DEVELOPMENT OF RESEARCH, SCIENCE & TECHNOLOGY IN TANZANIA

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INTRODUCTION

Much of the underdevelopment of developing countries arises from deficiencies in the development and proper application of science and technology. These deficiences have been brought about by a complex of factors arising from different circumstances. Before meaningful and realistic solutions can be found concerning the many problems retarding or hindering the development and application of science and technology in developing countries, it would be necessary first to highlight these problems and to have a critical analysis of them.

Some eight years ago the United Nations Economic Commission for Africa (E.C.A.) made field surveys of the needs and priorities in science and technology in a representative number of African countries in the various subregions of the continent. The main findings obtained from these surveys concerning the general climate for the development and strengthening of science and technology can be summarised as follows:

(a) There is a widespread recognition at Senior government and other levels that science and technology could contribute greatly to economic development. But this recognition does not reflect itself in policy-making or planning for development and most of the government officials who recognise the importance of science and technology do not really know in what form to use them for development.

(b) This absence or uncertainty of action on science and technology stems in part from the general shortage of officials with scientific training in the decision-making machinery of government and in part from the fact that in the majority of countries there is no department or section of the govern-

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ment administrative apparatus which has the specific responsibility of dealing whith science and technology as a regular or integral part of government business.

(c) The recognition of the importance of science and technology for development is almost completely lacking in the general public and in the majority of the political leadership. For most of the general public science and technology is symbolised by the Russian satellites, the American voyages to the moon and the esoteric activities of impractical scientists in university research laboratories.

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d. Science instruction is not widespread in school teaching, even at secondary level and where it is taught it is usually offered as an option for those intending to go into professional training for which a knowledge of some science subjects is the entry requirement.

e. The situation of the scientific and technical communities in the African countries and the attitude to them at government and often at the general public level are not conducive to the utilisation of science and technology more effectively for development. At the government official level the decision-making power is in the hands of an administrative elite with an essentially non-science culture. The official attitude has hitherto been that scientists and technologists do not participate in administrative policy or decision-making, but should be available to answer questions if asked.

f. On the side of the scientific and technological community there are also entrenched attitudes which are not conducive to their playing a useful role in the area of development. The prevailing traditions and practices of these communities wherever they are well organised appear to be directed towards preserving their privileged positions as an independent elite which will remain acharge on the community in terms of economic support but which should be left independent and free to pursue what science it wants. This tradition of academic detachment and excessive concern with the maintenance of "scientific liberty" has resulted in a situation in which scientists and technologists have little influence on public policy.

Although it could be argued that these are too sweeping generalisations which may not apply with equal force in every country of the region, and although the situation in some of these countries may have changed somewhat in the intervening years, it would appear, when the question is critically analysed, that in the main, these findings still represent a fairly realistic appraisal of the state of affairs obtaining in most if not in all the countries of the region, including Tanzania.

This paper is an attempt at a critical analysis of some of the more obvious problems relating to the development of science and technology in Tanzania.

1. PROBLEMS CONNECTED WITH SCIENTIFIC TECHNOLOGICAL MANPOWER DEVELOPMENT

Ideally the development of a scientific attitude and outlook should begin at home in the early days of childhood. This is to a large extent impossible among the majority of people in developing countries where most of the parents are uneducated and where apart from the use of fire, there is very little application of science and technology in the majority of homes no electricity, no piped water supply no gas or electric cookers, no refrigerators, no radios, no T.V.s, etc. etc. Then the training of scientific minds should start at the primary school. This is again largely impossible in most developing countries where there is a great lack of properly qualified teachers and where many of the primary schools available are so under-equipped as to hardly be worth of the name "school". Many developing countries cannot yet afford to send all their school-age children to school, which means that they are not making

full use of their scientific and technological manpower potential. In some young developing countries great efforts have been made to rapidly increase the proportion of children going to school but sometimes the great haste and unpreparedness with which this has been done has resulted into such a dilution of the education offered as to make the wisdom of the whole exercise questionable.

Secondary schools should be places where young people with scientific aptitudes are given a good background teaching in science subjects and in scientific methods. By the time they leave secondary schools these young people should be thoroughly acquainted with the basic principles of science and with the experimental approach in scientific investigations. Those going to the University should have a good background knowledge of the subjects they want to pursue for their undergraduate studies. The position in many secondary schools in many developing countries including Tanzania is very unsatisfactory for the training of scientists. Much of the teaching is too theoretical and there is very little if any practical or experimental work. Some of the old well established schools are better placed in this respect but many of the new ones especially the poor private secondary schools are hardly fulfilling their expected functions. In Tanzania this problem has worsened in the past few years largely because of the policy adopted by the Ministry of National Education of promoting senior teachers to administrative jobs away from the blackboard with the consequence that there are very few teachers of long experience in secondary schools today. Proficiency in teaching as in any other profession improves and matures with time and experience. There is a lot to be said for the good old system where a good teacher could spend the whole of his career on the blackboard and still reach any level of seniority in the education establishment. The great expansion of secondary school eduction in recent years has brought with it the problem of inadequate staffing and equipment. The lack of good textbooks and laboratory equipment is a real and serious problem in secondary schools. There is a great need for relevant science textbooks for secondary schools in Tanzania, and this is a great challenge to Tanzanian scientists.

The poor background that a student gets in his secondary school means that he comes to the University not really completely qualified to embark on undergraduate studies straight away. Because of this deficiency some of his undergraduate time is spent in trying to make up and bring him up to standard. Since the time for undergraduate studies is limited the consequence of this is that the student graduates without having covered as much in his subjects of study as he would do had he had a good background from school. This problem is compounded by the fact that under our existing undergraduate study structure the student's time table is overburdened i.e. he is required to study too many subjects over a relatively short time. The student who is reading for the B.Sc. (Education) degree for example, has to study 4 subjects for the three years of his undergraduate programme, i.e. 2 science subjects, Education and Development studies. This is a bit too much and means that when he graduates his knowledge of the science subjects he studied would be a bit deficient. Since these B.Sc. (Education) graduates are the teachers to be posted to secondary schools the poor background alluded to earlier is perpetuated and

a vicious circle is created. The present system of training graduate teachers was adopted soon after independence when with the rapid expansion of secondary school education and the exodus of expatriate teachers, there was such an urgent need for secondary school teachers. The move was a good and appropriate one and was fully justified by the circumstances of the time. But with the comparatively good stability in our secondary schools now one wonders whether it is not time to re-examine the whole issue and decide whether it might not pay to start thinking more about the quality of teachers than about the speed with which they are produced. The question being posed is whether it would not be more appropriate to offer education as a postgraduate diploma. In discussing this matter with some authorities one is sometimes told that teaching is such an unpopular profession to graduates that if it was offered as a postgraduate diploma very few would take. To say the least this is not a very sound argument. The way to make teaching a popular profession is to make the conditions including remuneration attractive. Trying to create conditions which would force one to become a teacher against his will will not give us the good devoted teacners we so badly need.

Because of the little time available for studying science subjects at the undergraduate level, only very few students graduate with sufficiently good degrees to qualify for postgraduate studies. This means that only a few students are available for training as professional scientists including research workers.

In spite of the great efforts made by the University of Dar es Salaam in recent years to develop its science departments and strengthen their staffing, it is not possible, nor can it be expected of the University, to train all the different types of professional scientists required in the country—entomologists, parasitologists, bacteriologists, biochemists, malariologists helminthologists, meteriologists, etc. etc. No University could afford to employ the numerous specialists required for all these areas, Besides, the number of specialists required in some of the areas is so small that it would not be economical to employ full time teachers to train them. In such cases it would be best for the University to collaborate with the relevant research institutions in the country in the training of such professional scientists. Recently proposals were put forward to the University authorities suggesting an arrangement which would make possible such collaboration for the mutual benefit of the institute concerned and the University. It is understood that these proposals are under consideration. Sending young graduates to be trained abroad is an alternative but one that should only be taken up as a last resort or in very special circumstances. There is really no proper alternative to training a scientist in the environment and under the conditions in which he is going to work. Where, because of the special equipment or expertise required it is necessary to send a postgraduate student abroad it would be best, where possible, to arrange the training so that it is done partly locally and partly abroad.

One would conclude this section by saying that one of the most fundamental needs in the development of science and technology in Tanzania is the strengthening of science teaching in schools and at the University in order to foster the evolution of a science and technological culture.

2. PROBLEMS RELATED TO THE UTILISATION OF SCIENTIFIC AND TECHNOLOGICAL MANPOWER

Although it is generally acknowledged that the lack of adequate scientific and technological manpower both in quality and in quantity is a real and serious bottleneck in the development of science and technology in many developing countries it is not sufficiently realised that misallocation and improper use of the available manpower is an equally and sometimes even more serious problem. Complaints from young graduates about being placed in jobs where their scientific or technological knowledge is irrelevant and of no direct application are heard too often to be ignored as grumblings from the disgruntled. Sometimes indigenous graduates are given white collar jobs while expatriates are employed to do the very scientific or technological jobs for which the graduates are qualified, sometimes even better qualified than the expatriates. It should be realised that to employ an expatriate even if his services were given under a technical aid agreement, in a job which could quite adequately be done by an indigenous professional is not only a gross misuse of local talent but also an insult to the country and to the country professionals.

Even where initially indigenous scientists and other professionals are given the right jobs they usually do not stay long, for they soon get promoted to white collar administrative jobs and are condemned to paper work for the rest of their career life. He who will break the myth that a white collar administrative job involving mostly paper work deserves more pay than a practical or field job involving the intellingent use of hands and tools will do the country a great service.

Talking of expatriate professionals there seems to be a belief in some quarters that the term "expatriate" is about the highest "professional" qualification one could have. People of this category are almost invariably referred to as "experts" whether or not they have any real qualifications or experience. It is almost fashionable nowadays to invite such "experts" to participate in practically every development project conceived, even if there are qualified local people for its execution. These experts" are invited to carry out feasibility studies, to work out costings of projects and implementation programmes and to say how many other experts will be required and under what terms. Very often the reports and advice of such "experts" are regarded as the gospel. In other words every aspect of the project is worked out and dictated by the "expert" and given to the local boss on a plate. This practice does not only greatly inflate the costs of such projects but it frustrates and kills local talent. The failure of some of our development projects is attributable to this; they were planned by people who, although with paper qualifications, had very little knowledge and experience of the special circumstances, and sometimes had an axe to grind. One cannot expect technological development among the indigenous people under these circumstances. It is like trying to grow maize under the shade of big sprawling trees. Such maize will never grow to bear fruit no matter how fertile the soil is for the large overshadowing trees will not allow the rays of the sun to reach its leaves. A few years ago the Vector Biology and Control (VBC) section of the WHO headquarters in Geneva was complaining about an African country which was requesting for an "expert" on the control of filariasis when one of its own nationals

was so qualified in the field that he was an honorary WHO consultant on filariasis, and the country knew it!

It also happens, not infrequently, that our scientific professionals or technologists are not given the opportunity to face challenging situations which would enable them to develop and sharpen their professional talents in accordance with the wise saying that "practice makes perfect". It cannot be denied that an unused brain or talent like an unused knife sooner or later becomes rusty and undergoes slow decomposition. Thus although we now have quite a sizeable number of Tanzanian engineers for example, one does not hear of or see many really challenging engineering undertakings like a big strong bridge, an aerodrome, a good road or even a modern large complex building conceived, planned and executed to the finish by an engineering team wholly composed of Tanzania engineers. The explanation sometimes offered for this state of affairs is that it is virtually impossible to find an engineering establishment with enough Tanzanian engineers of the right qualifications to be able to carry out such a complex project. If this is true, then one would suggest that the whole question of the organisational employment of Tanzanian engineers the majority of whom are under government employment should be reconsidered. An organisation like the Tanzania Legal Corporation would be the right solution. If all the engineers working for the government belonged to a "Tanzania Engineering Corporation", it should be possible for such an organisation to pick up from among its members a team of Tanzanian engineers of the right qualifications to be able to carry out a good piece of challenging engineering work such as was mentioned above. This and similar matters deserve serious consideration, for without such an arrangement we will continue to be inundated by expatriate "experts" and our budding professionals will never be allowed to come to bloom. It should be realised and appreciated that when all is said and done, the greatest need in developing countries today is the building up of their internal scientific and technological capacity.

In concluding this section one would wish to suggest that the employment of indigenous professional scientists and technologists should be carried out with such care as to ensure their maximum contribution to the development and application of science and technology in the country. The employment of expatriate professionals should only be resorted to when absolutely necessary even where the expatriate was offered as part of a technical aid programme. Indigenous professionals should be given every opportunity to practice their trade and to develop and mature through confronting and tackling challenging problems.

3. PROBLEMS CONNECTED WITH THE PROPER APPLICATION OF RESEARCH RESULTS AND TECHNOLOGICAL INNOVATIONS AND DISCOVERIES:

Very often it happens that in many developing countries there is much hesitation almost amounting to unwillingness in applying well proven and positive results of scientific research or well established technological innovations. Some-

times this inertia or hesitation is due to the conservative nature of the human species which makes people view with suspicion any suggestion of a drastic change in there established mode of life. Thus it is that although the obvious and great advantages of fertilisers and insecticides in agriculture were known to many African farmers, it is only in recent years (after independence) that their application as a common and defacto agricultural practices received general acceptance, after much effort on the part of the government to educate the farmers. The fact that the government did succeed to educate the farmers means that this aspect of the problem has a ready made solution i.e. education of the populace. However, not infrequently the hesitation and indecision and general apathy emanates from the decision makers themselves who sometimes lack self confidence in matters requiring important and far-reaching decisions. It is indeed ironical that we should today rank as one of the 25 poorest countries in the world when the country is endowed with natural resources including extensive and good deposits of iron and coal which have been known to exist for the last one hundred years. When one realises that the occurrence of iron and coal together or in close proximity is about the most favourable factor for the establishment of heavy industry one cannot help conjecturing about what this country could have been. The recent discoveries of rich and extensive reserves of natural gas in the Coast Region of the country is another important factor favouring our industrialisation. Natural gas is an important source of conventional energy, energy is the capacity of doing work: work is the basis of human advancement and developHent. So what else could one need? The proper utilisation of these gas reserves for industrial purpose could bring about a social and economic revolution of considerable magnitude.

Sometimes important and vital projects are put off because experts have advised rightly or wrongly that they would be, uneconomical. One of the great advantages of being a socialist country is that we can afford to look at the economy of our country not as being made up of many isolated and unrelated components each of which has to justify its own existence and be self sufficient or perish, but as a single entity. Provided the economy as a whole remains strong and viable we can afford to keep sections going which may not be directly profitable on their own but which may provide a strong and necessary logistic support for the rest of the economy. Just as an example, supposing it was possible (and there is no reason why it should not be) to supply villages with gas in suitable portable containers for domestic use at subsidised rates. Looked at in isolation this could be regarded as a very uneconomic undertaking. But it would relieve the village women of the burden of collecting fire wood, a rather unproductive activity which takes up a considerable portion of the village housewife's working time. The time thus saved could be utilised in more productive activities such as cotton growing which would add to the economy of the country. The cutting trees for firewood and charcoal contributes greatly to environmental deterioration, including desertification, which are immeasurable damages. Any step therefore that would help to eliminate this destructive practice is a positive economic measure that deserves to be supported in every possible way.

The fact that we have good and extensive deposits of iron and coal and rich sources of conventional energy in the way of hydroelectric power and natural gas means that the only basic requirement we would need for a really big industrial revolution would be technological know-how. This is indeed a big bottleneck. But the question is, is it necessary for us to wait until we have all the necessary technological know-how before we can start taking the leap forward? If the great Uhuru Railway is anything to go by, the answer is that it is not necessary to wait. We can in the meantime use borrowed or imported technology, and this will not be the first time we have done it, neither will we be the first country to have done so. Imported technology can be a useful stop gap provided its limitations are fully realised and provided it is fully acknowledged that it can only be used as a means to end and not an end in itself. It cannot be and should not be regarded as a substitute for local technology. Provided there is good planning and sympathetic understanding between all the parties concerned, imported technology can also be used as a means and a stimulus for the on job training of indigenous technologists.

In this connection, it is gratifying to note that the United Nations Economic Commission for Africa (E.C.A.) did recently decide to establish a Regional (African) Centre for the Transfer, Adaptation and Development of Technology as well as National Centres for the same purpose in each African Member State. This should be a golden opportunity for Tanzania to develop its indigenous technologists who will participate in the establishment of the Tanzania Centre and in its operation later Of even greater importance, this Centre should enable Tanzania later on to adapt and develop the imported technology in accordance with the needs, conditions and aspirations of Tanzania.

In concluding this section one would say that whenever useful and applicable results of scientific research and technological development are available they should be applied to solve development problems without undue delay. Imported technology should be used where necessary to set the country off on an industrial revolution which would enable us to use our considerable material and energy resources to the best advantage in the solution of our development problems. Tanzania is potentially a rich country but it is underdeveloped mainly because of its past history This underdevelopment can be overcome through the building up of the country's scientific and technological capacity and the will and determination on the part of the general public and the leadership to develop. This can be achieved through appropriate policy decisions which will lead to the allocation of adequate resources for the purpose.

4. PROBLEMS RELATED TO THE ORGANISATIONAL STRUCTURE AND FUNCTION OF RESEARCH INSTITUTIONS.

Many of the existing research institutions in the country were started by the British colonial government and their aims and research priorities were determined in accordance with the interests of the British government as expressed through the Colonial Office. Thus for example research in agriculture was aimed mainly at increasing production and quality of such economic crops as coffee, tea, pyrethrum,

sisal and cotton which were important for the British industries and their export markets. Likewise those institutes concerned with research in medical or public-health problems were designed to look into effective ways of protecting the white population in the country against important tropical diseases such as malaria, trypanosomiasis, bilharzia, etc. Control of these diseases was concentrated in areas with white settlements such as towns and not where the diseases were most prevalent and serious, i.e. in rural areas. Because of their history therefore many of the research institutions have been carrying out research programmes which in close scrutiny are not the most relevant from the point of view of present day conditions and circumstances. Some of the research institutes have been badly located in relation to their functions. The East African Institute of Malaria and Vector-borne Diseases, Amani, for example, whose major concern, as its name suggests, is supposed to be malaria research relevant to the control of malaria in East Africa, is situated high up on the Eastern Usambaras at a place which is itself largely free from malaria. Thus any field work on malaria has to be carried out a considerable distance from the main laboratories with the consequence that a good portion of the institutes' budget is spent purely on transport.

Another common weakness of the old as well as some of the new research institutions is that there is a tendency for much duplication of research effort and a lack of co-ordination of research activities between one institution and another. Thus at one time there was much in common between the research activities of the E.A. Institute of Malaria and Vector-borne Diseases, the E.A. Institute for Medical Research and the E.A. Pesticide Research Institute. Even the very names of some of the institutes suggest duplication of activities. The E.A.I.M.V.B.D. for example purported to be interested in research on malaria and other vector-borne diseases whereas the E.A.I.M.R. could according to its name, carry out all types of medical research, although in fact it was mainly preoccupied with research in schistosomiasis (or bilharzia).

The former East African Community through its research councils tried to rectify these weaknesses among its research institutes by appointing specialist and co-ordinating committees which had the responsibilities of scrutinising research priorities, reviewing research progress and co-ordinating research between institutes working in related areas. This was a move in the right direction but with the recent collapse of the E.A. Community these institutes have reverted to their former, unsatisfactory positions. This state of affairs also applies to a greater or lesser extent to the other research institutions in the country and there is a great need for a complete reorganisation of the administrative structure of all research institutions in the country.

Although the National Scientific Research Council has by its constitution the responsibility of co-ordinating all research activities in the country the present administrative machinery is not conducive to the smooth running of this arrangement. The Secretary-General of the National Scientific Research Council for example has no administrative powers to effectively influence research in any research institution and the research institutions themselves have no common administrative base.

The University is an important research institution and in order that it may have an important impact on the overall development of science and technology in the country its research activities should be closely co-ordinated and integrated with those of the other research institutions.

Finally there is the question of finance. Scientific and technological research are costly undertakings requiring good and sometimes expensive equipment, good laboratories and/or worksnops and highly qualified staff. They cannot therefore be run on the cheap. It is most important therefore that the relevant decision-making authorities in government should realise and acknowledge that it is not enough to make a general statement to the effect that the government believes and is convinced that the development of science and technology is the main key to economic development and the main weapon against poverty and underdevelopment. Such pronouncements should be accompanied or followed by appropriate action in the form of allocation of adequate financial resources towards the development of science and technology in all aspects, for if a farmer wants a good harvest he must be prepared to invest liberally in good seeds and good fertilisers.

In conclusion one would say that there is a great and urgent need to streamline and co-ordinate research in order to make it more relevant to the needs of the country and to avoid duplication. The best way of effecting this would be to bring all the research institutions in the country under one administrative machinery e.g. by establishing a Ministry of Science and Higher Education. Such a ministry would be responsible for the development of science and technology and would have the National Scientific Research Council and the University as its chief organs. This would place science and technology in their proper perspective.

RECOMMENDATIONS

In order to quicken the pace of scientific and technological development ir Tanzania the following steps should be taken:—

a. Strengthen the teaching of science at all levels of the education system in order to bring about a science and technological culture in the country.
b. Popularise science and technology among the general public through the press, radio, cinema and other mass media.
c. Introduce attractive employment conditions for scientists and technologists in order to attract the best brains; and provide adequate resources for scientific and technological research.
d. Make the best and maximum possible utilisation of indigenous scientific and technological manpower in order to facilitate its development through experience.
e. Enlist the participation of indigenous scientists in the decision-making process of government.
f. Arrange for and bring about a rational utilisation of the country's rich natural resources (both material and energy) in order to quicken the pace of economic development and to provide for increased allocation of resources for the development of science and technology.

g. Arrange for the adoption and adaptation of appropriate technologies to bring about an industrial revolution in the country in the shortest possible time.

h. Streamline the administrative structure of all research institutions and bring them under one administrative authority–? Ministry of Scince and Higher Education.