, the responsibility being thus transferred to the States. However, promotion of special studies of research, as well as coordination and determination of standards in the institutions for higher education or research remained within the purview of the Central Government.

I would like to refer in particular to the Indian Agricultural Research Institute founded in 1905 at Pusa, in the State of Bihar, and transferred to New Delhi in 1936 as a consequence of the disastrous earthquake of January 1934 which severely damaged

the original buildings. This Institute deserves special consideration because it has played a parental role in the development of agricultural research and education in India. It is well-known that the pioneering researches conducted at this Institute led to the development later of several full-fledged institutes such as the Sugarcane Breeding Institute at Coimbatore, the Central Potato Research Institute at Simla, and the Central Tobacco Research Institute at Rajahmundry. In its earlier phase of providing Postgraduate Education it played an important role in training candidates for the higher ranks of the agricultural services in India. Later, after the setting up of the its Postgraduate School in 1958, it not only established itself as a major world centre of postgraduate education in agriculture, but, especially in the 1960's it played a vital role in providing technically-trained manpower for the agricultural universities which were coming into existence.

When it was first established it had an outstanding staff of scientists including such well-known names as E. J. Butler in Mycology, Albert Howard in Plant Breeding, Lefroy in Entomology and Leather in Agricultural Chemistry and Soil Science. But for various reasons, and especially after the transfer of the subject of agriculture to the States, it had become greatly weakened, and at the time of its transfer to New Delhi in 1936 it consisted of only five sections with a skeletal staff though the imposing designations like Imperial Agriculturist, Imperial Mycologist and so on, remained intact. In its original site the Institute was isolated and it had no relationship even with the local farming community, as the Institute was not authorised to do any extension work in those days. After the move to New Delhi, isolation was broken. A section of agricultural engineering was added after some time. But it was only during the period 1950 to 1960, that is, soon after Independence, that the Institute expanded rapidly as a result of the Second Five-Year Plan. The momentum was maintained and even accelerated in the Third and Fourth Plans.

The Institute which now has 18 major Divisions, has magnificent facilities including the largest agricultural library in this part of the world, a gamma radiation field, a Nuclear Research Laboratory, and sophisticated equipment, besides one

of the best mycological herbaria; one of the largest named collections of insects; a very high-yielding milch herd of cattle, large living collections of crop plants, etc. It also has more than 20 branch stations of its own, located in the different soil-climate regions of the country to facilitate its researches. In 1958 with the founding of its new Postgraduate School it entered a new phase in its development. The Institute received the status of a deemed University with authority to give its own degrees of M.Sc. and Ph.D., and it attracts students not only from all parts of India but from many other parts of the world also.

Starting from 1951, the Institute reorganised itself to play a more vital role in Indian agriculture. A Staff Research Council was organised which met regularly to consider the research programmes of the Institute, and to arrange for the necessary co-ordination both between Divisions and within Divisions. The facilities for research began to be augmented susbtantially, or instance, by the addition of a Radio-Tracer Laboratory, an Electron Microscope, and so on. But an important landmark, as already mentioned, was the setting up of the Postgraduate School in 1958 on thoroughly modern lines, and with a complete integration research, teaching and extension education. As a result of the changes which I have referred to only very briefly, the Institute was able to play a dynamic role not only in providing highly-trained technical manpower to the newly emerging agricultural universities but it also naturally became the focus of many of the all-India coordinated research projects to which reference will be made later.

The second important factor to which I would like to refer is the establishment of the agricultural universities of which there are now more than 20. Previously there were agricultural and veterinary colleges attached to the traditional universities though often located at quite some distance from the main campus of universities. The curricula etc. were modelled on rather old-fashioned lines and there was missing the live contact with the farmers whom the researches and teaching in the agricultural and animal husbandry sciences were intended to serve. There had been stagnation of agriculture over a long period and something was needed to drastically change the state of affairs.

The agricultural universities were founded with the idea that there *must* be universities in a country in which agriculture is so dominant where the researches are primarily concerned with solving the problems of the farmers, and where the teaching material is based on the results of such researches. Extension education was also a necessary part of the process of improvement of agriculture and strong Departments for Extension Education were set up while the universities were also given some responsibility for extension work in rural areas. It was stressed that there must be a two-way traffic between the universities and the farmers whom they serve, one stream carrying the results of research to the farmers, and the other stream bringing back to the university, the reaction of the farmers to the new technologies which were being recommended and also the further problems of the farmers.

Typically, and ideally, an agricultural university was intended to be a single campus university to allow the fullest interaction between its constituent colleges which would be, according to the pattern, an agricultural college, a college of veterinary medicine and animal sciences, a home science college, a dairy science college and a college for the basic sciences and humanities. There might also be a college of agricultural engineering. However, because in several States there were already a number of well-established agricultural and veterinary colleges, quite a few multi-campus agricultural universities were established. According to the concept laid down by a high level committee, all agricultural research and education including extension education were to be transferred by the State to the universities which were also to be given adequate areas of the States for extension activity. The latter was to be carried out in cooperation with the Department of Agriculture which would continue to serve the most important function of making available the supplies and services, loans, etc. to the farming community. The first of the agricultureal universities was set up at Pantnagar in Uttar Pradesh in 1960 and it was soon followed by a number of other universities. The extent to which the original concept of the universities was followed in setting up the State universities has been a factor which has contributed to the degree of success of the agricultural universities. Some universities like those at Pantnagar, at Ludhiana in the Panjab, and Bangalore in Karnataka have

already proved very successful while the others are in various states of development. The universities have also got, besides their own campuses, a number of research stations for conducting research and testing out the various recommendations made by the research staff. The setting up of these universities has been a key factor in the development of agriculture in India, not only because of the research and education activities conducted by them but because they provide the necessary testing facilities for the results flowing from the All-India Coordinated Research Projects to which references will be made later.

The third major factor leading to the transformation of Indian agriculture was the reorganisation of the Indian (formerly, Imperial) Council of Agricultural Research Founded in 1929 on the recommendation of a Royal Commission on Agriculture, it was given the form of a registered society to give it the necessary independence and flexibility. The Royal Commission had felt that it was necessary to have an organisation which would coordinate agricultural research which now was being conducted both by Central and State agencies. However, the Council in the earlier years of its existence was not able to play the important role visualised for it and, in fact, for quite some time it had become, rather curiously, an attached office of the Government. It sanctioned a large number of research schemes and also brought out some publications, but there was no effective coordination of research and education within the country. As a result of the recommendations of a number of high level study teams which included international experts, the Indian Council of Agricultural Research was thoroughly reorganised in 1965-66.

Today the ICAR is a fully autonomous, non-Government institution, headed by a Director-General who is a career scientist. All research institutes in agriculture financed by the Central Government have been transferred to it including those which were previously financed by the Central Commodity Committees. As a result of this all the Central Research Institutes in the field of agriculture including animal husbandry and also fisheries now operate under the aegis of the Council. The present arrangement frees the ICAR and the Central Research Institutes from the rigid governmental, administrative control and procedures

while still ensuring public accountability. The twenty-four research institutes which now are with the Council cooperate with each other but they have a very adequate measure of functional autonomy. An Agricultural Research Service covering all the scientists in the ICAR system has already been initiated.

Though the agricultural universities are set up by the State Governments which provide them with the necessary funds, the Council also makes available substantial financial help for their development and for their research and educational programmes. In fact it may be said that taking together the present system of the Indian Council of Agricultural Research and the Agricultural universities of which there is now at least one in each State India has today perhaps one of the finest institutional infrastructures in respect of research and education for agriculture. It is an ideal set-up also for cooperating with the agricultural research and education organisations of other countries and with the International Institutes which have come up in several parts of the world.

We have seen how important changes took place, strengthening the infrastructure for research, teaching and extension in the field of agriculture. As a result of the interaction of this development, a new system of profound significance to the future of Indian agriculture was evolved, namely, the All India Coordinated Research Projects. It was the successful implementation of these projects that contributed very greatly to the breakthrough in agricultural production in India.

Basically an All-India Coordinated Project comprises the following features. In drawing up the projects, scientists from the Centre and from the States sit down together to plan a project in which the emphasis is placed on an urgent applied programme of research, which has as its objective the identification of high-yielding genotypes which will smash the existing yield barriers, and also the evolution of an appropriate agronomic technology, including plant protection practices, to go with it, so that the high yield potential of the new genotypes is achieved under field conditions. In looking at the problems relating to a particular crop, the political boundaries of States are disregarded and

a major research centre is established, usually by strengthening an existing institution or experimental centre. These research centres are administered by the States in which they happen to fall but additional funds are provided by the Indian Council of Agricultural Research to enable the programme to be carried out at full strength. Other important features include the appointment of a wholetime Project Coordinator and the provision of a world collection of germplasm so that the plant breeder can have at his disposal the maximum genetic material necessary for his work.

Once a year (twice a year in the case of rice which is grown in many areas in two seasons or sometimes even three, in the same year) there is held a workshop meeting at which the results of the previous year are critically evaluated and the detailed programme for the next year is drawn up. Whereas previously there was difficulty in effecting coordination between research workers in Central institutions and those working in State-controlled institutions with the introduction of the All India Coordinated Projects where scientists work as equal partners, the isolation has been replaced by cordial cooperation.

The research centres under each coordinated project also provide excellent facilities for the testing of new varieties evolved under the project, or even those imported from abroad. In fact the rapidity with which the dwarf wheats obtained from Mexico from Dr. Borlaug in 1963 were evaluated, leading to the large-scale multiplication of the varieties found suitable, was only possible because of the existence of this mechanism for trying out new material. Since the trials are conducted in a joint programme and the scientists at all the centres have an opportunity of seeing for themselves the material under trial, new varieties or agronomic recommendations made by the Project Workshop find ready acceptance.

For popularising the new varieties among the farmers the Central Government with the cooperation of the State Governments has been conducting National Demonstrations on the fields of the farmers themselves. Experiments had shown that if the trials are limited to state-owned research stations the farmers

are hesitant to take up the new varieties or new recommendations because they feel that Government has more resources than they have. But if they find that another farmer is adopting the new technology with success, they feel that they too can do what that particular farmer could do. Of course the story of success would not have been complete if the Departments of Agriculture both at the Centre and the States had not provided the supplies and services and the extension support which is absolutely necessary to carry the results of research to the fields.

We have seen how agriculture has advanced from a traditional system to a modern one involving the utilization of many inputs, especially those flowing from the application of science and technology. But the present technology can only help to feed mankind for a few years more because of the tremendous population explosion which is posing a great problem, especially in developing countries. It becomes necessary therefore to plan ahead so that for the future generations also, an adequate supply of food and other materials is assured. It was with this object in view that recently the Indian National Science Academy organised a Symposium on the subject of Basic Sciences and Agricuture.

At the Symposium it was recognised that the future needs of the human race will be so vast and in some ways so unpredictable that much thought needs to be given to the ways in which scientific research should be planned to anticipate and provide solutions to the colossal and intricate problems of the future. Basic research will be necessary to create, for instance, entirely new economic plants, to improve the ability of plants to use the sun's energy in photosynthesis, to augment the sources of biological nitrogen, and if possible, make crops like wheat and rice fix their own nitrogen from the atmosphere, and so on. Quite a number of ideas have been put forward by scientists regarding the revolutionary ways in which the plant and animal productivity of this planet could be substantially increased for the benefit of mankind. But at present most of these are only ideas and will require a great deal of basic research before a suitable technology can be evolved for their practical use.

There is no doubt that agriculture which has made tremendous advances based on science and technology will have to advance much further to cope with the problems of the future. To do this the resources of individual countries may not be sufficient and international cooperation on a much greater scale than here tofore will have to be secured. If we use properly the tools which science has made available to us and particularly if we do the right kind of thinking, we need not be pessimistic about the future of agriculture.

I would once again like to express my deep gratitude to the Sri Lanka Association for the Advancement of Science for the opportunity they have given me to address this distinguished audience. I thank you.

SECTION A — MEDICAL AND VETERINARY SCIENCES

PRESIDENTIAL ADDRESS

The Rational Basis of Therapeutics

by

N.D.W. LIONEL

Mr. President, Distinguished Visitors & Fellow Members:

I have chosen to speak on the rational basis of therapeutics because treatment of disease is a subject of primary concern to the doctor as well as the layman and as a clinical pharmacologist my chief interest in medicine has been the application of scientific methods to evaluation of drugs so that the art of healing may have a rational basis.

Throughout the ages man has searched for therapeutic agents and measures to cure disease or at least relieve his sufferings. The art of healing in the past was chiefly based on personal observations and experience as well as on tradition and authority.

Till recent times therapeutic measures were often adopted in clinical practice if their use was followed by a beneficial effect. If a person got well after a particular treatment, then it was assumed that the improvement was due to the treatment. Treatments were also used on the basis of traditional beliefs or because they were advocated by the medical authorities of that period.

Some of those authorities had their own fanciful theories regarding the origin of disease and the best methods of treatment, and depending on the power of their personality and their standing in the medical profession, were blindly accepted by others.

For example at one time it was thought that most diseases were caused by absorption of toxins from the colon. One powerful exponent of this theory was Sir Arbuthnot Lane, time one president

of the Royal College of Surgeons who advocated the drastic remedy of removing the whole large intenstine as the treatment of choice for a wide variety of diseases.

Hedley Atkins recalls this era in a paper read to the British Medical Association in 1966. "When my father was a dresser to Sir William Arbuthnot Lane at Guy's Hospital", he states, "fibroadenosis of the breast, thyrotoxicosis, rheumatoid arthritis and a dozen other assorted diseases were treated first of all by paraffin to dispel auto intoxication and if that failed, by total colectomy to remove the septic tank which an unwise deity had bestowed on mankind in the shape of the large intestine" (Atkins, H. 1966).

Letting out blood was a traditionally accepted therapeutic measure, widely used in the treatment of fever for hundreds of years. No one ever thought of questioning the value of this therapeutic measure as it was practised by everyone. In 1835 Pierre Louis working at the Charite Hospital in Paris, used what he called the numerical method to study the effects of blood letting in pneumonia. His results showed that the later in the illness the patient was bled the better the outcome of the illness, and he drew the logical conclusion that if bleeding had not been carried out the results would have been even better (Louis, 1835). However in the minds of his colleagues it was the best treatment advocated for the condition by the great medical practioners of that period. To have stopped the practice of blood letting would probably have amounted to criminal negligence and so it is stated that Louis continued to bleed his patients—a measure which we now know to be not only useless but also dangerous.

Medical history is replete with examples of treatments that have been adopted with great enthusiasm at one time but which are now largely forgotten. The uselessness of some of these therapeutic measures were known even to the laymen. In the seventeenth century in France Moliere in his plays ridiculed some of the therapeutic measures used in his time. In 1860 Oliver Wendel Holmes in a lecture to the Massachussetts Medical Society stated "Throw out opium which the Creator himself seems to prescribe, for we often see the scarlet poppy grow in the corn field as if it

were forseen that wherever there is hunger to be fed there must also be pain to be soothed. Throw out wine which is food, the vapours of which produce the miracle of anaesthesia, I firmly believe that if the whole material medical as now used could be sunk to the bottom of the sea it would be all the better for mankind and all the worse for the fishes".

Although today the acceptance of remedies on the basis of tradition and authority is much less, claims for the therapeutic value of drugs are still often based on clinical impressions formed as a result of observing the response which followed their administration. Unfortunately such clinical impressions can be wrong as they are based on the simple but fallacious reasoning that any change in the clinical picture that occurs after administration of a drug is due to it. Such resoning fails to take into account other factors which may influence the results.

There are undoubtedly a few clinical situations where the effect of these other factors are negligible. For example before the advent of streptomycin, tuberculous meningitis had a uniform course with a 100% mortality. Therefore in such an instance clinical impression of a dramatic reduction in mortality following the use of a drug would be sufficient to indicate its value.

But very often we have to evaluate drugs in diseases which run a variable course and which may be influenced by many factors other than the drug itself. Clinical impressions would then often be unreliable. In such situations clinical impressions are useful only in the sense that they may give some indication of the value of a drug or therapeutic measure but such impressions should always be verified by methods designed to take into account or eliminate other factors which may influence the results and in this way gain quickly an accurate knowledge of the value of a particular treatment with minimum loss of time, money and lives.

It is the evaluation of therapeutic measures on the basis of clinical impressions reinforced by tradition and authority that has been responsible for the survival of numerous remedies of no therapeutic value for a long time in clinical practice. We have only to think of such traditional methods of treatment as blood

letting for fevers, a practice which persisted for humdreds of years, to realise that clinical impressions of clinicians over centuries may still not reveal the true value of a treatment.

The classical example of the 20th century is the use of gold injections for the treatment of pulmonary tuberculosis which was introduced in the early 1920's and remained a popular method of treatment for about 15 years. D'Arcy Hart in 1946 in a survey of the number of papers on the treatment of pulmonary tuberculosis with gold, listed in the Index Medicus each year, found that it varied from about 20 to about 110 a year till it went out of fashion with the arrival of modern anti-TB drugs (Hart, P. d'A, 1946). In this instance gold would not have had any beneficial effect in pulmonary tuberculosis, and being a toxic drug there is no doubt that many patients would have suffered unnecessarily from these toxic effects and some may indeed have died as a result of the treatment rather than from the disease.

Judgements based on clinical impressions have been responsible even in recent times for the use of widely different drugs for a particular disease without clear proof of their value.

Another powerful factor which in recent times plays an important part in influencing therapy is the formidable and skilled promotion of drugs by the pharmaceutical manufacturers. According to the Report of the Committee of Enquiry into the relationship of the pharmaceutical industry with the National Health Service in Britain the source of information which most influenced the general practitioners to prescribe a particular corticosteroid for skin disease was drug firm representatives and drug firm literature in the case of 68 %. While the pharmaceutical industry is not heedless of the well being of patients it has other and more commercial interests as well. As a manufacturer once stated, "What we do for the public good is a by-product of what we do for our own private good." This has resulted in high pressure promotion of drugs based upon inadequate data which in turn has led uncritical acceptance and use of numerous useless remedies without any rational basis.

Just a little more than a decade ago bottles of a preparation labelled as a "blood purifier" was sold by the thousands, in this country on the basis of such promotion. All it contained was a little potassium iodide, extract of water cress and alcohol. Obviously there was no rational basis whatsoever for its use. Yet it enjoyed immense popularity for many years till its import was banned, because the manufacturers exploited the concept of impure blood believed by many in this country to be an important cause of some diseases.

In the interest of patients therapeutics must have a rational basis; one has to discard tradition, authority, clinical impression and promotional material of drug manufacturers as the basis for selection of a remedy to treat disease; one has to rely on proof that a remedy is of value based on scientific methods.

Fortunately a method —the controlled trial has now been devised which will determine the clinical value of a particular remedy or therapeutic measure, taking into account all the varying factors which may influence the results. Although this method is relatively new to medical research and has gained ready acceptance in medicine only since the late 1940's it has been used for a long time in other branches of science.

Much credit for the development of this method goes to Sir Austin Bradford Hill in Britain. His design of trials of streptomycin in tuberculosis may be considered a landmark in the history of modern therapeutic trials, although there have been in earlier times isolated instances of studies where controls have been used as for example the study by James Lind in 1735 on the value of orange and lemon juice in preventing scurvy.

In order to appreciate the importance of the controlled trial one must consider some of the factors which may influence the course of a disease.

One important factor is the natural remission of disease. Several diseases, acute as well as chronic, may show spontaneous remissions and if a drug or therapeutic measure is started by chance just before a spontaneous remission, the beneficial effect may be erroneously attributed to them.

Next, the bias the patient or the doctor may have, with respect to the treatment, may also influence the response to treatment and must be reckoned with in all clinical evaluation. Both patients as well as doctors may show enthusiasm or even a lack of enthusiasm for a particular treatment. Patients if told that they are receiving a new effective treatment for their disease may be inclined to see good effects after its administration. Similarly the doctor may be biased in favour of the treatment to be tested and may consciously or unconsciously record improvement after treatment, or he may even communicate his bias, to the patient. The importance of this unconscious or conscious communication has been shown by a study by Batterman and Grossman in 1955 in which no difference between aspirin and placebo was detected by the patient unless the physician knew what drug was administered to the patient (Batterman, & Grossman, 1955).

Bias may influence the results particularly when they are evaluated on the patients subjective assessment of the degree of relief of symptoms or where subjective evaluation of the treatment is made by a doctor who knows what treatment is used. Bias does not usually affect results assessed by objective measurements such as estimation of haemoglobin to evaluate drugs used in anaemias, or estimation of blood sugar to assess the effects of antidiabetic drugs. For example in lung infections when X-rays of the chest are used to measure the response, wide variations in interpretation may be seen depending on the observer's enthusiasm for the treatment given.

Another important factor which may influence the results is the placebo effect. A drug or therapeutic measure which produces effects on the patients as a result of believing what is suggested by their administration and not to any pharmacological properties possessed by them is termed a placebo. Except in an unconscious patient, every drug administration consists of more than the mere introduction of a particular chemical substance into the body. In most situations where drugs are used in the treatment of disease, factors influencing the response are, the drug itself, the person taking it, and the individual administering it or on whose advice or instruction it is taken. Each of these factors will contribute

a varying amount to the over all effect of the drug depending on the nature of the disease.

It is well known that many diseases are greatly influenced by psychic and emotional factors. Such factors may result from a physician's expectations from the drug used, the patient sharing the latter's expection as a result of the confidence engendered in the patient by the physician and also by the patient wishing that the drug will be effective.

Response to administration of drugs unrelated to the pharmacologic actions of the drug are known as placebo effects. All drugs may produce placebo effects and this complicates the interpretation of drug responses in man. Numerous studies have shown that placebos can not only relieve mental symptoms, such as anxiety but even symptoms such as angina, headache, asthma, intermittent claudication, seasickness and cough in about 30-40 % of patients (Beecher, 1955). Many drugs used in the treatment of such symptoms may have no more than a placebo effect. Clinical impressions alone are therefore not dependable in determining whether the effect of a particular drug is due to its pharmacological actions or to a placebo effect.

The introduction of any new drug is usually immediately followed by numerous uncontrolled favourable reports of its therapeutic value, but in many instances controlled studies indicate that it has very little value. The initial favourable reports are due not just to bais or uncritical enthusiasm but to a placebo effect. Placebo effects have their place in therapeutics and should not be ignored but it is our task to find out whether a therapeutic response obtained is due to a placebo effect or to specific pharmacological action. Such knowledge is needed if therapeutics is to advance and toxic effects are to be avoided.

In order to use drugs and therapeutic measures in a rational manner, they should be selected for use where possible, on the basis of their effectiveness demonstrated by controlled trials. The doctor must therefore have some understanding of the essential features of such trials so that he can judge whether a remedy he has in mind to use has been proved to be effective.

First of all adequate numbers of patients must be used in evaluation. In general, as the sample size increases, the effect of extraneous variations (provided it is not distributed in a biased manner among the group) becomes smaller and the chance of detecting a difference between the effects of the treatments if it really exists becomes greater.

The method of assessement must be a sensitive one. Sensitivity is the ability of the method to detect any difference between treatments if such a difference exists. This is best illustrated by the trial of obstetrical analgesia reported by Matthews in 1963. In this study 280 mothers were given pethidine and promazine or pethidine and saline in a randomised manner for the relief of pain during labour. The results were assessed by questioning the mothers after delivery on the effects of the treatment and there was no significant difference between the 2 treatments. The trial was then repeated in another 292 mothers, but this time the mothers were questioned during the period of action of the drug and a statistically significant difference was found between the 2 treatments indicating the effectiveness of promazine. The first method of assessment was too insensitive to demonstrate this.

The difference between the two methods, was that in the second method the patient responses were recorded as the course of drug action developed, while in the first method the patient recorded the data at a later time sometimes even as long as 2 weeks after the event.

Every effort should therefore be made to minimise the period between the experience with the drug and recording and collecting of the data.

Next, the drug to be tested must be used in optimum dosage determined by pilot studies. If the dosage used is too low, no therapeutic response will be seen. Conversely when too large a dose is used the incidence of toxic effects may be high and may obscure the therapeutic response. Also some drugs produce their effects slowly so that a therapeutic response will not be seen with short courses of therapy. The duration of treatment must be adequate to assess such drugs.

Several studies have indicated that patients often fail to take the drugs in the dosage and at intervals prescribed. The defaulting rate has been as high as 50% in some outpatient trials. This may explain some of the paradoxical results encountered in different clinical trials with the same drugs and also unexpected therapeutic failures. Drug administration should therefore be closely supervised where possible or else only patients who can be relied upon to take the drugs should be selected.

As mentioned earlier, since many factors apart from treatment influence disease, in assessing the effect of a drug or therapeutic measure, the results observed only have a meaning when they are compared with the results observed in an equivalent group of individuals not given the drug in question. This latter group is referred to as a control. By the use of controls, the effect of other factors which may influence the disease is taken in to account in assessing the effect of the new treatment, because, these other factors would influence the results in both groups of patients.

Absence of controls causes excessive optimism in the interpretation of results. It has been observed that uncontrolled trials of new remedies show a much higher proportion of success than controlled trials of the same remedies.

This is best illustrated by the MRC trial of antihistamines in the common cold. Extravagant claims were made several years ago that antihistamines were beneficial in the treatment of the common cold. The MRC of Great Britain in a controlled trial of an antihistamine in this condition treated 201 patients with an antihistamine and 173 with a placebo. It was found that 13.4% were cured with antihistamines on the second day and 68.2% were improved. One could have concluded that this was striking evidence of the value of antihistamines in the common cold but for the fact that the results obtained with the placebo were equally good—13.9% being cured in one day and 64.7 % in two days (Medical Research Council, 1950).

The importance of controls in evaluating even some surgical procedures has been demonstrated.

For instance ligation of the internal mammary arteries was once advocated for the relief of angina pectoris on the basis of uncontrolled studies which indicated that spectacular benefit was obtained in such cases. Some, suspecting a placebo effect performed double blind studies with the permission of a group of patients in half of whom the internal mammary was ligated while in the other half the arteries were exposed but not ligated. Neither the patient nor the doctors assessing the results knew what had been done. The results showed that the improvement was the same in both groups (Dimond, Little & Crockett, 1960) As a result of these trials the operation was abandoned within 2 years of its introduction, and all the investigators who initially reported good results have now abandoned the operation. Such a controlled study prevented many individuals being subjected to the operation which though simple had a mortality rate and like all placebo effects a transitory effect.

Interest was at one time aroused in the treatment of chronic intractable asthma by removal of the carotid body (cervical glomectomy). Nakayama a Japanese surgeon was the first to advocate this operation. In 1961 he reported on a series of over 3000 patients operated on by Japanese workers since 1942 and claimed that 80% showed marked improvement at the end of 6 months. Other, uncontrolled studies appeared to confirm his findings (Overholt 1962). However, controlled studies soon revealed that similar beneficial effects were obtained with a sham procedure where an incision was made and the carotid body left untouched (Marsellke et al, 1965). As a result of these studies the operation has been abandoned.

You will therefore realise the importance of using controls in evaluating treatments.

There are two types of controls used in assessing the therapeutic and toxic effects of a new drug. First is a placebo. The placebo control is important to assess the effects of what two types of phenomena on the therapeutic response. One is the effect of sugges-

tibility, personality, attitudes, anticipation and other forms of bias on the part of the patient, investigator or observer. Such a placebo effect is inherent in all medications regardless of whether they are pharmacologically active or inert. To be certain that the effect of the drug being tested is not merely a placebo effect it is essential to compare its effect with a pure placebo.

In addition the placebo provides a vital control for spontaneous changes in the course of the disease or in the symptoms.

Placebo controls are not always necessary or desirable as controls. If an effective drug is already available then the important question is whether or not the new drug is superior to the standard drug, and a placebo control would be inappropriate. There would also be no justification for withholding an effective drug from the patients. In such instances the drug which is being tested should normally be compared with the standard drug. For example in a trial of a drug in pneumococcal pneumonia it would be unwise to use a placebo as control because psychological factors have little effect in influencing this condition and the disease is known to respond well to certain drugs. It should be tested with a standard antibiotic such as penicillin.

Sometimes both placebo and standard treatment may have to be used as controls.

If comparisons are to be made between groups of patients then such comparisons must be made concurrently. This is because the severity of the illness may differ with different periods of time. Also the populations compared may be quite different in different ways not apparent to the investigator. Ancillary treatment may change with time and hospital and nursing care may improve or deteriorate. If comparisons are made concurrently the known and unknown fluctuations in the disease, with time, changes in the environment with time, the type of patient selected are more likely to be equally represented in each group.

In a trial of an oral vaccine against the common cold, it was found that volunteer students suffered an average of 5.6 attacks in the year previous to vaccination and an average of only 1.8

attacks in the year following vaccination. It would appear that there was a significant reduction in the number of colds, after vaccination, but a study of a control group who did not receive any vaccination showed similar results, namely an average of 5.5 attacks in the year before the study and 1.7 in the year of the study. This difference was therefore due to a change in the virulence of the organism, and if concurrent controls were not used the improvement would have been attributed to the new treatment (Diehl, Baker & Cowan, 1938).

There are however certain circumstances where concurrent controls need not be used, as for example if a previously fatal disease is cured by a new drug. When streptomycin was first tried in the treatment of tuberculous meningitis in the MRC trial in Great Britain in 1948 no concurrent controls were used because the disease was known to be 100% fatal and initial studies with streptomycin had showed a dramatic reduction in mortality.

Another important aspect of the design of a clinical trial is the method used to assign subjects selected for the trial to the treatment and control groups. This should be done in a strictly random manner. In other words, chance should determine whether a patient enters the control or treatment group. This is known as random allocation. In this way it would eliminate bias on the part of the doctor in allocating patients to the treatment and control groups. The doctor may for example believe that the drug being tested is an effective one and so may exclude severe cases from the control group and select only mild cases as controls. On the other hand conscious attempts to avoid bias may result in bias in the reverse direction. All this results in a deliberate distribution of one type of patient to a particular group so that the treatment and control groups are not comparable and if there are any differences in the results it cannot be attibuted solely to the difference in treatment.

The principle of randomisation is linked with the principle of controls for there is no point in making a comparison between treatments unless it is an unbiased comparison. Only random allocation ensures this.

Random allocation is also essential for the application and interpretation of statistical tests which may have to be used in the analysis of results. Many of the statistical tests are based on the assumption that the sample is a random one for only then can the laws of probability be applied to the sample.

It is also impossible to identify all the numerous extraneous influences beyond the control of the investigator which may influence the results. By the method of random allocation an attempt is made to ensure that these extraneous influences are equally distributed by chance between the treatment and control groups.

An important point with randomisation is that it only tends to ensure comparability. It will not always result in the treatment and control groups being comprable. So it is always necessary to examine the data after the trial to see if randomisation has ensured the similarity of the groups. If there are substantial differences in the characteristics of the patients in the different groups at the start, random allocation has failed and it would be difficult to draw definite conclusions from the differences in the results for the initial differences between the groups may have contributed to the differences in the results obtained.

Randomisation is best achieved by the use of a table of random numbers. These numbers have been obtained using a kind of electronic roulette wheel and checked in different ways for randomness. One must be careful to avoid allocation methods which appear to be random but is in fact not so and allows bias to influence the results.

This is well illustrated by a trial of anticoagulants in myocardial infarction carried out by the American Heart Association under the chairmanship of Dr. Wright. The trial was carried out in 16 hospitals and involved a total of 1031 patients. In this trial it was arranged that the patient admitted to the participating hospitals on odd numbered days of the month would receive anticoagulants while those admitted on even numbered days were not given anticoagulants and served as controls. The death rate was found to be 23 per 100 patients in the control group and 15

per 100 patients in the anticoagulant group. It was therefore concluded that anticoagulants were beneficial in myocardial infarction. (Wright, Marple & Beck, 1948).

However when the data was examined closely it was found that there were 589 patients on the treated group and only 442 on the control group. This was far too big a diference to be accounted for by the slight excess of odd numbered days in the year and by random allocation. It was also found that the anticoagulant treated group consisted of a considerably larger number of private patients than present in the control group. These differences in the treated and the control groups were eventually found to be due to the fact that the arrangement of alloting the patients to the anticoagulant group on odd days had become known and some doctors who believed in giving anticoagulant therapy for myocardial infarction had arranged to delay the patient's admission until the right day. Since a patient who survives the first day of an acute myocardial infarction is more likely to survive the rest of the acute period than one who is admitted to hospital at the onset of the infarction, the late admission of patient into the anticoagulant group may have good results not because of therapy but because of the natural course of the diseases. Therefore the 2 groups are not comparable and the conclusions not valid.

Another important aspect of drug evaluation is to prevent bias influencing the treatment or assessment of the treatment.

The method used to prevent doctor or patient bias from influencing the results is to keep both the patient and the doctor ignorant of the treatment given. This type of trials is known as the DOUBLE BLIND TRIAL. This method does not eliminate bias but tends to equalise the effect of bias by letting it influence both the treatment and control groups.

The effect of bias in influencing results is well illustrated by studies on a preparation containing Vitamin A, E and B6. This preparation was at one time extensively advertised in this country for atherosclerotic disease. When this preparation was assessed with the full knowledge that the drug given was the vitamin

combination there was a significant improvement in the symptoms; when however the effects were assessed by the double blind method to quote the authors, "it emerged that the improvement produced was not statistically significant in comparision with the placebo". (Multicentre Trial, 1962).

The principle to double blind evaluation requires that the control preparation should be identical in appearance to the preparation being tested. Where this is not possible, the person assessing the results must not give the treatment and this task must be assigned to someone else.

The double blind technique has now been adopted on a widespread scale in drug evaluation.

Unfortunately many seem to think that it is all that is necessary for a good clinical trial. Many authors highlight the fact that this type of technique was used in their studies as if the use of the double blind method automatically guarantees the validity of the results obtained. The enthusiasm for the catch phrase double blind has grown and even triple blind studies and a five way blind cross-over have been described. It would seem that the fascinating notion is developing says Prof. Modell that if there is sufficient blindness it will ultimately lead to some sort of occult vision. (Modell, 1959).

While the double blind method should be used whereever and whenever it is feasible it will deal only with bias and psychic factors which may influence the results. In situations where these factors will not influence the results its use is not essential.

A double blind design is also no guarantee against a variety of other faults in a trial. Unfortunately even today studies continue to be published where the double blind technique has been used but the studies are defective in other ways so that the conclusions drawn from these studies are open to question.

For example recently two American workers published the results of what they called "Acupuncture for pain relief, a double

blind self controlled study." They reported an overall improvement rate of 72.1% with real acupuncture and 11.1% with simulated acupuncture. A close study of the trial revealed several defects the most important being that the real and simulated acupuncture treatments were not administered randomly at different times to the different patients. Always the simulated acupuncture was given first and then the real acupuncture. Thus although it was a double blind study the order of control and active treatments had not been allocated randomly—a serious defect in evaluation preventing valid conclusions. (Man & Chen, 1974).

Quite in contrast is the double blind controlled study to determine the efficacy of acupuncture in ostecarthritic pain carried out in the United States by Gaw, Chang and Shaw (1975) and published a few months ago. In this trial in addition to double blind evaluation and use of control group the patients were randomly assigned to the group receiving treatment at the traditional acupuncture points and the control group receiving acupuncture at sites outside the traditional sites. There was significant clinical improvement in tenderness and subjective report of pain in both groups but there was no significant diference between the 2 groups.

We can therefore reasonably conclude that at least in osteoarthritic pain acupuncture using traditicnal points is no more effective than pricking the skin haphazardly.

Since it did not matter where the needles were placed, a placebo effect must be considered — a placebo effect probably lgreater than that produced by administering a drug because there is at present so much written and spoken about the miraculous cures produced by acupuncture. There is also the novelty of the treatment itself. The patient perceives the needle prick and feels the electrical stimulus sometimes used.

This is not to decry acupuncture but only to emphasise that its true place in therapeutics should be determined by controlled studies in conditions in which this form of therapy appears to be promising as revealed by uncontrolled studies.

The results obtained from a controlled trial may reveal a difference in the response to a treatment under test compared to the control. Since every event has some degree of probability and even the most improbable events may occur by chance it is necessary to find out what the odds are of such a difference arising as a result of chance and this requires the use of statistical tests.

Statistical tests are important in that they allow us to calculate the odds aginst such a difference in results occurring as a result of chance. Such tests are necessary to ensure that we do not make fools of ourselves in drawing rash conclusions from our experiments and attributing the results to treatment when it might very well be due to chance.

However, statistics provide a method of determining whether the observations were due to chance or the treatment under test only if the data has been properly collected and recorded. If the design of the method of evaluation is defective, application of statistical tests cannot salvage it. Bias in allocation and assessment of treatment will render statistical tests meaningless. Emphasis on the need of statistical tests does not imply that clinicians must be experts in statistics, but they must understand what statistics can do for them, and the requisites for application of statistical tests to data. One often finds clinicians bringing the results of poorly designed studies to statisticians to find out whether the results are significant.

If there is need for statistical analysis a statistician should be consulted right from the start in the planning of the study. In the words of Green, "his role in regard to the investigation should be that of obstetrician rather than morbid anatomist for it is unfair to expect him to extract scientific knowledge by performing a kind of mathematical post mortem upon the numerical remains of a badly planned study" (Green, 1954).

Statistical significance should not be confused with clinical significance. If a result is said to be statistically significant it only means that it is unlikely to be due to chance. Statistical tests do not prove that one treatment is significantly better than another.

They only give a measure of the probability that such a difference could not have been due to chance.

The controlled clinical trial is as Hedley Atkins says the tool for forging the scientific evidence of the therapeutic effect of drugs. It leads to objectively founded conclusions which can be verifided and replaces haphazard observation, tradition, opinions and authoritarianism as the basis for treatment.

One can never overstate the importance of carrying out properly designed clinical trials for rational therapeutics is impossible unless based on sound evidence obtained from such trials. Nowadays with the avalanche of new drugs that the clinician has to contend with, it is more important than ever for such clinical trials to be done without delay.

One of the unfortunate results of initial improper evaluation of a therapeutic measure is that even after it has been subsequently proved to be ineffective by properly designed trials, it is difficult to erase the origical impression from the minds of the practising doctor. Harry Gold has pointed out that "years of habitual prescribing based on early and authoritative impressions and optimism confer on a drug, qualities of survival which has a high degree of immunity against the disqualifying actions of scientific experiments in man."

This revolution in the approach to rational therapeutics has not occurred without oppositions from some doctors. There are those who resist the application of experimental and statistical data to clinical problems. Some still prefer to accept the consensus of opinion of practitioners who have used a particular therapeutic measure and found it effective to the results of a well excuted clinical trial.

When we look at the exacting nature of a good clinical trial it is obvious that the average practising physician does not have the time, facilities or the training to assess the efficacy of a therapeutic measure. How then can the opinions formed by a mass of such physicians be dependable? "I know of no statistical tests or intellectual manipulation" says Louis Goodman "whereby

the accumulated multitude of inadequate or inaccurate observtions can be made more meaningful than the original raw data of which it is composed." (Goodman, 1964).

As Louis Lasagna states, "there is a common belief that the addition of many bits of disorganised data will somehow yield a clear picture". But the history of medicine provides little support for such a belief. In medicine, methods of treatment advocated and widely used in one era is scoffed at and abandoned in another. We therefore need well designed controlled clinical studies to determine whether any therapeutic measure advocated really has a favourable influence on the course of a disease. The mere fact that a therapeutic measure is widely used by numerous practitioners does not automatically guarantee its usefulness. There is as Lasagna points out "no magical safety in numbers." (Lasagna, 1964).

Some argue that controlled trials are not necessary since the great therapeutic discoveries of the past such as insulin, penicillin, sulphonamides, digitalis and host of others have been made without recourse to such trials using controls, elaborate design and statistics. These drugs which have stood the test of time are however those which have yielded results so dramatic that their value would have been immediately apparant without carefully designed trials but such discoveries have only been made at infrequent intervals.

People who take this view ignore the innumerable remedies which have been advocated and used throughout the centuries and which have fallen by the wayside, because eventually they were found to be ineffective and even dangerous. I have already described the classical example of the 1920's when gold injections were used in the treatment of pulmonary tuberculosis. It took over 20 years of widespread use to discover that it was ineffective. Using the modern method of the controlled trial probably no more than 50-100 patients and a few months would have been necessary to demonstrate that this remedy was ineffective in pulmonary tuberculosis.

Very often we are confronted with the evaluation of remedies in diseases where the results expected are less dramatic than in

the case of insulin, digitalis and the other great therapeutic discoveries mentioned. Without the use of controlled trials this would be impossible.

Antagonism to controlled trials is sometimes based on the argument that each person is unique and therefore the manifestation of disease is peculiar to each individual and the decisions regarding choice of treatment should not be based on results obtained from controlled clinical trials. There is no denying that patients differ, otherwise there would be no need to test a new drug on more than one patient. On the other hand if each person is unique to the extent that treatment of a person with particular manifestations of a disease varies considerably from person to person then the teaching and practice of medicine would be absolutely impossible. In practice we know that particular form of treatment tested in a given number of people is effective when applied to the majority.

The controlled trial is designed to take into account the fact that patients do differ; that each one is unique in some respects and it is precisely because of this that it is necessary to study the drugs on groups of patients using statistical methods to analyse the results on the basis that individuals vary to some extent on their response to therapeutic measures.

In the case of controlled trials the results indicate how on the average, patients respond to a particular treatment. No one can draw any conclusions how a particular patient will react; but this is also true of clinical impressions formed as a result of treating a group of patients.

In fact results obtained from a controlled clinical trial give a more accurate idea of the treatment to be chosen for an individual patient than from the divergent opinion based on clinical impressions.

Attempts have been also made to discredit controlled trials because in some instances such trials evaluating the same drug have sometimes yielded contradictory results. In such instances if the trials are examined closely it will often be found that while

they have some of the main features of a good controlled trial such as controls, blind evaluation and randam allocation they may differ in other features such as proper selection of patients optimal dose and duration of treatment which may account for the differences in results. This is well illustrated by the early studies of propranolol in hypertension.

In the initial trials propranolol was given in a fixed dose irrespective of individual requirements and for periods of 8 weeks or less and it appeared to be no more effective than a placebo or at most a thiazide. However, in a susequent study Prichard and Gillam showed that for optimal effects the dose must be adjusted to suit individual requirements and that it varied from 10-4000 mg daily. Further, it required more than 8 weeks of treatment for maximal benefit to be seen. When these conditions were filled the drug was shown to have excellent hypotensive properties. (Prichard & Gillam, 1969).

Differences in the results could also be expected if the beneficial effect is only marginal. For example in trials to determine the value of anticoagulants in myocardial infarction the results have been conflicting and appear to be due to the differences being only marginal and beneficial effects being confined to young male patients. Such conflicting results are not seen if the therapeutic effects are considerable as shown by the controlled trials of anti-TB drugs in pulmonary tuberculosis.

Some are against the use of controlled trials because they feel that this means experimenting on patients; but surely all therapy is experimentation. When we use a treatment without definite proof of its value we are in fact experimenting. When we give a drug without adopting proper methods to evaluate it, it is a poor experiment from which we can learn nothing, whereas if we carry out a controlled study we are carrying out an experiment from which we can learn something definite about the drug.

Sir Derrick Dunlop in his Charles Hastings Memorial Lecture in 1965 drew attention to the fact that "there must always be some patient or group of patients who receive a new drug for the first time; it is surely desirable "he says" that this should happen to

them under careful observation by experts in hospital and that the experience of such patients should be made of value to others." (Dunlop, 1965).

Some have questioned the ethics of withholding treatment from the patients as in the case of those in a control group receiving a placebo. Such a procedure cannot be considered unethical as trials using placebos are undertaken only where there is doubt regarding the value of a particular treatment. In such instances it is far more ethical to test its effects by means of a controlled trial and obtain an answer once and for all, than to give it haphazardly and indiscriminately and continue to submit patient to unproved therapy before its dangers as well as its merits have been determined.

"Where the value of a treatment new or old is doubtful", says Green, 'there may be a higher moral obligation to test it critically than to continue to prescribe it year-in year-out with the support merely of custom or of wishful thinking.' (Green, 1954).

With the introduction of new remedies with all the pressure of commercial advertising the natural tendency for any doctor is to feel that their patients are best served by the use of the latest drugs and that it would be wrong to deprive anyone of the use of these drugs.

Sometimes in withholding a treatment the advantage may be with the control group. For example when paediatricians first suspected that oxygen therapy was possibly responsible for the occurance of retrolental fibroplasia and consequent blindness reported in premature babies, a controlled trial was designed to determine this. Half of the babies for the trial received the usual liberal amounts of oxygen as commonly practised at that time, while the other half received restricted amounts. At first many physicians were reluctant to deprive premature infants of liberal oxygen therapy as previous clinical experience had suggested that exygen in liberal amounts was of life saving benefit to premature infants. This controlled study however clearly showed that liberal oxygen therapy was dangerous to the premature babies.

Some think it is justifiable to use remedies even if they have no more than a placebo effect because they would still produce beneficial effects in about 30—40 % of patients. This would be correct if there were no remedies more effective than a placebo and if the preparation concerned was no more expensive and definitely known to be harmless. Although in the past, many of the medicines used were harmless placebos, today science has placed in the hands of doctors potent medicaments which even if they have no more than a placebo effect on a particular disease often have profound effects on bodily functions. In fact many diseases are known to be caused by drugs themselves and have received the label—iatrogenic diseases. It has been estimated that in the United States about 3-5 % of medical hospital admissions are due to drug induced disease.

Under these circumstances to use such drugs even if they have only a placebo effect would not be justified. Whenever pain can be relieved with an injection of saline why should we inject morphine? If insomnia is relieved with a capsule of lactose is it necessary to give a barbiturate?

Further use of such drugs may deceive the doctor into thinking that the remedy has more than a placebo effect and therefore carries the danger that thorough diagnosis and more appropriate treatment may be neglected. In general while the use of a placebo may provide a temporary solution and gives more immediate satisfaction to the patient as well as the doctor it may in the long run prove of little value to the patient, whereas reassurance and explanation would have produced a more permanent result. The patient not unreasonably interprets the intial prescribing of a drug as admitting a physical basis for the symptoms so that later attempts to reassure him that there is nothing physically wrong with him will not be easily accepted.

The time has come when practising doctors must realise that therapeutics based as in the past on uncritical acceptance of empiricism and tradition can no longer be upheld. Application of the scientific method to therapeutics has become essential because of the accurate knowledge it gives. Every doctor has an

obligation to his patient to adopt it whenever possible. It is only by scientific therapeutic studies that we can ensure that the patient receives the best treatment possible. It is our duty to see that the maximum chance of a cure is combined with the minimm risk of harm.

Some make it a point to stress that the practice of medicine is an art rather than a science implying that medical treatment is inherently a process which cannot be quantified, analysed or communicated. Threatment of disease is undoubtedly composed of a mixture of art and science. The doctor's human concern, and sympathetic understanding of the patient's problems constitutes the art. The art is important in dealing adequately with human material, To perform the task of healing effectively the therapeutic measures used must have a scientific basis. The performance of the healing function based on scientific evidence is what distinguishes a good doctor from other healers who too give patients aid and comfort but without the support of any valid evidence, reasoning and demonstrable proofs, for some of the therapeutic measures used.

In the words of Jean Sice, "Our goal is to give patients the synergistic benefits of compassion and science which need not be mutually exclusive or the sole property of either practioners or academicians." (*Sice*, 1972).

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SECTION B—AGRICULTURAL SCIENCES AND FORESTRY

Presidential Address

SCIENCE, SCIENTISTS AND SOVEREIGNTY—SOME CONSIDERATIONS FOR THE THIRD WORLD

by

S. N. de S. SENEVIRATNE

It is customary foi a Sectional President to commence his address by thanking the membership for the honour bestowed upon him in his election as President. I wondered whether I should follow the custom. I was given approximately fifteen minutes notice that my name was to be proposed for this office. Having being persuaded by respected elders that this was an ocupational hazard and an 'honour' which one had to accept sooner or later, I submitted. I had not consulted my crystal ball for the warning of the turbulent year that lay ahead, a year characterised by unprecedented trade union activity by SLAAS members, opportunism and humbug by scientists as well as border-line elements in an attempt to disrupt the Annual Sessions of our Association—a creation and an organisation of the scientific community. Neverthe less, let me express my appreciation for the honour you have done me.

It is also customary for a Sectional President to select as the subject for his address some topic closely related to his field of specialisation. My field is Plant Pathology, a discipline which, as you know, deals withdiseases in plants. With some satisfaction I could claim that I was able to demonstrate, for the first time, that three biotypes of the bacterium *Pseudomonas solanacearum*, the pathogen causing bacterial wilt of potatoes, occurred in this country and that all three biotypes infected potato in nature—a finding which was subsequently reported from Australia too. Or that for the first time, I was able to demonstrate the occurance of two serotypes of a virus, the necrotic ring spot virus, in the same species of fruit plant, *Prunus domestica*, which remains up

to now, as far as I know, the only record of such an occurance in fruit trees. Such work will be of interest primarily to Plant Pathologists. But how many of them are there around? My immediate senior in the Department of Agriculture, G.C. Marks, sensed that the path ahead of the research scientist in this country was a frustrating one, and that a brighter future was assured elsewhere. After completing his Ph.D. at Wisconsin, he took a direct route to Australia. Another colleague in the Department, D.L.S. Wimalajeewa, returned after taking a Ph.D. in California and busied hiself for a while at Maha Illuppallama. He trod on thorny ground and before long moved out to another station, Sita Eliya. There too he found little encouragement to pursue a career as a Plant Pathologist. He quit his job to go into the motor spare parts business, which presumably offered better prospects, before reverting to his speciality as a Plant Pathologist—in Australia. Another colleague, P. S.Y. Fernando, returned after post-graduate training in Hawaii to a situation hardly conducive to active research and spent a while in enforced dormancy. A domestic situation provided him a convenient escape route. He is now in the United States. Yet another colleague, K. Sivasithamparam, embarked on some pioneering work in this country but ran into trouble. He spent a while hanging around in corridors for want of a place to work and eventually found his loyalties to this country strained to the breaking point when, at the height of the insurgency, he was ordered to find his way from Peradeniya to Nuwara Eliya within a few hours before the curfew began, leaving behind a wife at child birth to face an anxious situation at Kadugannawa. He too has left for Australia where his research had already secured for him ample recognition. Dr. N. Shanmuganathan, formerly a Plant Pathologist at the Tea Research Institute, has also gone to Australia. So active Plant Pathologists are a vanishing species in this country while some have opted for positions as Administrators. But in this sphere their nerve centres sensitive to the feelings of scientists in active research appear to abort and my work will make little impression on them. It will be apparent, therefore, that if I deviate from the beaten track of the Plant Pathologist and reach out to a wider audience than the depleted ranks of Plant Pathologists, I have some justification. And therefore, when pressed by my Sectional Secretary for the subject of my presidential address, I scrawled as the title 'Science, Scientists and Sovereignty—

some Considerations for the Third World', a topic which might embrace some thoughts which have for some time engaged my attention.

And at this point, it is well to add a note or two by way of explanation. The subject as you will see, is not altogether free of political overtones, and one is often advised to keep politics and science, religion and similar subjects in water-tight compartments—not always a practical proposition. I remember the controversy aroused by a MCC cricket tour of South Africa. Basil D'Oliveira, classified as a 'coloured' South African, had been recalled to the England test team and celebrated his return with a competently compiled century. Shortly afterwards, the MCC team for the South African tour was announced. D'Oliveira was not included. Knowledgeable English cricket lovers were disturbed—perhaps this was the price of peace with the South African Government. The England Captain Colin Cowdrey's conscience was troubled. He consulted a Bishop and decided that his role was to build bridges. Guileless old ladies pleaded that sport and politics should be kept apart. And the prestigious London Times commented—the way the world lives is more important than the way it plays! Politics! after,all, is woven very closely into the stuff and substance of life and even science cannot be altogether insulated from its currents. I am no party man. As you can see, I am not wearing a green cap or a red shirt. The tie that I am sporting is a shade of blue but it is the only wearable one I have and is in any case eight years old—purchased at a time when the party identified by a brighter shade of it was in the Opposition!

And if I trespass on ground out of bounds to Government employees, my defence is simple. I am a citizen of this country. I seek no home in an alien land but rather the sonship of my motherland. I would wish to make the words of Arthur Jarvis in that moving novel, Alan Patons' 'Cry the Beloved Country' my own—with Sri Lanka substituted for South Africa—"I shall devote myself, my time, my energy, my talents, to the service of Sri Lanka. I shall no longer ask myself if this or that is expedient but only if it is right. I shall do this, not because I am noble or unselfish, but because life slips away, and because I need for the rest of my journey a star that will not play false to me, a compass that will

not lie....I shall try to do what is right, and to speak what is true. I do this not because I am courageous and honest but because it is the only way to end the conflict of my deepest soul.... I understand better those who have died for their convictions, and have not thought it was wonderful or brave or noble to die. They died rather than live, that was all."

I am also the father of two children. If my son were to pay the price with his life in fighting a worthwhile cause in this country, I will be a sad but proud father. If he were to sell himslef in an alien land and proudly present me with a pre-paid ticket, I will die a shamed and disappointed paient.

And so to Science, Scientists and Sovereignty.

I remember the excitement of that bright sunny day, February 4th 1948, Independence Day. A festive air swept the country. Crowds thronged into Indpendence Square, the scene of pomp and pagentry for here, a new nation was born. Of course the occasion had to be celebrated—with fireworks, illuminations and dazzling traditional art. As we jostled with the crowds that evening, a vociferous campaigner attracted my attention. "Fake" independence" he cried, waving the pamplets in his hand. My guide, nursed in the cradle of middle class conservatism quickly brushed me aside. "That's Colvin R. De Silva. Samasamajist Come away." Years later, S. W. R. D. Bandaranaike raised a similar cry. What independence could a country have if foreign bases were planted on her soil? And in another continent, Julius Nyerere of Tanzania questioned the whole purpose of independence—"the purpose of independence was not simply to attain political sovereignty, to participate in UN debates, or to provide the trappings of national prestige; it was to build a better life for the ordinary people, almost all of them subsistence peasants." Twenty seven years after the event and a new Repulbican Constitution we might ask what all this has meant. We have secured our seat in the UN and our man there can aspire to that supreme post—Secretary-General of the United Nations! We have the trappings of national prestige—an international airport although its airconditioning may not always work; a national airline although the operators may not always get youi baggage on the plane; a Trident even though its sound

system will make you strain your ears to hear the greeting in the official language! But what of that better life for the ordinary people? Those immortal words from the American Declaration of Indpendence can be written into the constitution of every country- "All men are created equal....They are endowed by their Creator with certain inalienable rights. Among these are life, liberty, and the pursuit of happiness." And to quote from another moving novel, Morris West's 'Children of the Sun'—"....a man is still a slave if he is forced to live on the edge of starvation, to live in fear of the whims of an employer or an underling, with no possible hope of sharing in the fruits of his labour or improving the lot of his children."And if these ideas confer substance on a citizens' independence, on human dignity, and on the sovereignty of a nation state, we have a long way to go to the promised land.

Returning from the Rice Station at Ambalantota in early 1971, I was unsuspectingly confronted by three youths while alone in a compartment on that monotonous train journey from Matara. They were impressive, intelligent lads in deadly earnest. After giving me details about themselves, their background, educational qualifications and their capabilities, their spokesman fired a series of questions at me. "We want to earn our living by our own industry. Tell us where we could go for employment—without pulling strings, without offering bribes, without approaching influential people we do not know for recommendations and certificates. Tell us where we will be judged according to our abilities and given what is our due." I mumbled an unconvincing answer. The next question followed. "If this is not possible now, can you give us an assurance that it will be possible next year, or the year after, or in five years time?" Again, I had to dodge the question. And the next quickly followed. "We in this country are blessed with fertile land, water and sunshine. We have people. If our resources are developed and utilized, need we be subjected to this anguish?" Even the most hard-boiled cynic would have been impressed by the passion of their plea. Not long afterwards, the April 1971 insurgency burst upon the country. To quote again from 'Children of the Sun'—"A child has no politics. A child has no nationality. He has only the right to live, the right to hope. If these rights are denied him, it is a crime against humanity...." I suspect that those young men and women who challenged the

authority of the state, if only for a brief peiod, felt acutely the denial of those rights. For who would have thought that in this land of religious fervour and easy-going people, a generation had emerged —young men and women—who were willing to lay down their lives for a cause. "It is better to die fighting than to survive in anguish." I realised later in those dark days of the insurgency the meaning of those cries of anguish that appeared on streets and walls as slogans. The younger generations are restive and bitter. The older ones fret and grumble and curse—for the cost of living is eternally going up. Yes indeed. Our sovereign state trembles each time the price of this goes up and the price of that goes up in the world market and the price of oil rocks the national budget.

The fact is that we got our independence cheap. Kwame Nkrumah once said, "Freedom has never been handed on a silver platter to any colonial territory; it has been won only after bitter and vigorous struggles." We were an exception to that rule. The ahimsa weapon of the great apostle on non-violence, Mahatma Gandhi, the threat of fiery mobs in countless uncontrollable centres, and the accommodating mood of Clement Atlee and the British Labour Party had released India from her colonial bonds. We were to benefit from the freedom struggle of our great neighbour for was it not said that we obtained independence without a drop of blood being shed? "Cheap grace is the deadly enemy of our Church," wrote Dietrich Bonhoeffer from Hitler's Germany. "Costly grace is the gospel which must be sought again and again the gift which must be asked for, the door at which a man must knock." And we may well say, cheap independence is the deadly enemy of our nation, costly sovereignty is a state which must be fought for, an experience which must be won through sacrifice and commitment. We have to look beyond the Himalayas for sovereignty secured through effort, determination and sacrifice, for while we, as an independent state, were acquiring more status symbols after the initial festivities were over, Mao-Tse-tung was organising the Chinese people for what was to be their glorious liberation. For they, unlike us, have released themselves from their bondage, youths and old men, peasants and workers, artists and scientists. A western commentator has said of China, "She has grown mighty by the efforts of her own people, and is too

powerful to be pushed around by the West." If sovereignty means anything at all, it surely must mean the ability of a state to stand firm and self-reliant and not be pushed around. Each state must look at its own resources and develop its own methods in achieving its liberation into a sovereign state.

The spokesman of that anonymous trio in the train I mentioned earlier identified our most important resources—land, water, sunshine and people. Yet, if resources alone had been able to achieve the transformation of societies and states from poverty and disorder to prosperity and stability, those countries now politely labelled 'developing countries' would have been developed long ago. Science is the key to that developmental process and it is the scientist who must unlock those national resources so that the sovereign nation state can emerge, released from the bonds of poverty, instability and exploitation. This simple fact is not a spectacular new discovery. Centuries ago, our forefathers realised it, recognised it, and was guided by it to positive action. For Minneriya and Parakrama Samudra are not merely monuments to our pristine glory and ancient culture. They are symbols of the fusion of national resources with scientific endeavour, for it was the spirit of scientific inquiry that conceived of the harnessing of the monsoonal rains to irrigate those vast fertile plains. It was the skill of the engineer that constructed those tanks and dams and channels and sluices. And the ancient civilizations flourished and mans creative genius found expression in those magnificient works of art and sculpture, Lanka's contribution to the cultural wealth of the human family.

Therefore, it is staggering that since independence, successive governments have failed to recognize the crucial role that science and scientists must play in the growth and development of this country. Science has, as it were, been an optional extra, and scientists unnoticed oddities in the national life to whom the eminent personage invited to declare open the Annual Session of our Association every year pays a glowing tribute. It is not a matter for amusement that scientific affairs were once accommodated in a housing ministry! National development without science. National development without scientists. Once again, we must look beyond

the Himalayas for a lesson we may learn even now, for this Government, more than any other, has looked to China for inspiration and assistance. China's commitment to science, education and technology has been confirmed by persons of international repute. Dr. J. Tuzo Wilson, an eminent Canadian scientist, visited China as President of the International Union of Geodesy and Geophysics in 1958. He said, "The government clearly believes in, and supports, education and science. Many scientists from the old regime, old universities and old institutes, are flourishing. They have never had so much support before...." And Sir Cyril Hinshelwood, who as President of the Royal Society visited China in 1959 declared, "Laboratories and equipment are good....the vast and well-equipped workshops I found a revelation. Library facilities, both in books and journals, are admirable. I have seldom, if ever, seen such extensive collections of scientific journals in all languages as I saw in several universities and Academic Institutes...." China considered support for her scientific effort such a priority that even in the difficult period after her liberation, she diverted substantial amounts in scarce foreign exchange to secure essentials for her scientific effort. It has been reported by Dr. John M. H. Lindbeck of Harward that between 1956 and 1957 the Chinese spent nearly 3¼ million to purchase scientific literature from non-communist countries. A couple of decades after her 'glorious liberation' (words of our Chief Guest at the Twentynineth Annual Session, Lord Caradon, formerly Britain's Minister to the United Nations) China, risen from the depths of degradation and exploitation, China restored, strong and confident, strides majestically into the community of nations. She has no internal or external debt. Presidents of the United States and Prime Ministers from the United Kingdom make the journey to shake her once despised hand. Sri Lanka, a quarter century after the pagentry at Torrington Square and the fireworks at Galle Face Green, wears the 'MSA' badge. Her emissaries make the treak to the various capitals of the world with outstretched arms, for she is still heavily dependant on international alms. Had we too, as a nation, made a greater commitment to science and to scientists, perhaps we too would have been today a proud nation, strong and truly free. We may not have joined the prestigeous nuclear club, but our rising generations could have been spared the agonising choices they now have to make in seeking a means of livelihood.

Believing as I do that science and scientists have a vital role to play in securing true sovereignty for a nation state in the Third World, I propose now to make the attempt to draw attention to crucial matters which have, for too long, been neglected or ignored or discreetly avoided.

In every area of national development, whether it be in the production of improved varieties of crops or in the exploitation of our mineral resources, scientists are actively involved. Yet, in planning our national strategy for development, in identifying our priorities for investment, in determining the apportionment of funds from the national budget, scientists virtually have no voice. These matters are the prerogative of an elite class who breathe the rarefied atmosphere of air-conditioned buildings in Colombo, for the most part persons who have read economics or classics or languages. Of course they are clever men, important men, impressive men. But they have one massive disadvantage—inhabiting those air-conditioned cubicles in the city, they are hopelessly out of touch with reality and their superb isolation from the fields where the country's battle for survival must be fought guarantees their insensitivity to the most crucial factors in winning that battle. Not infrequently, their plans, projections and theses become sterile academic exercises, obsolete before they roll off the press.

It is not impossible to overcome the defects inherent in this system. It is perfectly possible for scientists to be drawn into the national development processes to work in partnership with our planners and policy makers. Perhaps a comprehensive panel of scientists ought to be established to play a consultative and advisory role. Scientists in the various specialities drawn from this panel could be included in the highest organisational bodies planning, executing and continually evaluating national programmes and projects. Perhaps every Ministry ought to devise organisational arrangements to reach out to its scientific personnel operating in actual work situations so that a continuous dialogue could take place between active scientists and those who determine the content and direction of the work in a Ministry.

The organisational arrangements for scientists to participate in national planning and development can be established within the National Science Council. Such a role can also be conceived for the Sri Lanka Association for the Advancement of Science in its quest for new avenues for advancing science in this country.

If the initial task can be accomplished—to awaken in our planners, directors and administrators an awareness that there is a species called scientists and that these creatures can contribute to the transformation of our state of national poverty and dependence on others to one of national prosperity and self-reliance,a major barrier would have been breached.

Next, it is necessary to determine an order of priorities to which the resouces we have of funds and personnel ought to be diverted. It is essential that criteria relevant to the situation in this country, its available resources, raw materials and social considerations be recognised in determining these priorities. Agriculture, industry, tourism, all make their claims. It is evident that agriculture must, for a long time to come, remain the dominant sector in the life of this country. It is the principle occupation of our greatest numbers. It can release this country from its dependence on imported food supplies. Of equal significance is the unique position of agriculture in the social context. For agriculture alone can produce in this country a proud and strong peasantry, a cohesive stability to the village community, and a prosperous farming sector. It alone can check the migration of restless villagers into the cities in search of employment, only to create more social problems and to be drawn into the trade of illicit liquor, prostitution and violence.

Availability of local raw materials must also strongly influence the ordering of our priorities. We have natural rubber and endless possibilities for the production of a wide range of finished quality products. Our natural resources must receive the recognition they deserve. The hydro electric power that can be generated in this country has yet to be fully harnessed. In these areas too, science, and technology will determine what we make of our raw materials and our natural resources. An increased commitment to science

to scientists and their principal activity—research, is therefore inescapable.

It was our General President, Dr. Ernest Abeyratne, who once said, "The Research Base is the main spring of activity." Unfortunately, being a soft spoken and mild mannered man, he did not organise public demonstrations or lead processions to draw the attention of those who govern the destinies of this country to this truth. Take agriculture. Since independence, successive governments have recognized agriculture as an important area in our national life. And sincere men have held the protfolio of Minister of Agriculture. The sincerity and integrity of our present Minister of Agriculture, Mr. Hector Kobbekaduwa and of his predecessor, Mr. M. D. Banda, have never been disputed even by their political opponents. Yet, even they have not been sufficiently alive to this main spring of activity—Mr. Kobbekaduwa did not include research as a 'cardinal commitment' in National Policy needed for a large scale transformation of the agricultural sector to solve problems like employment and food shortages. How could this be? Dr. Charles Raven, a former Vice-Chancellor of Cambridge University once said, "You know the trouble about us is not merely that we are, most of us, incredibly stupid and incredibly lazy and incredibly selfish, but that we are only partially alive. Yes, only partially alive. I have no sense of the beauty of music, and I have no knowledge whatever of mathematics. Well, you think of what that means. I'm half dead, to that extent, I can't say I'm alone in my defect." Perhaps our Ministers, their Secretaries, Makers of Policy and many others share the defect and are insensitive to the creative possibilities of research. All credit to this Government and particularly to our Minisrer for the massive changes that have been set in motion affecting the land and the people. In various parts of the country Agricultural Service Centres have been opened. The buildings have come up or are coming up. However, these imposing edifices can become barren monuments if the technical knowledge to give content to the whole programme of agricultural development is lacking. Edna O'brien wrote about the church in Cuba—"The church is rather like a disconnected arm: there is flesh and bones, knuckles and nails and cuticles, but the blood flow is missing." In our agricultural development programmes also, the blood flow

is missing—that blood is the technical knowledge that comes from research.

We ought to take a lesson or two from our colonial masters. They developed the plantation sector. They established research institutes. In independent Sri Lanka, we have recognized that besides the plantation sector, the peasant agricultural sector and the crops to make us self sufficient in food are important considerations. Yet, the national commitment to research to support their development has been wholly inadequate. The Agricultural Research Station at Maha Illuppallama is a gift of the New Zealand Government. The Central Agricultural Research Institute at Peradeniya is a gift of the Australian Government. The Agricultural Research Station at Nuwara Eliya is a gift of the West German Government. And the Research Officers bat on, often working at a fraction of their capacity—short of equipment, facilities, living amenities, transport—and hoping for a better day when these inadequacies will cease; hoping also for a better tomorrow with a possibility of escape from their confinement in the recruitment grade.

The research effort must be supported by a conscious commitment—foreign exchange for essential requirements, competent personnel, and not least by decent conditions of employment for those engaged in the task.

The receptivity of those responsible for allocating funds is, as it were, controlled by a single switch—'on' if no valuable foreign exchange is involved, "off' if it is. Some years ago, J. B. S. Haldane ('Jack' to his friends, 'bastard' to his enemies) addressed our Association on research with simple apparatus. An observer with a watch recorded the number of times a butterfly alighted on a flower of a particular colour! Some remarkable discoveries were made with this type of investigation. Much valuable information can be obtained from experiments which require little more than a measuring tape and a balance. Unfortunately, this situation does not apply to all research. Equipment, chemicals, etc., are indispensible for research into many areas in which information of vital significance to development must be obtained. The informa tion now available on the numerous viruses causing diseases in

plants was not all obtained by looking meticulcusly at affected plants. We in the Third World must ask for no more than the essentials to make meaningful work possible. And these essentials must be obtained by expending foreign exchange. To deny these essentials to the scientists is to virtually immobilise them and to deny the country, in the long term, of the contributions which scientists can make to national development.

It is a pathetic commentry on our scale of values that while foreign liquor and toilet paper are imported to encourage that most corruptive and corrosive of industries, tourism, equipment and other requirements for research to support a productive and creative occupation, agriculture, are not even considered. It is a frightening thought that while vast amounts in foreign exchange are expended in procuring arms and ammunition for defence the most stringent controls are imposed on expenditure for science. Yet, what foreign invader do we fear? The fact is that this expenditure on armaments is incurred to ensure internal law and order because frustration and poverty drive people to disorder and even to insurrection. It is a costly business keeping them under control. In the People's Republic of China where one of the greatest agricultural revolutions of all time has occurred, there is no such disorder to fear. The People's Militia composed of teenagers and old people with access to arms serves as voluntary organisation, a 'national guard' in readiness for the defence of their motherland. We can spare our nation the agony of our restless rising generations being saughtered as they challenge the authority of the state in their struggle for a fairer social order. It has happened once and it can happen again unless we can persuade them that it is a preferable alternative to convert swords into plough shares. Their conversion cannot be achieved by chanelling our meagre resources to procure sophisticated armaments. But there is more than an outside chance that giant strides in agricultural development and in the exploitation of our natural resources could achieve this objective—as has been demonstrated by China. In 1974, Dr. Sterling Worthman led a group of twelve eminent American scientists on a visit to China sponsored by the National Academy of Sciences of the United States. His impressions were summed up as follows. "The most populous nation appears to have achieved the objectives of producing enough food for all

its people. It has done so largely by the adoption of improved strains of rice and wheat." The International Rice Research Institute released the indica dwarf IR 8 in 1966. The People's Republic of China was established in 1949. I have already referred to China's commitment to science and education. By the early 1960's China had already put into commercial production dwarf indica varieties similar to IR 8 developed in China by means of local breeding programmes that were initiated in 1956.

We can take a lesson from China by making a conscious national commitment to agricultural research. That commitment must involve the allocation of foreign exchange to support our research. Such an allocation should best be administered by a competent scientific body capable of assessing the relvance of national research programmes, a body before which any competent scientist could plead his case for support for his work—and be heard. Perhaps the organisation to operate such a system could be established within the National Science Council or a Research Council established in which our Association too can play a valuable role.

Money is necessary. But more important are the men for the long march to sovereignty. A dominant feature of the Arusha Declaration, the manifesto of Julius Nyerere's ruling party in Tanzania is its emphasis on self-reliance. And Nyerere has unequivocally answered the question as to what education should be doing in his country—"It must encourage the growth of a independent and free citizenry which relies upon itself for its own development." No country which relies on any other source can hope to rise to the status of a proud and sovereign state. That is why it is essential to ensure that adequate knowledge, technical skill and expertise for development is available within one's own citizenry. In this context, a passionate plea must be made for the training of our scientific officers as competent specialists in the many different disciplines essential for the national development effort, for a fuller utilization of their specialist skills, and not least for fairer conditions of employment that will encourage them to throw themselves without reserve into the national effort.

Most of the professionally qualified scientists in this country have received their post-graduate training abroad. Clearly, we in Sri Lanka must develop our own institutions for post-graduate training. But we should not be totally insensitive to the shortcomings of our own situation or to the advantages of post-graduate study in well established institutions abroad. Agriculture being a vital sector in our national life, first rate institutions for training competent agriculturists should have been functioning many years ago. But what in fact is the situation? The Faculty of Agriculture of the University of Sri Lanka has been reported as expanding at an explosive rate. True, there are more chairs than there were some years ago and certainly more students; the problem is that there are only a handful of competent teachers. A Post-graduate Institute of Agriculture has also been established within the Faculty of Agriculture. M.Sc. and Ph.D. degrees are to be given in several specialities, including my own, Plant Pathology. Yet, for Plant Pathology, there isn't a single qualified lecturer in the Faculty of Agriculture competent to teach the subject at under-graduate level, let alone organise post-graduate courses. Who kiddeth whom? Those of us who are professionally qualified owe a duty to the University to assist it in its tasks. But it is futile to argue that persons already in full time employment elsewhere can shoulder the responsibilities of a teaching institution. Obviously, an accellerated pace in providing adequate numbers of professionally qualified specialists to undertake these courses is essential. And such specialists must be recognised by the quality of their work and publications. They must be thoroughly immersed in University life. And they must also be fully alive to the developments in their own specialities taking place elsewhere in the world. Unless these requirements are fulfilled, there can be little confidence in the quality of the course provided by the Institute. At best, it might confer sentimental degrees and honorary doctorates. And until the credibility of its degrees is assured we must continue to send at least our most promising young scientists for post-graduate training to institutions abroad.

Elsewhere I have referred to the exodus of professionally trained officers to pastures abroad. It is a fair question to ask, "If the post-graduate degree from recognized institutions abroad are merely symbols enabling our specialists to desert their country,

why train them at all? Every society has its complement of individuals whose actions are motivated solely by self-interest. We are no exception. But the variety of reasons which induce scientists to leave this country in disgust and despair should not be lightly dismissed. Not infrequenty, young officers, after a stimulating experience in post-graduate research abroad return to empires where mere survival depends on the offering of incense to the Caesars in power. Writing about the struggle against colonialism in Africa, John Hatch observed"....the fight was concerned with African people, not simply with constitutional changes nor with the replacement of arbitrary colonial administrations by equally arbitrary African oligarchies." There are oligarchies in Asia too, in scientific institutions in Asian countries, ours included. For many scientists, disillusionment begin when they encounter the violence of this vicious systems. There are, ofcourse, scientific diplomats who have perfected techniques for survival and advancement in such systems. But for those who are unable or unwilling to make the adjustments, the professional qualification becomes the passport to escape into a more hopeful position elsewhere. The problem is sufficiently serious to warrant attention because no Third World country, struggling to achieve true economic freedom, can afford the improvement of its scientific capability by the sickness of its management system. Here too, a suitably structured Research Council can play a vital role in determining that scientists are allocated to contribute to national develop ment within an organisational framework which prevents, or at least minimses administrative violence.

The underutilisation of trained personnel in their own specialist fields is another aspect which deserves attention. At the present time, many specialist officers spend a considerable proportion of their time on activities incidental to their technical functions. Adequate institutional arrangements to provide the supporting services are often lacking. Not infrequently, such arrangements and organisations as are available simply do not work. Office trays with documents which ought to be processed expeditiously often seem to serve as archives where papers are preserved for posterity. Procuring supplies is a perennial problem and funds are not always the obstacle. A few examples will be illuminating. We have in the Department of Agriculture, an establishment

called the Agricultural Central Stores to service the securing of supples, clearance of cargoes, etc. While in charge of the Agricultural Research Station at Rahangala, I placed an indent for laboratory equipment to be obtained from England on 20th Decem ber 1962. The goods were eventually delivered at Rahangala on 25th January 1965, over two years later! It had taken our Departmental organisation eighteen months merely to clear the crates and have them despatched to the indenting unit! One can imagine the condition of the items when finally received. And our Departmental accounting unit was so efficient that it was 1970 when they got down to the business of setling Transit Vouchers of 1962/63. More recently, in 1973, I followed the clearance of a shipment of laboratory equipment which was delayed due to cussedness, stupidity and inefficiency. I was informed that it had taken 1—1½ months to "process the documents." The Postal Department has a similar record. Customs Declaration Forms in respect of a parcel with materials for virus research were sent on 17th March 1975 and followed up by a series of reminders and registered letters. On 15th May the GPO informed me that the parcel was lying unclaimed and will be disposed of. More activity prevented this. The parcel was eventually received on 3rd June 1975. Innumerable examples may be provided of how scientific research can be obstructed by the sheer inefficiency and apathy of servicing organisations. However, the point is clear. If a revolution does not take place in vitalising those organisations which exist to serve and assist our national effort, scientists too are wasting their time in attempting to contribute their mite to national development.

Time is another vital commodity. Scientists cannot operate with their eyes directed towards the clock. Time for them has a premium value. "From each according to his ability, to each according to his needs." This is a good socialist principle. In the old days, independent transport, particularly a car, was very much a status symbol. The bigger the chassis, the greater the prestige. For scientists, independent transport is not primarily a status consideration. Mobility for them is an essential need-if they are to perform their functions efficiently. After all the Government has provided vehicles to Police Officers and personnel in the armed forces—it is a recognition that special consideration must be given to officers responsible for maintaining law and order. The

crucial importance of the nation building tasks which scientists must accomplish also deserve consideration. There is a strong case in favour of scientists and professionals engaged in work demanding mobility, to be allowed to obtain independent transport— practical utility vehicles, not prestige symbols. Their usefulness will be considerably enhanced if their time is not wasted and their energies dissipated on account of inadequate transport facilities. Some concessions also ought to be considered so that the burden of possessing independent transport will not be overbearing. It is naive to argue that this is a luxury or a privilege. Of course there is an alternative, — greatly reduced work output, lack of interest and premature death of persons whose contributions to national development the country can ill afford to loose.

It is appropriate, finally, to refer here to the type of recogni tion, or rather the lack of it, experienced by scientists in the public service. The scientist, generally, is an anonymous animal. He works in relative obscurity. Unlike certain privileged groups in the public sector, he is not perpetually or biting influential centres. He cannot topple a government by drastic trade union action although any slackening of his efforts could jeopardise the well being of future generations as well as his own. Perhaps this explains why scientists as a group have received little attention from successive governments and why they continue to remain a 'depressed caste.' In the public sector, Research Officers live and die in the recruitment grade if they opt to work in their fields of specialisation. Their only hope of better renumeration is to leave their specialist jobs and climb the hierachical ladder in administrative posts. For them the Report of the Salaries and Cadres Commission— 1974 graciously recommended a single grade with a scale

Rs. 7,800 — 9 x 360 + 12 x 480 — 16,800.

Scientists in this country have been victims of a system in which creative work, valuable work having far reaching effects on national development carry no weight at all in securing for them better renumeration and improved prospects. Of course, creative work, whether of writers or musicians or even of scientists has seldom been recognised by the establishment. The great composer Mozart was buried in a pauper's grave and Milton got £ 10 for

his Paradise Lost'. However distinguished the company of the disinherited, no government can be excused for continually overlooking the conditions of employment of its scientists. Scientists do not seek to be considered a class apart. When officers of the Administrative Service with five years service can aspire to Calss II posts, when engineers with eight years service can be in the Directorate, when very ordinary mortals are elevated to dizzy heights in the Corporations, it is inconceivable that professionally qualified scientists with years of service and contributing substantially to national development should be consigned for life into the recruitment grade if they remain as active scientists. A lone dissenter of the Salaries and Cadres Commission—1974 declared:

> "The Scientists have a pre-eminent role to play in the development of a country. I wish in this connection to endorse the views expressed in his Dissenting Report by Mr. N. S. Perera, member of the Wilmot Perera Commission. We cannot hope to attract into the ranks of Scientists men of the highest calibre unless their salaries and cadre ratios are at least as attractive as those of the Administrative Service. Many of our problems including those relating to rice and other produce would have been solved long ago if only we had the foresight to give a proper place in the salary structure to Scientists. It is absurd to suggest that one post in Class I Grade I would be sufficient for this Service and I believe that this has already been realised by the Government."

A realisation that scientific research is vital for national development has still not dawned in the minds of those who determine the conditions of employment of scientists. They are still obvious of the conditions essential to stimulate and sustain scientists engaged in the production and identification of better varieties of crops; in the development of methods that would achieve their greater productivity and combat natural enemies such as pests, diseases and adverse conditions of growth; in the conservation and utilisation of our resources of land and water The currency of their thought was acceptable in a colonial era when the country's best brains were hired to collect revenue and keep the "bloody natives" in their place. That currency is no longer legal tender.

A radical transformation in thinking is long overdue—that work other than managerial and administrative work is of profound significance for national development; that scientists perform a function as important, if not more important than that of administrators; that scientists must be encouraged to stay in their jobs and contribute to national development in their specialist fields. Regrettably, the attitude of successive governments to their cause has been one of apathy. A succession of officials who occupy the seats of power have played their part in denying the scientists a fair deal, officials some of whom have subsequently left the country for jobs from the international employment exchange. Meanwhile, the country's scientific potential has been steadily eroded and impoverished. The sickness is serious, the remedy urgent.

Ironically, the Prime Minister, Mrs. Sirimavo Bandaranaike, and her predecessor, Mr. Dudley Senanayeke, were both actively involved in the country's food production effort. We have had food drives, crash programmes and production wars. Such wars cannot be fought without their special kind of armaments—the scientific research and the technical experties which can carry these efforts to their final victory. And scientists must be at the front, they cannot be ignored.

I want to conclude this address by posing some questions on the social responsibilities of scientists and their moral obligations in a developing country. The task of a liberal education, wrote Bertrand Russell, is "to give a sense of the value of things other than domination, to help to create wise citizens of a free community, and through the combination of citizenship with liberty in individual creativeness to enable men to give to human life that splendour which some few have shown that it can achieve." On that definition not many scientists in Sri Lanka can be recognised as educated individuals. Scientists, like most other professionals, have a great store of technical lumber in their heads—about the complex reactions involved in photosynthesis, the fine structure of virus particles, or the anatomy of the head and neck. Rarely do they pause to consider their responses consistent with a combination of citizenship with liberty. Most scientists and professionals have received from this country the benefits and

privileges conferred by her citizenship—a University education, opportunities for post-graduae study abroad, employment. They are fruits matured on costly human manure—the anonymous mass of village peasants, plantation workers, city labourers and a host of others whose sweat, toil and tears have enriched them. Their responses must be conditioned by an awareness of the immeasurable debt to an anonymous people. It is questionable whether selling oneself to the highest bidder in the marriage market or taking the most lucroative job abroad are legitimate choices or exploitative characteristics of a privileged group, morally bankrupt and spiritually dead. A simple question. It is freely stated that scientists, doctors, etc., take up positions abroad because they lack facilities to do a job here. Will somebody give me the number of University students who have left the Faculty of Science or the Faculty of Medicine of the University of Sri Lanka because of inadequate facilities. So scientists, violated by successive governments in their conditions of employment, harrassed by unscrupuilous administrators, hampered by inadequate facilities cannot altogether escape their social obligations and moral responsibilities in a Third World country. To quote Russell again, "Love and knowledge, so far as they were possible, led upward toward the heavens. But always pity brought me back to earth. Echoes of crise of pain reverberate in my heart. Children in famine, victims tortured by oppressors, helpless old people a hated burden to their sons, and the whole world of loneliness, poverty, and pain make a mockery of what human life should be. I long to alleviate the evil, but I cannot, and I too suffer." Scientists can contribue to alleviate that evil; they cannot isolate themselves from the suffering it involves. Colin Morris commented on the African experience; "The New Africa was carved out of colonial torper by faceless men without rank and precedence in society. They were marked out from their fellows by two simple qualities, the ability to feel more deeply and absorb more punishment." Elsewhere he said, "For all the misery, frustration and anguish of our world, there are forces at work seeking to rehumanise man, restore to him the dignity in which God first clothed him and revitalise jaded cultures and decadent societies." Building the New Asia is a massive undertaking, Mao Tse-tung and Ho Chi Minh will take their place in history as builders of the New Asia who have brought life and hope to the most disinherited, oppressed, exploited and

wretched of Asia's millions. We scientists too can share in the tasks of nation building in the New Asia—as faceless men, restoring to man the dignity which poverty and exploitation have, for years denied him.

SECTION C—ENGINEERING ARCHITECTURE AND SURVEYING

Presidential Address

THE TECHNOLOGY OF DEVELOPMENT AND THE UNDER DEVELOPMENT OF TECHNOLOGY IN SRI LANKA

by

D. L. O. MENDIS

In presenting this address I wish to take the opportunity to thank the members of Section C: Engineering, Architecture and Surveying, of this Association, for the honour they have done me in electing me President for 1975, and the Sectional Committee for their encouragement and support throughout the year. This year, the Committee introduced a scheme whereby the general membership of this Section could participate in development projects on an adhocratic basis, and a Seminar on these "Special Projects" is being held during this Session. We have also started a scheme to provide opportunities for students in the Faculties of Engineering at Katubedde and at Peradeniya to participate in development work, and a Symposium on these student projects is being held during this Session. The author of the best student paper will receive a prize awarded in memoray of the late President-Elect Mr. H. de S. Mannamperi.

Introduction:

In accordance with custom I have chosen for this address a subject that is within the ambit of my professional experience. I have titled it the Technology of Development and the Under-development of Technology in Sri Lanka. This is also of topical interest, but I must preface my remarks with the usual qualification that what I say here is my own responsibility and does not in any way commit the organization for which I work.

The current global economic crisis has given rise to a demand for a New International Economic Order. The United Nations

General Assembly made 2 historic decisions in 1974, the Declaration and Programme of Action on the establishment of a New International Economic Order at the 6th Special Session of the General Assembly in June, and the Charter of Economic Rights and Duties of States adopted at the 29th regular session of the General Assembly in August.

The principal impetus for these historic decisions has been an increasing militancy on the part of the so-called 3rd world countries in the face of deteriorating terms of trade for their economies. The inspiration for the concerted action has no doubt been the success of the oil-producing countries in achieving a fair price for their products starting from late 1973. Sri Lanka has been given the doubtful honour of being included in the category called the most seriously affected countries in the global economic crisis. We therefore have a particular interest in the efforts of the poorer countries to get a fair deal at the hands of the rich. It is in this context that I present this paper to this distinguished audience.

The Centre-Periphery Theory

In the early 50's Raul Prebisch, Executive Secretary of the U. N. Economic Commission for Latin America, brought to the attention of the International world the deterioration in the terms of trade of the Latin American countries over a long period of time from about the 1870's which he said was the fundamental reason for the distortion and underdevelopment of their economies. Prebisch and his staff developed a Centre-Periphery theory to explain this situation. At the Centre were the developed industrial countries which produced manufactured goods, whilst the Periphery was engaged in agriculture and mining for the production of primary goods. Such an international distribution of labour would have benefited the whole world community if the benefits of technical progress were distributed to the whole community either by lowering prices or raising incomes. This could have resulted according to classical economic theory if there was unconstrained competition in the product and factor markets at the Centre. In actual fact a declining terms of trade for the Periphery with respect to the Centre had occured over a long historical period.

According to Prebisch (1959) the root of the problem is the difference in the income elasticity of demand for imports at the Centre and at the Periphery. This is low at the Centre, generally less than one, and higher at the Periphery, always greater than one. The reason for this is that the Centre imports mainly food and other primary products. The growth of demand for food imports is slow because of "the operation of Engels law and agricultural protective measures practiced by many countries at the centre"[1] (Bear 1961-62). The demand for primary materials increases slowly on account of improvements in Technology at the Centre which results in more efficient use of inputs, and also on account of synthetic substitutes[2]. On the other hand output from the Periphery increases due to increases in productivity, and hence the price of imports to the Centre from the Periphery, decline.

Thus export prices at the Periphery decline over the years. In regard to imports at the Periphery however, the higher income elasticity of demand keeps these prices from declining. In actual fact the Centre had soon learned to control prices of their exports to the Periphery by monopolistic and oligopolistic measures, so that prices of imports at the Periphery actually increased rapidly over the years. Substantial increases in productivity at the Centre, due to technological development, further aggravated the situation of exploitation of the Periphery by the Centre through the terms of trade. The ultimate result was that there were substantial transfers of income from the Periphery to the Centre! This in fact was the "development of underdevelopment" a phrase coined some years later by Gunder-Frank (1969).

Sri Lanka has a mixed economy with a traditional sector and a Plantation sector. The Prebisch argument can be applied to Sri Lanka as depicted in the model shown in Figure 1. The expoit sector of our economy is here represented by the plantation industry producing Tea, Rubber, and Cocunut. Research Institutes, the TRI, the RRI, and the CRI support this sector of the economy. This investment in research and development results in increased productivity which should give increasing income. However, on account of price fixing, transfer pricing, protective tariffs, and other such devices, the terms of trade are manipulated to the disadvantage of the Periphery, so that there

is a nett transfer of income from the Periphery (Sri Lanka) to the Centre. Thus at the Periphery there is virtually a fixed income generated by the plantation industry. At the Centre, increased income results from the transfer of income and this leads to increased wages and in time, to increased prices of their manufactured products, some of which of course are exported to the Periphery. Added to this, due to non-elastic marginal demands for imports of primary products, the outflow of capital is controlled to maintain a favourable balance of trade for the Centre with respect to the Periphery. Thus we have twin circles which demonstrate the control over terms of trade of the plantation economy according to the Prebisch Theory.

Although there was considerable research on this theory which led to the development of what was later called the Latin American Structuralist school, the discussion was somehow hardly heard in this country. In fact it is possible that the Centre-Periphery relationship in which both the Latin American countries and Asian countries were caught up enabled the Centre to screen information, and there was no direct information channel between different parts of the Periphery.

Although the Prebisch theory was well-known in the West it was by no means universally accepted. Ellsworth (1961) and others argued that manufactured goods exported from the Centre increased in price due to improvements in product quality, whilst primary products exported from the Periphery remained constant in quality. The first development decade 1960—70, launched by the United Nations also paid more attention to the Anglo-Saxon view of the world rather than the Latin-American. This was perhaps because, "the teaching of economics in the developing countries themselves has so far been based firmly on orthodox Anglo-Saxon economics. Western economists in fact use the term economics, as though they possess a general set of analytical tools which can be used in all economic situations.....This belief in the generality of economics has been helped by the carry-over of western economics into socialist economics. The competitive model appears politically neutral because it is the theoretical optimim which would be reached *either* with a perfectly wise socialist planning committee *or* under a system of free competition with all its assumptions of perfect knowledge, free entry, and so on" (Livingstone 1969)[3].

Arising from Anglo-Saxon economics is the concept of the Vicious Circle of Poverty. According to Nurkse (1953) "A situation of this sort, a vicious circle of poverty, relating to a country as a whole be summed up in the trite prosposition: "A country is poor because it is poor".[4]

This theory is shown in Figure 2 where low income gives rise to low savings which means that there is low capital formation so that, with little capital for development, there is low productivity and hence low income. Western economists promoting their own brand of development have expressed the view that a forced savings break-through and a foreign aid break-through are necessary to free a country from this vicious circle.[5]

This thinking has also been evident in the planning process in our country. Significantly, the concept of a technological breakthrough[6] between little capital and low productivity has never entered the cognition of the National Planners. On the other hand, reference is often made to the achievements in China, without recognition of the fact that these achievements were based on just this type of technological breakthrough, where increasing productivity and production has been obtained with little monetary capital on account of systematic research and the application of Science and Technology to development, and where, though domestic savings may have been forced, foreign aid has been non-existent for the last 15 years or so. It is also self-evident that this concept of the Vicious Circle of Poverty cannot be applied to the plantation sector of our economy. It has relevance only to the so called traditional sector.

The characteristics of underdevelopment have been described by Sagasti(1971) in these terms: "The main characteristics of an underdeveloped country are that it is dominated, disarticulated, and incapable of covering the costs of a human status for the majority of its population. Domination implies that the UDC does not have an autonomous capacity for decision and that it has little control over its own destiny. External environmental factors, beyond the control of the underdeveloped country, are the main determinants of the direction taken by its economic, social and even political structures".[7]

THE DEVELOPMENT OF UNDERDEVELOPMENT

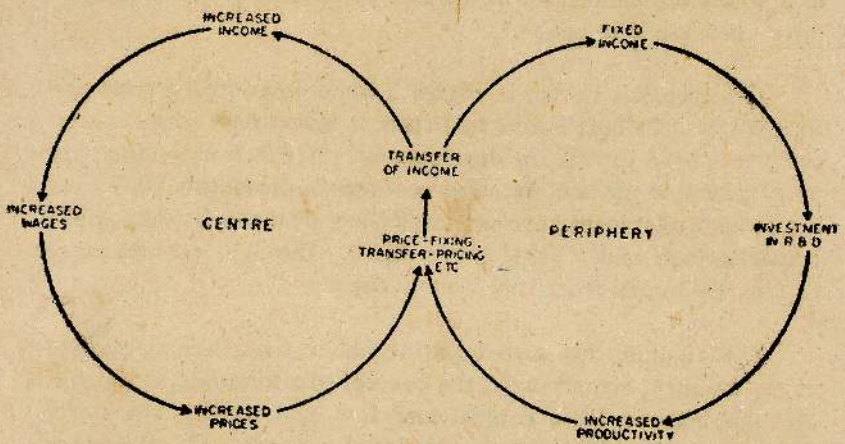

Fig.1

THE VICIOUS CIRCLE OF POVERTY (after Nurkse)

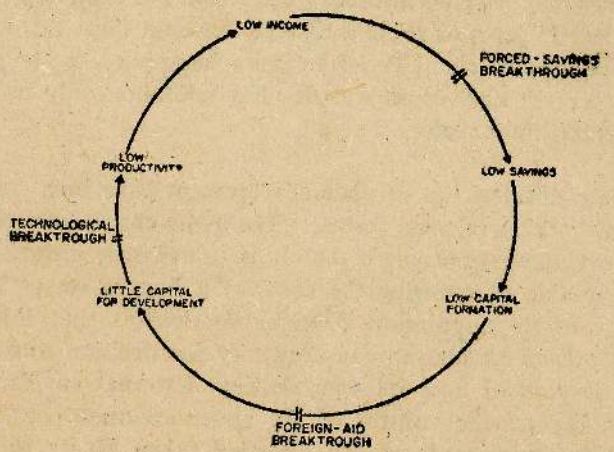

Fig. 2

The concept of a global division into a Centre and a Periphery, or dominent and dependant countries, or just rich and poor, calls to mind C.P. Snow's (1958)[8] decription of the two cultures. Indeed it is significant that Snow (1964)[9] himself in a later comment on his famous essay said "Before I wrote the lecture I thought of calling it 'The Rich and the Poor' and I rather wish that I hadn't changed my mind". One can list the alternative terminology for the two cultures in the global context as shown in Table 1.

TABLE 1

Some terms describing the Two Cultures
(on a global basis)

			Source
1.	Centre	Periphery	Prebisch
2.	Dominant	Dependent	Sagasti
3.	Rich	Poor	C. P. Snow (in "A Second Look" sequel to the Two Cultures
4.	"Rich, civilized peoples, conquerors and builders of empires".	"poor, backward peoples, those who did not have, or could not develop means of effective defence against conquest-longer the political or economic colonies".	J. Leite Lopes (reference to division a few years ago (1968))
5.	Developed	Developing	U.N. (Economic)
6.	Modern	Traditional	U.N.
7.	Advanced countries	Developing countries	Amilcar Herrera
8.	Developed	Backward	
9.	Developed	Less-developed (L.D.C.)	I.D.S. Sussex
10.	Over-developed	Under-developed	Malcolm Caldwell
11.	First & Second Worlds	Third World	U.N. (Political)
12.	Imperialist	Colonial	

Inside a country a similar dichotomy is apparent and this has been documented by Ananda Coomaraswamay (1904) amongst others in Sri Lanka, who drew attention to the traditional sector of our country and incidentally warned of the evils of so-called modernization, 70 years ago. In Sri Lanka we thus have two cultures of a traditional sector and a modern sector of the economy.

This has also been described as formal and informal, urban and rural, and so on. These terms are shown in Table 2.

TABLE 2.

The Two Cultures inside Sri Lanka

Modern Sector	Traditional Sector
Formal Sector	Informal Sector
Urban Sector	Rural Sector
Privileged Minority	Under-privileged majority

Of special interest at the present moment is the attempt to integrate the Plantation Sector with the rural indigenous sector, following on the Land Reform programme. In this exercise it is necessary to bear in mind that the plantation sector is subject to a Prebisch-type exploitation by the metropolitan Centre overseas, whilst the traditional sector is subject to a Nurkse-type Vicious Circle of Poverty. It is also worth noting that de Silva (1973) has drawn attention to a Prebisch-type Centre-preipheral exploitation of the rural hinterland in our country by our own urban sector.

The Sri Lanka Economy

With this background we may now examine the influence of the Centre on our economy, with special attention paid to technology, because "technology is the cornerstone of economic independence".

The empire building Western powers visited our country from the 15th century onwards at a time when our ancient agricultural civilization based on an intricate Irrigation system, was on the wane. They were able to over-power us with their energy and virility of outlook. They gave us an inferiority complex that has lasted to the present day. Our minds were turned to the metropolitan centres of power and we soon lost faith in our own abilities. The development of the plantation economy for the benefit of the metropolitan power resulted in the first transfers of technology from the Centre to Sri Lanka. There was no pretence but that local markets had to be captured and local resources transferred in return to the Centre.[10] In this process there was

a neglect that amounted to suppression of the traditional industries. These in time came to be described as cottage industries or mere crafts.

The same neglect of the traditional sector in agricutlture was evident. The expanding plantation industry over-ran the traditional village. Agricultural tools and implements imported for the plantation sector infilterated into markets in the traditional sector.

The colonization schemes that were enthusiastically promoted in the years immediately prior to world war II were conceived in a manner similar to the development of the plantation sector. The only real difference was that these schemes were promoted by the State and not by private enterprise. They were based on piece-meal restoration of major ancient irrigation works, the irrigable areas below the headworks being blocked out afresh. The planning of these irrigation projects was done with little refere-reference to the social organization of the existing traditional sector in these areas. These people together with others from more distant areas were physically re-located in these irrigation colonies (appropriately named colonies) with an allocation of resources from the State including a house, and such agricultural equipment as a mamoty, an axe and so on, all of which were imported.

Roads, railways, harbours and communications systems together with workshops in both the public sector and the private sector, constituted the investment in infrastructure for the plantation sector. In the irrigation colonizaton schemes, all the infrastructure was State owned but the individual allotments, one an irrigated lot for paddy cultivaton, and the other a highland allotment, were the property of the individual colonist. Without a social organization of the colonists themselves to look after the project, predictably every colonization scheme sooner or later ran into massive difficulties. The inevitable sequel in such a situation is of course a state committee or commission of inquiry.[11] Nevertheless, the source of the mistakes has hardly even been identified, far from being corrected. It is a safe bet that there will be new and greater problems in the Mahaweli development project unless

radical changes of attitude are seen in the implementation of this project.

An example of the inherent pitfalls is the so-called problem of water management. Whilst the cultivator is the only person whose very survival depends on the water, he is the only one excluded from the operation of the so-called water management system. At the moment there is discussion about getting down experts from abroad to advise us on water management problems in colonization schemes. In passing it my be mentioned that a real technological breakthrough in agriculture may be achieved if we could move rain bearing clouds from the wet zone to the dry zone, a distance of between 50 and 100 mls. It is ironical to note that the United States has probably developed such technologies, during the course of the war in Vietnam, but we would rather have them send us water management experts and PL 480 flour than clouds-seeding and rainmaking technology.

In British times the remains of the ancient irrigation system had excited the admiration of many colonial administrators who devoted much time to their investigation. Of these, the engineer Henry Parker (1870) has provided a pioneering study of the technological achievement of the ancients. In more recent times Brohier (1934) has used the excellent topographical survey of the whole island to document the available information on these ancient irrigation works. Needham et al (1973) have presented an analysis of the evolution of the ancient irrigation system in Sri Lanka. Kennedy (1935) has studied the maintenance and operation of the village irrigation works which are the earliest of these ancient works, and Arumugam (1966) has continued this work on the same lines. Nevertheless a comprehensive study of the ancient irrigation system has not yet been made by a modern engineer.

Transbasin diversion as a concept has been given publicity in recent times on account of the Mahaweli diversion project. It is not widely known that the ancient irrigation system included many transbasin diversions and in fact had been planned on a multi-purpose basis of irrigaton, drainage, flood control and conservation over very long periods of time. The best example is

the Anuradhapura city tanks—Kalawewa—Mahaweli basin complex. Anuradhapura became the capital of Sri Lanka in the 3rd Century B. C. It was first supplied by small city tanks like the Basawakkulama and the Tissawewa. In due course as the city expanded the Nuwara wewa was constructed and this was later augmented by a canal that took off from a diversion anicut. The Nachchaduwa wewa built later impounded more water and consolidated the supply to Nuwara Wewa. Still later, Nachchaduwa itself augmented from the adjacent basin of the Kala oya by a diversion anicut and canal. But the major achievement in supplying the capital city with water was the augmentation of all the city tanks in the 5th Century A.D., by a transbasin diversion from the Kala wewa via the 55 mile long Jaya ganga. This canal had a fantastic gradient of $\frac{1}{2}$ ft. per mile for the first 17 miles and an average of 1 ft. per mile throughout its length. Finally, the Kalawewa itself was augmented, probably in the 8th century A.D. by a diversion from the Mahaweli ganga basin.[12]

In contrast to this remarkable water resources planning over several centuries in ancinet and medieval times, a recent school of thought exists of a single basin balance of water and land.[13] This appears to be an example of a transfer of technology that has been accepted by local specialists without an appreciation of the superior techniques already avaialble from our ancient heritage, for multi purpose all island development. One example of an error resulting from this concept is the location of the Uda walawe reservoir. If a single basin water-land balance was not being sought in this valley, this reservoir would have been located several miles up stream of the present location, with provision for later augmentation from the adjacent Wet Zone basins.[14] Another such project recently proposed is the Lunugang wehera across the lower Kirindi oya. The location of this proposed reservoir can only be justified from the standpoint of a single basin balance of water and land, a ludicrous concept indeed.

The piece-meal restoration of the major ancient works started by the British has been continued up to recent times; (at the present moment the restoration of the Wahalkade wewa is going on). At the same time a modern version of multipurpose basin development has been introduced. This can be traced to the Tennessee

Valley Authority project started in USA in the depression years of the mid 30's, and carefully followed in the planning of our own Gal oya valley multi-purpose project in the late 40's.[15]

After world war II the spotlight was on the Galoya project. Here, under a brand-new T.V.A. type Galoya Development Board, American consultants, contractors and some local counterparts had a field day. On a cost-plus profits contract, the latest construction technology was used to build the largest earth dam in this country, and two main channels, in record time.[16] This magnificent achievement inspired many Ceylonese personnel with the modern approach to construction, complete with air-conditioned cabins, a Juke box in the club house, individual jeeps for all construction personnel, and a refrigeration van that ran daily between Colombo and Inginiyagala bringing in such essential supplies as beer.

Strangely enough, in the Irrigation Department at the same time, construction work was going on using all manner of other techniques. Several Indian engineers in Kantalai, Allai, Meeyoya etc. were promoting so-called labour intensive construction methods. At the same time war displaced engineers of various nationalities were making some remarkable contributions to our development in Kantalai, Elahera, and other schemes using what in today's jargon would have been described as appropriate technology. At headquarters in Colombo the Irrigation Department was developing an excellent Research Branch which was using the inherent genius of local people for irrigation development work. All this feverish activity in the early post war years led to something of an anti-climax in the late 50's. At this stage a foreign exchange problem was emerging, the American image in the construction world was being challenged by new comers from the Socialist countries, and labour intensive construction techniques that were once taken for granted were now loaded with political overtones.

The situation in the industrial sector at this time should also be mentioned. The government had pioneered the establishment of several factories: Coir—1937, Steel—rerolling 1937, Plywood—1941, Leather—1941, Acetic acid—1942, Drugs—1943 ,Paper—1942, Glass—1944, and Ceramics —1944. These early State projects had served their purpose during the war years. However

after 1948, new concepts of modernization were introduced, and some of these State projects were scrapped. "The influence of the IBRD on industrial policies and development pursued by the government in the early 1950's is clearly discernible" (Karunaratna 1973). After the political changes in 1956, a plan for industrialization was drawn up and the State Industrial Corporations Act No. 48 of 1957 was promulgated. The CISIR was set up under this act. Seven industries, Steel, Cement, Chemicals, Fertilizer, Salt based industries, Mineral sands, and Sugar—Alchohol—Rayon were to be the exclusive preserve of the State. Another 23 light consumer goods industries were ear marked for joint enterprises between the State and the private sector. Finally, a long list of 82 small scale industries was identified for exclusive prospecting by the private sector. It was been remarked that this, "scheduling of Ceylon's industries turns out to be an adhoc and pragmatic listing of existing industries at that time in their respective centres".[17]

The Development of Underdevelopment

The influence of the Centre is very evident in our strategies for development, even after the so-called social revolution of 1956. The best manifestation of this influence is the 10 year plan of 1959, which highlighted, "Ceylon's relative advantages vis-a-vis many other countries of Asia," and identified these alleged advantages as due to "the prevelance of plantation agriculture producing Tea, Rubber and Coconut for exports to world market". It further stated that "the problem of growth is in large measure one of establishing and expanding industries". Perhaps anticipating changes in emphasis from the public sector to the private sector and vice versa, from time to time for political reasons, the plan also stated that its development strategy was "independent of the institutional forms that are to be established", on the basis that it would "not depend very closely on institutional systems and forms of ownership".[18]

The adverse terms of trade in the Plantation sector and the Gunder Frank phenomenon of the development of underdevelopment were to be discussed much later. The influence of the Centre could be traced to the preparatory work for the 10-year-plan 1959 which had commenced shortly after the change of Government

in 1956, when the planning Secretariat was headed by the new Prime Minister as Chairman and the Finance Minister as Deputy Chairman. The following quotation is relevant:[19]

"In November 1957, the Government of Ceylon invited a number of distinguished economists from abroad to visit Ceylon for the purpose of advising the National Planning Council on broad questions of planning and economic development.

Mr. Gunnar Myrdal and two associates Mr. Mogens Boserup and Mrs. Esther Boserup, Mr. Nicholas Kaldor, Mrs. Joan Robinson, Mr. Oskar Lange and Mr. J. K. Galbraith were able to accept this invitation and visit Ceylon at different periods between March 1958 and May 1959.

These visits were of relatively short duration ranging generally from 4 to 6 weeks. Much of the time of the visitors was spent in consultations and discussion with the National Planning Council, the Planning Secretariat, and other authorities in Ceylon. The papers and memoranda prepared by them are in the nature of additional contributions. They are being published in view of and their interest to a wider public—particularly in the context of the Ten-Year Plan.

On account of their relevance to the general discussion, this volume also includes two papers prepared earlier by Mr. J. R. Hicks and Mrs. U. K. Hicks who visited Ceylon in early 1957 on the invitation of the Central Bank.

In presenting this volume the National Planning Council wishes to express its thanks to the visiting experts for their valauble contributions to planning in Ceylon."

The 10 year plan was hailed as a masterpiece, and although it was not systematically implemented, the setting up of the Ministry of Planning & Economic Affairs in 1965 was due to the efforts of the Planning Secretariat that had prepared the Plan in 1959. To explain these events it is necessary to use two models described as a New Map of the World[20] (Figure 3) and the Social Basis of Science and Technology Policy[21] (Figure 4).

A NEW MAP OF THE WORLD

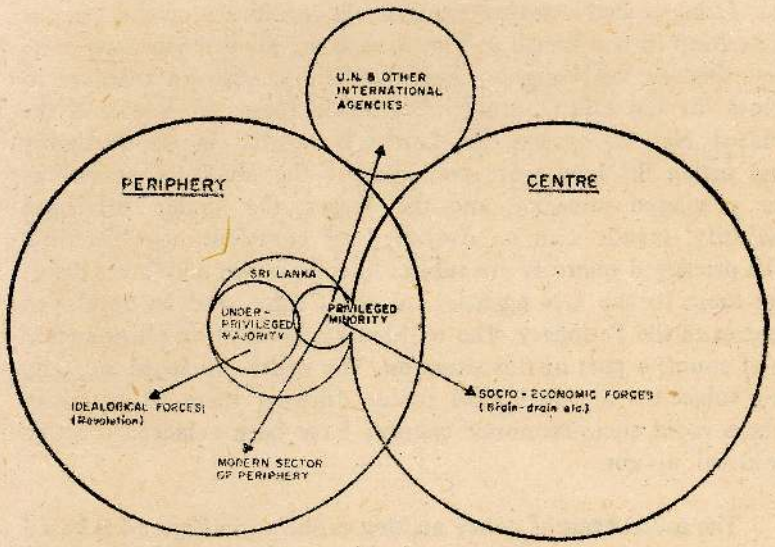

Fig. 3

THE SOCIAL BASIS OF SCIENCE & TECHNOLOGY POLICY (after Amilcar Herrera)

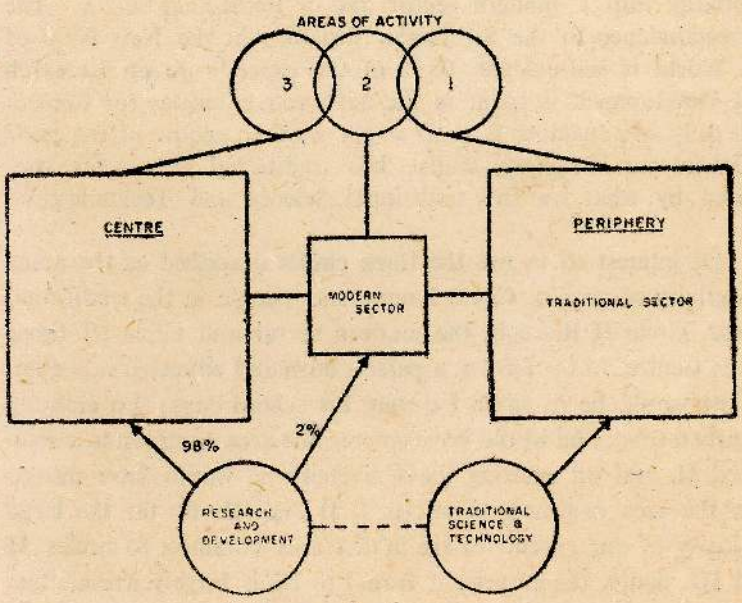

Fig. 4

Using a Prebisch-type analysis the world is depicted, in the New Map of the World in Fig. 3, as being divided into two parts described as the Periphery and the Centre, with an overlap to allow for the OPEC countries. Outside these two worlds is the United Nations system. Sri Lanka is located in the Periphery and inside Sri Lanka are two groups—the smaller described as the privileged minority, and the larger the under privileged majority, (again with an over-lap, for conscientious objectors!) The privileged minority are subject to socio-economic forces drawing them to the UN agencies, to the Centre, and to developed centres in the Periphery. The well-known brain-drain phenomenon is of course a part of this situation. The under-privileged majority are subjected to idealogical forces drawing them to countries where rapid socio-economic changes have been achieved through political action.

The social basis of policy making as shown in Figure 4 is based on the analysis of global society by Amilcar. O. Herrera (1971) who recognises two broad categories of advanced countries and developing countries corresponding to the Centre and the Periphery. The developing countries or Periphery are themselves divided internally into a modern sector and a traditional sector. The correspondence to the Sri Lanka situation in the New Map of the World is self-evident. 98 % of the expenditure on Research and Development is spent in the advanced countries (or Centre) and only 2% sustains R & D in the modern sector of the poor countries (or Periphery) whilst their traditional sectors are supported by what we call traditional Science and Technology.

Of interest to us are the three circles described as the areas of activity of people. Circle I represents people in the traditional sector, circle II those in the modern sector and circle III those in the Centre. In Sri Lanka, a person born and educated in a rural village would be in circle I during his school days; on entering an urban school he would have entered the area common to circles I and II, and on entering the University he would have moved into the area common to circles I, II and III. By far the large majority of our executives are in that area common to circles II and III. Sadly, the movement from I to III is largely irreversible;

also, the situation between circles II and III is one of domination of II by III.

Herrera points out that the influence of the Centre in this fashion can be implicit or explicit. Explicit influence is by difinition amenable to analysis. It is tangible. It may even be quantified. Implicit influence on the other hand is intangible and elusive. Nevertheless it is real. The role of the Planning Ministry from 1965—1970 also illustrates this. Quite explicitly there was dependance on foreign expertise in the form of the UNDP team, whilst the mechanics of the planning process was implicitly inspired by external Centres such as the Institute of Development Studies in Sussex.

The increasing dependance on the World Bank and the International Monetary Fund during this period has been analysed by Hewawitharana (1974). The general situation has been described by Cherryl Payer (1971). This trend culminated in the proposals that either originated or were inspired in Washington D.C. such as the 25 MW Gas Turbine Project and the Highways Project for the modernization of the Highways system in this country. In 1969, these issues were taken up by the scientists and technologists in this country who presented an unprecedented united front against the Planners on these issues. Nevertheless there was no change until the Government itself changed, when both these projects were thrown out. At the same time the UNDP team was considerably reduced, but, contrary to the expectations of local scientists and technologists, they were not replaced by local men. Finally the ILO employment mission that visited the country in the pre-election period continued their activities after the change of government and published a report which was accepted in the old tradition of relations between the Periphery and the Centre.

The influence of the Centre is also seen in an obvious way in the education system. Attempts to reform and restructure this system have met with no more than the usual difficulties confronting any reform programme. Curiously, even our radical politics has all the signs of influence from a metropolitan centre.

It is perhaps a reaction against this subtle remote control influence in the spheres of education and politics that inspired men like Anagarika Dharmapala. More recently the upheavals in 1971 could be traced to a similar reaction against the Centre, mainly amongst the youth of our country.

It is thus evident that in the past, the national planners and higher decision-makers all belonged to the privileged minority who collaborated with counterparts (experts) from the Centre (advanced countries, U. N. etc.) without reference to indigenous potential outside their own charmed circle. They consciously or unconsciously accepted the so-called Rostowian view of economic growth in stages, used impersonal criteria such as per capita income and gross-national product as yardsticks for development, and watched these indicators hopefully for signs of progress towards the magic point of take-off. Their jargon which included expressions like "spin-off" and "trickling-down" (of benefits from planning) indicated their state of mind. That their methods have failed is evident from a glance at the increasing foreign debt during the 10 year period from 1964 to 1974. (See Table 3).

However, Fr. Balasuriya (1975) has expressed the view that according to International law we do not have a problem of foreign debt, because of appropriation without compensation in colonial times by the metropolitan powers. Vimalananda (1965) and P.H. D.H. Silva (1975) have actually listed a number of priceless documents removed from our country in colonial times and now lying in Archives and Museums at the Centre. One can go on in this strain to point out that western civilization itself has been built on misappropriated 'black gold' resources from slave traffic to petroleum, but what will it avail us? For example, can Egypt's priceless treasures that today lie in European Museums be used to redeem her recent debt to the Soviet Union? We should remember that when the Arabs increased the price of oil President Ford said that the United States was prepared to take direct action if the American way of life was threatened. Obviously the message is that when it suits the mighty, might is right.

Science, Technology and Economic Independence

The 5-year Plan 1970-1976, published in November 1971 had the advantage of some hind sight resulting from the 1971

TABLE 3.

GROSS EXTERNAL LIABILITIES OUTSTANDING*
(*Rs. Million*)

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Official loans (including stering loans)	412	489	549	739	1074	1376	1596	1919	2336	2687	2926
Supplier's credits	—	—	—	17	66	192	197	190	158	303	518
Short-term trade credits	37	60	31	108	95	130	273	317	340	477	525
IMF	108	181	271	376	636	626	490	448	466	464	628
Central Bank borrowings	—	—	—	57	29	256	412	334	352	245	262
Total	557	730	851	1297	1900	2580	2968	3208	3653	4176	4859

*Official loans for period 1964-69 represent amounts outstanding at the end of September

blood bath. This plan made an attempt to liberate the economy from over dependence on the external Centre. For this purpose it proposed mobilising local savings at an average of 17% compared to an actual achievement of about 12% during the previous decade. It also focussed on the development of indigenous technology and presented a scheme for development at grass-roots level through the Divisional Development Council Programme. It also stressed the small scale sector and identified the urgent need to diversify the export sector.

The DDC programme has been hailed in some quarters as the new hope for Sri Lanka especially as it has attempted to harness the productive capacities of traditional techniologies in development; but this programme will make only marginal impact on the economic situation unless a strategy for upgrading the traditional technology of the rural areas with an infusion of modern science and technology is prepared and rigourously implemented. To achieve this the structure of the administration has to be revamped. One cannot see this happening in the present context where inspiration for institutional reform still comes from the Centre—the National Indstitute of Management, the Academy of Administrative Studies and the Mini-Kachcheri system, are examples.

Nevertheless it can be shown analytically, that the DDC programme does offer some hope for the achievement of economic independance within the existing political framework. Sagasti (1971) has analysed the nation-system into various component systems of Science, Technology, Education, Production etc. He says that "Economic development, taking the point of view of the underdeveloped country, is considered a dynamic process of structural change characterized by three factors: (1) absolute and sustained economic growth, (2) scientific and technological progress, and (3) social propagation of the effects of (1) and (2) to all sectors of the population.

The first factor, economic growth, traditionlly has been considered as synonymous with economic development. Although a necessary condition, it is not sufficient by itself, for economic growth, without technological progress and the propagation of

their effects, does not lead to overcoming the conditions of domination and disarticulation which characterise underdevelopment.

The second factor, technological progress, refers to the autonomous capacity on the part of the country to generate, diffuse and utilize scientific and technological knowledge, incorporating it in its productive processes. However, this autonomous capacity does not imply autarchy and rejection of technology imported from abroad, it rather implies the capacity for importing, absorbing and modifying foreign know-how, adapting it to local conditions and even re-exporting it after further elaboration. Only through a process of creating its own scientific and technological capacity, the underdeveloped country will be in a position to counteract the effects of technological domination, establishing relations of interdependence with other countries which would not become asymmetrical and unbalanced.

The third and last factor refers to the social propagation of the effects of economic growth and technological progress to all sectors of the population. This would be equivalent to breaking down the disarticulation which characterizes underdeveloped countries, making the benefits derived ftom the two preceding factors of a development process available to the various regions of the country and to all segments and sectors of its society."[22]

Using a Sagasti-type analysis, the Science-Technology Production System of Sri Lanka is shown in Figure 5.[23] Here a modern science system leads into a modern technology system which feeds modern local technology into the production system. Likewise the traditional science and technology system feeds local technology into the production system. Foreign technology comes into the local production system via the modern sector or directly from outside, this being the well-known Transfer of Technology.

The production system itself has been defined in terms of several areas such as primary goods, intermediate goods, capital goods, construction, agriculture, health and transport. In each one of these areas or sectors there can be a local investment or a foreign investment. In each investment there can be a component

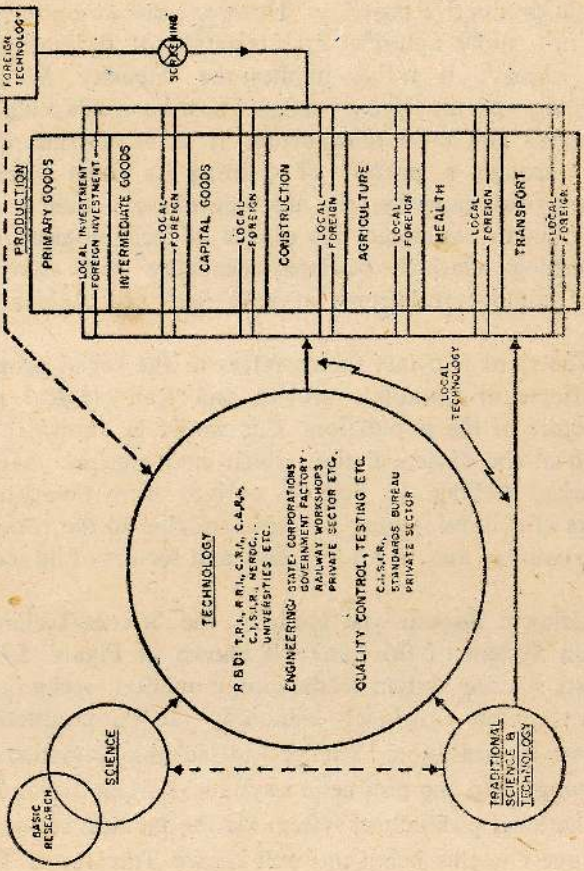

Fig. 5

of local technology either modern or traditional, and a component of foreign technology.

The D.D.C. Programme represents local investment in the production system, organized on a cooperative basis. D.D.C. dispersed production cooperatives have made an impact in three areas, in which apex organizations or Unions have been established. Firstly, village blacksmiths were organized into Light Engineering Industrial Cooperatives, followed by the organization of Medium Scale Industrial Cooperatives of small workshops in provincial towns. Together they have an apex organization, the Light Engineering Industrial Cooperatives Union. Secondly, village potters were organized into dispersed production cooperatives which today have their apex organization, the Sri Lanka Geological Resources Industrial Cooperatives Union. Finally the Ayurvedic physicians organized into dispersed production co-operatives for the systematic manufacture of their drugs, now have an Union of Medical and Chemical Industries Manufacturing Co-operatives.

D.D.C. projects using local technology have also been organized in other sectors, including Agriculture and Construction.[24] However imperfect, the D.D.C. programme remains the only effort to resurrect and restructure traditional technology.[25] This development of an indigenous technology is often impeded by uncontrolled influx of foreign technology. It is therefore stressed that foreign technology should be effectively screened to prevent it from suppressing indigenous technology (see Fig. 5).

In 1971, a proposal for the establishment of a National Engineering Research and Development Centre had been made and one of the proposed functions of NERDC was the screening of foreign technology. The long-drawn out preliminary work in setting up NERDC which took 3 years, was also typical of the under-developed attitude to technology in this country. Highlights of this history were, the application made by the Secretary to the Ministry of Industries for UNIDO assistance in setting up this project when local engineers were stressing at every available forum that we had the resources to set up the NERD Centre without such external assistance; and the setting up of a "Steering Committee" by the Minister of Industries with a Member of the

the once hallowed Civil Service as its chariman! Ultimately, the NERD Centre was set up with an engineer as Chairman although the present acting incumbant is also a non-technical man, an ex-civil servant.[26]

Transfer of Technology

Today the topic of the hour in development planning is the Transfer of Technology. This is the subject named as the Topic of the Year for 1976 at the Colombo Plan Conference held very recently in Colombo. It has been discussed at a special ESCAP meeting in Malaysia a few months ago. It is also one of the front line subjects for discussion at the 4th UNCTAD at Nairobi next year. This association also lent its patronage to a joint Seminar in Colombo last month financed by UNCTAD as a preparatory discussion for UNCTAD 4, and a preliminary meeting at Singapore will follow, later this month.

It is well known that the very expression "Transfer of Technology" was coined at the Centre, although it is now part of the vocabulary of international jargon. It is therefore well to remember that.... "developed countries have been continuously shifting their modes of domination over underdeveloped ones in response to changing conditions and to pressures from them. From the control of raw materials extracted from, and manufactured goods supplied to the UDC through export-import trading measures, they moved to the control of industrial production facilities through direct investment, and are now shifting to the control of technological know-how required in manufacturing industries. This last form is often exercised through direct investment and also through licencing agreements, sales of patents, etc. The primary vehicles through which these various forms of domination have been and are exerted has been and is the international or multi-national corporation".[27] (Sagasti 1971).

The multi-national corporations have not come into our country on the same scale as they have invaded India, for example, for obvious reasons such as the size of the market. Nevertheless, there are signs today that some decision makers believe that we should open our doors still wider to the multinationals because

this is the road to development. We should therefore remind ourselves that many multinationals today have larger budgets than many developing countries. The activities of some of these monster organizations in Latin American countries have been proved to be subversive. Yet they appear to remain beyond the reach of International Law even when they participate in political activity aimed at overthrowing lawfully elected governments. It is therefore not difficult to imagine that concepts such as the transfer of technology that are now part and parcel of U.N. jargon have in fact been introduced by vested interests into the International organizations.

Sri Lanka is well represented in almost every U.N. organization. In fact it is fast becoming the done thing for the privileged elite to aspire to U.N. employment in the later years of their working lives. But are all these representatives really serving the interests of Sri Lanka? Are not some of these actually doing the home country a dis-service? Some clues may be found by a scrutiny of their activities here, prior to acceptance of employment in the International circuit. Similar remarks would apply to our representation at International Conferences, Seminars and so on.

Independant scientific and technical organizations like the S.L.A.A.S. should take steps to examine these issues, and advice the government.

One is reminded of the first UNCTAD conference held in Geneva in 1964 as a result of pressures from the 3rd world led by the Latin Americans where Raul Prebisch was elected first Secretary-General. At this Conference, the representatives of the Centre successfully withstood effective unification of the various portions of the Periphery; whereupon, a signiicant warning was given by the representative from Cuba, the Minister for Planning Major Guevarra who said:

"If the groups of underdeveloped countries, lured by the siren song of the vested interests of the developed powers which exploit their backwardness, contend futilely among themselves for the crumbs from the table of the world's mighty and break

the ranks of numerically superior forces....the worldwill remain as it is".[28]

Recently the U.N. Environmental Programme has selected Sri Lanka as the location for a Regional, Solar Wind and Biogas (SWB) project for Asia. We can expect a massive transfer of technology on account of this project in the future. It is therefore of interest to note that all 3 energy sources had been developed at the Centre, but the technology had not been transferred to the Periphery, in colonial times. In Paris, a solar powered printing press had operated daily (on sunny days of course) as far back as 1882, but this technology had not been transferred to French Colonies in the sunny equatorial belt in Africa, for example.[29] In the Netherlands, wind-mill technology was highly developed but only for local consumption. In their colonies the Royal Dutch Shell Co. expropriated the black gold of the poor countries and promoted more and more consumption of oil-based technology. (Similarly, bicycles were used extensively at home but were not manufactured in Dutch colonial territories). Finally in Britain, during World War II, Bio-gas generation was very common in urban sewage plants with a useful by-product of fertilizer,[30] but this technology too was never transferred to British colonies.

Appropriate Technology:

The British however demonstrated Appropriate Technology for power in the form of small hydro power plants in the plantation sector in our country. However, once the planning process got started a development project was financed by a loan from the Asian Development Bank, for the electrification of the plantation sector. This resulted in scrapping of many small-scale hydro power plants that were working very well up to that time. Now, a SLAAS special project has taken this up.

A similar project is the rural electrification project financed by the Electricity Board out of its own revenue. This is a concept that also originated in U.S.A. after the depression as part of Roosevelts New Deal. That is how it has been adopted here whilst other proposals such as the electrification of railways and the establishment of a fertilizer plant at one of the hydropower projects has not been accepted, because these latter projects not only originated

in this country, but were not in the interests of the Centre to finance.[31]

Many more such examples of the results of our disadvantageous bargaining position may be given. But it would be better to conclude this discussion with a glance at the other side, namely,the overdeveloped world of the Centre which has been and continue to be such a source of inspiration to our modern development planners.

The Club of Rome had highlighted the rapid exhaustion of natures non-renewable resources. The Limits to Growth (1972) study has shown that in the developed world the environment is being polluted, and the ecological balance with nature is being distributed perhaps to an extent that never be repaired. Many mineral resources are being consumed so fast that there does not appear to be any prospect of finding suitable substitutes in time. This situation in the overdeveloped world at the Centre is due to waste-making economic systems. This is shown in Figure 6, called the Vicious Spirals of Overdevelopment.[32]

"This model shows that the situation prevailing in many areas of the so-called developed world is far more urgent and dangerous than that in many areas of the developing world. This could be described as the problem of unbalanced development or euphemistically, over-development.

The over-developed system can be represented by twin spirals representing broadly production and consumption, respectively. The common front is High Productivity closely linked with High Pressure Salesmanship. In the production spiral, High Pressure Salesmanship produces High Profits, and High Profits means High Capital Accumulation. With plenty of capital the tendency is to to use High Cost Technology which gives High Productivity, and so that the cycle is complete. On the consumption side, High Pressure Salesmanship results in High Consumption which gives rise to a high degree of Waste which in turn means a High Exploitation of Natural Resources. Unfortunately most of these resources are non-renewable, the outstanding example being oil.

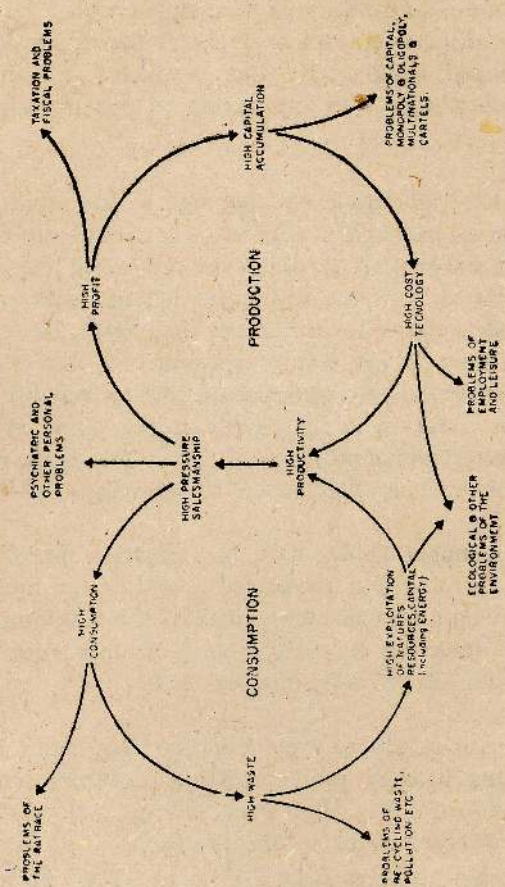

Fig. 6

Each of these cycles is in effect a spiral because inevitably there is an accomplying inflation.

Every single feature of the twin spirals of the over-developed economy gives rise to one or more specific problems. High capital formation is at the root of problems of Monopoly and Oligopoly, Multi-Nationals and Cartels. High cost technology gives rise to various problems of employment and leisure. High exploitation of nature's precious resources by the use of high technology results in ecological problems. High pressure salesmanship and high consumption are responsible for many of the psychiatric and psychological problems, and all the social problems of the rat-race.

All these are materialistic, non-idealogical problems, although their ultimate solution may require ideological as well as materialistic treatment. However, by the mere fact of their colossal scale their impact is global, and the need for solutions is therefore of the utmost urgency. If a fraction of the time, energy and other resources now spent on studying the nature of appropriate technology for the developing countries, is transferred in good faith, to a study of the requisite appropriate technologies to reverse the vicious spirals of over development in the developed countries, such solutions will surely be found very early—and the world will be a safer and healtheir place for developing and developed countries slike.

What would be the characteristics of such appropriate technologies for the developed world? Firstly there must be an immediate substantial and dramatic increase in the prices paid for primary products of developing countries. This will be to restrain the present high exploitation of scarce natural resources. To reduce high consumption and waste there must be an easing off of high pressure salesmanship. To achieve this objective in practice there must be a deliberate effort to reduce the quantum of overheads and establish shorter links between producers and consumers. Whether this can be achieved without centralised planning, at least in different sectors of the economy, is questionable. Centralised planning of the indicative type practised in France where the major producers are called in as advisers to the central planning authority may be possible in the United States where

the constitution permits business interests to lobby their points of view on political issues. A similar lobby system may be institutionalised to assist a central planning authority.

However, these are mere speculations far removed from the monstrous reality which is the gross distortion of the production process that we have labelled over-development. The immediate good that can result from a discussion of the need for apropriate technology in the developed world will be to restrain the over-enthusiastic efforts to "transfer technology" to the developing nations on account of the realisation that such a cure can be patently worse than any disease of under-development. Furthermore, the aggravation of under-development by continued extraction of resources from the poor countries in the form of primary production will be checked, if the insatiable hunger of the high-technology production machine of the developed world can be curbed."[32]

Conclusion

It would thus appear that the over-developed economies must be curbed. This means that a point on the Rostowian growth curve similar to the famous point of "take-off" has to be identified, at which point growth must be planned to ease-off. The point of ease-off (see Figure 7) has already been passed in the case of many western economies. Srianandа (1974) has demonstrated this by an analytical method. How the miracle of ease-off can be achieved is another question. Certainly many societal changes such as bringing the jeans of production closer to the point of consumption are implied. A number of different mechanisms of social organization are possible to achieve this. For example we may talk of the Chinese Commune or the Israeli Kibuts; but whether the over-developing world is going to willingly change its institutional structures is rather hard to immagine at the present time. Nevertheless the very future of mankind may depend on just such an unthinkable situation.

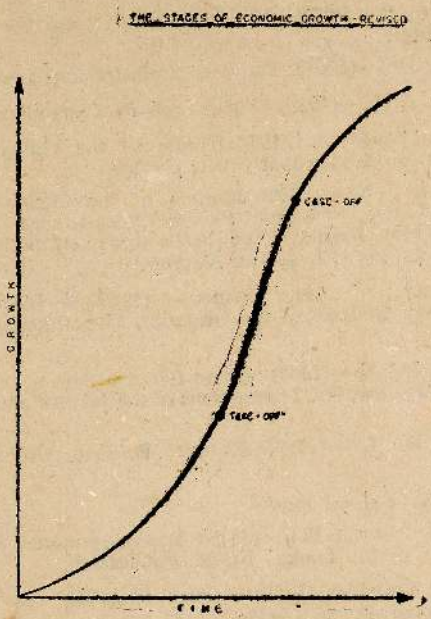

Fig. 7

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31. For example, the IBRD Mission in 1952 did not favour the seting up of a Fertilizer Plant at that time. The 10 Year Plan in 1959, proposed to "modernize" the railways by "replacement of steam traction by more modern means of motive power". But electrifification was ruled out: instead "the development of the Colombo and suburban areas by the introduction of diesel trains and colour light signalling "was proposed These proposals were subsequently implemented. and in the name of "modernization" the existing steam locomotives were scrapped and replaced with diesel-hydraulic traction. Today when despera'e efforts are being made to achieve the long-awaited electrification of the Government Railways, first proposed by Wimalasundara as for back as 1917, these diesel-hydraulic locomotives and power-coach sets are assuming the proportions of a massive liability.

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SECTION D—NATURAL SCIENCES

Presidential Address

SOME REFLECTIONS OF EDUCATIONAL CHANGE IN SRI—LANKA

by

R. N. de FONSEKA

Section D (Natural Sciences Section) of the Sri Lanka Association for the Advancement of Science have done me the honour of electing me as their President for this year and I am indeed much grateful to the members of this section for electing me to this position.

After pondering for quite sometime over a subject on which to address you I finally decided to give expression to some of my thoughts on education. It is certainly not my intention to engage in "vituperative education" although I am at the tail end of my office. Yet, this should not prevent me from saying what I candidly feel on some matters pertaining to education. At the outset I must admit that I am not an educationalist. At the most I am only an educator. If the little I have to say would give educationalist a glimpse of how one outside their own domain views the educational changes in this country, then, I would be more than satisfied.

Mr. President, it may become necessary at times to refer to past educational changes in this country. In doing so it is not my intention to bore you with history. It is also not my purpose to impress on you that all that is wrong is due to sins of the past.

If one is to recognize the major events in the history of education in this country one would probably be inclined to give the following high priority. The introduction of free education, the shift to the mother tongue as the medium of instruction, the state control of education and the expansion of tertiary education.

What I now hope to do is to consider each of these aspects, somewhat in detail.

To me it appears that free education, the pearl of great price could be justified for two reasons. The first is that it democratizes education. As the special committee on education commented in 1943, talents and ability are not confined to any social class or group and the social system must provide for their emergence by the provision of equal educational opportunities. When the largest countries in Southern Asia, India, Pakistan and Indonesia had independence, far below 1/5 of the population was literate. Ceylon however entered the independence era with a comparatively high literacy rate and this attributable to the activity of the Buddhist monastries and the Christian missions.

Prior to the introduction of free education there was a wide discrepancy in the quality of the staff and amenities in the two sets of schools that existed then, the vernacular and the English schools. It is also true that the colonial governments helped to preserve this barrier between an entrenched upper calss and the masses of people. It was only the middle and the upper class who ware able to send their children to the fee levying schools. But for most people in South East Asia the condition of the common man was static and every parent craved for social mobility, that their children make better lives than their parents had done. No government committed to demociacy could resist such a force at work. Free education was the answer.

With the availability of free education there occurred an explosion in the University, particularly in the Faculty of Arts, and, that too, with the combination of subjects like Sinhala, Pali and Sanskrit. Graduate employment as teachers was freely available as secondary education could still bulge in the middle and these teachers produced for the University more entrants who read more and more for Arts degrees with the same combination of subjects. This created the problem that the numbers leaving secondary schools and the numbers leaving after tertiary education were both in excess of the countries requirements and unutilizable in terms of the countries needs. Taking into account the political climate where every political group had as its slogan

the establishment of a democratic form of government in Sri Lanka and considering the fact that the slightest mistake would have had its adverse effect politically one could understand the disinclination to stop the democratisation trend of education. However, with the passage of time the numbers of educated unemployed increased astronomically with the result that no government could last without a quick solution to this problem. The governments from 1965 onwards had to decide which was the lesser political evil, whether it was better to allow matters to drift and to be faced with tackling the problem of the educated unemployed, or to step in and modify the liberal system of education prevailing, in such a manner as to gear it to the requirements of the country.

Successive governments realised that several constraints operate on democracy. As social service items have an unlimited capacity to absorb resources every government had to ensure that such expenditure was contained leaving sufficient resources for the other sectors. Thus a new educational theory sprang up from among economists studying education and this is what I referred to as the second reason. To the economists education was not a form of consumption but a national investment. They considered education as a medium or a long term investment and politicians were forced to regard education as an essential element in economic development. In the absence of economic development no government could plough more and more money into education. Furthermore, if economic development of a country is to take place it must provide the right talents at the right time. The mere availability of natural resources, capital and equipment was not going to produce wealth of the specialized and skilled manpower required in the sphere of economic activity was in short supply. No development program could then succeed. Economic planning could be short term, medium term or long term. The last is what economists call perspective planning. Any of these plans and particularly a perspective plan could depict the structure of the economy at a certain point of time. It would express in terms of quantity and quality the man power requirements of the country. According to this view of education, though education is given free of fees it does not permit freedom with regard to alternatives. Parents and pupils must suit their likes

and interests to the requirements of the state. Towards the realization of this goal the last government established what were called Junior Universities with the intention of producing the technical men so necessary for this country. The present government under played the importance of these establishments. Instead they have made drastic changes in the 6—9 forms and more rigorous changes are envisaged for the contemplated grades 10 and 11. You will agree with me that if there is a change of government we will, without doubt, have still another national system of education. Thus recent governments have been moving towards some measure of perspective planning, though in Sri Lanka's democratic politics the speed of change depends on how often we change the party that governs.

To return to the theory that education is investment by the state of good money I am tempted to assert that whether the country is communist or capitalist, the state becomes a vast business organization working like all businesses for profit. The profit is utilization of man power for improvement of the state. Education, in this view, is an institution of state to serve the needs of national development. In such an investment the state must decide on the course for its future workers, not the parents. The children must fit in where the state needs there services most. Parents may like their children to be doctors but the state may need technicians. If the state does not think along these lines or if it does not have the required machinery to implement such a scheme then we would continue to believe in the basic philosophy of the free development of man according to his natural inclinations. If this be so, it is not correct to say that the money we are now spending on free education has to be debited as an item of social welfare where knowledge is pursued for knowledge's sake.

One could perhaps argue that a minimum degree of education is necessary for the maintenance and stability of democracy. This is, of course, true but in that case should not our order of priorities towards democracy give protection against starvation and malnutrition a higher rank? While we provide education free we do not provide food free. The most that we do is to subsidize it. It may appear to be basic but nevertheless I feel that before we give education free we should give food free.

The question which I am posing before you is that we have to take a decision as to why we are educating. If the purpose is to give knowledge for the sake of knowledge then we will never have the men or the fiscal resources for national development. If giving of knowledge for knowledge sake is a necessary concomitant of democracy which we want to sustain then let us do this and not engage in idle talk of national development. If we have not made up our minds at least let us have a levy on education, however small it is, just as we have on food, for those who are acquiring this knowledge for the sake of knowledge would at least feel that something bought is better then what one gets free. Those who are not without their basic requirements for sustenance pay for their food. Likewise those who want education for the luxury of education may pay for it.

The second change I would like to take up is the shift to teaching in the mother tongue. The reasons for adopting the mother tongue as the medium of instruction have been many and varied. English was considered the preserve of the privileged minority, only about 5—6% learning it. In addition to being a badge of distinction it provided a barrier between the English educated and the vernacular. It was a passport to lucrative employment. To me these by themselves are not sufficiently valid reasons for switching over to the national languages for all these could be corrected by making more and better English available to the wider populace. Even after a decade or more of education in the mother tongue English is still a badge of distinction and it certainly remains a passport for lucrative employment. Quite a number of the onetime ardent advocates of swabasha who now have obtained lucrative employment often in International organisations abroad, and who have the habit of visiting Sri Lanka during Christmas time, have being able to do so because they wear this badge of distinction. I am not implying that it should not be so. I am only saying that it is inevitable, What gives quality will be valued more. Today we recognize that a knowledge of English which is the language of learning in many countries in the world, gives depth and enrichment of quality to subjects taught in the University, even for the study of eastern languages.

I do not deny that we should have moved into the mother-tongue medium of instruction. But the only sure and valid reason for teaching in the mother tongue is educational. Fraser of Trinity in his submissions to the educational committee of 1911 stated that untruthfulness and want of readiness were defects encouraged by education through a medium of a foreign language.[2] The Bridge report of 1911 states "Education based on a medium other than that in which the whole of a child's ideas are contained is in reality education limited to the acquisition of a new language."[3]

Sir, Educationalists are agreed that the best medium for learning is the mother tongue and we have to accept it. However in accepting this we must always remember that the bulk of educationalists, who have recommended such a change over, did in no uncertain terms stress the importance of English. The Kannangara Report[1] in recommending that the medium of instruction in the primary school shall be the mother tongue also recommended that English should be universally taught so that, apart, from any other result by making it a common second language it would cease to be a badge of distinction. The Kannangara commission in their concluding paragraph on the medium of instruction stated "Even when the mother tongue becomes the universal medium for all types of education English will still have to be retained in the educational system. There is no doubt that it will enrich education."[1]

My understanding of the Kannangara recommendation is that it was a joint recommendation. That is, along with instruction in the mother tongue there had to be English compulsorily taught. What we implemented was quite different, for we carried out only a part of the recommendation. The department of education did not make any effort to organise the English teaching in any systematic way even though an English unit was begun about 1960. We are dismayed to see that this unit which was formed over ten years ago has not produced one shred of evidence that it has devised a technique to teach English in a specified period of time in our local context. In fact the Lanerolle Committee of Enquiry of 1971 has even recommended the virtual disbanding of a centralised English unit.[4] In addition, it has advocated the formation of an English Language Institute to try out and test

methods and schemes of teaching. But no action has been taken. If Malay Street cannot act it is about time that the University took up this question and inaugurated without any delay several concurrently run courses in the teaching of English to work out a viable method for our different university needs. We cannot afford any further to endanger University education by treating, our work of University English teaching as a hit or miss affair as now. We have gone on like this for too long. Let us do something about it after two decades. If the University sub departments cannot produce a viable English scheme, let us of the science faculties in the Universities organize ourselves to achieve this end.

Malay Street has taken cover in this unsatisfactory situation by stating that English was compulsorily taught although not compulsorily examined at the G.C.E. (O.L.). For example we are told that until 1946 English was not compulsorily taught in Ceylon but since 1946 it has gained in importance because it received a legal and official status as a second language and has been made compulsory. But why fool ourselves. The English skill has steadily declined in spite of this new legal position until today we have young men who cannot speak or write English being trained to teach English in training colleges and University campuses. The pedagogical skills have been made problems of abstruse linguistic concepts. Could it be that the whole area of English teaching as a second language whether in the University or in the Department of Education is in the stranglehold of some vested interests? For instance a survey carried out in 1966 revealed only 4.65% of students in the advanced level forms and in the arts stream had a knowledge of English sufficient to read and understand. You can imagine what it is today. There are serious and profitable consequences. Students entering higher education had to confine themselves to dictated notes and hastily written or translated textbooks largely done under the authorship of mercenary minded individuals who were cashing in on the situation to earn easy money. Teachers, University teachers not exempted, who never lectured in the Sinhala medium, provided text books for publication by the Educational Publications Department. There are those who swear that some of our colleagues who fought hard for the extension of swabasha in the University too and who had

contracted with the Educational Publications Department, to write text books subcontracted their assignments to students well versed in swabasha but poor in the knowledge of the subject, because of the poverty of their own swabasha. We could all try to guess who ultimately got the money.

At the time and very soon after we switched over to instruction in swabasha we were numerically strong in teachers who knew English. All that was necessary for the take off for English teaching was to undertake the practical job of giving these teachers the pedagogical skills. Today there is the great danger of not having teachers competent in English. The Post-graduate diploma for the teaching of English is being open to those who have just only read for their degree in the English medium because even those who have offered English for the first examination are so few. We may soon have to get our teachers of English from Malaysia, India and the Phillipines if we cannot produce a better English teaching programme in the school.

Should we put the blame on the Kannangara Commission recommendations for the poor knowledge of English among students. Unless one is a fanatic or interested in making quick money by writing swabasha books one could see clearly that the Commission only wanted to set the swabasha goal which was that the mother tongue be the medium of instruction at all stages of education. It did not want to banish English. As the first step towards the realization of this goal the Commission recommended that instruction in the primary school, which then comprised the infant class, first standard and the second standard, be given in the mother tongue and that, too, not with immediate effect but within a period of three years from the appointed date. Thereafter instruction was to be in the mother tongue or through a bilingual medium in which case one of the media would be English. What is often forgotten is that the Commission recommended the teaching of English as a compulsory subject from grade three onwards. They even recommended that financial provision should be made for the appointment of additional teachers of English. The recommendation to shift to the mother tongue was therefore only a conditional recommendation. The shift to the mother

tongue and the compulsory teaching of English had to be implemented at the sametime. The late C. W. W. Kannanagara came from the village but was fortunate to get his education from an English school. Si F. de Silva in writing on Kannangara's contribution to the education of the people and in making a personnel reference says that once Dr. Kannangara told him "I must see that village boys get a better chance in life than I had.[5]" I leave it to you to determine how many village boys have done better than Dr. Kannangara.

Today after sacrificing several batches of undergraduates particularly in the Arts stream and arising partly from the protests of the undergraduates themselves who have realised quite rightly that there is very little they could learn from lectures delivered on public address systems, the policy makers have tried to put second language teaching on a better footing but have yet not succeeded. The Faculty of Arts in the Colombo campus is still labouring on the need to provide the compulsory requirements of English although the level is low, but we must invite many more experiments and inaugurate different and concurrent courses. There need be no vested interests. It is a national enterprise. It is however gratifying to note that the government has been able to affirm both the compulsory teaching and examining of English in the new reforms for education initiated in 1972. But just affirmation alone would not do. Let them take some substantial steps to work out a viable program.

The third important event in educational reforms has been the take over of schools. The clamour to take over schools was to provide a just distributional of educational opportunities. The Buddhist Commission report argued that the Buddhists had experienced many social and economic disadvantages and this they attributed in the main to the dual control of education. Directly springing from the agitation of the Buddhists, the government passed the Assisted Schools and Tranining Colleges (Supplementary Provisions) Act No. 8 of 1961 whereby all state financed education came under state control. This meant that what educationalists call the interna of education, namely curricula, courses of study and methods of instruction were all subjected to prescription by the state. Thus what Dr. C. W. W. Kannangara had wished

in 1936 came to the realised. "In all justice to the country and the state council if the state council pays the money for education of the youth of this country it should be able to control eduation.." He who pays the piper should be able to call the tune. It was argued that the state could produce equality of opportunity and justice in social life better than any other organization. It was also realized that national welfare and security depended on education and therefore state interference was absolutely necessary.

Today in addition to the state schools financed and controlled by the state we do have a few private schools not getting fiscal support from the state. The elite patronising these institutions still feel that the only way their children would learn to speak with propriety and have good manners is by sending them to private schools. When we give thought we realise that these reasons cannot be dismissed easily. There may be something both right and wrong in them. Some of us might call such a parent a snob and dismiss the reasons as wrong. Then is it our position that values, refinements, the imponderables such as the ability to speak fittingly are of trivial concern? Is it our position that parents have no right to do the best they can for their children? However, whether we have this right or not our socialist democracy as we are made to understand it does not allow or at least minimises institutionalized privelage which can be purchased. Recently several constraints have been laid down by the state regarding these private schools. For example students in these institutions have to take the common departmentally held examinations and must follow state policy. In otherwords they have come much more within the general orbit of the ministry. Nevertheless these institutions are allowed to have a discriminatory admission policy which denies equality of opportunity and they even defend their practices as justified. They give special consideration to applications from children of alumni which is not furthering of opportunity Parodoxically those who advocated a state take over of education seek places foi their children in these private institutions because of the high premium they place on the imponderables I mentioned. But the reason for nationalising was to guarantee equitable distribuion of available facilities. Why then this anomaly of private schools.

I am not arguing against private schools. All that I am trying to show is that when it comes to finding reasons for their continuation we give still another definition to democracy. Surely we do not allow a person to hold more than 50 acres of land just because he is looking after the land well and treating his employees with immense charity. Nor do we allow a person to own more than a certain number of houses just because he is charging the assessed rent from his tenants. Then why should we allow a few institutions to charge fees and keep these schools for the elite just because these institutions follow state policy governing education. We seem to believe in "more equality" for some than others.

We have had two revolutions, one in 1956 and the other in 1970 for the sake of equality. During the last 10—15 years we have had changes of Government, the U.N.P. the United front and a United front without the L.S.S.P. all working towards what is labelled as "equal democracy". But every democracy, equal or otherwise has had sufficient numbers of administrators, educationalists, politicians and above all families in the powerful upper-classes who feel that on certain issues some should be "more equal" than others. If one parks oneself outside one of these private educational institutions any week day morning one sees who the "more equal are".

I am not saying that we should give up the values and the imponderables of education which so many top administrators seek in the private schools. In fact we now have exclusive schools even under the state system both for girls and boys in Colombo 7. So obviously these values are recognized by the state. But let us not be guilty of hypocrisy. Let us recognize them and make them more widely available for all and not the preserve for a few.

Lastly let me get on to what immediately concerns me and my colleagues, that is, tertiary education. This country by its scheme of compulsory free education has been able to give the whole child population a primary and secondary education bringing our literacy rate to one of the highest in Asia. During the early stages the promising students were sent abroad for tertiary education. With the establishment of a University College, tertiary educa-

tion of a rather high standard was available, What was considered the upper class monopoly was broken up with the introduction of free education at the tertiary level. With the availability of tertiary education in the mother tongue the number claiming tertiary education particularly in the arts stream increased considerably The single University planned at Peradeniya was for a thousand students but with larger numbers seeking University admission every year several steps were taken to accommodate more and more.

When the Peradeniya numbers were bursting at the seams and when the pressure of numbers seeking admission to the single University became irresistible the University in 1961 grudgingly admitted a large number of non-residential students categorized as external students. It was about this time that those who had used the mother tongue as the medium of instruction also gained admission to the Faculty of Arts. To provide more places for University tertiary education, in 1961 the Vidyodaya and Vidyalankara pirivenas, considered to be the products of the Buddhist renaissance of the last quarter of the last century, were given University status, with no restriction placed on the fields of studies. The Faculty of Science of the University of Ceylon had still not moved to Peradeniya. To accomodate the increasing numbers seeking admission to the Faculty of Science it was decided not to shift the faculty from Colombo but to plan a second faculty in Peradeniya. This happened in 1961 and later a Faculty of Medicine was duplicated in Peradiniya in 1964. The pressure on the Faculty of Arts was so great that another Faculty of Arts was created in Colombo in 1963. D. L. Jayasuriya writing on Development in University education, the Growth of the University of Ceylon, stated that there was a four fold increase from 1960 to 1965.[6] The physical problem of numbers particularly in the Faculty of Arts of the University of Ceylon was so great that it demanded more lecture room space and more staff. The former need was met by the conversion of a race-course grand stand to a lecture theatre. No better place could have been found for a domain for undergraduates gambling with their future. Additional sheds were built here and there and these you could still see in plenty. In spite of all this the lack of space continued to be acute, and the story is told that in certain Universities or Campuses the lecturer

and students used to loiter around at the correct hour hoping that they would hit upon on empty room to be used for the lecture. When they did discover one, probably they shouted Eureka in Swabasha and proceeded to occupy it.

The two campuses of the University of Ceylon located in Peradeniya and Colombo were for quite some time administered from Peradeniya and this led to the Vice Chancellor, administrators and a goodnumber of University dons becoming what I call "Road Scholars"—as opposed to RHODES scholars for they were spending a good part of their valuable time on the Kandy—Colombo road.

An important requirement namely additional staff, was met by mass recruitment often at the expense of quality. In more than one instance staff was selected to new faculties a fortnight or so before the expected date of arrival of students. Going through the records one sees that even lecturers Grade II sat on the selection Boards making Professorial appointments.

According to the laid down selection procedure every permanent appointment to the University is done by a selection board. The specialist members of the selection board are appointed by the Senate which consists mainly of Heads of departments. With the sudden establishment of a new faculty the acting heads of departments by virtue of their posts became members of the Senate. Subsequently, when Professorial appointments had to be made to the faculty, while being prospective applicants for chairs, they also become specialist members of selection boards for other Professorial appointments.

The procedure is still more interesting when it comes to Professorial appointments in new campuses. As you know the President of a campus under the act is appointed by the Minister on the recommendation of the Vice Chancellor. The President appoints the Deans and the Deans appoint the acting heads of Departments at least in this period of non-terminating transition When Professorial appointments are made the President and the Dean become ex officio members of the selection committtees at a time when they themselves are applicants for chairs. Those whom they

they interview for Professorial appointments are the potential members of their own selection board. Would this not be a burlesque for the crazy boys!

The most recent exercise in University education is the establishment of a campus in the north called the Jaffna Campus. The first batch of science students were taken in for the combination of subjects, Double Maths and Statistics. The guiding principle in this academic adventure was not the necessity of graduates with this type of training but that the staff available at instant notice could teach only these disciplines.

Those involved in the planning of tertiary education argue that the amount of money given for tertiary education is extremely small, and that higher education will continue in this mess for this reason. While recognizing that the amount of money spent on this item is small and while asking for money, we have to ask the question whether a developing country like ours is making the maximum use of the money that is already invested in tertiary education. We have to compare the total costs with the benefits. Sometimes it is true, even if economic returns are not obvious, we make concessions for free primary education and a limited amount of secondary education based on the policy of knowledge for knowledges sake. Washing soap for everybody is certainly better than Old Spice for a few.

But education, has several objectives. One is the development of charater and intellect often referred to as Psychic returns of education. Another is giving the student the joy and satisfaction of learning to learn. Thirdly it becomes an investment designed to produce the skilled labour, or the capital necessary for economic growth.

I shall take up the third objective for it is what I have already considered at the beginning. Those who ask for almost unlimited investments on education justify this claim on the grounds that education contributes to economic growth. It is also true that it is only economic growth that would make it possible for a country to invest on educational development. Education is therefore considered by non-botanists as both the seed and the flower of

economic development. On this basis education has to be relevant for economic development.

No country, overdeveloped, developed or developing could plan its tertiary education unless the basic educational questions calling for decision by the governments or educationalists have been answered. One question is the knowledge that we want those in tertiary institutions of learning to possess. A second question is related to the investment level of the country. I have already led you to these questions at the beginning but till we have at least approximately correct answers to these two questions we could continue only to tinker with higher education.

As far as our country goes both these questions cannot be answered by the University or by officials of the Ministry of education. It would require a political decision at the highest level. Matters related to national interests and development should not be left to everybody to meddle with.

My own view is that we have been producing an over educated labour force and for relatively simple labour. Producing graduates who would ultimately be employed as clerks may appear reasonable, for education has its enrichment effects on citizenship and on personnel and family motivation but a country like ours cannot afford this, certainly not at this juncture.

If the government is anxious to produce the trained manpower required this has to be in relation to the investment capacity available. I see no reason for producing well qualified medical personnel if we do not have the resources to provide these doctors with the basic amenities to carry out the tasks they are entrusted with. We produce 150 or so doctors annually and I am told that quality wise they are on par with the doctors coming out from the best of medical schools in the world. We plough in a lost of resources both from inside and outside to produce this quality product. On joining government service, as they always have to, the basic amenities in the form of equipment and drugs are not available. Resources are limited. If it is our position that we cannot provide the resources then is the initial investment justified? Does every medical man need the inputs we provide? Can't we manage with

lesser inputs for about half this number of medical men? High skills and intermediate skills are after all interchangeable within certain ranges. If there is a scarcity of intermediate skills the highly skilled will be forced to assume functions which the intermediate group could perform if they are available in adequate numbers and thus it would be a waste of limited resources for a developing country to continue to produce at the higher level. Could we not divide our total resources to produce both types of skills?

I have referred to two important questions which have to be answered at the highest level before we could plan our higher education. These questions still remain unanswered. Without knowing why we are educating and the amount we can put in for this purpose how can Universities plan their progress. With a view to reorganizing tertiary education in this country we have had two Higher Education Acts, the Higher education act No. 20 of 1966 and the University of Ceylon Act No. 1 of 1972. The Higher education act of 1966 made provision for the establishment of an authority called the National Council of Higher Education. The Act of 1972 had a governing body called the Board of Governors. Both these governing bodies were charged with the function of making University education adequate to national needs. The state took greater control of higher education and the 1972 act attempted to rationalize and orient the teaching to the requirements of the country. It is about time that we take stock to determine the extent to which we have been successful in this endeavour. As a direct outcome of the Jayaratne Commission Report the University commenced what are now vaguely referred to as job orientated courses. Perhaps for the first time in the country the educationalists of the department of education sat with the educators of the University and after a quick deliberation took the decision to admit about 750 students to what was labelled as a Diploma in Social Studies. The trainees were to augment the short supply of teachers in the new Social Sciences program in school.

Even before the birth pangs had disappeared there was uncertainty as to whether this number could be employed in keeping with their training. It is only organized student pressure that brought the jobs for at least the first group of students. Clearly

sir, the educational planners did not know what they wanted even for the short term plan. When we cannot plan for the next two years can we indulge in perspective planning. We have yet to see what results will crown the job oriented courses in the Faculty of Arts. I must make clear that I am not against job oriented courses or planned educational development. I am all for it. But the planners must give us better constructed plans.

We may have new and newer higher education acts and more and more amendments but higher education will continue to peril till we straighten out the purpose for which we are educating. The 1972 act gave tremendous power to the Vice Chancellor. Section 85 subsection A reads as follows:

> "notwithstanding any other provisions of this act, the first Vice-Chancellor shall have the power to reallocate the staff, students, equipment, land, buildings and other facilities of the University, inclusive of those of the old Universities, among the several campuses of the University and to determine the structure and composition of each campus including the Faculties, the Departments and sub-Departments and the disciplines and subjects that are to be assigned to such Faculties, Departments and sub-Departments and he shall during the transitional period have and exercise powers of the Board of Governors and any other Authority or body for the University in respect of any matter concerning the University, and the appointment of any person or persons inclusive of officers named under this Act for the purpose of organizing, carrying out and directing the functioning of the University during the transitional period."

Subsection (f) reads as follows,

> "Notwithstanding the provisions of section 81, the first Vice-Chancellor or any person or persons appointed by him shall within the transitional period determine the staff required for the proper functioning of the University and any person in excess of such actual requirements shall be retired from the service of the University and such retirement shall be deemed to be a retirement on the ground of the abolition of such post.

The first Vice Chancellor held such powers that he could have asked any University teachers to go with or without reason. We are perhaps fairly safe now because it was only the first Vice-Chancellor who enjoyed these powers.In any case in the absence of a definite program what can a Vice-Chancellor do. Even if a Vice-Chancellor has the wisdom to plan out a reasonable scheme for higher education he would not be in a position to implement it because of pressure groups successfully manoevering to make significant changes during the plan implementation stage. We, in the University may have our faults. Perhaps some of us are only part time academics and for longer hours politicians but the defects in our tertiary education are not our own creation.

If the government is anxious to plan higher education in keeping with the requirements of economic development then it should be sincere enough to plan such a program irrespective of political feasibility. I would stress that a developing country cannot afford the luxury of giving high level general education for this would lead to an oversupply of "generalists". We cannot for instance go on producing well rounded engineers, doctors and scientists and we cannot afford academic freedom as understood in England & America where a student could seek truth as he sees it. If our goal is development them we cannot look for the non monetary ends or the hidden benefits of education.

Once the government decides on what its intentions are and is aware what inputs are available it should then plan out its program of tertiary education. Such a program has to be carefully watched. Parts of the plan may become impracticable and fresh guide lines may have to be thought of. It is only then that a tight frame of discipline become necessary, and that is the time to provide the Vice-Chancellor with tremendous powers. Bestowing a Vice-Chancellor with tremendous powers at any other time is completely unnecessary when he has no plan to implement and will only serve to antogonize university staff.

I am sure some of you may not agree with all what I have said. You may feel that my suggestion that questions of policy should be decided at the highest level by government is not quite democracy. I would still maintain that in this country it is politics which will finally decide whether we should give goggles to the fancy girls or spectacles to the people.

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SECTION E—PHYSICAL SCIENCES

Presidential Address

"LIPIDAEMIAS"

by

S. SENTHESHANMUGANATHAN

I am most grateful to you for the honour you have done, in inviting me to the chair of Physical Science Section of the 31st Annual Session of our association. While I thank you for this gesture of good will, I should like to think that my election as President of Section E, which is dominated by Chemists, Physicists and Mathematicians, is an indication that you recognise the importance of Clinical Biochemistry or you may call it Chemical Pathology in the progress and health of the nation. In the past there has been a neglect of these science and this has caused a serious harm to the health of the nation. Recently we has marched forward further and a college of Pathologist has been formed by our medical colleagues, to which the Clinical Biochemists have been invited to join its membership. This indicates the fundamental importance of this branch of science in the development of modern medicine.

Clinical Biochemistry or Chemical Pathology is briefly the study of the Chemical and Biochemical constituents of the human fluids in relation to the practice of modern medicine. At least a more than hundred different tests are carried out in hair, nail clippings, urine, blood and blood cells and tissues. Out of these I propose to deal today the researches carried out on lipids by me, in collaboration with the various medical institutions in Sri Lanka, at the Medical Research Institute, Colombo over the several years of my carrier as a Research Biochemist.

The increasing number of dangers caused by thrombosis in the arteries of the brain, the lower limbs and most frequent, of all, the coronaries worries the lay public more than the doctor.

This question has claimed the attention of Biologists and specially Biochemists since observations made from animal experiments, have thrown light on the Pathological mechanism of these accidents and indicate the possibility of preventive treatment.

Many studies in Sri Lanka and other countries throughout the world have shown that hyperlipidaemia (increase level of lipids) is often present in patients with clinical manifestations of artherosclerosis. In families with genetic forms of severe hyperlipidaemia. the commencement of these complications commonly appears earlier. Prospective studies also indicate that even milder degree of hyperlipidaemia predispose to artherosclerotic vascular disease. The lipids under reference in my talk will therefore be confined to include Cholesterol, Triglyceride, chylomicrons, Lipoproteins, Phospholipids, cholesterol bound to β & pre — β lipoproteins and Total Esterfied Fatty acids. For the benefit of the non-Biochemists and others, I wish to say a few words on the chemistry of each of them.

The lipids are a heterogenous group of compounds related either actually or potentially to the fatty acids. These classes of compounds are relatively insoluble in water and soluble in fat solvents such as other chloroform and benzene. These are important dietery constitutuents not only because of their high energy value but also they carry with them the essential fat soluble vitamins and fatty acids which are found with the fat in natural products. Fats are classified into three groups which are further subdivided as indicated.

(*i*)	Simple	—	Fats & waxes
(*ii*)	Compound	—	Phospholipids, Cerebrosides Lipoproteins
(*iii*)	Derived	—	Substances derived from (i) & (ii) viz. Fatty acids, glycerol, alcohols, steroids, Fatty aldehydes and Ketone bodies.

Fatty Acids: (FFA) These are higher acids and may be envisaged as based on the simpler acid acetic acid as the first member of the series with the general formula $C_n H_{2n+1} COOH$. These can be either saturated or unsaturated. Among the unsaturated

ones we have mono and poly unsaturated fatty acids. The poly-unsaturated fatty acids may have two three or four double bonds e.g. (I)

(i)	one double bond	— in nearly all fats
(ii)	two double bonds	— corn, peanut, cotton seed and soyabean oils.
(iii)	three double bonds	— Lin, seed oil.
(iv)	four double bonds	— Peanut oil.

Triglycerides: (TG) These are esters of glycerol with three fatty acids; the latter can be saturated, unsaturated, similar or dissimilar. Dietery fats like coconut, gingelly, butter, astra margerine, covo etc. are the source of plasma TG of exogenous origin. Plasma TG of endogenous origin mainly arises from hepatic synthesis. TG ultimately provide a source of FFA for energy purposes.

Phospholipids: (PL) The plasma PLs are a heterogenous group of substances of complex structure and are found in many of the membranes. In plasma the detergent properties are almost due to its importance in the Glycerol H_3PO_4 and a base viz. choline, ethanolamine, serine, inositol & carbohydrates.

Cholesterol: (CHOL) It occurs as the alcohol and in the esterfied form, about 70% of the CHOL is esterified except in obstructive disease of the liver and some rare diseases. It occurs only in animal fat but not fats derived from plants. The CHOL of the blood arises from dietery CHOL and also from that which is synthesized in the body viz. carbohydrates and mainly saturated FA derived from TG through - oxidation supplying acetyl CO A; CH_3 CO S Co A.

Chylomicrons: (CHYL) These are considered to be of exogenous TG, some dietery TG also appear soon after meal. These large particles have a density of about 0.9 and collect at the top plasma left standing for 16—24 hrs at 4°C and they remain at the origin on cellulose acetate paper electrophoresis (Fig. 1).

Lipoproteins: (LP) All the lipids in plasma circulate in combination with proteins (Fredrickson et al 1967). The FFA are bound to

the albumins, the other lipids TG, CHOL, PL, & CHYL aggregate with other proteins and these latter complexes are called lipoproteins. They range in size from small "soluble" lipoproteins of 100° A in diameter having molecular weights of less than 400,000 to particles larger than 1μ in diameter. The smaller the LP the greater is the relative amount of protein present, the lipid component decreases the density of the LP. The differences in the content of lipid and proteins among the several lipoproteins give them different densities and thus permit their separation in the ultra certrifuge. They also differ in electrical charges and this property permits separation of the LPs by electro-phoresis. (Fig. 1) gives the plasma LPs spectrum as segregated by cellulose acetate paper electrophoresis (above) and ultra-centrifugation below (WHO, 1970).

Methods: Total Esterified Fatty acids (TEFA) was estimated by the method of Bauer, Hirsh (1949) in which Triolein was used as the EFA. Cholesterol was estimated by the colorimetric method of Armond, Courochaine, William, Miller & Stein(1959). Standard solutions of CHOL. were put through the same procedure. The method of Laurell (1966) was adopted for the

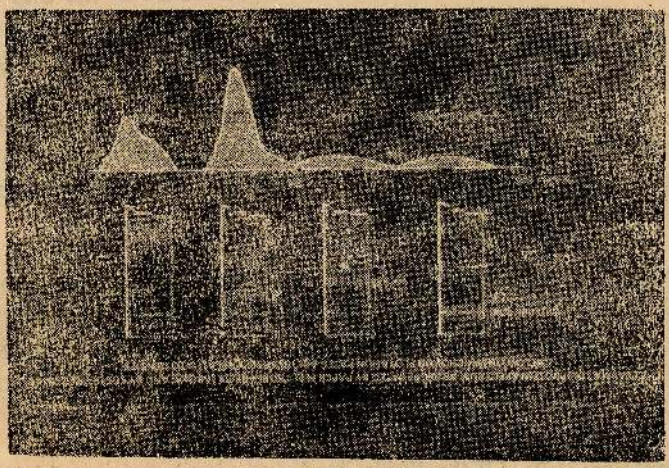


Fig. 1

estimation of TG, using Tripalmitin in $CHCl_3$ as the standard. Phospholipids were estimated as described by Connerty, Briggs & Eaten (1961). The separation of human plasma lipoprotein by Electrophoresis on cellulose acetete was performed as described by Chairman & Landowne (1967). The cholesterol bound to alpha, Beta and pre-Beta lipoproteins of serum was carried out by the rapid method described by Burnstein & Samaille (1960).

Sampling conditions: Since lipid pattern may be altered by a variety of conditions including recent fat ingestion, it is necessary to define the conditions under which the lipid patterns are established. All samples of blood analysed were taken from patients before breakfast, the subject having not eaten after about 8.00 p.m. the previous night. It should be emphasized that failure to adhere to this leads to erroneous conclusions about the nature of lipidaemia to the extent that either the wrong diagnosis is made or the presence of hyperlipidaemia may be missed.

Fasting venous blood samples were taken on the morning after admission, the acute stage and at 4 weekly intervals thereafter; which will be called 1st, 2nd, 3rd, 4th convalescent stages in project IV. In II & III fasting venous blood samples were taken on the morning after admission (A) one week after (B) and at the time of discharge from the wards (C).

Screening for a lipid disorder usually consist of the determination of cholesterol, Triglyceride and cholestrol or cholesterol Triglyceride and Lipoprotein paper electrophoresis. If one considers the cholesterol in blood it should be borne in mind that the determination of total cholesterol in whole plasma gives the amount carried out by alpha, Beta and Pre-beta lipoprotein. Ultracentrifugation fractionation with density 1.006 will give the cholesterol bound to alpha and pre-beta lipoprotein. This method requires a preparative ultra centrifuge and is currently beyond the resources of any of the Technical Laboratories in Sri Lanka. The cholesterol bound to Beta and pre-beta Lipoproteins could be determined in the precipitate obtained from serum heparin and $MnCl_2$. A modification of this procedure which

dispenses with the use of preparative ultra centrifuge was adopted in this study. We determined the total cholesterol (bound to α, β & pre-β—Lipoproteins) and the cholesterol bound to β & pre- β Lipoproteins on the precipitate obtained with $MnCl_2$ and heparin; from these results we calculated the percentage of cholesterol, bound to β & pre-β, of the total.

MATERIAL RESULTS AND DISCUSSIONS

Hyperlipidaemia associated with Xanthamatosis

This investigation was carried out in association with Drs. S. Ramachandra and Selvi Perera, Physicians, General Hospital, Ragama. This is a case of familial hyperlipidaemia of Xanthamatosis. The patient (KP), 18 years of age, who was admitted to the hospital for diarrhoea was found to have a number of lumps of varying shapes and sizes distributed throughout the body especially over the elbows, knees and feet. Those lumps were confirmed as Tuberous Xanthomas. The other members of her family, who we investigated seven sibs of which six were girls three of them (1, 2 & 5) showed clinical evidence of Xanthamatosis. The mother of this patient belonged to a family of 8 sibs, consisting of 4 girls and four boys. (pedigree of this family is shown in (Fig. 2). Sib No. 1 of this generation died at the age of 45 years within a few minutes of a complain of chest pain and so of sib No. 2 at the age of 35. The mothers generation (II) had two sibs (3 & 6) of ages 50 & 34 with Xanthematous deposits. Members of generation I were dead and hence could not be investigated. Xanthomatosis is characterised by the presence of climatically recognisable deposits of cholesterol and other lipids in the skin, tendons, periosteum and bone. It may occur secondary to a number of well defined diseases but also occurs as a primary inheritable disorder of lipos-protein metabolism as in the case of a family which I propose to discuss in this section.

Several investigations, were carried out on the members of a family affected by the above condition, viz. EGE, X-rays and blood lipid levels. I shall pay special attention on the following-cholesterol, Triglyceride, cholesterol bound to the β and pre β

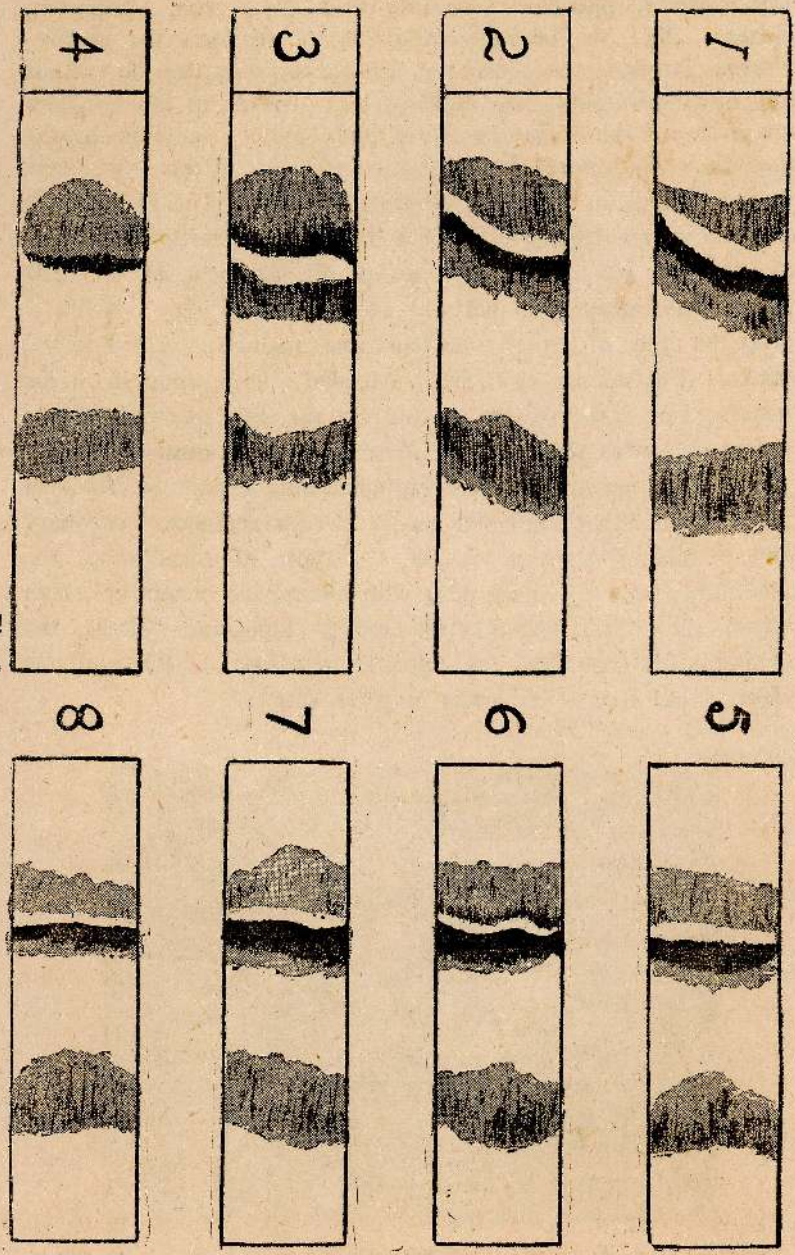


Fig. 2

Lipoproteins, phospholipids, uric acid and serum lipoprotein patterns. Due to the non-availability of scanners for electiophoretic strips, it was found not feasible to quantitize the various lipoproteins fractions. The lipid pattern of some of the members are given in Table 1. Studies of this family under discussion showed that their cholesterol levels particularly the affected members were very high in the range of 454—545 mg%. The PLS are all elevated in the affected cases. The TGS were all within the limits of normality (40 to 160 mg%) except No. 5, whose TG was 220 mg%. The liproprotein patterns are shown in Fig. 3. Table 2 gives the types of hyperlipoproteinaemia associated with Xanthomatosis (Fredrickson et al, 1967). Mishkal (1968) reported on the results of an investigation carried out on eight members in four generations who were to have Xanthomas and another member who had documented hypercholesterolaemia (Table 3). As seen in this Table 3 that family demonstrated high incidence of coronary and peripheral vascular disease, the types of Xanthomas, the inheritance of a dominant gene with incomplete penetrance, high serum cholesterol, phospholipid and β—Lipoproteins levels, the cholesterol phospholipid ratio greater than one and the moderate elevation of serum TG levels in some cases.

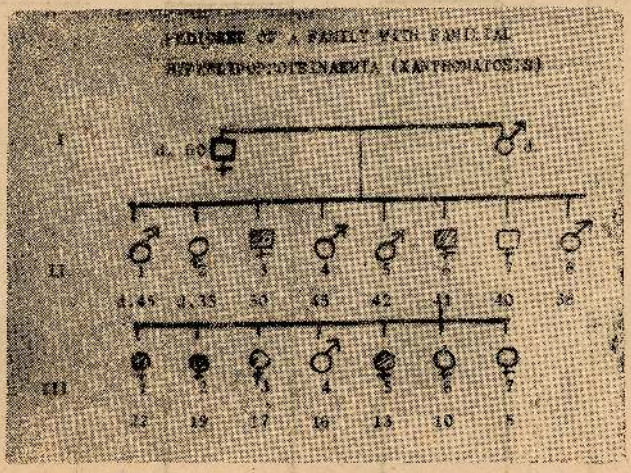


Fig. 3

TABLE 1.

THE LIPID PATTERNS OF SOME OF THE MEMBERS OF THE FAMILY AFFECTED BY XANTHAMATOSIS

Name	Cholesterol mg %		% of total	Triglycerides TG mg %	Phospho Lipids mg %	Uric Acid mg %	Lipid pattern			
	Total	Bound to β & pre β					Chyl	β	pre β	∝
1 Karunaseeli	523	239	46	80	362	5·1	—	4+	+	+
2. Kamala	545	285	52	60	412	5.8	—	3+	+	+
3. Kalyani (UA)	154	100	65	64	270	—	—	ND	—	+
4. Sumith Kumar (UA)	241	105	43	50	150	5.8	—	1+	+	+
5. Ratnachandra	545	318	58	220	487	2.7	—	4+	+	+
6. Priyanka (UA)	418	216	51	60	290	1.2	—	3+	—	+
7. Subhadra (UA)	236	136	58	40	165	3.0	—	1+	+	+
8. Mother	454	250	55	110	290	3.0	—	2+	—	+
9. Father (UA)	320	205	64	80	275	6.3	—	2+	—	+

TABLE 2.

THE INDIVIDUAL HYPERLIPOPROTEINAEMIAS FREDRICKSON ET AL (1967)

Phenotype	*Lipoprotein abnormality*	*Typical Lipid levels*	*Typical appearance of plasma after cold storage (4°)*	*Mode of inheritance*	*Xanthomata*	*Treatment*
I	chylomicrons	C, N or + TG 4 +	cream layer over clear layer	autosomal recessive	eruptive	Fat restriction and MCT
II	Increased β + increased pre β	C + to 3 + TG N or +	clear plasma	autosomal dominant	Tendinous Tuberous xanthelasma arcus	Low cholesterol diet cholestryamine
III	Floating beta	C 2 + TG 3+	slight cream layer over clear layer	probable autosomal recessive	Tendinous Tubo-eruptive planar arcus	Wight reduction then 20:40:40 & low cholesterol diet, clofibrate
IV	Increased pre β	C N or + TG + to 3 +	Homogenous milky plasma	autosomal dominant	Eruptive (rare)	Weight reduction 20:40:40 clofibrate
V	chylomicrons + increased pre beta	C + to 3+ TG 2+ to 3+	cream layer over milky layer	Probable autosomal	Eruptive	Weight reduction then low carbohydrate diet progestationalan

C = Cholesterol
TG = Triglyceride

TABLE 3

FAMILY MEMBERS ILLUSTRATING THE BIOCHEMICAL FINDINGS IN TYPE II HYPERLIPOPROTEINAEMIA

Patient	*Types of Xanthomas*			*Cholesterol mg%*	*TG mg%*	*PL mg%*	*UA mg%*	*Lipoprotein Electrophoresis*
	Xanthelasma	*Tendon*	*Tuberous*					
1. Great grandfather	+	—	—	—	—	—	—	—
2. Grandmother	+	+	Nil	440	181	346	7.3	β +
2. Grant aunt	+	+	+	678	—	—	—	—
3. Uncle	Nil	Nil	Nil	430	—	—	—	—
3. Mother	Nil	+	Nil	357	189	264	2.3	β +
3. Father	Nil	+	Nil	394	161	334	5.9	β +
3. Uncle	+	+	+	465	177	304	6.8	β 2 +
4. Propositus	Nil	+	Nil	403	66	296	2.9	β 2 +
4. Propositus	Nil	+	+	965	123	563	3.3	β 3 +

M. A. Mishkel *Brit.J. of Hosp. Medi.* Nov. 1968

\+ Present
— Not known

Hyperlipoproteinaemia have been phonotyped into five types, Table 2 by Fredrickson et at (1967). Types I & II can be further differentiated from III, IV & V by the determination of Glusose Tolerence Test (GTT). For this we selected three cases of this family (1, 2 & mother) and determined the GTT and the lipid patterns (Table 4). All three were found to have a nomral GTT with unusual lipid patterns indicating that the formation of xanthomas was not carbohydrate induced. We thought that it would be desirable to place the affected members on high carbohydrate or fat diet. The results provided in Table 5 showed that high Carbohydrate diet produced an increase in Chol, TG and lipoprotein patterns. In one case (No. 2) we were able to carry out the lipid pattern when fed on high carbohydrate or fat diet. From the results, we, observed that both fat and carbohydrate induced the synthesis of all the lipid components in the cases investigated.

From all the investigations carried out on the members of this family, we can safely conclude that they belong to Type II of the Fredricksons Classification and must be homozygous for the genes since the disease manifests itself at an early age (13-22 years) and already have evidence of cardiovasular involvement. The mothers family obviously carries the trait as many of its members have Xanthomas. The father too must be carrying the trait as his serum cholesterol was 320 which even if corrected for age is on the upper limit of normality and the electrophoretic strip show β Lipoproteinaemia. This double dose of the gene may render the children homozygous and therefore the virulent and early expression of the gene in this third generation of our group.

II. Lipid Pattern of Myocardial Infarctions

The subjects studied were patients of all group of ages admitted to the General Hospital, Ragama with complain of chest pain followed by sweating. They were confirmed clinically and Biochemical tests as positive cases of myocardial infarction. The criteria for selection of cases were—

(*a*) Changes in Electro Cardio Gram.
(*b*) Elevated SGOT Serum Lactio dehyrogenase (LDH)
(*c*) Other clinical symptoms.

TABLE 4.

GLUCOSE TOLERENCE OF THREE MEMBERS OF THE FAMILY AFFECTED BY XANTHAMATOSIS

TIME	BLOOD SUGAR mg%		
	Karunaseeli (1)	*Roslin Mother* (8)	*Kamala* (2)
Fasting	87	83	75
30 mins.	100	100	112
60 mins	95	108	120
90 „	79	85	91
120 „	70	73	70
150 „	66	66	62
Cholesterol Total mg. %	520	360	455
Bound to β & pre β Lipoprotein	250	250	275
% of Total	48	70	60
Triglyceride	176	56	128
Phospholipid	344	325	481
Uric Acid	3.2	3.0	3.2
Chylomicrons	++	++	++
β—Lipoprotein	4+	4+	4+
Pre β - Lipoprotein	+	—	—
∝ Lipoprotein	+	+	

TABLE 5

THE LIPID PATTERNS OF SOME MEMBERS OF THE FAMILY ON HIGH CARDOHYDRATE AND FAT DIETS.

"HIGH CARBOHYDRATE"

NAMES	CHOLESTEROL		%	TG	LIPOPROTEIN PATTERN			
	Total mg%	*Bound to β & pre β Lipoprotein*			*Chyl*	β	*Pre* β	∝
1. Karunaseeli	546	341	60	166				
2. Kamala	735	368	50	147	++	4+	+	+
5. Ratnachandra	735	368	50	187	++	4+	—	+
8. Mother-Roslin	472	210	45	93	++	4+	—	+
"HIGH FAT DIET"								
2. Kamala	666	366	55	155	Nil	Broad 4+	+	+

These projects were investigated in collaboration with Dr. S. Ramachandra and Selvi Perera, Physicians, General Hospital, Ragama. The criteria for the selection of cases were as described under above except that only patients under 40 years of age were taken for this study.

The total cholesterol levels of the patients at the time of admission, one week later and at the time of discharge from the wards are provided in Table 6. In our Laboratory, with the method employed, we have established the normal ranges as 150—225 mg%. It should be stressed that there is no normal range for a population, the normal is for a particular individual. The clinical norm serves as a guide to the clinician and not as an absolute figure. The norm is also provided in the same Table (6). More than 83% of the normal subjects studied had values below 220 mg% irrespective of the sex. If we are permitted to assume 220 mg% as the upper limit of normality, then only 50% of the myocardial infarction cases had values more than 220 mg% either at the onset of the infarct, one week later or at the time of discharge from the wards. If cholesterol estimation is the criterion for establishing vascular diseases, then we are missing about 50% of the cases.

Triglyceride levels: TG frequently vary independently of cholesterol and phospholipid levels. Albrink & Man (1955) observed that 70% of patients with coronary heart disease had elevated serum TG levels, though other workers notably Kays & Coworkers (1957) believe that elevated serum cholesterol is the lipid factor associated with a tendency to atherosclerosis and coronary heart disease. We have observed in this study that only 22% of the cases of myocardial infarction (Table 7) had elevated TG viz. 160 mg%. Among the normal male subjects investigated 83% had values less than the upper limit of normality (160 mg%).

Cholesterol and Triglyceride: Let us now compare the cholesterol and TG levels of these patients. From the (Table 7) you may note that only 17 had both chol and TG elevated above the upper limits of normality. This pattern was observed in all three phases viz. onset of the infact, one week later and at the time of discharge from the ward.

TABLE 6

TOTAL CHOLESTEROL BOUND TO BETA AND PRE–BETA LIPOPROTEINS IN MYOCARDIAL INFARCTIONS AND NORMAL SUBJECTS.

CASES OF MYOCARDIAL INFARCTIONS				CONTROLS	
Cholesterol n g%	*A*	*B*	*C*	*Females*	*Males*
100	00	00	00	00	00
140	05	01	02	00	20
180	16	17	11	10	46
220	24	30	27	04	20
260	17	28	16	01	14
300	17	07	16	01	02
340	08	08	04	00	00
380	03	00	03	00	01
420	01	01	03	00	00
	91	92	82	16	103

CASES OF MYOCARDIAL INFARCTION			
Cholesterol bound to β & pre β Lipoproteins	*A*	*B*	*C*
10	00	00	00
20	00	00	00
30	01	00	00
40	07	06	05
50	13	17	15
60	23	12	13
70	25	20	24
80	11	26	13
90	06	06	06
≥ 100	05	06	06
	91	93	82

A = Patients at the time of admission to Hospital
B = One week after admission
C = At the time of discharge from the ward

Cholesterol raised Above the upper Limit of normal
A = 46 = 50 %
B = 44 = 48%
C = 42 = 51%

Raised above upper limit of normal
A = 90 = 99%
B = 92 = 100%
C = 82 = 100%

Cholesterol bound to β and pre-β Lipoproteins:

As mentioned earlier, cholesterol is carried in the blood by ∝, β and pre-β lipoproteins. We thought that the establishment of this parameter may throw some light on the condition of the patients and that this factor may be associated with a tendency to atherosclerosis and coronary heart diseases. It has been observed that in normal subjects, the cholesterol bound to β & pre-β lipoproteins is about 35% of the total cholesterol. Total cholesterol and the cholesterol carried by β & pre-β Lipoproteins were estimated on the sample and at the same time. From these results (Table 6) we obtained some interesting findings. You can see that at the time of the onset of infarct, 99% of the patients had the chol-bound to β & Pre-β lipoproteins, elevated above the upper limit of normality (35%). Similar observations were made at the next two phases.

From the present investigation we conclude the following:—

(1) It is not possible to state with certainty that cholesterol is the lipid factor associated with a tendency to artherosclerosis and coronary heart disease since only 50% of the patients, had cholesterol elevated above the upper limit of normality. (220 mg%). If one decide to estimate this parameter, definitely he is missing more than 50% of the cases.

(2) Triglyceride estimation is the last parameter which should be considered since only 22% of the patients had TG elevated above the upper limit of normality.

(3) Estimation of cholesterol and TG too did not reveal any normality in majority of the cases.

(4) On the contrary, the estimation of cholesterol bound to β and pre-β lipoprotein, gave the best indication of the condition since 99% of the cases studied had their values elevated above the upper limit of normal. It should be emphasized at this stage that more than 50% of the patients had their cholesterol, bound to β & pre-β lipoprotein more than 70%, 1% greater than 90%.

TABLE 7

TRIGLYCERIDE PATTERNS IN MYOCARDIAL INFARCTIONS AND NORMAL SUBJECTS

CASES OF MYOCARDIAL INFARCTIONS				CONTROLS	
Triglyceride mg%	*A*	*B*	*C*	*Females*	*Males*
≤ 40	10	06	08	10	16
≤ 80	22	14	10	02	27
≤ 120	20	28	23	03	28
≤ 160	19	23	20	01	12
≤ 200	14	18	05	00	07
≤ 240	04	02	10	00	06
≤ 280	01	01	03	00	03
≤ 320	01	00	01	00	01
≤ 360	00	00	02	00	00
	91	92	82	14	100

Triglyceride raised above the upper limit of normal

A = 20 = 22%
B = 21 = 22%
C = 21 = 25%

A = Time of admission to the Hospital
B = One week after admission
C = At the time of discharge from the ward

Chol ↑
A = 46 = 50%
B = 44 = 48%
C = 42 = 51%

TG ↑
A = 20 = 22%
B = 21 = 22%
C = 21 = 25%

Chol TG ↑
A = 16 = 17%
B = 14 = 15%
C = 14 = 17%

Chol bound to β & pre β Lipoprotein % of Total Cholesterol ↑
A = 90 = 99%
B = 92 = 100%
C = 82 = 100%

III. Lipid Pattern in young Heart Patients: under 40 yrs of age.

Next I wish to discuss some further studies carried out on subjects under 40 years of age, who were admitted to the Government Hospital, Ragama complaing of chest pain, They were diagnosed as cases of myocadial infarction as confirmed by clinical and Bio-chemical investigations which include ECG, SGPT and LDH.

In addition to the biochemical investigations carried-out in the earlier project, lipoproteins electrophoresis on cellulose acetate paper were also performed in the serum.

The results showed (Table 8) that of the 20 cases investigated, 11 had cholesterol elevated, 4 had increased Triglyceride while 16 had the cholesterol bound to the β & pre-β Lipoproteins raised which is in accordance with the earlier observation. Electrophoresis was carried out on 19 of the 20 cases and such studies showed the following:

(1) 13 were Familial Hyper β and pre-β lipoproteinaemia (Table . .)

(2) and six were Familial Hyper-β-Lipoproteinaemia

From the present investigation it could be concluded that determination of cholesterol or Triglyceride will not reveal the cases with a tendency to atheroslerosis and coronary heart disease. The cholesterol bound to β and pre-β Lipoprotein, and Lipoprotein electrophoretic pattern give a better and clear indication of the nature of the condition in patients with heart ailments. Therefore it is suggested that it is very essential that the last parameters be established on patients with heart conditions before any conclusion is arrived at.

IV. Hypertriglyceridaemia following viral Hepatitis and Ketoacidosis:

This work was conducted in collaboration with Dr. J .E. J. Aiyathurai, Paediatrician, General Hospotal, Ragama on children of the ages ½ to 11 years and belonged to both sexes. The criteria for selection of cases for viral Ketoacidosis were:—

TABLE 8.

LIPID PATTERN IN HEART PATIENTS UNDER 40 YEARS OF AGE.

Subjects	*Cholesterol*			*Triglyceride*	*Lipoprotein Electrophoretic Pattern*			
	Total	*Bound to β & pre β*	*% of Total*	*mg %*	*Chyl*	*β*	*pre β*	*α*
1	364	272	75	225	3+	3+	2+	+
2	332	240	72	94	Nil	3+	Nil	+
3	320	182	57	133	Nil	Broad 4+	4+	+
4	312	212	67	46	Nil	4+	2+	+
5	266	154	59	15		NOT DONE		
6	262	103	39	107	++	2+	+	+
7	270	183	67	131	Nil	4+	Nil	2+
8	260	105	40	60	2+	+	Nil	+
9	233	112	49	13	Nil	1+	2+	+
10	233	175	90	322	Nil	2+	4+	+
11	220	73	33	100	Nil	1+	+	+
12	208	160	77	30	Nil	Broad	Nil	+
13	204	112	55	120	Nil	3+	+	+
14	192	121	63	187	Nil	2+	1+	+
15	190	157	80	60	+	Broad	+	+
16	184	87	42	75	+	1+	Nil	+
17	150	132	88	200	Nil	Broad 4+	4+	+
18	135	82	60	25	Nil	Broad	Nil	+
19	132	132	100	105	Nil	4+	4+	+
20	120	30	25	125	+	2+	+	+

Cholesterol elevated = 11 cases.
Triglyceride raised = 04 cases.
Chol. bound to β & pre β = 16 cases.
Familial Hyper β & pre β Lipoproteinaemia = 13 cases.
Familial Hyper β Lipoproteinaemia = 6 cases.

(*a*) A history of respiratory infection followed by anorexia nausea and vomiting.
(*b*) Clinical evidence of an upper respiratory infection of probable viral aetiology associated with tachycardia, tachypnoea and hyperpnoea.
(*c*) and Ketonuria of at least 5—10mg/100 ml.

The cases of Viral Hepatitis were, carried out on 8 boys and 4 girls of the age group ranging from 4—11½ yrs. The children were invariably admitted for interus and their passing of dark coloured urine together with anorexia and nausea. They were in patients during the study and the only treatment given them was the normal ward diet, minimum physical excercise and multivitamin tablets. The criteria for selection of cases were:—

(*a*) a history of fever with anorexia, nausea and vomiting followed by jaundice.
(*b*) The presence of bile in the urine and
(*c*) the finding of elevated bilirubin, Serum glutamate transminase (SCOT) and Serum Glutamate Pyruvate Transaaminase (SGPT).

Some children who have or have had mild viral respiratory infection tend to develop acidosis; this occurs either during the acute stage of the illness or during convalascence. This is a transient phenomenon lasting for a period of 12—36 hrs. This has been proposed (Aiyathurai, 1973) to be due to a transient inhibition of the glucose carrier system (Fig 4), In such a situation, fat is utilized to meet the energy requirement of the child. A study of the serum TG & Chol. was undertaken to determine the duration of this inhibition of glucose transport.

Based on a study of SGPT, LDH urinary urea and NH_3 excretion it has been postulated that the raised SGPT in viral hepatitis, is probably the result of an adaptive increase in cellular GPT which is necessary for increased gluconeogenosis from lanine and glycine; in this situation the hepatic glycogen synthesis is inhibited due to a diminished hepatolyte uptake of glucose (Aiyathurai et al 1974). Since the SGPT is elevated for at least 4—6 weeks (Fig. 5) in viral hepatitis, the muscle cannot be an indefinite source of these amino acids unless it could at, the same time resynthesize these two amino-acides. It is known that the

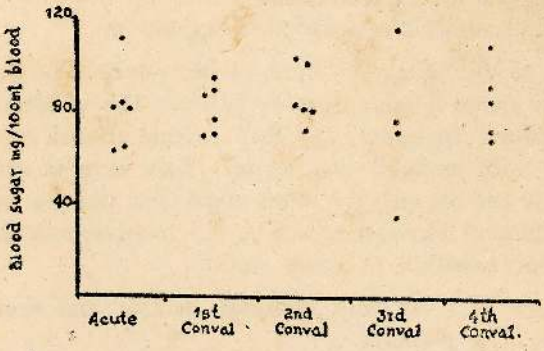


Fig 4 Showing fasting blood sugars at different stages

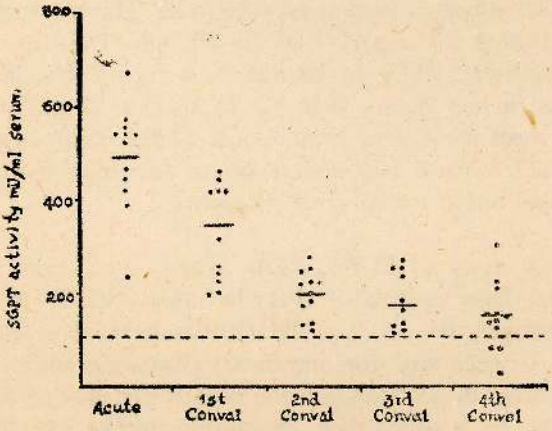


Fig. 5: Showing SGPT activity at different stages.

substrates utilized by muscle are glucose and fat and it has been established that changes on blood lipids, in viral hepatitis (Philips, 1960), has been due to a depletion of FFA from the adipose tissues for energy. This project therefore reports the results of a study of fasting SGPT, LDH, TG and Chol. in viral ketoacidosis and hepatitis (Figs 6, 7 8).

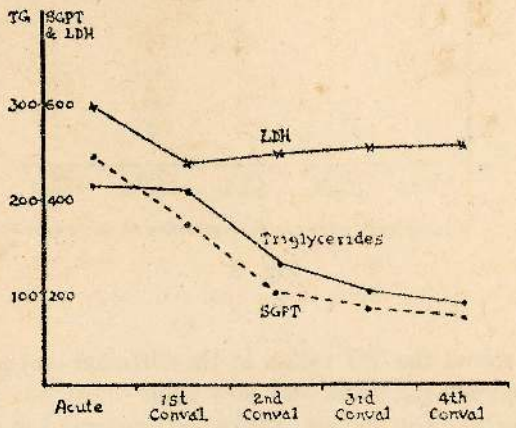


Fig.6: Showing mean serum triglycerides and mean SGPT and LDH activities at different stages

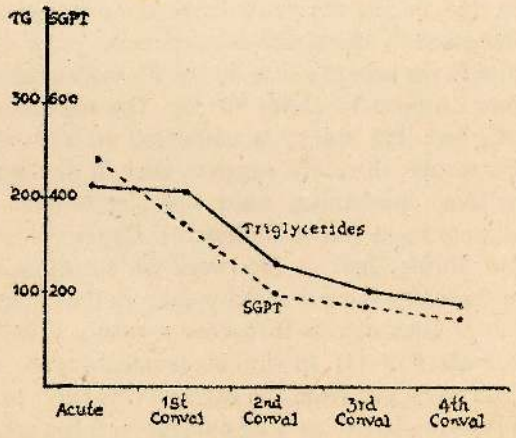


Fig. 7 Showing mean serum triglycerides and mean SGPT activity at different stages

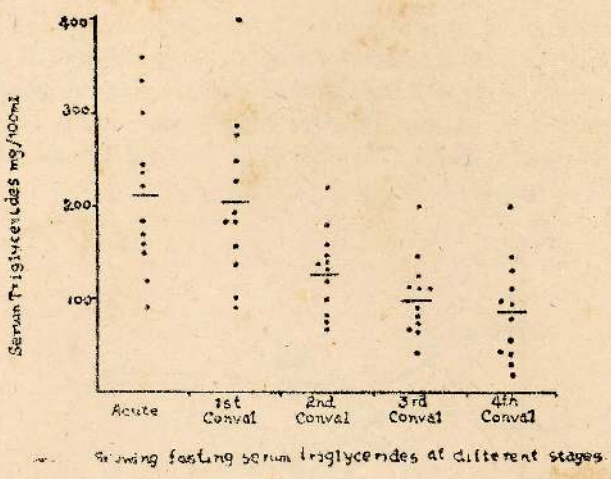


Fig. 8

Fig. 9 shows the TG values at the different stages; the time intervals between the acute and post acute stage was 2—5 days, in viral hepatitis. You will see that the TG increased in the clinical recovery, continued to increase for another week and then decreased. At the 6th week the TG value was about $^1/_3$ rd the value observed at the acute stage. In viral ketoacidosis however, there is a slight difference in that during the acute stage the average TG was 90 mg% and increased to about 170 mg and never came down below the acute stage. In the hepatitis case, by the 5th week of convalescence the TG values dropped to about 90 mg. The maximum value in viral hepatitis was 195 mg.% as compared to 170 mg in keto-acidosis. The results therefore suggests that in any type of viral disease, the same mechanism must operate. Similar (Fig. 10) observations were made in the cholesterol. Hyper cholesterolaemia was observed during 2nd — 3rd week of convalescence. Even here, in viral hepatitis there is a sharp drop in the cholesterol level (170 mg.) but in ketoacidosis it reached a steady value of 210 mg after the 4th week (Fig. 11). In viral ketoacidosis, there is an inhibition of glucose transport from the extracellular fluid to within the cell. This was established by carrying out glucose tolerance, liver biopsies and nitrogen excretion studes. The results showed that there was poor utilization, swelling of liver fatty changes and glycogen

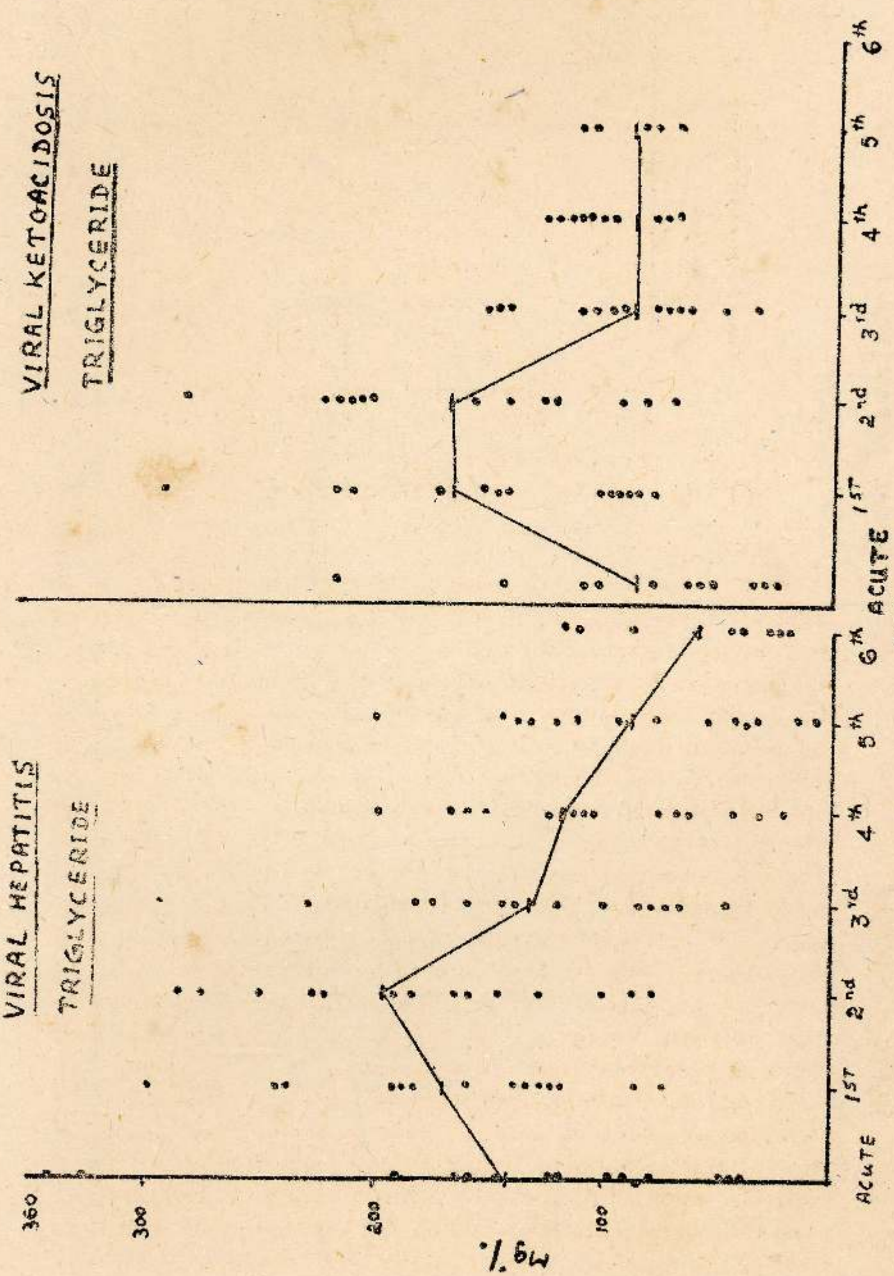

VIRAL KETOACIDOSIS
TRIGLYCERIDE
VIRAL HEPATITIS
TRIGLYCERIDE
mg%
360
300
200
100
ACUTE
1ST
2nd
3rd
4th
5th
6th

Fig. 9

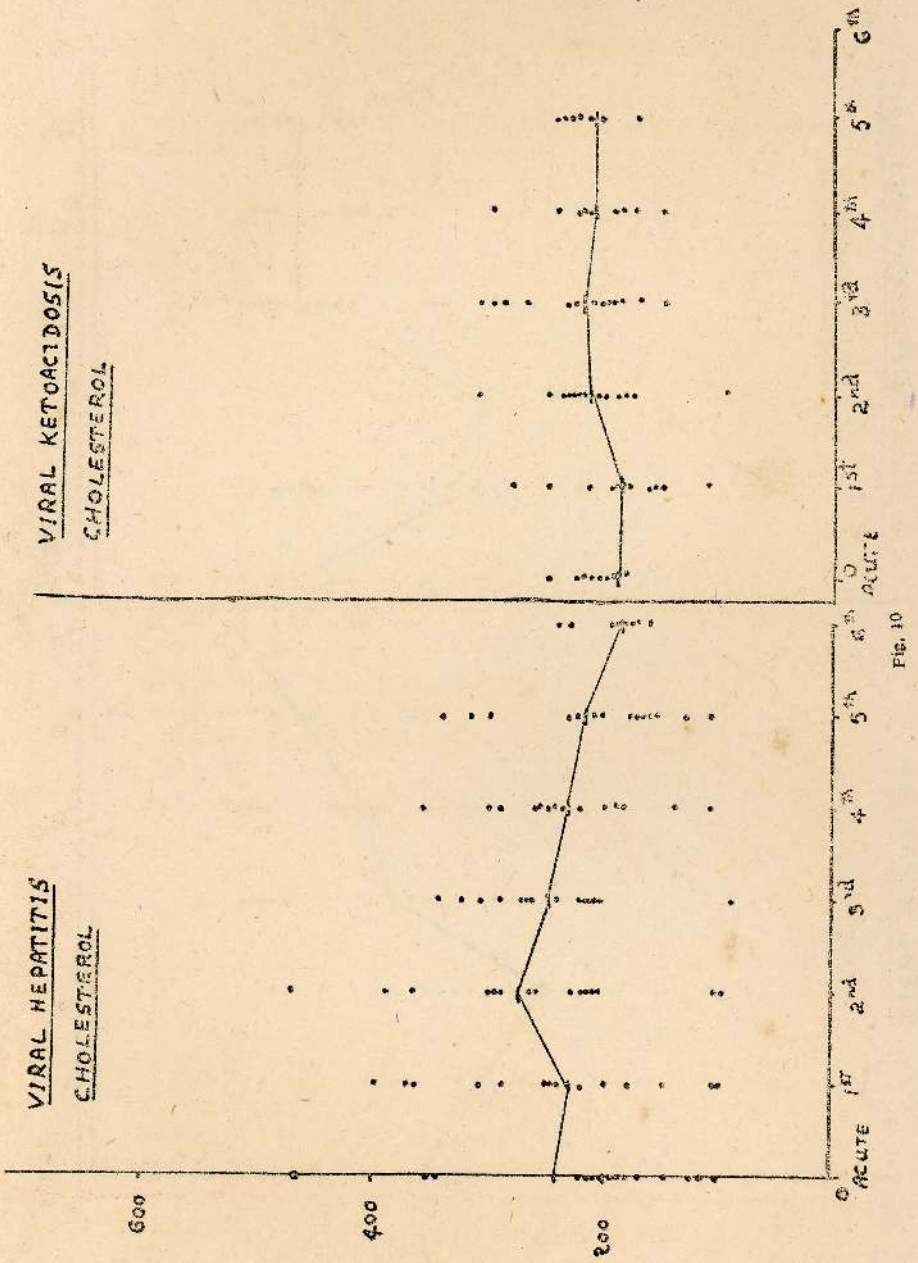
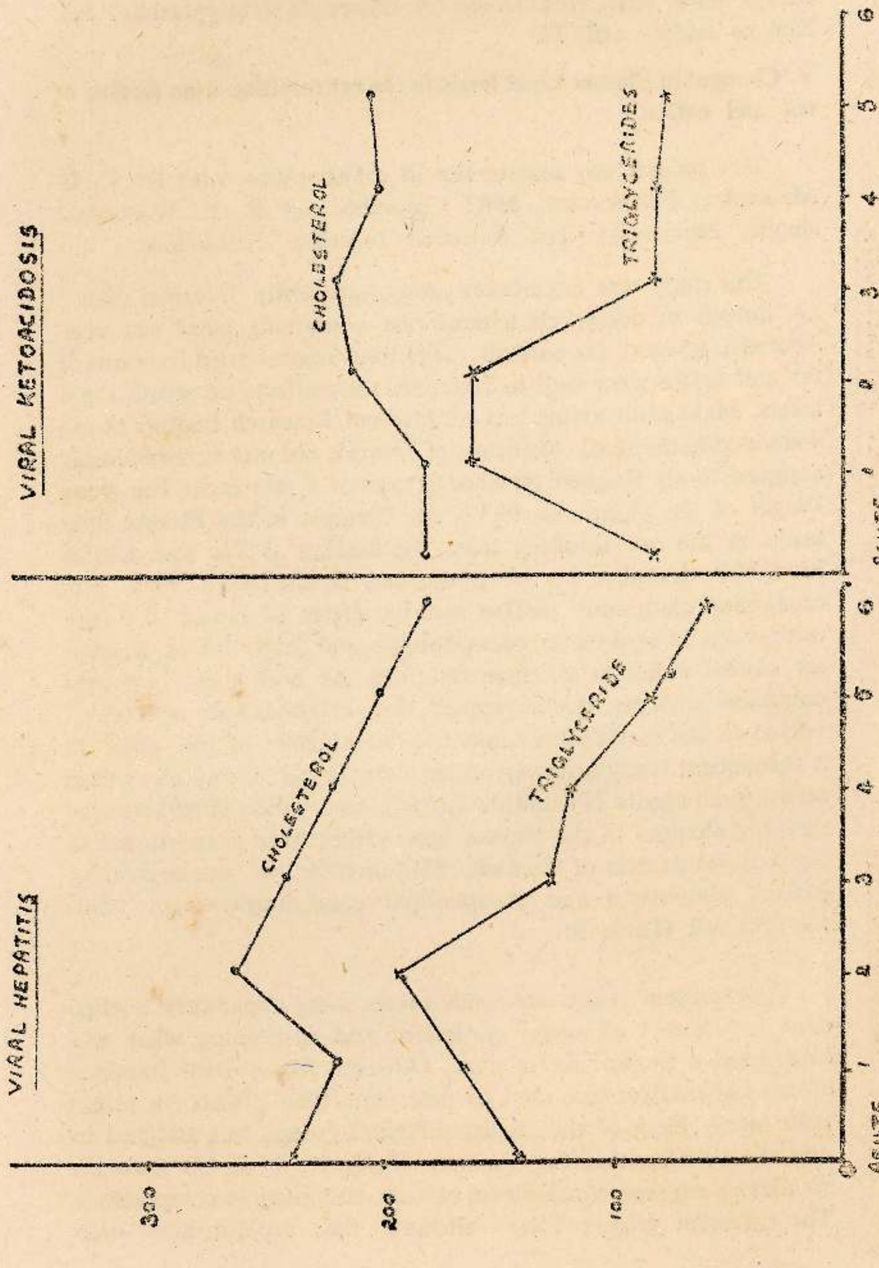


Fig. 10



depletion. When there is poor utilization of carbohydrate, the energy has to come from stored fat, this could be supplied as F FA, Ketone bodies and TG.

V. Changes in Plasma Lipid levels in the rat resulting from feeding of tea and coffee.

This project was undertaken in collaboration with Dr. C. C. Mahendra, Nutritionist, MRI Colombo and R. L. Wickremasinghe, Biochemist, Tea Research Institute, Talawakele.

This study was undertaken using apparently "Normal diets" i.e. devoid of added cholesterol and containing what was considered a normal fat content. Different freeze dried fractions of tea and coffee were used to determine their effects on serum Lipid levels. Male adult abline rats of Medical Research Insitute strain were used in the study. Six litters of 14 week old rats were randomly assigned to six weighed matched groups of 6 rats each. The mean weight of the group was 993$\pm$ 3g. Changes in the Plasma lipid levels in the rat, resulting from the feeding of Tea and Coffee have been described by Akinyanju and Udkin (1967). In a diet containing cholesterol, coffee had the effect of raising the concentrations of cholesterol, phospholipids and Triglycerides, whereas tea caused a fall in all three fractions. As both these beverages contained caffeine, it was argued that caffeine could not be involved in the disturbances noted in metabolism of the lipids. In a subsequent study however, using diets devoid of any recognised atherogenic agents Naismith Akinyanju and Udkin (1969) showed that the changes in the plasma lipid values were proportional to the caffeine content of the diets. With increase in intake caffeine plasma cholesterol and phospholipid concentration rose while the TG fell (Table 9).

The present study was undertaken using apparently normal diets i.e. devoid of added choleserol and containing what was considered a normal fat content. Different freeze dried fractions of tea and coffee were used to determine their effects on serum lipid levels. Each of the six experimental groups was assigned to one of six different dietery regimes. (Table 10, 11 & 12) show the six dietery regimes, composition of diets and nutrient composition. The different groups were allowed the experimental diets

TABLE 9.

PERCENTAGE CAFFEINE

BLACK TEA	3.8
TEA FRACTION 1	2.5
TEA FRACTION 2	2.6
GREEN TEA	3.4
COFFEE	5.5

TABLE 10

DIETS

1. 'CONTROL DIET
2. COFFEE
3. TEA FRACTION 1
4. TEA FRACTION 2
5. BLACK TEA
6. GREEN TEA

TABLE 11

PERCENTAGE COMPOSITION OF DIET

	Cals. / 100 g	*Proteins/100 g.*
CONTROLLED DIET	425.7	19.1
COFFEE DIET	416.5	19.4
TEA FRACTION 1 DIET	414.2	19.1
TEA FRACTION 2 DIET	414.2	19.2
BLACK TEA DIET	417.4	19.3
GREEN TEA DIET	419.1	19.6

TABLE 12.

	Control Diet	*Tea / Coffee*
WHEAT FLOUR	39.0	37.7
TEA/COFFEE	00	2.3
SKIMMED MILK	40.0	40.0
COCONUT OIL (Hydrogenated	4.0	4.0
VITAMIN MIXTURE	5.0	5.0
MINERAL MIXTURE	5.0	5.0
CELLULOSE	4.0	5.0
CORN OIL	2.0	2.0
	100.00	100.00

adlibitum. The groups weighed weekly and food consumption measured at regular intervals. Food consumption and efficiency of food conversion were similar in all groups.

At the end of 100 days on the diet, blood was collected from the tails of the animals for the estimation of total esterified fatty acids (TEFA), TG, and total cholesterol. The TEFA provide an estimate of the total, lipid concentration in the serum or plasma since each of the three major lipid types contribute to it. It may be more informative than separate measurements of choleserol, as this does not consistently reflect the total lipid concentration. The combination of serum total cholesterol and TEFA measurements is useful in that both hypercholesterolaemia and hyperlipidaemia will be demonstrated.

Table 13 summarises the results of the estimation of serum lipid levels at the end of 100 days on the diet and Table 14 gives the statistical analysis of the results using standard procedure. The significant features which merge from this investigation are:—

Total Cholesterol:

(1) The groups fed the different freeze dried tea extracts had significantly lower cholesterol levels than the group fed the coffee diet or the "control" diet.

(2) There was no significant difference in the serum cholesterol levels of the coffee and "control" diet fed groups.

(3) There was also no significant difference between the serum cholesterol levels of the green tea and black tea groups or between the groups fed tea fraction 1 and tea fraction 2.

(4) But serum cholesterol levels were significantly lower with both Tea fractions 1 and 2 than with green or black tea.

Working with diets containing no recognised atherogenic agents, Naismith and Co-workers (1969) concluded that the total cholesterol levels rose with increasing intake of caffeine. However, though in the present study the final total cholesterol levels appeared to be directly related to the caffeine content of the diet, the diferent tea extracts in fact lowered serum cholesterol levels

when compared to the control groups, whereas coffee did not. However, there was no significant difference in the serum cholesterol levels of the "caffeine" free control groups and the "high caffeine" coffee group.

Triglyceride:

(1) Triglyceride levels were significantly lower in the groups fed any one of the tea extracts or coffee, than in the control group.

(2) Animals fed either tea fraction 1 or 2 or black tea had significantly lower triglycerides levels than coffee fed groups.

(3) Diferent tea extracts had similar effects on Triglyceride levels.

(4) Caffeine in the diet appears to lead to a reduction in the triglyceride level but no corelation exists between the caffeine content and the TG levels.

Naismith and co-workers in a study with rate concluded that the rise in concentration of cholesterol and fall in the concentration of TG were in proportion to the intake of caffeine. However, this is not borne out by the present study and some factors other than caffeine appears to be involved. Young and co-workers (1967) found that theophylline and theobromine were far less effective than tea itself in preventing atheroma developing in the aerota of rabbits. In the present study both tea fractions 1 and 2 had similar effect on the TG and serum cholesterol levels, though they differed in their polyphenol and polysaccharide content. Though tea fraction 1 has some polyphenols (the flavanols) and tea fraction 2, the major polyphenols, similar effect on lipid levels could be due to some common polyphenol fraction, thought its exact nature needs further elucidation.

Lastly we do not know whether virus infections produce hypertriglyceridaemia in the adult. There is evidence that a mild

virus infection of sandfly fever produce impaired carbohydrate metabolism together with increased FFAS (Rayfield et al 1973). A detailed study of lipid metabolism in viral infection on adults is essential since there is growing demand amongst the clinicians for triglyceride estimation in heart disease. I also wish to emphasize that determination of serum total cholesterol and or Triglyceride has not revealed any significant abnormalities in cardiac diseases that we have studied. However, the percentage of cholesterol bound to β and pre-β is probably the factor associated with coronary heart disease.

TABLE 13

MEAN SERUM LIPID LEVELS OF RATS AT END OF 100 DAYS ON DIET.

	TOTAL Cholesterol (mg/100 ml)	*TEFA (ME/Litre)*	*TRIGLYCERIDE (mg/100ml)*
COFFEE	116.0 ± 8.3 (90 — 143)	7.7 ± 0.4 (6 — 9.13)	102.3 ± 12.1 (59.0 — 141)
TEA FRACTION I.	64.8 ± 5.1 (50 — 90)	6.3 ± 0.6 (5.0 — 8.3)	63.7 ± 10.2 (13 — 94)
TEA FRACTION 2. ..	66.7 ± 4.8 (50 — 85)	3.6 ± 0.8 (0.8 — 6.4)	48.0 ± 8.2) (18 — 74)
BLACK TEA ..	92.0 ± 4.5 (90 — 110)	4.7 ± 0.6 (2.8 — 6.4)	64.4 ± 6.6 (34 — 80)
GREEN TEA ..	91.7 ± 2.7 (81 — 100)	6.1 ± 0.6 (4.2 — 8.4)	66.6 ± 26.7 (0 — 164.5)
"CONTROL" DIET	108.7 ± 3.5 (100 — 124)	7.6 ± 0.7 (5.2 — 9.1)	156.1 — 16.9 (118 — 223.2)

Mean ± S. E. and range (within parentheses) indicated

TABLE 14

STATISTICAL ANALYSIS OF RESULTS

(P Values)

		Tefa	*Triglycerides*	*Cholestero*
1.	COFFEE / GREEN TEA	< .05	n.s	< .01
2.	GREEN / BLACK TEA	< .001	< .01	<< .02
3.	COFFEE / TEA 1	n.s	<< .02	<< .001
4.	COFFEE / TEA 2	< .001	<< .001	<< .001
5.	BLACK / TEA / TEA 1	n.s	n.s	<< 001.
6.	TEA 1 / TEA 2	< .01	n.s	n.s.
7.	BLACK TEA / TEA 2	n.s	n.s	<< 001.
8.	GREEN TEA / TEA 1	n.s	n.s	<< .001
9.	GREEN TEA / BLACK TEA	n.s	n.s	n.s
10.	GREEN TEA / TEA 2	< 0.1	n.s	<< .001
11.	CONTROL / GREEN TEA	n.s	<< 0.01	<< .001
12.	CONTROL / BLACK TEA	< .01	<<< .001	<<< .01
13.	CONTROL / TEA 1	n.s	<<< .001	<<< .001
14.	CONTROL / TEA 2	< .001	<<< .001	<<< .001
15.	CONTROL / COFFEE	n.s	< .01	n.s

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SECTION F — SOCIAL SCIENCES

Presidential Address

LAND SETTLEMENT PATTERNS IN SRI LANKA

by

A. S. KUNASINGHAM

Mr General President, Ladies and Gentlemen. I thank you sincerely for the great honour bestowed on me by electing me President of Section F.

A President is in a dilemma in choosing a topic for his address, unable to get a proper mix of a popular theme and his research. In deference to the wishes fo my colleagues I have changed my topic of address (from Agricultural Project Selection and Macro-economic Objectives) to develop a theme of popular interest that grows out of my field of specialisation.

Introduction

Land reform can be defined as changes in the agricultural institutions which improve the economic, social and political status of the people, particularly those occupying the land, in the process, contributing to the general social and economic development of the country.

The concept of land reform is not new—if I may say so—it is as old as man, and has gradually taken diverse forms. In the early days land was divided periodically according to the needs of the people.

In some countries land was considered to belong to each and all who cultivated it whenever the individual wished to do so. In some other countries, land was re-divided among families every decade or so.

Today land reform includes concern to raise the social status and economic conditions of the peasantry. It had received the serious attention of governments in many countries throughout the world. A part of the unrest in many countries could be traced to landlessness or alternatively, to insecure and inequitable systems of land tenure. In these conditions the peasants do not feel that they have a stake in the land nor that they are receiving an equitable share of the land.

The United Nations too, in its Thirteenth Annual Sessions resolved that: "governments institute appropriate land reforms in the interests of landless farmers and those with small and medium sized holdings."

Since World War II many developing countries, in keeping with their needs, have undertaken land reform measures for limiting ownership and redistributing large estates and land from the public domain to landless peasants. The programmes, broadly speaking consisted of

(*a*) those in countries free of total totalitarian domination with ideals of land reform under democratic processes e.g. Sri Lanka.

(*b*) those in totalitarian dominated countries characterised by the disregard of the rights of the land owner and by the forcible imposition on the peasantry of some form of collective operation.

Until 1972 Sri Lanka had attempted to meet the thirst for land through settlement on newly developed jungle land. This latter type of land reform could be widely implemented only in countries where land is freely available in the public domain e.g. Malaysia, Colombia. In this address, I shall deal with both types of land reform in Sri Lanka.

(*a*) land settlement on newly developed land, and
(*b*) redistribution of estate lands

Background to Settlement efforts

In Sri Lanka the term settlement usually refers to the work done by the Land Settlement Department in settling title to land.

I would treat it in the universally accepted sense of settling people on land. To be more explicit, I refer to the concept of land colonisation in Sri Lanka.

Although the Dutch restored some ancient irrigation tanks for example the Amparai Tank in the Eastern province, modern land and irrigation development dates from the enactment of the Crown Lands Encroachment Ordinance in 1840. The primary objective of this Ordinace was to prevent large scale encroachments of land by the villagers and also to define Crown land. Chena and other lands periodically cultivated by the villager were deemed to be Crown lands.

The evolution of land policy and development can be broken up into the following sub-periods.

1. 1840 to 1914—Enactment of the Crown Lands Encroachment Ordinance (1840) and the Waste Lands Ordinance (1897). No definite efforts in land settlement are noted here.
2. 1914 to 1934 — World War I (1914). Implementation of the Donoughmore Constitution (1931) granting partial independence.
3. 1935 to 1947—Enactment of the Land Development Ordinance (1935); The Soulbury Constitution (1947), and Independence (Dominion Status; 1948).
4. 1948 to 1955—Gal Oya Development and accelerated implementation of aided colonisation.
5. 1956 to 1965—Growing demand for land and awareness of the people of the resources of production. Advanced alienation and reduction in farm size.
6. 1965 to 1971 —Changes in policy from welfare to production oriented systems. Udawalawe and Mahaweli Irrigation Development Projects.
7. 1972 onwards—Enactment of the land reform laws restricting ownership to 50 acres and acquiring company owned estates. Also implementation of the agricultural land laws and the agricultural productivity law. Enactment of the State Land Sales (Special Provisions) Law.

The Crown Lands Encroachment Ordinance No. 12 of 1840 defined that all forest, waste unoccupied or uncultivated lands shall be presumed to be property of the Crown until the contrary was proved. This presumptive right of the Crown resulted in most of the land in the Wet Zone, particularly in the Kandyan areas where land was used as Chenas, for village pasture, forest and for village expansion purposes being declared Crown Land. The Ordinance was designed for those who had capital resources for land development, and enabled the formation of the plantation economy which is today the principle source of our export income. Some concessions were granted to the peasants but they were not sufficient to attract them to the land.

Land disposal took the form of an "application system" which is continued even today at Land Kachcheri Meetings. An individual had to apply to the Revenue Officer if he wanted a lease or outright purchase of land. Free grants of land were given in the Wet Zone but lands in the Dry Zone particularly those under reclaimed tanks, were sold. The system obviously did not serve the needs of peasants who lacked capital, in spite of the fact that they were allowed to pay for the land in instalments.

During this period an attempt was made in settling some people at Kalawewa. Assistance was given to them in the form free transport, subsistence allowance, fully constructed houses free seed materials, implements and so on. Many of these settlers, left the area due to sickness and dissatisfaction from not getting the land free.

There were no genuine efforts at 'aided' colonization on a wide scale during this period. The land under the restored tanks was sold to those with capital, which prevented the peasants from bidding for the land. Some peasants illegally squatted on Crown Land, which influenced the enactment of the Waste Lands Ordinance (1897).

1914—1934

Land policy formulated during this period laid the foundation for the settlement projects of today. It was directed towards preserving the peasantry, disposal of land on easy terms and easing

of population presure in the congested areas of the Wet Zone. Food production, though important, was secondary.

A unique method called the Peasant Proprietor system was established in the Eastern Province. This system enabled the peasants to obtain land for food Production under certain conditions that preserved the ownership of land with them. It proved unsatisfactory as speculators used the peasants to obtain land. The outcome was the appointment of a Land Commission (1925). The Commission report (1929) was the turning point in aided colonization, and the current peasant settlement projects are primarily based on its findings.

The Land Commission recommendations were as follows:

1. the main objective of settling people should be the preservation of the peasantry,
2. the government should sponsor disposal of Crown land through a special officer, the Land Commissioner,
3. land should be 'mapped out' before disposal. This involves a systematic study of an area and the demarcation of Crown Land for various purposes e.g. village forest and pasture, village expansion, public purposes, colonisation and so on.
4. three types of tenure under which land should be disposed of:
   (*a*) outright grants; the system is to be operated in areas where the peasant is free from land speculators, creditors and others,
   (*b*) Lease under the Peasant Proprietor system to be continued in the Eastern Province, and to be intiated in some other areas too.
   (*c*) Peasant tenure under specific conditions that he cannot sub-divide below a given size, dispose or mortgage the land,
5. the large and increasing educated class should be encouraged to go back to the land and be usefully employed in agriculture rather than drift into unemploy ment.

1935—1947

During this period aided colonisation in the Dry Zone did not make much progress. At Nachchaduwa a project where some families were settled on five acres of paddy land with all the assistance, failed for lack of interest among the settlers. Sickness and inability to repay the cash advance also contributed to the failure of the projects. A number of unassisted less ambitious survived but could not be considered successful tests of Land settlement.

Even though there was a time lag of over five years in implementing the Land Commission recommendations, action culminated in the enactment of the Land Development Ordinance. The latter Ordinance was the prime legal document for disposal of land in settlement projects until 1973.

The objects of the Land Development Ordinance was to preserve the peasantry and initiate land disposal by the government. The enactment of this Ordinance was the most important occurence in the period 1935—1947 and began the next phase in the development of land coloniszation.

In 1939 the report on 'Aided Land Colonisation' presented to the Legislative Council by the Minister of Agriculture and Lands recommended

(1) that farm size should be sufficient to make the settler economically independent,
(2) specific planning of cultivation,
(3) a liberal system of assistance,
(4) systematic planning of projects,

Nine settlement projects covering over 14,CC0 acres of paddy land were established during this period.

1948—1955

So far the government had not only concentrated efforts on the peasantry but also on one type of tenure only—the protected holding. The Crown Lands Ordiancne (1947) was enacted for the issue of outright grants and leases to peasants and others.

The priod 1948 to 1955 brought an accelerated disposal of land under the L.D.O. Over 60,000 acres of rice land were given to about 16,500 settlers. The scheme of assistance did not change. Farm size was reduced in 1953 to three acres paddy land and two acres highland. The reasons for the reduction in farm size from five acres paddy land and three acres highland were that

(1) family labour was not sufficient for the optimum cultvation of large farms, and
(2) a larger number of persons could be given the limited resource of developed land.

The most important event that took place in this period was the development of the Gal Oya Project. It was designed for

(1) the agricultural development of 42,000 acres (32,000 acres in paddy land and 10,000 acres in sugar cane)
(2) flood protection, and
(3) provision of domestic water to over 20,000 farm families.

By 1965 the project had estalished over 30 villages and about 12,000 families in both village expansion and major colonisation areas. Farm size was four acres of paddy land and three acres of highland which was later reduced to three acres of paddy land and two acres highland

1956—1965

In the period 1956—1965, a social revolution gave the people great confidence that they too were taking part in the democratic political system. The demand for resources, particularly land, was much greater than in the earlier periods. Consequently the consensus was that disposal of land should be further accelerated. The limiting factors were the lack of capital and manpower for the development of the land. To meet this demand for land, a major change was made in the timing of the arrival of the colonists to a project. A concept of advance allienation was implemented. Under this scheme, the settlers were brought to the land one year before the provision of irrigation facilities. Unlike the earlier system of bringing the settlers to a 'ready-made' farm, the new system was more advantageous in that

(1) the settlers participated in the construction work and earned wages,
(2) in areas with a shortage of labour for construction of irrigation works and canal development, the settlers filled in the gap,
(3) the settler cleared the jungle and was paid up to a maximum of Rs. 100/- per acre,
(4) there was rapid disposal of land; over 35,000 settlers benefited under this scheme covering an extent of over 90,000 acres of paddy land,
(5) there was production of rice under rainfed conditions a year prior to the completion of irrigation works; the land was expected to be stumped and ridged during the second year of settlement,
(6) the colonist was not only more acclamatised to his new environment (before bringing his family) but also had a greater sense of participation and ownership in the projects, and lastly,
(7) the new system of land disposal minimised illegal squatting in irrigation projects.

Basically, the system of assistance was not changed but it was modified in 1963 as follows:

(1) the government did not undertake the construction of houses but issued a grant of Rs. 1000/-per settler for this purpose
(2) Rs. 80/- was granted for the construction of a temporary hut,
(3) Rs. 100/- per acre was paid for stumping instead of Rs. 200/-
(4) a grant of Rs. 40/ per acre for ridging (the government abandoned its practice of ridging paddy fields,) and
(5) assistance for perimeter fencing a group of farms was given to the settlers.

As the demand for land in settlement projects exceeded the supply, the unit of alienation was reduced from three acres paddy-land and two acres highland to two acres paddyland and one acre highland.

In 1956, as part of the programme of accelerated disposition of land the government introduced the peasant to the plantation sector through highland settlement projects. The first project (1956) was in Tea, the price of which was then favourable to the producer. All the highland colonisation projects except for the coconut project were started during this period. About five years after the initiation of this programme opening up of new land in tea and rubber was suspended due to fluctuations and unfavourable prices in the international market for these products. The efficiency of production was also very low as the management of these crops was complex and the 'know-how' of the peasant limited. Further, farms of two acres in tea or rubber were managed by the settler and not collectively on a plantation scale.

1965—1971

After 1965, the rate of land disposal decreased, 17,000 settlers were given about 34,000 acres of paddy land. In 1966 the number of unemployed persons was over 450,000 of which a large per cent was educated youth. With the objective of absorbing a section of these youths into self employment, a new series of projects, Youth Settlement Projects, was started in 1966. The programme envisaged the opening of 235 projects, at least one per electorate, to benefit 20,000 to 25,000 youths. For various reasons, not more than 5000 youths were settled in 49 projects.

As the returns on major colonisation projects (the major objective of which were to ease population pressure in the Wet Zone) were not commensurate with the investment made in these projects an I.B.R.D./F.A.O. mission that visited Sri Lanka in 1966 recommended a package programme of integrated development to maximise production. The objects of this programme were

1. to maximise production through improved method of cultivation,
2. to strengthen institutional arrangements in respect of marketing, credit and farm management,
3. to rehabilitate irrigation facilities for better production,
4. to encourage development whereby the community will grow into a self-sustained one.

A pilot project implementing the package programme was first initiated at the Elahera Colonisation project in 1967. A farm management survey carried out in this project in 1970/71 (Maha) had revealed that the yield of rice per acre had increased by over 50 per cent of the figure in 1968. In 1972 the yield per acre at Elahera was 79 bushels. The package programme is now being implemented in over 22 colonization projects which are referred to as special projects.

In 1971 there was a major change in land policy. The assistance given to settlers was not only reduced but was made uniform. The activities were broadly divided into the following catetories.

(*a*) capital expenditure (jungle clearing, fencing, farms equipment)
(*b*) recurrent expenditure (e.g. planting material, fertilisers, agro-chemicals),
(*c*) infra-structure and communal facilities (roads, water supply, health and educational facilities),
(*d*) subsidies for houses, wells, latrines and permanent roofing.

With regard to capital expenditure in all types of colonisation projects including the youth settlement projects, each settler will receive a maximum of Rs. 1600/- per acre for activities connected with land preparation, purchase of farm equipment and other capital items. The amount of subsidy for each activity will be determined at the time of planning each project. It can be recalled that the system of assistance implemented earlier enumerated the rates of subsidies by type of project viz. major colonization or highland colonisation, irrespective of other factors such as location etc. The new policy is rational as the rates, of subsidies are not only determined by the prices prevailing in the area per unit time, but also reflect the nature of the area and other factors.

In 1971, a programme to set up cooperative farms was introduced throughout the country, The object of this programme was to harness the manpower resources particularly the youth for agricultural production. The settlers had to work on a collective basis in the development of the land.

During the same year another form of settlement project, the District Development Council projects, was introduced by the Ministry of Planning and Economic Affairs. These projects were formulated on a smaller scale of production than the co-operative farms. The prime objective of these schemes was to harness the manpower and raw material resources in the respective district for agricultural and industrial production.

1972 onwards

A revolution in land policy took place in 1972 with the enactment of the Land Reform Law, and this process continued in 1973 with the State Land (Special Provisions) Sales Act and in 1975 with the Land Reform Law Amendment Act.

The objectives of the Land Reform laws were to

(*a*) restrict the ownership of private land to 50 acres of highland or 25 acres of paddy land with a view to a more equitable distribution of land and wealth,

(*b*) to increase productivity and provide additional employment in the agricultural sector. Some of the estates whether company or individually owned were not being managed at the highest possible efficiency,

(*c*) to build a socialist society, owning land on a co-operative basis,

(*d*) vest all lands possessed or owned by companies in the Land Reform Commission.

Under the law (Stage I) all areas of land over the ceiling are deemed vested in the Land Reform commission. 5487 persons owning lands in excess of the ceiling declared to the Commission by December 1972, covering an extent of one million acres. After determining the owners' share an extent of 559,377 acres was available for re-distribution, and was vested in the Commission by August 1974. 65 per cent of the land vested in the Commission was in Tea, Rubber and Coconut, while 32 per cent were in jungle, patna and uncultivated. A notable feature is that only 3 per cent of the lands vested in the Commission are cultivated in paddy.

According to the pilot survey conducted by the Census and Statistics Department in 1972 over one-third of the paddy lands

are in units of over 5 acres and about 16 per cent of the acreage in holding of over 10 acres; only 4—5 per cent of the paddy lands are in units of 25 acres and over. It is therefore obvious that if Land Reform is to have a wider impact the ceiling on paddy lands should be reduced to 5 acres. A five acre size farm is an economic unit, more so if a portion of the land is cultivated during the Yala season either in paddy or other field crops. Such a unit should give the farmer a minimum monthly income of over Rs. 400/- which puts him into the group of high income earners who form, at present, only 20 per cent of the population.

The object of the Land Reform (Amendment) Law is to vest every estate land owned or possessed by a public company in the Commission. 415,508 acres have been vested in the Commission under the Amendment Act. Table 1 summarises the particulars of the lands taken over according to districts and crops. 70 per cent of the lands are cultivated in tea while 25 per cent are rubber lands.

Table 1.

LANDS OWNED BY COMPANIES VESTED IN THE COMMISSION

	No.	Tea	Rubber	Coconut	Others	Total
Colombo	9	687	6170	1459	1111	9418
Kalutara	31	2863	23107	1642	144	27756
Kandy	77	76963	—	—	—	76963
Matale	10	11917	625	625	—	13167
N'Eliya	87	82171	—	—	—	82171
Galle	18	3992	17296	—	—	21288
Matara	6	3481	1338	—	—	4819
K'gala	7	—	2961	3070	—	6031
Puttalam	1	—	—	911	—	911
Moneragala	4	—	2081	—	—	2031
Badulla	73	77556	281	—	—	77837
R'pura	42	27849	21539	338	626	50352
Kegalla	39	4647	34673	—	3444	42764
Total	404	292126	119921	8036	5325	415508

The lands taken over under both stages of land reform may be utilised as follows:

(*a*) dispose or sell, lease exchange or rent purchase to persons for agricultural development or co-operative or colective enterprises.

(*b*) sell individual parcels to persons for residential purposes,
(*c*) alienate to any corporation established or to be established under the State Agricultural Corporations Act No. 11 of 1972 or to the Ceylon State Plantation Corporation,
(d) dispose for a farm or plantation managed by the commission directly or by its agents,
(e) alienation for village expansion or other public purposes.

The State Lands Sales (Special Provisions) Law provides for:—

(*a*) the sale of State Lands to peasants and middle class persons who are citizens of Sri Lanka, for agricultural pruposes,
(*b*) to enable the allottee who was given land under the L.D.O. to purchase his parcel of land,
(*c*) to liberalise the conditions of tenure stipulated under the L.D.O.

State land may be sold for the following purposes:

(*a*) the establishment of plantation crops,
(*b*) the cultivation of crops other than plantation crops,
(*c*) the establishment of settlement schemes,
(*d*) livestock rearing and animal husbandry.

The persons to whom land may be sold are classified into

(1) peasants
(2) educated youths
(3) persons of lower income class and
(4) persons of higher income class.

Current Land Settlement Projects

With a diversity in the types of settlement projects, it is now best to enumerate them for clarity. They are

(1) Major Colonisation Projects
(2) Highland Colonisation Projects
(3) Village Expansion Schemes
(4) Educated Youth Settlement Projects
(5) Middle Class Settlement Projects
(6) Co-operative Farms (Samupakara Gammannas)
(7) Divisional Development Council Projects

(8) Janawasas
(9) Special Leases, and Marginal lands leases scheme

Major colonization projects are designed for the cultivation of the staple food, rice, and range from about 50 acres in extent to over 30,000 acres in the Gal Oya Project. It is the practice to group all irrigated projects which would have settlers of varying ages selected from villages located over a five-mile radius of the respective project, as major colonization projects.

The village expansion projects, as the name indicates, are for residential purposes located on the fringes of villages. The principal objective of these projects is to ease the pressure of population in the villages which are located adjacent or in close proximity to the project. However, in areas where sufficient land is available from the public domain, there are agricultural village expansion projects. The settlers in these projects are from the within five miles of the project area. The principal difference between these projects and the major colonization projects is in the scale of aid.

The highland colonization projects are without irrigation facilities and are cultivated in plantation crops. They were originally meant to assist the peasants in the wet Zone (some of whom did not want to go to the distant dry Zone), and also to exploit the small hilly area of jungle land unsuitable for rice cultivation in the Sabaragamuwa and Southern provinces. This program was later extended to the dry zone for coconut cultivation.

The middle class projects are meant for the upper income group, of Rs. 24,000 per family. The concept of middle class has been altered to

(*a*) lower income group; income should not exceed Rs. 6000/- per annum if single and Rs. 12,000/- if with a spouse,
(*b*) upper income group, income ranges from Rs. 6000/- to Rs. 15,000/- per annum if single and Rs. 12,000/- to Rs. 20,000/- with a spouse

The Land Commission in 1929 had attempted to utilize this group of persons with some capital in agricultural development. The settlers are usually absentee landlords and are not given any

financial assistance. In rare cases, they are settled in irrigation projects. Middle class projects are located in areas where the paesant is not capable of utilizing the land.

The youth settlement projects are a combination of the major, highland and village expansion types except that settlers are restricted to the age group of 18—25 years. There are forty-nine projects, each stage being counted as one project, comprising 5000 farmers covering a total area of 14,000 acres. The objectives of the youth settlement program are to:

(1) provide employment to the youths with a minimum net operating income of Rs. 250 a month; and
(2) diversify crop production.

Basic data on some selected settlement projects are given in Table 2.

Co-operative Settlements (Janawasas)

With the take-over of large extents of estate lands, the management and development of these lands form the next stage of land reform. To continue the large scale production units in the estates, and in keeping with the social objectives of the country, a large number of collective settlements were established in the areas taken over under the first stage of land reform. All activities in these settlements are managed on a co-operative basis. 175 Janawasas with a membership if 1500 persons and covering the extent of 40,000 acres have been established.

Financing of the projects firstly is in the form of advances from the Land Reform Commission when the revenue from crop sales is insufficient to meet the usual expenses of the settlement. As in the other co-operative settlements, the Janawasas are entitled to obtain loans from the People's Bank.

The project officer, who is an employee of the Land Reform Commission has no direct control over the project. He functions in an advisory capacity. The management body consists of an executive committee consisting of 9 members, 6 elected and 3 representatives of the Agricultural Productivity Committee, Primary Co-operative and the District Land Reform Authority.

Table 2.

BASIC DATA OF SELECTED SETTLEMENT PROJECTS

Project	No. of Farms	Farm Size Acres Homestead.	Agri-culture	Crop	Total costs	Investment Cost per acre	Cost per Farm	Gross Per Farm	Out put per Acre cultivated
					Rs.	Rs.	Rs.	Rs.	Rs.
(1) Youth Settlement									
(a) *Field Crops*									
Viswamadukulam	370	1	2	Chillies	3,636,000	3,275	9,825	6,997	3,611
Thiruvai Aru	100	1	2	Chillies Onions Vegetable	1,158,179	3,894	11,681	3,958	2,596
(d) *Fruit Project*									
Ihala Hewessa	55	0.5	3	Passion fruit	686,125	4,158	12,475	3,761	—
(c) *Vegetable*									
Galpalama	40	0.25	1	Potato and Vegetables	377,400	7,548	9,435	5,000	5,000
(d) *Plantation Crops*									
Mandalapura	40	0.5	2	Tea	439,920	4,399	10,999	3,640*x*	1,820*x*
Campbells Land	57	0.5	2	Cardamon	442,830	3,108	7,769	4,480	2,240
Kiulekele	110		5	Coconut	1,010,575	1,837	9,187	1,250*x*	250*x*
(2) Major Colonozation									
Nagadeepa	2000	1	2	Rice Chillies	23,077.00	3,846	11,538	1,400 (2,968)*z*	700 (1,187)*z*

x Estimated yield

z The gross output in parentheses is from rice and chillies.

The settlers are paid at a rate not less than the government approved wage rates. Profit is expected to be distributed to the members under the Co-operative Bye Laws.

Ownership of the land is held collectively as in the case of the Co-operative farms. A programme of alienating lands for residential purposes not only to the members of the Jawanasas but also to local villagers is being formulated.

Divisional Development Council projects (agriculture) could be compared to the agricultural village expansion schemes managed by the Land Commissioner. The objectives and the functions of the Divisional Development Councils are:

(*a*) Formulation and Operation of an integrated development programme for the area using local raw materials where possible,
(*b*) Coordination and review government activity in the area and suggest any corrective measures.

The councils are expected to examine the natural resources including raw materials available within their area of jurisdiction and to formulate projects which will provide employment to the people of the area.

The Divisional Development Councils comprise Government Officials and representatives of institutions such as Cultivation Committees, local bodies, People's Committee, Co-operative Societies and so on.

Financing of the projects is similar to that of the Co-operative farms. As indicated earlier, the financing of agricultural projects has been made uniform. Each settler receives a grant of Rs. 1600/- for capital works, and the co-operative society (or the primary co-operative society when a special society is not formed in the project area) is entitled to loans from the People's Bank and Co-operative Institutions.

Ownership of land is on a family farm basis in some projects (as in the Youth Settlement projects) while land is co-operatively owned in other instances as in the case of the co-operative farms.

Co-operative Farms are primarily for the Youth and are established on an electoral basis, priority being given to areas where unemployment is acute. Where State land is not available for the establihsment of a co-operative farm private land is acquired for this purpose. Participants are selected from within the respective electorate within a radius of five miles from the project. Preference is given to the age group of 18 to 35 years and to those youths with interest in co-operative faming. The projects are financed by

(1) Rs. 1600/- per acre as grants to meet the capital costs — land preparation, fencing, farm equipment etc. from the government,
(2) Loans from the People's Bank,
(3) Share capital of members, varying from Rs. 500/- to Rs. Rs. 1000/-. The initial share capital is loaned to the members by the People's Bank.

During the last four years 62 co-operative farms have been established covering a total area of 14,540 acres of which about 5300 acres have been developed. 341 acres are in Tea, 1433 acres in coconut, 1047 acres in rubber and the balance developed extent is cultivated in vegetables, other field crops, and minor export crops. The number of participants at present is 14878. The participants are paid an allowance varying from Rs. 2/- to Rs. 5/- per person per manday.

Planning of Settlement Projects

In planning a settlement project, many factors have to be considered:

1. Physical planning—irrigation planning, layout of the farms according to agronomic and irrigation logic, soil types, land classes etc.
2. Choice of suitable settlers
3. tenurial conditions,
4. farm management and production, and
5. institutional structure which includes the financing agencies.

The organisations responsible for planning the projects vary and are indicated in Table 3. In the case of the settlement projects

established under the Land Development Ordinance, a Settlement Planning and Development Board at the Centre is responsible for the planning of the projects, and the District Agricultural Committee at the district level. The Settlement Planning and Development Board consists of the Secretary of Agriculture and Lands and Heads of Departments connected with land settlement work. The Government Agent is the Chairman of the District Agricultural Committee and the other members are district heads of the department represented in the Settlement planning Board.

Planning a Major Colonization irrigation project commences with the proposal from the District Agricultural Committee. On acceptance of a proposal the Irrigation Department will be responsible for the technical feasibility studies including soil and engineering surveys.

Factors vital to irrigation feasibility analysis include catchment areas and rainfall pattern, hydrological data on stream flows, occurence of floods, evaporation and sedimentation, and volume of water used by the proposed crops. Data on these factors permit the computation of the irrigable area under the command of the, project and also the size of the outlet. With the data available of ten the estimates of the irrigable areas in projects have not been accurate, resulting in the lack of water to some farmers.

The preparation of the Blocking Out Plan indicating the different types (highland and paddy land) and parcels of land has been mainly confined to irrigation logic. Until recently, even though the soil and land use patterns were known, such variables (together with social and farm management factors) have been largely ignored in the preparation of the Blocking Out Plan of the maor Colonization Schemes. Administrative proceedures call for a draft Blocking Out Plan to be sent to the District Agricultural Committee for discussion. In the absence of technical personnel such as a sociologist, agricultural economist, rural planner, soil chemist, the District Agricutural Committee merely approves the Blocking Out Plan.

At most a discussion is held on the pro-rata costs or the location of residential allotments. In short, a comprehensive system

Table 3.

PATTERNS IN MANAGEMENT IN SETTLEMENT PROJECTS

Settlement Projects	*Institution*	*Crops*	*Management pattern in Settlement Projects*	
			Government	*Owner*
1. Major Colonization Project	Land Commissioner through the Government Agents	Paddy and other field crops,	Through Govt. Agents assisted by District Land Officers and field officers e.g. Colonisation officer, Surveyers. etc.	(1) Individual ownership (2) Co-operative Marketing of input and output
2. Youth Settlement Projects	—do—	Tea, rubber, cardamons, animal husbandry, vegetables,		
3. Highland Colonisation Schemes	—do—	Tea, Rubber, Coconut, Cocoa		
4. Village Expansion Schemes	—do—	Mostly residential with food crops in agricultural V. E. Schemes, paddy, tea, rubber, coconut.		
5. Middle Class Schemes	—do—	Cashew, paddy, coconut, rubber, other field crops.		
6. Special leases, and Marginal Lands Leases	—do—	Paddy, other field crops	—do—	Individual ownerships or cooperative or partnership

7. Divisional Development Councils Projects	Ministry of Planning & Economic Affairs	Paddy, field crops, sugar, animal husbandry	Through Govt. Agents and Asst. Director, Planning, assisted by Development Assistant etc.	Individual or Co-operatives
8. Co-operative Farms	Ministry of Agriculture and Lands	Paddy, passion-fruit, animal husbandry, other field crops, spices, vegetables.	Through Govt. Agents District Land Officers, assisted by Development Officers.	Co-operative basis
9. Janawasa	Land Reform Commission	Tea, rubber, coconut, minor export crops.	Control through L.R.C. and District Land Reform Authority.	Co-operative Management by members

of planning for major colonization projects, which include aspects of farm management, soil conditions, benefit-cost studies (except one Nagadeepa Wewa), sociological aspects, planning of the community centres has been lacking.

In the planning of Youth Settlement Projects, the experience of the major schemes, resulted in more careful preliminary planning and site selection. Yet, farm management and soil studies or even benefit-cost studies were not been undertaken in the Youth Settlement schemes.

Through experience, planning improved in the establishment of Co-operative farms. Feasibility studies included cropping patterns, suitability by climate and soil for the crops selected, marketability of output, farm size and income, and a cost-benefit analysis. Since these projects were cooperatively managed the question of one farm having better physical advantages over another did not arise. In most of the Youth Settement Projecs there was a wide difference in the quality of soil, drainage facilities, level of land etc. among the different farms. Such variations have been observed in a study made by me of Thiruvai Aru, a Youth Settlement Project in the Jaffna District.

The Land Reform Commission Officers are responsible for the preparation of the feasibility studies for the Janawasas after consulting the members and local officials. The plan is, however subject to approval by the members of the Janawasas. Agricultural planning in these projects is not difficult as they are developed areas. In the planning of Janawasas detailed benefit-cost analysis has been undertaken. A study of the Janawasas will now enlighten us as to the results of the comprehensive system of planning undertaken in these Cooperative Settlements.

Selection of suitable settlers committed to the objectives of the programme of development, is another important factor in settlement planning. Until 1966, the criteria for selection were welfare oriented; landlessness, large families, and old age were some critaria. The selection policy has now been changed to obtain a prototype belonging to the age group 18 to 35 with only 2 or 3 children and with experience in farming. A marking system

was introduced in 1968 in the selection of settlers in the major colonisaion irrigation projects while in the cooperative farms the Government Agent in consultation with the Member of Parliament for the area selected the persons with the necessary qualifications. In the Janawasas the problem is different. The estates already contain workers. All citizen workers were automatically made members of the Janawasas while the non-citizens continued employ ment as agricultural workers. Villagers were brought in on the recommendation of the Member of Parliament for the area, in accordance with the objective and the idelogical philosophy of the Janawasa. In Youth Settlement Schemes the characteristics required for selection are age 18-25 education grade 6 to 9, agricultural background and experience, preferably unmarried and temperametally suited to living with other youth in a comminity.

A study of the relationship between the characteristics of the Youths and production in two settlement schemes was made by me. The successful farmers, that is those who obtained over Rs. 3000/- net operating farm income for a year, were grouped together while the others were classified as 'no success' farmers. Regression techniques were used to ascertain the influence of certain qualitative variables on output. The variables are area of origin of farmer, education, experience in farming, occupation of father, soil porosity and drainage, scarcity of water. Dummy derivatives of both the explanatory and independenct variables taking a value of zero or one were used in the regression analysis.

Variables, origin of the farmer, age, occupation of father and level of land were clearly not significant in the projects studied. The variance in age, 18 to 25 too did not singificantly influence the income. The results thus indicate a homogenous group of youth selected for the two projects examined. Academic and agricultural qualifications were significant at 1 or 2 per cent lelvel. The marking system weighted this variable with 15 points—(out of a total of 155 points).

Regarding agricultural experience, the variable no experience was highly significant at the 1 or 2 per cent level but the influence was negative while at the other extreme 5 — 8 years experience was significant at 5 or 10 per cent levels but again, the influence

was negative. One possible explanation is that with satisfactory agricultural extension work, experience of about 2 to 3 years is sufficient to become a successful farmer and is better than no experience or many years of experience. In the latter case the farmer may be so prejudiced in favour of traditional methods of cultivation that he cannot accept innovation or new methods of cultivation.

Another variable which proved to influence production was acquisition of knowledge in farming through a parent or close relative.

Land tenure in all settlement projects started under the Land Development Ordinance is generally the protected type recommended by the Land Reform Commission (1929). The settler cannot mortgage, lease or otherwise dispose of his land. Succession to his land is by nomination by the colonist according to a shedule of persons given in the ordinance which restricts the land being transferred to a person outside his family.

The settlement tenure policy is thus designed to maintain owner operated family size farms. In the social structure too the farmer enjoys a self-employed owner-producer status.

With the encatment of the State Lands Sales Act (1973), the tenure has been liberalised to enable the settler to use his land as a collateral for investment loans obtainable from cooperative institutions, State Mortgage Bank, People's Bank and Agricultural Industrial Credit Corporation. The protection is still maintained; any transfer of the land requires the approval of the Govternment Agent. In view of the ceiling on land holdings, some observers feel that the lands should be released to the free market. But is a free-hold right a necessary condition for increased production? Rainer Schickele suggests: "Under a free market transfer of land, many sales go to pruchasers under whose ownership the tenure deteriorates, land becomes concentrated in the hands of a few, insecure tenency increases, and speculative investments in land leads to neglect of its current use and mangement.

The argument of neo-classical economists that a free land market is essential for the valuation of land and its allocation

to optimum use and management is highly fictitious in the light of practical experience and unrealistic assumptions upon which it is based. In fact, a free market of farm land (for agricultural use) in developing countries is about as imperfect a commodity as one can find" Schickles argues that a free land market is not in the interests of efficient production of the great majority of farmers, of their local institutions and of the country.

Further, only 3 per cent of the paddy acreage is in holdings of more than 25 acres and about 85 per cent is in less than 10 acre units. Concentration of paddy land in the hands of a few speculators is, therefore, possible if farm lands are thrown into the free market.

In the Youth Settlement schemes work started on a collective basis. Jungle clearing and land preparation was done communally. As the progress in some schemes was poor and as the pressure for individual holdings was high, the government decided to divide up the land into 2 or 3 acre units according to the crop. Rapid development in some projects was seen after the division, and on co-operative farms as indicated earlier, is held in common ownership with a quarter acre individual homesteads to be given on successful development of the projects. How long can the membership of the Co-operatives remain cohesive? In spite of the fact that the members were supposed to have been committed to co-operative ownership and management, indications are such that individual ownership is still preferred, and doubts have been expressed regarding the viability of the Co-operative (agricultural) enterprise. Unless there is a single purpose objective, or the members are bound by one ideological philosophy, it appears that the basis for a co-operative enterprise, more so, the small scale ones and those established on newly developed jungle land, may begin to tilt.

Farm size in major colonisation projects varies from 2 to 5 acre of paddy land and one to three acres of highland. The principal determinant of farm-size was the demand for land, the higher the number of applicants, the greater the tendency to reduce the size of farm, economic scale considerations being overlooked.

In settlement planning we should differentiate between the physical unit area and the size of farm enterprise. Cultivation of two acres of paddy land is a small enterprise when compared to the same size farm cultivated in chillies.

Over 53 per cent of the paddy land in major colonization schemes is in 3 acre units, while five acres—and two acre units constitute 25 and 30 per cent respectively.

The farm size on highland colonisation projects varies according to the crop, two acres in tea and rubber, and five acres in coconut areas. Quarter acre is also given for residential purposes. In youth settlement projects, the unit of alienation varies from 2 or 3 acres in field crop projects and 5 acres in coconut projects. The residential allotments are 1 acre units in field crop and fruit projects and 0.5 acres in the tea and tubber areas. The size of the holding varies from one to five acres in agricultural village expansion projects, while the unit varies from 0.2 to 0.5 acres in residential projects. Most middle class projects are for agri cultural purposes and the farm size ranges from five to fifty acres.

Conclusions

1. We have seen that not only is there a multiplicity of government agencies implementing setlement projects but also various departments are involved in the activities of the settlements. Coordination between these agencies is far from optimum; I would rather say it is minimal. This is more evident in irrigation projects. The irrigation rehabilitation and package programme introduced some institutional reforms in the special projects, which have already shown the potential available for rice production in major colonisation schemes. Yet, co-ordination between the different agencies through the project manager is not at optimum level-retarding the pace of growth in these schemes. I would strongly urge the establishment of an independent Land Authority under the Ministry of Agriculture and Lands, not only to implement but also co-ordinate all activities relating to land settlement work. This Land Authority should have its own officers, perhaps on secondment from other agencies but under the direct control and supervision of the Land Authority.

2. Because the ultimate goal in early settlement projects was not entirely development oriented, the economic profitability

of major colonisation schemes remains low. At Nagadeepa rice project the benefit-cost ratios using an estimated yield of 50 bushels per acre ranged from 0.42 to 0.82, according to the different discount rates, varying from 6% to 15%. On the other hand we have seen the high production potential of special projects. Therefore, we should aim at consolidation of development of the existing land rather than opening up new land. This does not mean that no new projects should be initiated. Rather such projects should be temporarily suspended to permit better assessment of the economic potential of the existing area. New projects emphasising the production of field crops and minor export crops could usefully be implemented.

3. A comprehensive system of planning incorporating aspects of farm management, layout of farms according to agronomic and irrigation logic, soil types etc. should be implemented in planning settlement projects. At field level, this objective could be achieved with the assistance of the agricultural productivity committees.

4. Suitable settlers committed to the programme of development and with the necessary qualifications, such as satisfactory education and agricultural knowledge, and experience in agriculture should be selected for the settlement projects. It is immaterial which agency or individual selects the settlers, as long as suitable persons are selected for the projects.

5. Land tenure has provoked much discussion among scientists and policy makers. Whether farm land should be released to the free market or whether the ownership of land should be on a co-operative basis or individul family farms are questions in the minds of many of those involved. The type of tenure will depend on the area and the nature of the project.

6. Farm size is determined by the demand for land. Instead the farm unit should depend on the enterprise. A rice farm should range from four acres depending on the soil conditions, etc. while a farm of two acre in field crops (e.g. chillies) or in minor export crops (cardamons) is an economic unit In other words determination of farm size involves a thorough investigation of soil conditions, type of crop, availability of labour and farm managemet capability.

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PHOTOSYNTHETIC EFFICIENCY AND PRODUCTIVITY OF RICE IN INDIA

by

*S. M. SIRCAR**

Since 1962 the problem of enhanced rice production has been centered around evolving high yielding varieties having short stiff straw and narrow upright leaves with higher photosynthetic efficiency and resistance against lodging and pest infestation. The first two promising varieties evolved by the collaborative research work of physiologists, geneticists and breeders at International Rice Research Institute (IRRI), Philippines are **IR8** and **IR5**. The yield good farmers get from these varieties lie between 6-8 with a possibility of having top yield to 10-12 tons per hectare under ideal conditions of management with all necessary inputs. The grain and eating qualities are rather imperfect and fail to attract consumers, preference over the traditional local varieties remain but because of their yield performances are profitable large tracts of rice growing area in south east Asia and India have been put under **IR8** cultivation. Geneticists, breeders and physiologists rather feel now that further spectacular increase will not be achieved by mere improving the plant type. Other physiological processes like varietal differences in photosynthetic efficiency, translocation of dry matter, sink capacity, reduced respiration loss during ripening and photorespiratory activities appear very promising field of study. These problems that have direct bearing in productivity of rice have been studied by the author and his associates at the Bose Institute, Calcutta for a number of years.[1,2] It has been shown that the net assimilation rate (NAR) a measure of field photosynthesis of a plant population is higher for the dwarf varieties than the local varieties in both wet and dry seasons. However, NAR at flowering is positively correlated with grain yield in the dry season only. The poor performance of dwarf varieties in the wet season and lack of any correlation of NAR to grain yield in this season might be due

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to several unfavourable climatic factors. The varietial difference up to 65 per cent in leaf photosynthetic rate was noticed amongst the different rice varieties. This differences however hardly showed any relation with grain or biological yield. The local cultivars giving poor grain yield showed considerably higher leaf photosynthetic rate than the dwarf high yielding ones. But the dwarf varieties were found more efficient per unit of their chlorophyll content.[3]

The relative photosynthetic efficiency (RPE) measured with **IR8** as check showed considerable variation; the local varieties which give poor grain yield were not necessarily less photosynthetically efficient per unit of their leaf surface. For all the varieties photosynthetic rate measured with ^{14}C was much higher in the dry season than in the wet season (Table I). This is due to higher light intensity and presumably to higher photosynthetic efficiency of the leaves in the dry season. Again the local varieties showed higher relative photosynthetic efficiency over **IR8** due to saturated amount of light received by the leaf canopy in bright sunny winter. Amongst the local varieties **Bhasamanik** and **Patnai 23** are very much less efficient than **Rupsail** and **Latisail** on the wet season. While in the dry season the former show significantly higher efficiency. This is explained from their higher LAI in the wet and lower values in the dry season.[2]

The photosynthetic production of dry matter during 30 days after flowering and its distribution between the straw and the ripening spikelets/grains is the deciding factor in the grain yield. This was shown from experiments carried out with **IR8** and local cultivars.[4] The local cultivars have high photosynthetic production of dry matter but not more than 66 per cent is transported to the ripening spikelets while **IR8** producing 15 per cent less transports more than 90 per cent dry matter to the grains (Table II). Thus the grain filling is an important varietal character on which yield depends. This was further elaborated from the study of the distribution of radioactivity immediately after $^{14}CO_2$ feeding to the plants at flowering and also the redistribution of the radioactivity at harvest after respiration loss[3] while leaves plus culm accounts for most of the radiocarbons of the whole plant

TABLE 1.

Relative photosynthesis efficiency (RPE) on unit leaf area basis Condition for $^{14}CO_2$ feeding 33.5° C air temperature and 30-40 K lux sunlight (wet season; 36.5° C air temperature and 60-80 K lux sunlight Dry season). For RPE determination top 3 leaves were sampled immediately after feeding and their area, specific leaf weight and radio activity were determined (Palit etc. 1976)

	Wet Season Apparent photosynthetic rate (APR)		Dry Season Apparent photosynthetic rate (APR)	
Varieties	*mg CO_2/100 cm^2 leaf/hr*	*RPE (percent) check of IR8)*	*mg CO_2/100 cm^2 leaf/hr*	*RPE (Per cent check of IR8)*
Bala	6.27	84	16.63	115
Ratna	5.63	75	16.47	112
Jaya	4.71	63	14.58	99
Vijaya	7.29	97	16.42	112
Sona	7.36	98	13.78	94
IR8	7.50	100	14.66	100
KI36	6.60	88	14.59	100
Rupsail	7.74	103	16.00	109
Bhasamanik	6.53	87	24.04	164
Patnai	6.56	87	22.43	153
Latisail	7.65	102	15.54	106

TABLE II.

Relation between assimilation, translocation of dry matter and spikelet and grain yield (g/m^2 land area) of rice treated with fertilizer combination of N_{60} P_{60} K_{60} kg/acre (Sircar and Das, 1974).

Variety	*Total dry matter 30 days after flowering g/m^2 land area*	*Grain yield g/m^2 land area*	*Per cent dry matter transported to grain*	*Grain/straw ratio per plant after harvest*
Latisail	626.4	329.2	55.6	0.82
Bhasamanik	538.8	349.4	64.8	0.85
Patnai	569.1	377.5	66.3	0.72
IR8	527.6	485.9	92.11	1.32

immediately after feeding that in the panicle increase significantly in proportion at harvest time due to the transport of products synthesized after flowering. The translocation index defined as the percentage of radioactivity present in the panicle to that in the whole plant at harvest (Table III) shows that dwarf varieties, have much higher translocation index of 67—83 per cent compared to 31—55 per cent of local ones. Amongst the varieties **Bala** showed higher translocation capacity which is evident from fairly good yield in spite of shorter growth duration and fewer leaves. The local varieties rather retained much of the radioactivity in the culm and leaves. These results with distribution of radioactive carbon confirm the previous report of Sircar and Das[4] that deficiency in translocation of photosynthates and sink capacity/numbers are responsible for poor grain yield in the tall varieties though the photosynthetic efficiency is even greater than the dwarf ones.

TABLE III.

Post flowering translocation index as percentage of radio activity present in the panicle to that in the whole plant; results calculated from $^{14}CO_2$ feeding at flowering and re-distribution of radioactivity at harvest (Palit etc. 1976).

Variety	*Transloction index*
Bala	83
Ratna	77
Jaya	67
Vijya	72
Sona	80
IR8	78
KI36	55
Rupsail	51
Bhasamanik	32
Patnai	31
Latisail	48

Amongst the factors responsible for photosynthetic efficiency and productivity particular emphasis has been shown on the loss of stored carbohydrate by dark and photorespiration. Rice has been established a Calvin cycle plant.[1,2] The Calvin cycle plants exhibit a wide range of light saturated photosynthetic rate which is generally lower than those plants having C_4 dicarboxylic pathway. C_3 plants also loose a large amount of photosynthetic dry

matter by photorespiration. Several varieties have been studied as to their photorespiration from the release of $^{14}CO_2$ from C_{14} labelled glycolate in leaf tissues and biosynthesis of glycolate in light.[1,3] The varietal difference in the enzyme glycolate oxidase indicated that the dwarf varieties generally giving higher grain yield have lower photorespiration rate. **Bala** a dwarf variety with lower photorespiration and higher translocation rate indicates a suitable material for breeding with one having higher photosynthetic efficiency and longer duration which is likely to enhance grain yield.

Thus the lower photorespiration rate is a desirable character for breeding high yielding varieties. To this is to be added the sink capacity which is the product of number of panicles and spikelets per panicle and grain size. The significance of these characters has also brought out the yield potentials of local varieties.[4] The question now remains whether the yield potential based on sink capacity is more limiting the final grain yield than the photosynthesis during the grain filling period as the photosynthates from other green parts are likely to contribute to the yield potential of a variety. This obviously will pinpoint the future physiological and biochemical studies on the photosynthetic efficiency of the leaves and other green organs during the flowering period and the transport and conversion of organic matter in the storage form in the endosperm.

Rice research now faces the problem of increasing protein content of grains. In India protein deficiency amounts to a very large quantity, at present requirement will be 12 million tons per annum with a basic need of 65 gm per person per day. Very few people can afford to have their minimum requirement of protein food. Unlike the developed countries where most of the protein supply is met from animal products it will not be feasible to feed the Indian population with required protein from animal sources. This brings the question how we can increase the protein quantity and quality from plant sources which can be grown throughout the year having enough sunshine and equitable temperature. FAO has also highlighted that in years to come with increasing population and restricted supply of protein from animal sources cereals will continue to be the larger sources of protein for direct human

consumption. Nuts and pulses should be of increasing importance possibly the second largest source of protein considerably greater than meat or milk. There is one difficulty in plant proteins lacking in essential amino acids, lysine and methionine. In recent breeding and genetical studies the possibility of increasing the contents of these amino acids have been indicated. In India protein is mainly obtained from pulses and cereals and there is enough scope to increase protein supply by proper orientation of research programme based on physiology and genetics of the crops. Rice protein is of good quality but the average protein value is only 7—8 per cent. The problem is to increase rice protein by breeding suitable strains. IRRI by several crosses have indicated the scope for suitable strains with a limit of 10 to 13.5 per cent. A wide survey in North Eastern India has indicated suitable varieties having 15 per cent protein but with low yield potentials. In the collection from Assam, protein content has been found to be as high as 17 per cent.[5] This would mean that proper breeding specially mutation may be of particular value for having a desirable combination of high protein content with high yield potential. Both these desirable characters are largely controlled by environmental factors and their influence on photosynthetic efficiency and nitrogen metabolism will have to be studied in close cooperation between different disciplines of plant sciences.

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BIOMEDICAL RESEARCH IN THE FEDERAL REPUBLIC OF GERMANY:

TENDENCIES OF FUTURE DEVELOPMENT

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Biomedical research plays now an important role in every nation's scientific life. Mankind is facing a tremendous number of problems which can only be solved by a joint effort of all scientists.

However, financial sources for carrying out large-scale experiments in biomedicine have now become limited. Moreover, the number of qualified people who are capable of performing creative biomedical research with a high degree of innovation is also limited. As far as the Federal Republic of Germany is concerned, this means that most of biomedical research has to be done at universities, whereas only a comparatively small portion is conducted by governmental research institutions which are financed directly by the Ministry of Health and by the Ministry of Research and Technology.

Research in general and in bioscience in particular at universities is increasingly supported by the German Research Society which was established in 1949. It was first named "Emergency Association of German Science" and after merger with the "Research Council" in 1951 then became the "German Research Society".

The German Research Society (Deutsche Forschungsgemeinschaft) is a supra-regional organization for the promotion of German science, with complete autonomy in all scientific matters. The German Research Society determines its own statutes; its organs and committees are chosen by free election. It has the following functions:

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— to provide financial support to German scientists for research projects;
— to foster cooperation among scientists;
— to encourage especially the promotion of junior scientists;
— to advice parliaments and governments on scientific problems;
— to maintain relations between German research and foreign science.

These functions give the German Research Society a wide range of activity; within this framework, its promotion programs are adjusted to the regularly changing structures of scientific progress.

The German Research Society is a non-profit organization. Its members comprise most of the universities in the Federal Republic of Germany, some important scientific societies and insittutions, and the Academies of Sciences; they pay no fees. It is financed by the Federal Government and the eleven States of the Federal Republic of Germany, and it receives additional funds from the Donor's Association for the Arts and Sciences and from various private foundations. In 1974, the total sum of financial contributions made available to the German Research Society amounted to 590 million DM.

In most industrialised nations, one or several organizations are engaged in the promotion of science. Governmental influence on their activities varies. Although the Federal Government and the States of Germany are represented in all Research Society organs which adopt financial decisions, they do not hold a majority of votes. The Executive Committee and the Senate are exclusively composed of scientists. Taking into account that over 90%of the funds distributed by the German Research Society are raised by public resources, this self-restraint of the national governmental agencies is particularly noteworthy; it ensures the scientists independent responsibilities within their organization. Nevertheless, this independence in making decisions does not mean isolated action within the overall concept of research promotion in the Federal Republic of Germany. The German Research Society gives particular emphasis to cooperation with the governmental agencies, the foundations, and the scientific associations. Close

cooperation exists with the Federal Ministry for Education and Science, with the Federal Ministry for Research and Technology, with the Max-Planck Society for the Promotion of Sciences, with the Volkswagen Foundation and with the Fritz Thyssen Foundation.

The German Research Society is an autonomous organization which operates on the principle of collegiate decision based on expert opinions. Its commission and committee members hold honorary positions. Only the President and the Secretary General, and the staff of the managing office are salaried employees. Of the many activities of the German Research Society, to promote research at German universities, the most important ones will be discussed briefly.

Normal Programme.—Financial support for individual research projects is granted under the Normal Programme. Research promotion under the Normal Programme covers all scientific disciplines. Primarily financing is granted for projects of limited duration and defined subject. Initiative for any such project emanates from the individual research scientist who in most instances–is a member of a university. As a general principle, the German Research Society does not take any influence on the subject of a proposed research project—in differentiation to contract research. Deliberately, it gives wide latitude to initiative and creativity of the individual scientist. Another important aspect of the Normal Programme is the fact that it provides for the training of an essential part of the scientific research potential. And, last not least, the Normal Programme enables the German Research Society to recognize the development of new scientific trends, which may then be advanced through policy-oriented promotion under the priority programme as a special research area.

Applications are reviewed—in written form —by the Scientific Committees. Any proposal is at first reviewed by two selected experts in the subject field, who prepare separate opinions; where necessary, additional experts are consulted. Final decision lies—on the basis of expert opinions obtained—with the General Committee. Under the Normal Programme, 6648 applications were

reviewed in 1974. The high rejection quota of 23.3% shows the critical nature of applied criteria. The total sum spent for the Normal Programme was 191.5 million DM in 1974. Of this sum, 28% was given to bioscience (including medicine), 28.5% to natural sciences, 25.8% to humanities and 17.7% to engineering. Personnel costs cover the greatest share of expenditures within the Normal Programme. In the past few years, about 75% of funds granted under the Normal Programme were spent for scientific and assistant personnel and other personnel costs. The majority of these funds thus benefits young scientists.

Financial support of individual research projects conceived and implemented by the individual scientist is the irrevocable basis of progressive promotion of research and technological development. However, there are now research problems in life science of so complex a nature that their solution does not seem possible through isolated individual accomplishment. Projects of this kind, which require the joint efforts of scientists from a number of dicipliines, are gaining in importance. In many cases this requires extremely expressive auxiliary technical equipment On the other hand, limited fiancial resources and a shortage of qualified scientific personnel demand a concentration of resources. The German Research Society tries to meet the requirements through flexible research planning and promotion.

The Priority Research Programme.—One of the instruments of policy-oriented research promotion is the priority research programme of the German Research Society. Priority research projects are supraregional. Scientists of all levels and fields, coming mainly from universities, but also from federal institutions and occasionally from industrial research laboratories, cooperate in research priorities with specific objectives. Suggestions for the establishment of research priorities originate mainly from individual scholars or groups of scientists. A number of recommendations of various programmes in bioscience have also been made by members of public authorities acting as spokesmen of applied science in the expectation to find through research the scientific basis for the solution of important problems of life.

A number of priorities is closely connected with the activities of the Senate Commissions, mainly in the fields of health protection and social problems. Others have emerged out of large international projects. By selection of new research priorities of special importance for established science policy, the Research Society Senate exercises policy-oriented promotion of research. In 1974, the total amount spent for priority research programmes amounted to 86.5 million DM. The rejection quota was 28.8 %. Of the total amount granted, 28.3% were given to biosciences, 27.5% to natural sciences, 20.5% to engineeting sciences, 11.9% to humanities and 11.8% to environmental research.

Among the current Priority Research Projects and Programmes in medicine and biosciences, the following deserve to be mentioned.

Cancer Research. This programme started in 1961 and is still continuing on a small scale. Once a year, experts on cancer research meet in a small circle together with other scientists, to discuss progress in cancer research, joint research programmes, and the result of therapeutic measures. Particular emphasis is put on the investigation of leukemia, clinically and experimentally. Considerable efforts are made to study the quantitative characterization of leukemia processes as basis for reorientation of therapeutic measures. In this connection, it should be mentioned that, upon recommendation of the Senate Commission for Problems of Gene Mutation, the German Research Society established a Central Laboratory for Mutagenicity in 1969. The Central Laboratory studies mutation effects on chemical substances, especially those absorbed by man with food, cosmetics, and drugs, through water and air emissions, or through specific workshop conditions. Due to the multifarious objectives and genetic methods involved in necessary routine checks of gene mutation, this work cannot be performed by a single university or research institute.

Pregnancy and Child development. This is a large-scale prospective study in which about 12,000 pregnant women have been included. By now, the development of their children has been followed for 10 years, and a huge amount

of information has become available. Interesting correlations have been found between drug intake or diseases of the mother during pregnancy and the development of the child.

Biochemical Principles for the Effects of Pharmaceuticals and Foreign Substances. This Priority Research Programme is now in its sixth year and has made major contributions to the understanding of the side effect of drugs in man. Thus, the mechanism of induction of liver enzymes has been studied in detail and also the metabolic process, underlying the excretion of foreign substances.

Clinical Pharmacology. A considerable amount of information is now requested by the Federal Ministry of Health before a new drug may be introduced into general clinical use. Although pharmaceutical firms carry out experimental and clinical trials at various levels, many problems still remain to be investigated, such as pharmaco-kinetic studies under various conditions, comparative evaluation of different drugs and interference with numerous physical and psychical functions in man.

Physiology and Pathology of Reproduction. The main objective of this programme is to elucidate the processes which govern female fertility, and to study in detail the mechanism of fertilization and capazitation. It is hoped that, in collaboration with leading reproduction centers in the world, the physiological processes of reproduction will be better understood. Since population control is probably the most pressing problem of the world,every effort seems to be justified to carry out basic research in this field.

Special Research Areas at Selected Universities.—A second programme of policy-oriented science promotion is the establishment of special research areas at selected universities. In accordance with Science Council definitions, special research areas involve institutionalised grouping of research scientists of different disciplines from universities and other institutions, such as Max-Planck institutes or federal research establishments, for carrying

out long-term coordinated work in a specific field of research. The programme covers all disciplines, however, so far emphasis was placed on medicine, biological sciences, and technology. Charateristics of special research areas are interdisciplinary co-operation, scope and continuity of research work beyond possible influence by replacement of individual scientists, and possible expenditures which cannot be met out of regular university budgets.

During the last 7 years, the special research areas have been a rapidly expanding programme. Thr Government of the Federal Republic of Germany and the States make available special funds for this programme. For 1968 approximately 5 million DM were budgeted, for 1969 20 million DM, for 1970 64 million DM, for 1971 90 milion DM, for 1972; 130 million DM, for 1973 160 million DM and for 1974 180 million DM. Due to serious financial difficulties, the programme is now limited, and will be definitely limited during the next four of five years to about 190 million DM. For biomedical research 92 million DM were spent in 1974. This is about 40 % of the total sum available for special research areas.

The following list contains some of the subjects and research projects in the biomedical field which are covered by the special research area programme:

— Embryonic Pharmacology
— Cardiology
— Endocrinology
— Restitution and Substitution of Organs
— Brain Research
— Teratology
— Immunology
— Diabetes
— Psychotherapy
— Early Diagnosis of Cancer
— Molecular basis of Development
— Biological Membranes
— Medical Molecular Biology and Biochemistry

Under the special research area programme, the universities have an opportunity to participate in the selection and support

processes and thus to influence the future development of research. The requirement that proposals must be reviewed by representatives of educational institutions serves to make the special research area programme a vehicle for a thorough reconstructuring of the university. The programme supports the view that academic research is becoming an increasingly complex scholarly activity of social implication. By merging the interest and needs of all concerned—research, the university, and the nation the German Research Society has taken a step which promises well-balanced progress.

As already mentioned, the Scientific Commissions appointed by the Senate for selected fields are of special importance. The first Senate Commissions of the German Research Society were concerned with public health hazard, originating from the increasing technologization of our industrialised society. Even up to date, the majority of these commissions deal with problems of toxicology. In close contact with governmental authorities and industrial research they try to determine the effect of certain food additives, of contamination of water and air. The activities of the Senate Commissions include, inter alia, the following:

The Dye-Commission has been active for more than 14 years on the clarification of problems of food dyes. Such activities have been expanded to include the dyeing of drugs and cosmetics. Licenced tolerable food dyestuff are listed in so-called positive lists and published. All dyestuffs not contained in these lists are considered not acceptable for foodstuff dyeing.

A Commission for the Testing of Toxic Materials in Industrial Plants is responsible for the testing and control of toxic concentrations in the air in workshops. Reports on maximum allowable concentrations are published biannually and are widely distributed and adhered to. A special study on professional cancer is in preparation.

A Commission for Food Additives is responsible for the examination of food additives and processing methods as to their innocuousness to human health.

A Commission on Pesticides, and Plant, and Food Preservation Substances is concerned with the preparation of scientific standards for toxicity criteria and methods for analysis and definition of residues of pesticides and chemicals, used for plant protection and food preservation. As requested in the Commission's first report, legislation on the obligatory testing of residues likely to injure human health was enacted in the meantime.

A Commission for Medical Epidemiology, and Social Medicine coordinates, through working groups, current test series and evaluates and records epidemiological research programmes. It advises other organizations providing support in the fields of epidemiological research and social medicine, and deals with the development of future medical diagnostics by computer.

The Commission on Food Research, active since 1957, consults on problems of food physiology and biochemistry, food production, chemistry and technology, to establish standards on optimum human nutrition as well as minimum nutrition requirements. In addition to its responsibility for a programme on nutrition research, the Commission acts as advisory board to the Federal Government and as public information organ.

The polarity between science and politics, government and self-administration, Federal and State Governments, individual scientists and universities as scientific corporations, at all times effectively stimulated the work of the German Research Society. The responsibility of the German Research Society is multi-dimensional. It is not charaterised by a purely scientific appraisal of research projects as to their distant merits, but extends to giving justice to the fact that research must be judged by its commitment to our existence. Therefore practical applicability of research results may essentially influence the orientation of its considerations. In this sense, problems of ensuring a humanised future and fighting the dangers of bureaucratization, dirigism, or enslavement through technology are significant motives of our activities. While no binding list of criteria is available to the organs of the

German Research Society for their decisions, they have after many years developed basic standards which, it seems will continue to be valid in future. Prime demand is the preservation of the diversity of scientific opinion and method. The immanent scientific priority which includes a certain degree of continuity, is decisive in case of doubt. Nevertheless, the scientific objectives and the importance of factors decisive for the German Research Society have undergone a number of changes. The contest between the traditional values of scientific system and the compuslory of political reality is in full swing.

In the coming years, the German Research Society will place increased emphasis on working out concrete suggestions for priority models. This will, of course, require expert advice and assistance. On the other hand, it was frequently experienced that it took activities and authority of the German Research Society to stimulate such planning by experts. Research planning is based on projected results. However, if such activities have attained or failed to reach their goal, or all relevant criteria considered may not be expected to pay, they must be willingly discontinued. Criteria established for this negative measure are still far from adequate.There is general reluctancy to write off as lost, in case of crisis, the funds and efforts invested in a research project. Moreover, it is much easier to go on with the same old project than to figure out new promising objectives. Nor can and will any expert be willing and capable to understand that other research projects came to outrank his own in terms of priority. Here, convincing guidance is essential to get the switches turned.

The future-minded concept for seeking an optimum innovation coefficient will succeed more rapidly, if directed towards organizational forms and procedures which are suited to the specific disciplinary task, developmental stages and trends. There will be factors of influence for planning; they will be at one time the optimum collaboration among experts of various disciplines, at another time problems of equipment or long-term financing of research groups; at other times questions of promotion of individual research scientists and their coordinated activity by way of round - table discussions may be decisive. As already pointed

out at the beginning, promotion of individual projects is an indispensable and reliable source of experience for future programming. It is here where talents are discovered, where spontaneous intuition gets its chance, where one can probe future promises of potential major investments on a trial basis, and where unknown junior scientists may build the reputation for their future professional career. Here are the first indications of quite normal research projects, and here fair criticism may be voiced without inhibition.

In conclusion, I have tried to show where in the Federal Republic of Germany the concerted efforts of government and self-administration to cope with future tasks give reason to seek new organizational relations. I have also tried to explain that the German Research Society will not shirk its assigned responsibilities in support of research but rather makes every effort to enable independent scientists to engage in qualified scientific work in accordance with the standards of methodically independent research.

POSSIBILITIES AND ASPECTS OF AGROCLIMATOLOGY TOWARDS LAND UTILIZATION AND LAND USE PLANNING: THE EXAMPLE OF SRI LANKA.

by

*Prof. Dr. MANFRED DOMROES**

Agroclimatology, also called agrometeorology or agricultural climatology resp. meteorology, is a rather young scientific branch of interdisciplinary nature between climatology on the one side and agriculture on the other. The Wolrd Meteorological Organization has given in its 'Guide to Agricultural Meteorological Practices' (1963) the following definition: "Agricultural meteorology is concerned with the interaction between meteorological and hydrological factors, on the one hand, and agriculture in the widest sense, including horticulture, animal husbandry and forestry, on the other hand. Its object is to discover and define such effects, and thus to apply knowledge of the atmosphere for practical agricultureal use".

The aims of agroclimatology are given by Austin Bourke at the opening ceremony of the UNESCO-symposium on "Agro climatological Methods" (1966): "The task of the agrometeoroligist is to apply every relevant meteorological skill to helping the farmer to make the most efficient use of his physical environment, with the prime aim of improving agricultural production, both in quantity and quality".

From this uderstanding agroclimatology is of vital importance to achieve optimum yields in agriculture which is a claim indispensable at present and almost much more in future. In fact, one of the biggest problems of human race is the care for sufficient food for all people of the world. At the moment it seems questionable how to fill the gap between the more rapidly growing population and the slower increasing agricultural production. From the world population prospects of the United Nations we have learnt that the average annual growth rate of the world's

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population amounted to 2.0 per cent in the decade from 1965 to 1975 so that due to estimates of the United Nations the total world population will grow up to 6 or even 6.5 billions in the year 2000. At present world population ranks at 4 billions. The rapidly increasing world population raises the problem of an over-population of the world or at least parts of it. More than ever it is the very prime demand to all countries in the world "to make the most efficient use of their physical environment", according to Austin Bourke's statement already previously cited. That means that cultivation of crops, including animal husbandry and forestry, should be done everywhere and at any time on the basis of optimum growing conditions from the point of climate and soils. Therefore, the present land use pattern in the world should be carefully evaluated under 2 topics: First whether the crops cultivated at present are grown under optimum climatic and edaphic conditions or not; secondly, whether there is a restruction or diversification of the cultivated crops necessary or not, due to the climatic and resp. or edaphic suitability.

These problems cannot be solved generally and worldwide. However, these questions are relevant to each country of the world, first of all to agrarian countries including Sri Lanka. Therefore each country should be urgently requested in improving agricultural production by the most efficient use of climate and soils.

In this lecture I shall try for Sri Lanka to show only a few possibilities and aspects of agroclimatological studies towards land utilization and land use planning. For further details see Domroes, M.: The agroclimate of Ceylon, Wiesbaden 1974. For several reasons Sri Lanka presents a model case for carrying out an agroclimatological survey:

First, Sri Lanka as an agrarian country, its economy depends on agricultural products. Due to the lack of minerals, agriculture will continue to remain in the future the dominant factor in the island's economy. Therefore investigations on the agroclimate of Sri Lanka might prove to have the greatest practical value, in particular to master the food problems of the island.

Secondly, Sri Lanka's export economy depends almost totally upon the traditional export crops of tea, rubber and coconut products under which tea already accounts for two thirds of the total export volume. This, in fact, raises the question how this unbalanced export orientation of Sri Lanka can either be stabilized or diversified. For this the climatic conditions for the agricultural potentialities have to be investigated in an accurate manner.

Thirdly, an agroclimatological survey of Sri Lanka can be carried out successfully from the point of climatological observation data upon which such a survey necessarily depends. Sri Lanka has not only an efficient meteorological service with well-functioning observatories all over the island and a well established Department of Meteorology, being a rich storehouse for many kinds of climatological research, furthermore Sri Lanka has a large number of reliable private weather stations, partly supervised by the Colombo Department of Meteorology; in particular these stations record rainfall, they are located chiefly on tea, rubber and coconut estates and other places.

Due to these facts it is without any doubt yet also practicable to carry out an agroclimatological survey of Sri Lanka. Its final aim is an attempt towards a climatic-potential land classification and zoning of Sri Lanka according to the cultivation of crops. For this in the case of Sri Lanka I have chosen the following methodological way:

The first step is a brief presentation of the basic features of the climate and agriculture of Sri Lanka.

Secondly, the finding out of the general climatic requirements of Sri Lanka's most important crops, by interpreting the specialist literature, and considering the individual observations of my field studies in Sri Lanka. An agroclimatological survey of Sri Lanka seemed for the beginning to be most successful when considering only those crops which are already cultivated in Sri Lanka, instead of including also crops which so far have not been grown at all in Sri Lanka. The reason for this is that it seems to be easier and more realistic to improve growing conditions for crops which are already familiar to the farmer than to

introduce new crops, unknown to the farmer in their cultivation, harvest, processing and marketing. On the other hand from the view point of agriculrural exports it seems hardly likely that "new" agricultural products from Sri Lanka could assert themselves in the world market, whereas an increase in the world market share of already established products of Sri Lanka seems much more likely.

The third step is a detailed presentation and analysis of the various agroclimatic indices resulting from the general climatic growing requirements of the crops under investigation. For this, representative and reliable climatic observation data of meteorological observatories and 'private whether stations', as well as individual field studies of certain climatological phenomena, for example shelter belts in tea estates for localizing local wind phenomena, have to be analyzed.

Finally, an attempt being done at an agroclimatic potential land classification and zoning of Sri Lanka according to the crops under investigation, or in other words, an agroclimatic regional planning of Sri Lanka with the aim of an optimum land utilization.

What are the main results of the agroclimatological survey of Sri Lanka?

The survey has considered the following crops: tea, rubber, the coconut palm, cocoa, cinnamon, pepper, cardamom (all of them are perennial crops) and rice, the only annual crop being investigated. The climatic-potential cultivation areas of these crops have been drawn in 4 maps, the first of them for the 3 'major commercial crops' (tea, rubber, the coconut palm), the second map for the 'minor commercial crops' of cocoa, cinnamon, pepper and cardamom and the third and forth maps for rice, showing on the one hand the percentage of irrigable paddy lands in the Maha season, on the other hand in the Yala season. These two maps are based on the amounts of river run-off for all of the 103 river catchments, which are generally distinguished in Sri Lanka.

In both the maps showing the climatic-potential cultivation areas of the perennial crops investigated in this survey, three or

four categories of different suitability for cultivation were distinguished:

1. **Optimum** climatic-potential suitability for cultivation exists when all agroclimatic indices are fulfilled.
2. **Favourable** suitability applies when one agroclimatic index only fails.
3. **Difficult** suitability or even **unfavourable** cultivation conditions occur when two or more agroclimatic indices are not fulfilled. In such cases the profitable cultivation of the crop concerned woruld appear to be questionable.

The climatic-potential cultivation areas for the crops under investigation, accordihg to the different grades of suitability, can be seen in detail in the maps (Nos. 1 and 2). In both of them also the boundary between the Wet and Dry Zones has been entered.

Comparing at first climatic-potential cultivation areas of the traditional export crops it becomes evident, that it is the Wet Zone of Sri Lanka which offers optimum and favourable growing conditions for all these crops, thereby the cultivation areas are partly overlapping. In fact the Wet Zone offers extremely favourable climatic conditions for the cultivation of a multitude of perennial tropical crops, besides of course also for the wide range of annual tropical crops. The climatic advantage of the Wet Zone, due to the agroclimatically efficient rainfall and temperature conditions, is the reason for the fact that already at present the Wet Zone constitutes the most internsively and almost completely exploited part of Sri Lanka; there is hardly any land still available for cultivation. Due to this fact and the massive pressure on land of the rapidly increasing population, an agroclimatic regional planning of the Wet Zone is faced with the task of examining how the present pattern of land utilization might be restructured or intensified or diversified according to the agro-climatic conditions.

A comparison of the lands presently occupied by certain crops with those of climatic-potential suitability results in many conformities and less deviations. In the case of **tea**, for example, the optimum climatic potential lands are already completely exploited, as well as the areas favourable from the agroclimatic

viewpoint. Even regions with difficult agroclimatic conditions for tea cultivation record a great number of tea estates, for example the central parts of the Uva Basin and the tea districts of Rakwana and Deniyaya. Moreover, tea is even grown outside the climatic potential cultivation areas, as in parts of the southwestern lowlands, for example in the Galle district.—The **rubber** lands are situated largely in the districts of Kegalle, Kalutara and Ratnapura, exactly in the optimum climatic cultivation area. The agroclimatically favourable regions for rubber cultivation are so far but little cultivated with rubber. Also in the case of rubber a number of estates is situated outside the climatic-potential cultivation area, for example in the Koslanda, Moneragala and Bibile areas. — The **coconut palm** has in the present land use pattern its main cultivation area in the mid-western lowlands between Chilaw—Kurunegala—Colombo, generally called the 'Coconut Traingle' of Sri Lanka. Besides, a narrow coastal strip of coconut palms is found along the West and Southwest coasts, being situated in the climatically favourable cultivation areas for cocopalms. Of the three 'major commercial crops' of Sri Lanka the coconut palm is the only one which is also cultivated to a greater extent outside the climatic-potential cultivation area, namely in the Puttalam-Kalpitiya area, on the Mannar Peninsula and the mid-east coast north and south of Batticaloa, here, however partly based on artificial irrigation.

An expansion of the present area under cultivation with tea, rubber and coconut palms can be recommended from the point of climate to a limited degree only (Fig.1). An expansion of the cultivated lands can almost only be achieved at the expense of lands already under cultivation. In this respect, for example, Kalutara District would offer optimum climatic conditions for rubber cultivation, which might replace some tea being cultivated under unfavourable climatic conditions. This case tries to suggest in examining the agroclimatic conditions of the marginal tea, rubber cocopalm lands in order that a restructuring of land use and diversification of crop cultivation might be arranged. In the Wet Zone of Sri Lanka, an expansion of cultivated lands seems most likely in the Sabaragamuwa Hill Country where still larger parts are either occupied by primary or secondary forests or under chena respectively shifting cutivation. On the other hand further attempts

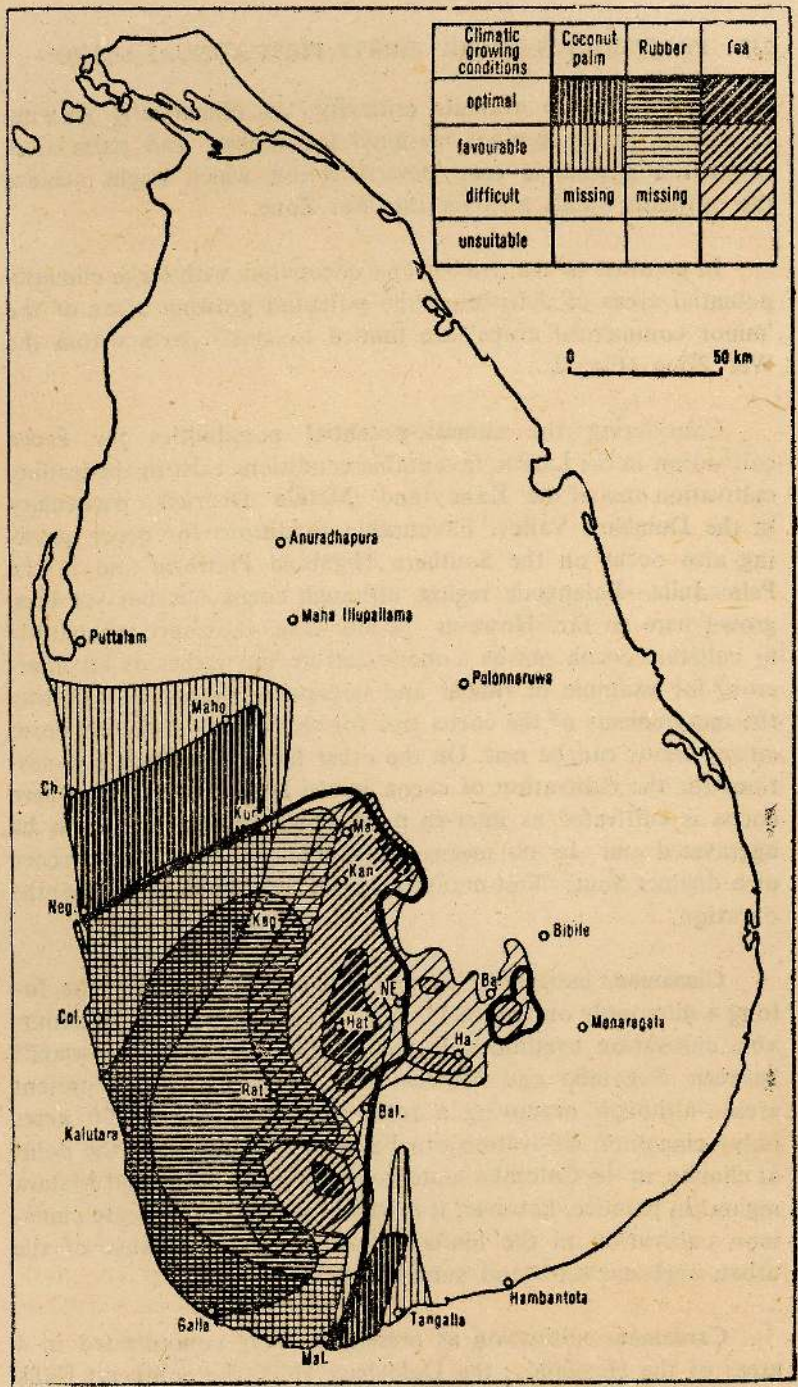


Fig. 1 The climatic-potential cultivation areas of tea, rubber and coconut palms.
Kur. = Kurunegala, Ma. = Matale, Keg. = Kegalle,
NE. = Nuwara Eliya, Hat. = Hatton, Bal. = Balangoda,
Rat. = Ratnapura, Kan. = Kandy, Ba. = Badulla.

should be done to evaluate critically the climatically growing conditions in the present marginal tea rubber and palm lands towards a profitable crop deversification which might achieve the optimum yields all over the Wet Zone.

In contrast to tea, rubber and cocopalms with large climatic-potential areas of cultivation the potential growing areas of the 'minor commercial crops' are limited to small parts within the Wet Zone (Fig. 2).

Considering the climatic-potential possibilities for **cocoa** cultivation in Sri Lanka, favourable conditions exist in the leading cultivation area of the Kandy and Matale Districts, particulary in the Dumbara Valley. Favourable conditions for cocoa growing also occur on the Southern Highland Platform and in the Pelmadulla—Balangoda region, although cocoa has not yet been grown here so far. However, in any case, it is recommendable to cultivate cocoa not as a mono-culture but rather as an inter-crop, for example in rubber and cocopalm estates. In this way the requirements of the cocoa tree for shade and protection from strong winds can be met. On the other hand, the climatic conditions for the cultivation of cocoa in the Moneragala area, where cocoa is cultivated as inter-crop of rubber estates, appear to be aggravated and by no means favourable due to the occurrence of a distinct South-West-monsoonal dry season of 3 to 4 months duration.

Cinnamon, indigenous to Sri Lanka and in older days for long a monopoly on the world market, gets optimum and favourable cultivation conditions in the southwestern coastal lowlands between Negombo and Matara. In comparison to the present areas—although occupying a total area of about 33.000 acres only—cinnamon cultivation can be best extended, from the point of climate, in the Colombo hinterland and in the Galle and Matara region. In practice, however, it is hardly possible to increase cinnamon cultivation in the hinterland of Colombo because of the urban agglomeration and suburbs of the capital.

Cardamom cultivation at present is being concentrated in 4 areas of the Highlands: the Dolosbage Hills, the southeast flank

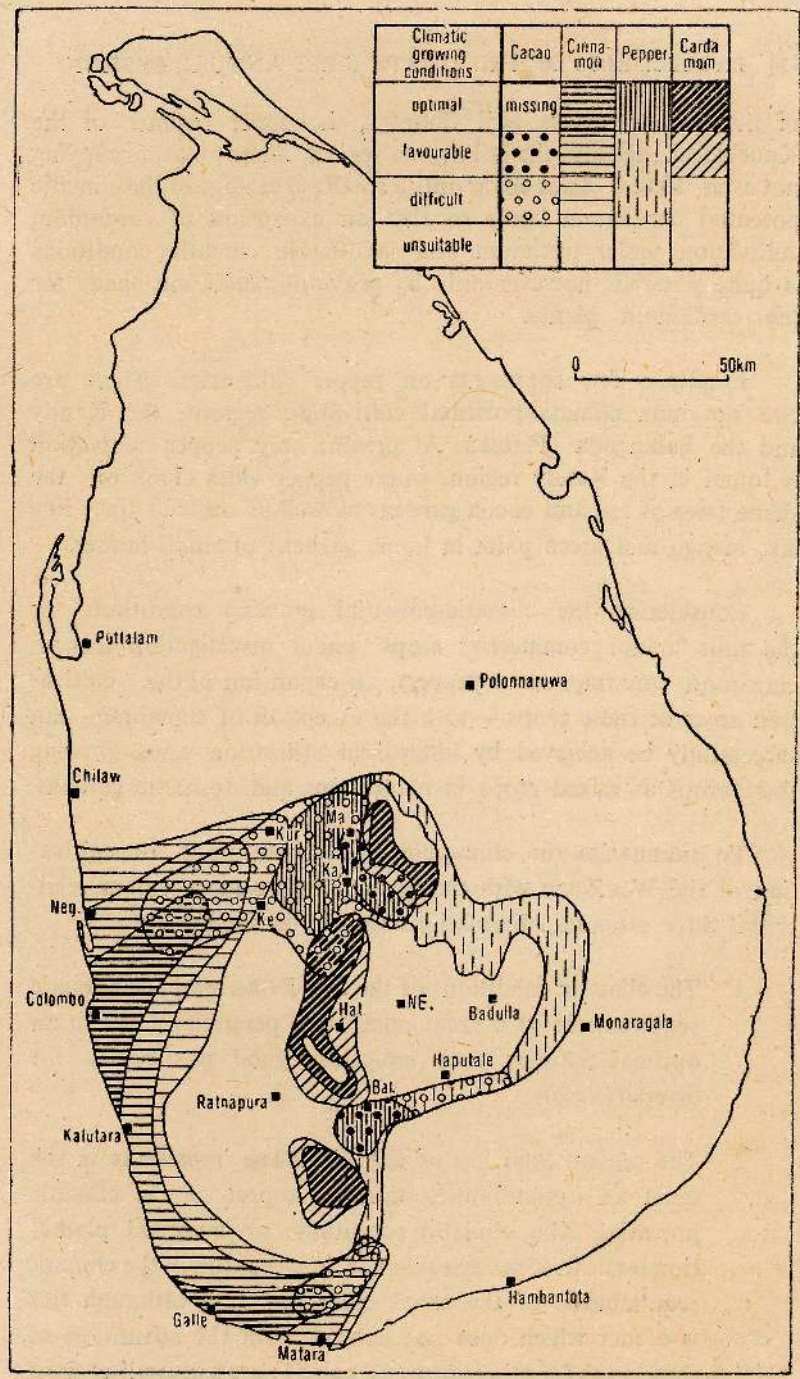


Fig. 2- The climatic-potential cultivation areas of cocoa, cardamom cinnamon and pepper.
Kur. = Kurunegala, Ma. = Matale, Keg. = Kegalle,
NE = Nuwara Eliya, Ka. = Kandy, Hat. = Hatton,
Bal. = Balangoda, Neg. = Negombo.

of the Sabaragamuwa Hill Country, the upper regions of the Knuckles Range and the Balangoda region. These areas, occupying not even 10,000 acres cover only a small percentage of the climatic potential cardamom lands so that an expansion of cardamom cultivation under optimum and favourable climatic conditions is quite possible, however only by providing sufficient shade for the cardamom plants.

Finally a few comments on **pepper** cultivation. There are two optimum climatic-potential cultivation regions, the Kandy and the Balangoda Plateau. At present only pepper cultivation is found in the Kandy region, where pepper vines climb on the shade trees of tea and cocoa gardens as well as on fruit trees like jak, mango and areca palm in home gardens of small holders.

Considering the climatic-potential growing conditions for the four 'minor commercial crops' under investigation (cocoa, cinnamon, cardamom and pepper), an expansion of the cultivation areas of these crops —with the exception of cinnamon—can successfully be achieved by intensified utilization when growing these crops as mixed crops in plantations and domestic gardens.

To summarize the climatic-potential conditions for cultivation of the Wet Zone with the 'major' and 'minor commercial-crops' three essential observations should be singled out:

1. The climatic conditions of the Wet Zone meet the climatic requirements of a great number of perennial crops in an optimal manner, thus indicating good possiblities for diversification.

2. The present land use of the Wet Zone represents in the main an optimal utilization in respect of the climatic potential. The climatic conditions of marginal plantation lands in some cases do not, however fulfill the climatic requirements of the crops cultivated here although this is a fact which does not detract from the advantage of these areas for other crops (see point 1: crop diversification)

3. In the Wet Zone an expansion of cultivation and the opening of new agricultural lands are rather limited.

How are now in comparison to the Wet Zone the possibilities of climatic-potential land utilization in the Dry Zone, mainly with regard to rice the staple crop of the people of Sri Lanka? (Figs. 3 and 4)

From the economic point of view cultivation of wet, irrigated rice is of prime importance. The presently and since ancient times dominant role of wet rice or paddy is the high proportion of the paddy land as part of the total cultivated land which in most of the Dry Zone districts amounts to over 50 per cent. (In the Wet Zone, in comparison, the percentage of paddy land as part of the total cultivated land varies only between 27 at the most and about at least about 10 per cent although the total acreages of paddy lands are higher than in the Dry Zone, due to the much more intensively cultivated Wet Zone.

An expansion of rice cultivation and paddy, lands in the Dry Zone of Sri Lanka depends chiefly on the possibilities to increase artificial irrigation. The question is to which extent an extension of irrigation is possible. For this purpose the amounts of river run-off for all 103 river basins of Sri Lanka for compared with the irrigation water demand of paddy cultivation, separately for the Maha and Yala season (Figs. 3 and 4). The result shows that irrigation in the Dry Zone could be considerably increased and hence paddy cultivation could be expanded: In fact, in the Maha season the amounts of river run-off would be sufficient to irrigate about 4.2 million acres of paddy land, however at present the acreage of paddy land in the Dry Zone amounts to about 800,000 acres only. That means that in the Maha season a potential expansion of wet rice cultivation in the Dry would be five-fold. This observation is based on the demand for irrigation water for wet rice at a level of 4 acre feet during the Maha season.

In comparison to the Maha season in the Yala season only an extremely limited percentage of land could be cultivated by wet rice, namely only 4.7 per cent of the total area whereas this value amounted to more than 37 per cent in the Maha season.

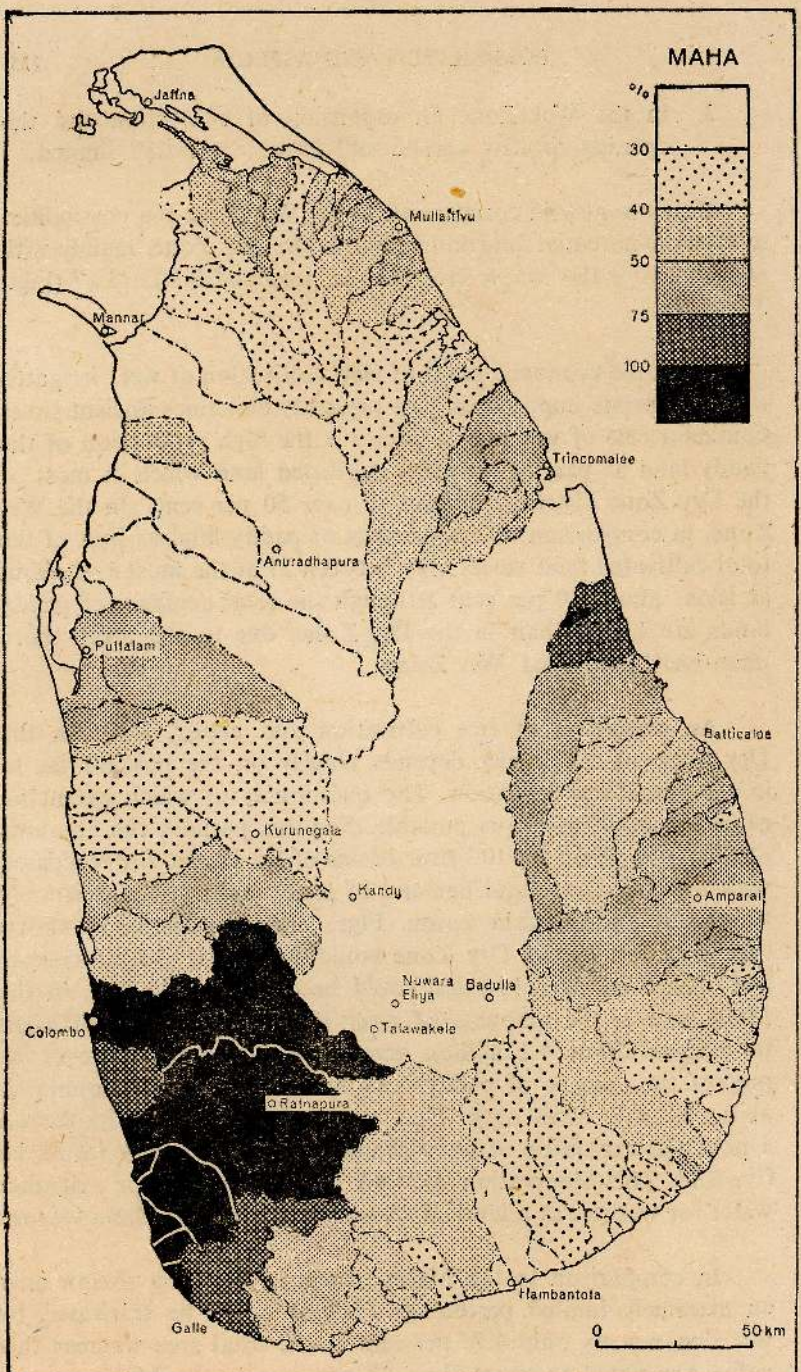


Fig. 3- Percentage of irrigable rice land in the Maha Season, by river catchments, based on the amounts of river run-off.

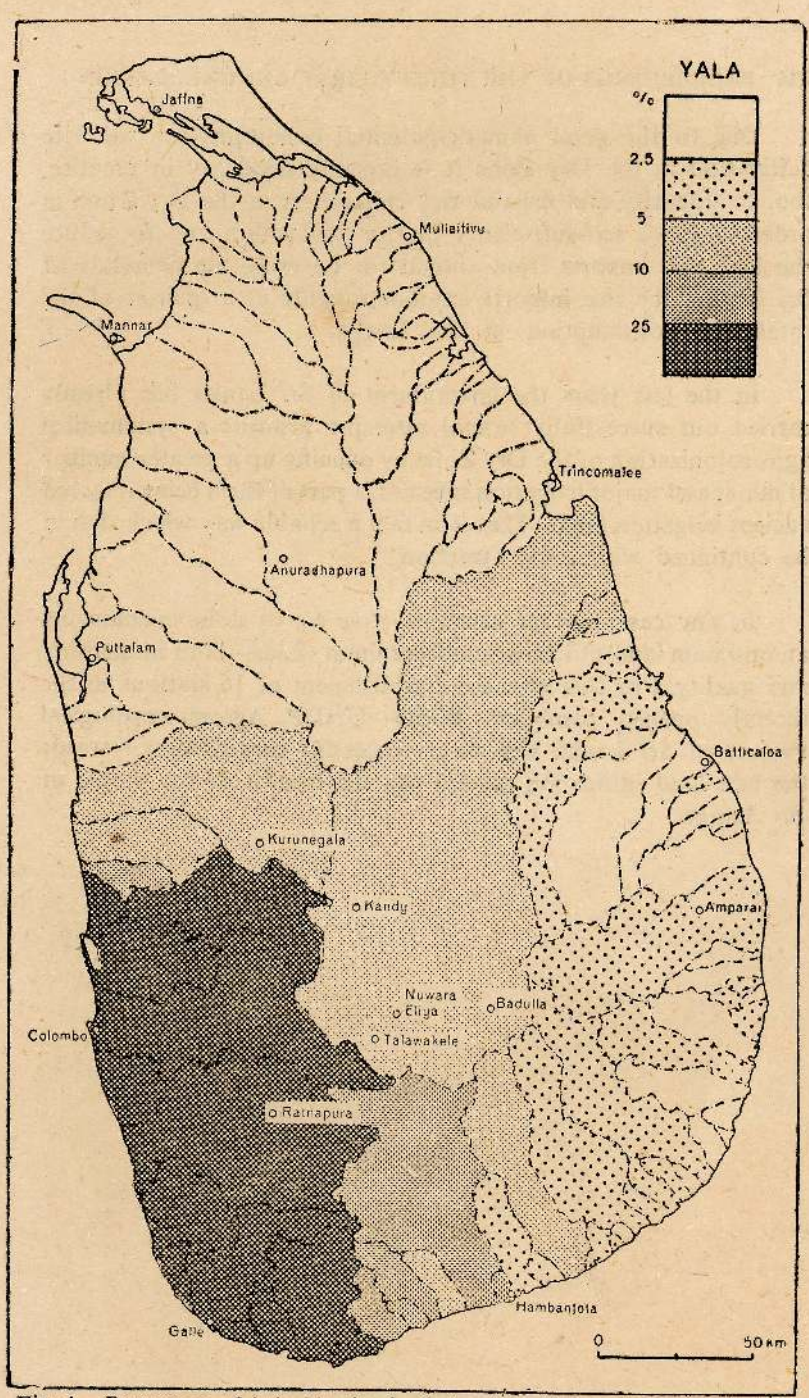


Fig. 4- Percentage of irrigable rice land in the Yala season, by river catchments, based on the amounts of river run-off.

Due to the good climatic-potential conditions for wet rice cultivation in the Dry Zone it is urgently necessary in practice, too, to intensify and expand rice cultivation in the Dry Zone in order to reach self-sufficiency in rice production and to reduce the high rice imports from abroad for covering the demands of Sri Lanka; the rice imports amount roughly at a quarter of the total rice consumption in Sri Lanka.

In the last years the government of Sri Lanka has already carried out successfully several attempts towards a systematical agro-colonization of the Dry Zone by opening up a greater number of minor and major irrigation schemes, a part of them being restored ancient irrigation tanks. That is in fact a reliable way which should be continued with great attention.

In any case, further attempts have to be done in achieving an optimum land utilization and optimum yields—both in quantity and quality. For this aim, the establishment of 16 stations in the recently opened combined WMO—UNDP Agrometeorological Project of Sri Lanka will be a successful contribution towards the best land utilization pattern—to the benefit of the people of Sri Lanka.

CHEMICAL ANALYTICAL SERVICES IN AGRICULTURAL PRODUCTIVITY

(With Particular Reference to the Natural Rubber Industry in Malaysia)

by

*M. MOHINDER SINGH**

The demand for chemical analytical services for agriculture has increased rapidly in the recent past. As a wide spectrum of agricultural chemicals are utilised by the agricultural industry (e.g. fertilisers, pesticides, yield stimulants, etc.) the testing of these are often required to ascertain their composition or determine their residues in soils and plants. In the recent past however there has been an increasing use of diagnostic tools for assessment of fertiliser requirements and this has led to a widespread use of soil and plant analyses which today account for the bulk of the chemical analytical support needed for increasing agricultural productivity.

Soil and plant testing laboratories

Soil and plant analyses are being carried out by a large number of laboratories in Malaysia. The main ones are:

1. Government Department of Agriculture (mainly to Govt. departments for land use planning, national soil mapping etc.)
2. Research Institutions
   e.g. Rubber Research Institute of Malaysia (R.R.I.M.). Malaysian Agricultural Research and Development Institute (M.A.R.D.I.) (for crops other than rubber), Pineapple Research Station (for pineapple).
3. Commercial Organisations which service themselves or their associated companies
   Federal Land Developement Authority,
   Dunlop Research Centre (Dunlop Estates Ltd),
   Socfin Co. Ltd.,
   Sime Darby Ltd.,
   Highlands Research Unit (Barlow Boustead Ltd).

*Rubber Research Institute of Malaysia, Kuala Lumpur

4. Commercial Organisations which provide private analytical services.

   Chemara Research Station (Guthrie's),
   Harrisons Fleming Services (Harrisons & Crossfield),
   Agricultural Research & Advisory Bureau.

While the services provided by the Rubber Research Institute of Malaysia are only for rubber producers and free-of-charge, since the Institute is supported by a research cess on all rubber exported from the country, commercial organizations do charge for their services. Nevertheless, the commercial services are quite popular. This is a clear manifestation that farmers in Malaysia have been convinced of the usefulness of soil and plant analyses for assessing fertiliser needs.

Private services in soil and plant testing

To give an indication of the cost of analytical services in Malaysia, given below are the fees for testing charged by a commercial organisation in Malaysia.

Material	Tests	Charges for Analylis (M$)
Plant	N, P, K, Ca, Mg, Mn	$25 per sample
	B, Cl, Fe	$10 per element per sample
	Zn, Cu	$15 per element per sample
	As	$25 per element per sample
Soils	pH, Org.C, total N, soluble P, exc. cations	$30 per sample
	acid extractable cations	$10 per sample
	mechanical analysis	$25 per sample
	structural composition of soil	$25 per sample
Fertilisers	N, P. K and Mg	$25 per sample
	NO3-N, water soluble P	$10 per element per sample
	total, P, citrate soluble P	$15 per element per sample
	trace elements	As for plant analysis

Commercial laboratories provide not only chemical analysis but also comprehensive consultancy services for which higher fees are charged. Some such services provided by a commercial organisation are summarised below:

- Agronomic services with soil and leaf nutrient survey and manuring recommendations (including two personal visits in a year) — $3.50 per acre per year
- Agronomic services without soil and leaf nutrient survey and manuring recommendations (including two field visits for field inspection) — $1.50 per acre per year

- Ad hoc visits—special visits to identify investigate and report on problems in cultivation and/or pest and disease controls — $ 300 per day

(above charges exclude travelling and outstanding expenses)

The alaytical cost represents a very small cost of the fertiliser input since one soil and one leaf sample would normally be sufficient for 25-50 acres (if fertiliser cost for rubber and oil palm can be around M$50 and M$200 per acre per annum respectively).

Soil and plant analyses at R.R.I.M.

The figures in Table 1 give an idea of the rising demand for routine chemical analytical services by the natural rubber industry in Malaysia. These figures represent the annual output of soil and plant analyses by the Analytical Chemistry Division of the Rubber Research Institute of Malaysia.

Table 1.

OUTPUT OF SOIL AND PLANT ANALYSES

Year	*No. of Samples*	*No. of detns.*
1930	300	1,400
1950	1,500	15,000
1966	5,000	50,200
1968	10,000	107,300
1970	21,900	207,500
1972	24,200	204,800
1974	31,400	225,300

What caused this surge for chemical analysis in the last decade? Since 1962, the R.R.I.M. had established that optimal usage of fertilisers could be only achieved if a discriminatory approach was adopted. This discriminatory approach was based on the assessment of the soil and leaf nutrient status of the rubber tree. In fact, field experimentation even showed that rubber yields were in some cases depressed by indiscriminate use of fertilisers (Anon, 1967; Puspharajah, 1969).

The rising cost of fertilisers had added to the problem. While in the past fertilisers were already expensive, the recent increase in crude oil prices, has caused sharp increases in the cost of fertilisers.

In 1974, an acute shortage of fertiliser arose and there was a world-wide scramble for fertiliser at any cost. Given in Table 2 are fertiliser costs in the last 3 years in Malaysia:

Table 2.
COST OF FERTILISERS

Nutrient	*Approx. cost per unit of the nutrient**		
	1972	1973—74	1975
N (Urea)	$6	$17	$11
Other forms of N .. .. .. (sulphate of ammonia, ammonium nitrate)	$10	$20	$17
P_2O_5 (soluble)	$10	$18	$18
P_2O_5 (rock phosphate)	$4	$5	$7
K_2O	$4	$7.5	$7.5

*-Unit ir defined as a ton of 1% of the nutrient)

This clearly shows that fertilisers are too expensive a commodity to be wasted. In 1972, before the sharp increase in prices, fertilisers already accounted for about 25% of the maintenance cost of immature rubber and about 18% of the non-tapping costs in mature rubber (Pushparajah etal., 1974). The increases in cost of fertilisers since then have increased the proportion of the fertiliser cost, making the fertiliser a substantial proportion of the total cost of agricultural production. The fertiliser input therefore constitute an important investment and calls for its efficient usage. Hence it is necessary that some scientific tool is available to the farmer to critically assess the fertiliser needs of his plants.

Assessment of soil nutrient status

The advent of rapid chemical analysis has been a great boon to farmers. Firstly it has allowed soil scientists to characterise their soils better. While previously soils were characterised mainly by physical characteristics, to-day they are supported by a whole spectrum of chemical data. While the performance of the crop, is significantly influenced by soil series, detailed variations of chemical morphological and physiographic properties, e.g. soil texture, depth and slope, occur within the limits of a soil series and influence productivity.

Results of fertiliser experiments have shown that different responses to fertiliser application are obtained within a soil series (Table 3).

This variability of the responses must be accounted for by the differences in the nutrient levels of these soils. As the soils are classified according to their physical conditions, allowance is not made for their chemical nature. Chemical analysis data shows that while majority of the soils of a soil series fall within a well-defined range of the nutrient elements, there can be wide differences in some of the soils on different sites belonging to the same soil series.

It is therefore necessary that a diagnostic tool be used to assess the nutrient status of soils, This is therefore the role of chemical soil analysis.

Chemical soil analysis is nothing new. In fact it has been used for a long time to assess the fertility status of soils. However the complex nature of the soil makes interpretation of soil tests rather difficult. Nevertheless they are useful and have been used with limited success.

Methods of Chemical soil analysis

A large number of chemical soil tests are available. The more common ones are pH, organic cabon, total nitrogen, readily soluble phosphorous and exchangeable cations. These tests are generally referred to as "available nutrient indeces" since they are often utilised to make short-term predictions on the availability of nutrients in the soil.

A more cumbersome test is the "acid extractable" test in which soils are extrated with strong acids. This test is often used to give an idea of the "reserve" nutrients in the soil which would be available to the plant in the long-term. As the acids attack the unweathered minerals in the soil matrix, the amount of nutrients brought into solution by strong acids however depends on strength and volume of acid and time of extraction. A wide range of extractant conditions have and are being used by soil chemists.

TABLE 3

DATA ON SOME MANURIAL EXPERIMENTS ON RUBBER (*HEVEA BRASILIENSIS*)
(E. PUSHPARAJAH, *Private Communication*)

Site	Type of experiment	Acid extractable contents in soil		Leaf contents		Fertiliser responses († = response, 0 = no response)	
		K, me/100g	Mg, me/100g	%K	%Mg		
Rengam/Jerangau series soil							
Fd 65A RRIES	NKMg	0.4	0.7	1.1	0.28	K: 0	Mg: †
Fd 63C RRIES	NPKMg	0.4	0.7	0.8	0.26	K: †	Mg: 0
Edinburgh	NPMgCu type P	—	2.0	—	0.25	—	Mg: 0
Kok Fai Yin	NK	0.4	—	0.8	—	K: †	—
SHN RRIES	NPK	0.2	—	0.8	—	K: †	—
Swee Lam	PKMn	0.1	—	0.7	—	K: †	—
Serdang/Munchong series soils							
Sepang	NPK	6.0	4.7	2.2	0.20	K: 0	Mg: 0
Fd 31 RRIES	NPK	1.1	—	—	—	K: †	—
N. Hammock	NKMg	1.8	1.9	1.6	0.30	K: †	Mg: 0
Tanjong Malim	NPKMg	1.1	2.4	1.0	0.13	K: †	Mg: †
Selangor series soils							
Braunston	NPKMg	3.6	11.4	1.3	0.28	K: 0	Mg: 0
Sungei Kapar	NPKMg	3.8	12.2	1.4	0.28	M: 0	Mg: 0
Bukit Panjang	NPKMg type N	4.7	17.6	1.3	0.30	M: 0	Mg: 0

The methods used in the above tests are generally empirical and classical and have been selected after correlation with glass house or field experiments. The actual procedure used in the above tests varies with the locality and the crop for which it was correlated. Although these emprical tests are limited in their scope and cannot be used universally, they have nevertheless been found to be useful in assessing soil nutrient status provided they have been correlated with plant response. Another source of error which seriously restricts the value of soil analysis is the heterogeneity of the soil. It is therefore essential that a sound scheme for representative sampling of soils be established for soil analysis to be meaningful. Studies have shown that for fairly uniform fields at least 20 random sampling points are required over a 16 hectare field to give a precision of $\pm 10\%$ within 95% confidence limits for pH, C and N at least 30 sampling points are necessary for a precision of $\pm 20\%$ for other parameters (Ng et al., 1971).

For rubber, "critical" soil nutrient values have been deduced for some soil series on the basis of past experimental results (Table 4). Due to the limitations in the number of field experiments that can be established, these values have to be considered as approximates, nevertheless they permit a reliable differentiation between soils which are likely or not likely to show responses in growth and/or yield to manuring (Guha, 1969).

As soils on which rubber grows fall into a large number of soil series, it is not possible to derive critical soil nutrient values for all soil series. Hence it is necessary that some extrapolation be made by grouping similar soil series into soil associations.

Use of critical soil nutrient values has improved the assessment of fertiliser requirements over the previous general fertiliser application but is an accepted fact that soil chemical analysis alone is not sufficient for a proper assessment of fertiliser requirements.

Assessment of leaf nutrient status

Leaf analysis is the other diagnostic tool which is available fo the farmer to assess the fertiliser requirements of tree plants (Shorrocks, 1961, 1962 & 1965; Chapman, 1941; Beaufils, 1955, 1958, 1959). The availability of modern instrumentation such

Table 4.

"CRITICAL" SOIL NUTRIENT CONTENTS FOR *HEVEA* ON DIFFERENT SOIL SERIES

Nutrient	Soil series			
	Selangor	Rengam	Serdang/Munchong	Kuantan
N, %	0.21 (†)	0.10 (†)	0.14 (†)	0.16 (†)
R, ppm	339 (—)	101 (†)	254 (†)	2306 (—)
K, me 100 g	3.4 (—)	0.2 (†)	1.1 (†)	0.4 (†)
Mg. me/100g	10.3 (—)	n.a.	2.4 (†)	6.4 (—)

n.a. = not analysed.

(†) Levels below which response is likely, being values for control plots of experiments where application of the respective nutrients showed response in growth and/or yield.

(—) Levels above which response is not likely, being values of control plots where application of the respective nutrients showed no response in growth and/or yield.

as atomic absorption spectrophotometers and autoanalysers has made plant analysis a comparatively rapid and simple tool. The elements which are commonly analysed are nitrogen, phosphorus, potassium, calcium and magnesium which are the major plant nutrients. Analysis of the trace elements such as manganese, copper, zinc, boron and molybdenum is often also needed to correct for trace element deficiencies.

While the laboratory procedures for leaf analysis present few problems, the proper interpretation of leaf analysis data for fertiliser requirements is however not simple, since the nutrient content in the leaf is affected by several factors including the position of the leaf on the canopy, the age of the leaf, effects of climate and weather, clonal differences, leaf diseases, and interactions between nutrients. To minimise the effect of these variables rigid standardisation of the sampling methods is essential. Also the leaf nutrient contents have to be calibrated with yield and growth in fertiliser trials in order to be able to correlate the leaf elemental content with the fertiliser requirements.

For rubber, sampling procedures to remove the positional and tree-to-tree variation and a method for correcting for leaf age

variation have been well established (Shorrocks, 1961, 1962, & 1965; Guha and Narayanan, 1969). However the effect of climate and weather which lead to seasonal variations in leaf nutrient values, and the interactions between nutrients continue to restrict the sensitivity and usefulness of leaf anlysis. The "critical" leaf nutrient values for rubber have been worked out by Anon (1963) and are a usuful guide to determine the fertiliser requirement of the plant (Table 5).

Table 5.

"CRITICAL" LEAF NUTRIENT CONTENTS FOR *HEVEA**
(Expressed as % of oven-dry sample)

Nutrient	Nutrient level below which response likely		Nutrient level above which no response likely	
	Leaves exposed to sunlight	Leaves in shade of canopy.	Leaves exposed to sunlight	Leaves in shade of canopy
Nitrogen	3.20	3.30	3.60	3.70
Phosphorus	0.19	0.21	0.25	0.27
Potassium	1.00	1.30	1.40	1.50
Magnesium	0.23	0.25	—	0.28

* As in Annual Report of the Rubber Research Institute of Malaya. 1962.

Relationship between soil and leaf nutrient contents

Attempts to relate the nutrient contents in soils with those in the leaves, have shown that there is a general relationship between the two but correlations are not always highly significant. The acid extractable K value is highly correlated with the leaf K value, the relationship being slightly better when individual clones are considered (Singh, 1971). But for Mg, the exchangeable Mg value and not the acid extractable Mg value was highly correlated with leaf Mg value. The correlation coefficients are small showing that only a small percentage of the variation is accounted for in the relationship. This is not unexpected considering the many variable factors which affect soil and plant analyses (Table 6 and 7, Fig. 1&2).

Table 6.

RELATIONSHIPS BETWEEN SOIL K CONTENTS AND LEAF K CONTENTS

Soil series	n	L_k vs S_k (acid)	L_k —vs S_k (acid) L_{Mg}	L_k vs— $S_{k(acid)}$ / $S_{Mg(acid)}$	L_k S_k (acid) —vs— L_{Mg} S_{Mg} (acid)	n	L_k vs S_k (exch)	L_k — vs S_k (exch) L_{Mg}	L_k vs— S_k (exch) / S_{Mg} (exch)	L_k S_k (exch) — vs— L_{Mg} L_{Mg} (exch)
Rengam	343	0.335***	0.377	0.161**	0.214***	229	0.041NS	—0.008NS	—0.028NS	0.171*
Jerangau	106	0.262**	0.238*	0.296**	0.269**	60	0.543	0.183 NS	0.336	0.272*
Serdang	132	0.235**	—.004NS	0.063NS	—0.113NS	106	0.047NS	—0.088NS	0.077NS	0.007NS
Munchong	187	0.324***	0.214**	0.173*	—0.087NS	134	0.077NS	—.254**	—0.008NS	0.147 (P <0.1)
Durian	101	0.307**	0.207*	—0.183 (P<0.1)	0.017NS	60	0.257*	0.322	—0.115NS	0.462***
Batu Anam	46	0.491***	0.027NS	—0.306-	0.069NS	32	0.566***	0.192NS	0.790***	0.100NS

***: P <0.001 **: P <0.01 *: P <0.05 NS: Not significant.

L_k, L_{Mg} — leaf K and leaf Mg contents respectively.
S_k (acid), S_{Mg} (acid) = acid - extractable K and Mg in soil respectively.
S_k (exch), S_{Mg} (exch) = exchangeable K and Mg in soil respectively.
n = number of samples.

Table 7.

RELATIONSHIPS BETWEEN SOIL MG CONTENTS AND LEAF MG CONTENTS OF *HEVEA BRASILIENSIS*

Soil series	n	L_{Mg} vs S_{Mg} (acid)	$\frac{L_k}{L_{Mg}}$ vs S_{Mg} (acid)	n	L_{Mg} vs S_{Mg} (exch)	$\frac{L_k}{L_{Mg}}$ vs S_{Mg} (exch)
Rengam	342	—0.043 NS	0.219***	227	0.246***	—0.130-
Jerangau	108	0.091 NS	0.201*	70	0.760***	—0.137 NS
Serdang	131	0.094 NS	0.031 NS	105	0.583***	—0.364***
Munchong	190	—0.011 NS	0.199***	139	0.504***	—0.316***
Durian	101	—0.011 NS	0.149 NS	60	0.339**	—0.315*
Batu Anam	46	0.198 NS	—0.062 NS	34	0.579***	0.044 NS

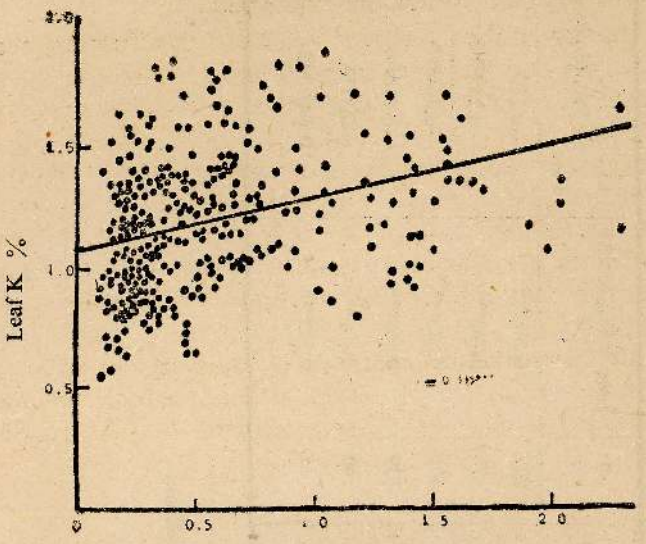
***: P <0.001 **: P <0.01 *: P <0.05 NS: Not significant

n — number of samples.

L_k, L_{Mg} — leaf and leaf Mg contents respectively.

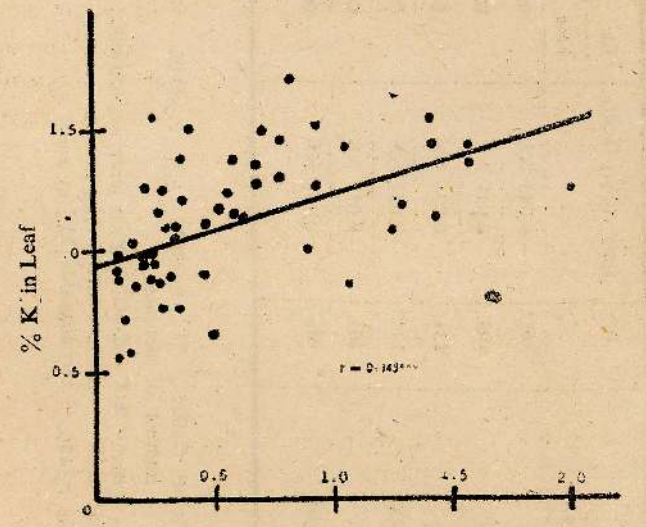
S_{Mg} (acid) — acid extractable Mg in soil.

S_{Mg} (exch) — exchangeable Mg in soil.



Acid-exIractable K in soil me/100g

Fig. 1 Soil K content vs leaf K content of *Hevea brasiliensis* in Rengam series soils (all clones)



Acid-extratable K in Soil, me/100g

Fig. 2 Soil K content vs leaf K content of *Hevea brasiliensis* in Rengam series soils (Tjir 1 clone only)

Combined approach in fertiliser assessment

In view of the limitations which soil classification, chemical soil analysis and leaf analysis each have, a combined approach is the most sensible and is adopted in Malaysia (Pushparajah & Guha, 1968; Guha, 1969; Guha *et al.*, 1971). As the soil status is unlikely to change drastically in a short period, the analysis needs to be done only once in two-to three years. However it is preferable that leaf analysis be carried out annually so that the benefit of the previous year's fertiliser can be assessed and adjust ments made in the subsequent application of fertiliser.

This discriminatory approach of assessing fertiliser requirements based on soil survey, results of fertiliser trials, soil analysis and leaf analysis has also in the recent past been adopted by the Rubber Research Institute of Sri Lanka (Silva, 1975).

Standardisation of soil and plant analysis

The value of soil and plant analysis is increased if standard procedures can be established between laboratories within a country or region. Analytical laboratories in Malaysia have since 1966 actively participated in round-robin type cross-checks to examine inter-laboratory errors in soil and plant analysis. These laboratories have also participated in international cross-check exercises on plant analysis conducted by the laboratory of Soils and Fertilizers in Wageningen.

Plant analysis for the major nutrients has been found to give few problems and there is good inter-laboratory agreement between laboratories. However trace elements are more difficult and give wider variability and need to be more rigidly standardised. This is currently receiving the attention of the analytical chemists in Malaysia.

Soil analysis is more problematic since the methods used are empirical, the experimental procedure is subject to many variables and wide variabilities are often obtained between the results of the different analytical laboratories. However the order of this variability is still much smaller than the soil variability

in the field. Standardisation of laboratory procedures has permitted the inter-laboratory variability to be reduced. In Malaysia, standard procedures have been adopted for pH, organic carbon and total nitrogen determinations of soil. Also tentative recommended methods have been drawn up for the other tests. Such standardisation of test procedures both at a national and regional level is to be encouraged as it increases the usefulness of analytical data.

Table 8 gives the inter-laboratory variation is soil analysis between seven analytical laboratories in Malaysia from 1969 to 1975. It will be noted that inter-laboratory agreement has improved with increase standarisation of the test procedures.

Table 8.

INTER-LABORATORY VARIATION (C.V. %) IN SOIL ANALYSIS BETWEEN SEVEN LABORATORIES IN MALASIA

	1969	1970	1971	1972	1974	1975
pH (H_2O)	1.5	3.1	4.1	4.5	2.7	1.8
pH (KCl)	3.8	3.7	3.1	2.7	2.3	3.1
Carbon	25.6	12·5	9.6	11.9	3.2	8.4
Nitrogen	11.1	12.0	24.2	10.0	6.5	6.8
Soluble P	36.6	50.1	41.9	57.2	35.6	14.8
Total P	—	—	—	53.0	11.4	19.6
Conductivity	—	—	—	23.9	16.8	23.0
C.E.C.	15.6	32.8	20.2	31.0	17.3	29.7
Exch. Ca	28.7	18.7	16.3	22.8	20.9	10.6
Exch. Mg	23.0	17.8	22.6	27.0	14.0	12.8
Exch. K	19.1	27.6	29.4	11.3	20.5	6.4
Exch. Na	—	—	—	—	43.6	22.3
Clay	23.3	30.9	14.4	5.1	16.4	15.2
Silt	32.7	22.4	13.1	18.8	8.6	11.6
F. Sand	17.2	14.2	9.0	16.2	23.1	12.5
C. Sand	15.5	21.7	16.0	9.9	52.3	25.3

Research to improve soil nutrient availability assessment

Attempts are being made in the Rubber Research Institute of Malaysia to develop soil test methods for assessing soil nutrient availability based on sound fundamental principles and hence more meaningful than the conventional methods currently in use (Singh, 1972). Schofield's quantity-intensity concepts, which are based on thermodynamic principles and governed by the fundamental laws of ion exchange equilibria, have been examined but have so far not been developed to a stage where they are superior to the existing conventional parameters (Singh *et* al; 1968, Singh

and Talibudeen, 1969). The quantity and intensity values have proved more sensitive in reflecting past manuring and current manuring than the conventional parameters (Singh, 1971) but were not better related to *Hevea* performance (Lau *et. al*; 1972)

Recent studies on the extraction of cations by strong cation-exchange resins gave indications that resin extractable K may correlate better with leaf K for *Hevea* than the conventional indices (acid-extractable K and exchangeable K) (Lau, 1975).

Radiotracer studies are also being pursued to find a suitable radiotracer technique which can complement the existing conventional soil indeces. While the radiotracer technique has been found to be suitable for detecting "active" root zones of the rubber tree in the soil (Soong *et al*; 1971; Singh *et al*; 1972) and for measuring the relative efficiency of fertiliser uptake by the rubber tree (Guha *et al*; 1975), no suitable index has yet been found which can be used to predict the fertiliser requirements of different soils.

The future improvement in soil chemical methods will probably depend on a better understanding of the physico-chemical nature of the soil exchange complex. Some studies in this area have been made (Singh and Talibudeen, 1971) but much more needs to be done before a practical soil chemical index, which is more sensitive and theore tically sound, than the current conventional techniques, can emerge.

Conclusion

The current state of development of soil and plant analysis as diagnostic tools, coupled with proper classification of soils into homogenous units with similar physical and morphological characteristics, has improved the efficient use of fertilisers. The high cost of chemical fertilisers, makes the small expenditure involved in carrying out soil and plant analyses very insignificant and hence gives little excuse for those who do not make use of these diagnostic tools for greater agricultural productivity.

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Population Control — Present and Future

by

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The human population on the earth probably passed the 3.6 billion point in 1970, increasing by some 70-75 million each year. We say "probably" because current census data for many countries are nonexistent, unavailable or unreliable. At the current 2 percent rate of increase, every three years the world population grows by a number greater than the 207 million people now living in the United States. Every five days we add another million to our human population.

When one of the worst disasters of the twentieth century occurred in East Pakistan in the fall of 1970, an estimated half million people were drowned by a great tidal wave. Yet, it took only 35-40 days for Pakistan's population to exceed the number it had reached the day before the disaster, assuming continuation of the growth rates of the recent past.

Another way to look at the population explosion is in the perspective of man's development as a species. During the hundreds of thousands of years of the Old Stone Age when man was a hunter and a food gatherer, the world population probably never exceeded 10 million. Sometime between 8000 B.C. and 6000 B.C., man learned how to grow his food and create settlement and eventually cities. In the next 6,000-8,000 years, man's numbers increased to about 200-300 million and by 1650 A.D. reached an estimated 500 million.

The increase from about 10 million, at the beginning of the agricultural era, to 500 million about 8000-10,000 years later-a fiftyfold increase—was a "population explosion" in itself. This term, however, has been applied with greater reason to the even more rapid gain which has occured in the last three centuries. In the

200 years from 1650 to 1850, the world population doubled and reached its first billion. In the next 80 years, it doubled again to a total of 4 billion. By the year 2000, it will exceed 6 billion and possibly approach 7 billion, unless there is a major reduction in birth rates or a major increase in death rates. At present rates, we will add 1 billion people in a mere dozen years.

The question arises: How and when will the growth in man's numbers come to an end? And when it does come to an end, will world population level off and stablise, or, having overshot the sustaining capacity of the earth, will it then fall back? Nobody really knows the answers to these questions. We must try to find them, however—and we must also try to understand what has caused man's population to spurt ahead so rapidly.

Besides the effects of better nutrition on resistance to disease, the main components of the medical-public health revolution were a general approach toward cleanliness and purifying food and water, and the conquest of specific infectious diseases which had long plagued man. Although public hygiene had been the concern of communities for several centuries, it was not until 1850 that the need to sperate water supplies from sewage was firmly established, and medicine gradually reached the point where more people were cured by treatment than were killed by pre-antiseptic conditions. In the last half of the century, and on into the present one, the causative factors of a host of killers, including plague, yellow fever, cholera, typhus, amoebic and bacillary dysentery, tuberculosis and malaria were identified; and the means of controlling them developed. For some diseases. notably malaria, effective control had to wait until after World War II.

Starting in the 1800s mortality rates began to drop in countries undergoing industrialization. In the 1840s in several Western European countries data indicate that only about 85 percent of those born survived the first year of life and about 65 percent lived to age 15. A century later, close to 96 percent survived the first year, and about 75 percent lived to age 60. It is estimated that the mortality rate in the more deeveloped regions dropped from 28 per 1 000 in 1850 to 15 in 1950.

Thus, the three ancient scourges of man were brought under varying degrees of control. Famine was vastly reduced, pestilence was almost equally controlled, and only war and accidents remained a lessened but still significant cause of untimely mortality. With the near elimination of most serious infectious diseases, the causes of mortality shifted to the chronic and stress diseases, such as cancer and heart disease, which strike more at the older sectors of the population.

The situation was different in the developing world. Until the end of World War II there was a gradual decline in mortality, probably due in part to better control of epidemic diseases including plague, smallpox and cholera, but estimates indicate that death rates were still close to 30 per 1,000 in the late 1940s.

Following World War II, however, the decline in mortality became much steeper. In the case of Sri Lanka for instance, the death rate came down from 19.8 to 14.0 in a single year and, in consequence, the estimated expectation of life at birth went up from 43 years in 1946 to 52 years in 1947. In general, in the developing areas the death rate dropped from an estimated 28 per 1,000 population in the decade 1940-1950 to 17 per 1,000 in the decade of 1960-1970.

In many cases, including Sri Lanka, this reduction in deaths resulted in large degree from success in the battle against malaria which was probably the world's most potent single cause of sickness and death before World War II. The widespread use of DDT, sprayed from airplanes brought the disease under control in many areas. While malaria control may have been the major single factor in declining mortality, other public health measures also played their part. Campaigns to control smallpox on a worldwide scale were undertaken for instance.

The reduction in infant mortality has particular significance in terms of population pressure, since the survival of children means that they will probably become reproducers themselves. Although deaths among infants remain high in developing areas, compared with industrialized nations, the decline has been dramtic.

Most of the industrialized nations have made a gradual shift and accomodation from age-old high birth rates and high death rates to much lower birth rates and very much lower death rates. Demographers refer to this shift as "the demographic transition.' Its distinguishing feature in the West was the approximate parallelism of the gradual declines in the birth and death rates, so that net population gain was comparatively moderate and could be accomodated—at least up to the present—within expanding industrial economies. This contrasts with the very sharp drop in death rates in developing nations without a parallel decline in birth rates, causing rapid population growth.

The social, cultural and economic factors that contributed to fertility decline in industrialized nations are not operating in the same way in the developing areas of the world. In Europe, mortality decline reflected profound changes in society, which also affected fertility. In developing areas, however, the mortality decline has been a result of medical and other technology which could be imported and applied almost overnight. The cultural changes which were required to affect fertility in the industrialized countries required decades to bring it about, and similar cultural changes have been slow in coming in developing countries.

A particularly large research effort has been required in the area of human reproduction, not only because of the pressure for quick results, but because of the variety and large numbers of men and women concerned. How can methods, approaches, and service structures be developed that reach, and continue to reach, most people of reproductive age in a community? Beside the difficulties encountered in all froms of preventive medicine, methods of fertility regulation pose problems for research seldom encountered with other therapeutic agents; they may be used over very long periods of time, with little or no medical supervision, many of them interfere with normal body processes, and a wide choice of methods is required to meet the different needs of individuals.

Three main considerations affect the individual's or couple's choice and continued use of a method of fertility regulation: its

effectiveness, the likely side effects, and other characteristics that affect its acceptability. These characteristics include its actual form, i.e., whether it is an oral or injectable drug or one of many types of devices; the timing of its use, i.e., immediately before or after intercourse or entirely dissociated from it; the duration of its effect (including reversibility); and the sex of the user. As well as cost, social and cultural considerations play a part in influencing the acceptance or successful use of a method; since an intrauterine device (IUD), for example, involves a gynaecological examination, it may be unacceptable in certain cultures.

Although the available methods represent a considerable advance over those of the past, they remain relatively crude, for many of them are associated with unacceptable side effects on health and, as a whole, they fail to meet the varied requirements of consumers and services in different countries, particularly developing ones. For these reasons, which have been stressed by WHO Member States and groups of experts convened by the Organization, the priorities of the research program include the improvement of existing contraceptive methods and the development of new methods.

Modern methods of fertility control, especially the hormonal steroids and IUDs, have been developed in, and tested in women from, the developed countries. It has been assumed that these drugs in the same dosages, and these devices in the same shapes, would serve for women in developing countries, in spite of the fact that they differ in body size, diet, child-bearing patterns, work habits, and genetic constitution and many of them suffer from nutritional deficiencies and are prone to a number of infections and infestations. Lack of research and expert knoweledge on these questions has held authorities back from making a number of contraceptive methods available, for fear of their possible ill effects. This reluctance has been accentuated by the ambiguous and harmful effects, occasionally observed in women from the developed countries.

As far as the hormonal contraception is concerned, one of the fundamental requirements for the assessment of the effects of oral and injectable contraceptives is to have good baseline

data on normal levels of estrogen, progesterone, follicle-stimulat ing hormone, gonadotrophins, etc., and on changes in them when different preparations are used.

Clearly, the amount of additional research that would be possible on oral contraceptives is almost unlimited. In a decade and a half of use, the world has learned a great deal about these drugs and their side effects. The early enthusiasm over a uniquely effective contraceptive was tempered in the mid 1960s by the first evidence of thromboembolic hazards. Today, these risks can be put into a more realistic perspective while, at the same time a number of potential benefits, in addition to prevention of pregnancy are becoming more apparent. Protective effects in ameliorating menstrual irregularities, reducing iron deficiency anemia, and possibly preventing tumors in reproductive organs are of consider- able value. Moreover, no further research is needed to show that the higher the levels of infant and maternal mortality, the greater the health benefits that will accrue from an effective means of spacing and planning births.

Today, about half of the fifty million oral contraceptive users are located in developing countries. Their proportion will almost certainly increase—yet only a handful of controlled studies have been conducted in these areas. Specificially, research would be useful to determine the effect, if any, of oral contraceptives on women in settings where malaria, liver fluke, schistosomiasis and various other parasitic diseases occur more frequently.

It is equally important to determine whether conditions that occur in developed countries, such as thromboembolism, are equally likely to occur in developing countries. There is "a clinical impression" that thromboembolic disease is rare in tropical countries, even after surgery. Any side effects involving the cardio- vascular system, including high blood pressure and thromboembolic disorders may therefore be less serious in developing than in deve- loped countries.

Nutritional factors also play an important role that deserves further attention. On the one hand, in some users, oral contracep- tives may interfere with vitamin B_6 and folic acid metabolism

and also adversely affect the liver function. On the other hand, women suffering from iron deficiency anemia or other forms of malnutrition will benefit from the child-spacing and reduced menstrual bleeding which oral contraceptives provide. Iron tablets (75 mg ferrous fumarate) are included in many 28-day pill packages, and vitamin or other supplements might also be added.

Physicians or medical personnel cannot predict in advance which individual patient will develop various conditions and sophisticated epidemiological studies are required to document any increased risks; therefore, the need for medical prescription of oral contraceptives is being increasingly questioned, especially in areas where doctors are not available. Expanded nonclinical distribution systems which permit door to door delivery of orals, sales by village shopkeepers, or distribution by indigenous midwives are being developed in many countries. New types of packaging and information for users will be necessary as well as some training of nonphysicians to provide sound advice and follow-up.

The place of the injectable progestogen in family planning is still uncertain. Although some compounds have been used as injectable contraceptives for over a decade and are both popular and effective, controversy still surrounds them.

Injectable progestogens offer many advantages that may be of special importance in developing countries. They are:

- highly effective in preventing pregnancy, on a par with oral contraceptives.
- independent of coitus.
- simple to administer.
- long-lasting, with injections required only two or four times a year.
- not lactation suppressors and thus, unlike combination oral contraceptives, can be offered to nursing mothers without danger of reducing the supply of milk.
- popular in developing countries, where injections are associated with safe, effective, modern medicine.

An estimated 1 million women now depend on injectable progestogens for contraception. That number is small compared

with the 50 million who use oral contraceptives and the 15 million who use intrauterine devices (IUDs), but the use of injectables appears to be gradually increasing. In recent years, international donors of contraceptive supplies have received a growing number of requests for injectables and several countries have added injectables to their national family planning programs.

Because of suspicions about long-term effects, the use of injectables has been limited In some countries concern about permanent infertility after injections has caused it to be restricted to older women with completed families. A controversy in the USA over the interpretation of statistical data on cervical carcinoma in situ has prevented approval specifically for contraception.

An injectable contraceptive is a welcome addition to family planning methods. But the present progestogen injectables, troubled as they are by menstrual side effects and unresolved questions about long-term effects, have not yet won the unqualified approval of clinicians. Nevertheless, if further research can dispel fears about carcinogenicity and disprove or define the risk of infertility, the injectable progestogens may yet become an important component of family planning programs, especially in areas where treatment by injection is popular.

Every new advance in contraceptive technology has introduced family planning to additional groups in population, while still failing to meet the personal requirements of others. In 1972, therefore, WHO expanded its program of research to develop a variety of new, safe, acceptable, and effective methods for the regulation of human fertility. Specific methods that are being developed in over 200 ongoing collaborative (task force) projects include agents for the following purposes.

- Regulation of ovum transport, either by blocking the oviduct by modifying ovum transport so as to prevent implantation, or by preventing ovum development through the alteration of oviduct secretions.
- Regulation of sperm migration and survival in the female by means of new types of vaginal or cervical devices that can be retained for prolonged periods and that interfere,

through their physical or chemical properties, with the transport and survival of sperm in the female reproductive tract.

— Regulations of implantation by intrauterine delivery systems for drugs that have minimal side effects and do not inhibit ovulation. Delivery systems are also being explored for the introduction into the uterus of therapeutic substances to prevent the most common side effects of IUDs (bleeding, pain, and expulsion). Other projects aim at developing an acceptable IUD for immediate postdelivery or postabortion insertion.

— Immunological regulations of fertility to prevent or disrupt implantation and to prevent sperm transport and fertilization. This approach is much more problematic than those described above. Nevertheless, it is considered worth pursuing since the development of a suitable vaccine would represent a very great advance in fertility control.

— Prediction and detection of ovulation. To improve reliability of the "rhythm" methods of fertility regulation, simple and accurate methods are needed whereby women can predict and detect the time of ovulation.

— Regulation of male fertility by gestagen-androgen oral and injectable combinations inhibting the formation of sperm. Another approach is to develop methods of destroying the fertilizing capacity of sperm by interfering with their maturation and survival in the epididymis.

In some instances, a compound may already have been developed by a pharmaceutical company and WHO support is given for carrying out the clinical trials while the company assumes responsibility for the other steps, including short-term and long-term toxicity studies in anmials. In others, the WHO projects begin at the first step, that is, the elucidation of physiological mechanisms, and either undertake the complete development of the method or arrange collaborative projects with companies and institutions receiving financial support from other sources, so that the development costs are shared.

Other potential leads to new birth control methods are being assessed continuously, and social scientists are collaborating in

research aimed at defining those characteristics of potential methods of fertility regulation that could affect their acceptance in various social cultural settings. Biomedical scientists will then be asked to take these socio-cultured factors into account in developing contraceptive methods. Research is starting on the value ascribed by different communities to the reversibility of contraceptive action, the importance of such side effects as amenorrhoea, the potential use of pills or injections for the control of fertility in males, and the characteristics of various indigenous methods of fertility regulation.

There is a steadily increasing congruence of interest between the totality of mankind, nations and adult citizens and their offspring in shifting to a pattern of procreation which will, at most reproduce the current generation. The question is whether the younger generation throughout the world can quickly unlearn the reproductive habits and attitudes of thousands of preceding generations and substitute a new perspective and a new conviction, which is strong enough to make a pervasive change in human behavior. It is the younger generation which will decide. Some members of the older generation may have the wit and wisdom to use their influence to help bring about such a change. But the members of the younger generation, if they are provided the essential facts, may well have greater intuitive insight into the nature of "Man's Population Predicament" than most of their parents and teachers.

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