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Minireview on Needs and Means for Education and Training in Science and Technology: Perspectives in Developing Countries

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Abstract

The focus and funding for science and technology education in Ethiopia is to channel bright students into MSc and PhD programs and science research careers. Research in higher education in regard to technology should contribute directly or indirectly to the satisfaction of the basic needs such as food, clothing, health and education for the broad masses of Ethiopia. While this goal is necessary to our country's continued technical innovation, the contributions of out of school members of our society to the cycle of economic development through technical innovation are usually overlooked. Public support of scientific research, both financial and philosophical, and the commercialization of useful techniques by businesspeople are critical components of the cycle which depend on increasing science education for non-scientists. For the industry's continued success, it must adopt business strategies that maintain public confidence and defuse counter marketing efforts by several small but influential public opposition groups. Research should be carried out to generate and adopt environmentally sound, socio-economically relevant (appropriate) technology. The research in higher education should also probe into the methods of carrying out effective teaching by combining theory with practice and teaching with production. The strong industrial and academic origins, therefore, necessitate continued interactive relationships in order to sustain the future growth of this rapidly emerging high technology.

Keywords: Technology; Education; Public awareness; Commercialization; Technical innovation; Provision of a sound; Cloning techniques; Fermentation technology; Agriculture; Environmental protection

Introduction

Developing countries including Ethiopia are being increasingly involved in the general advancement of science and technology which is enabling biotechnology to make progress in various parts of the world. Important contributions can be made to the general advancement in biotechnology at the national level through partnerships with other developing countries and with more industrialized ones [1]. Through these means, opportunities arise to share in the benefits of improvements in economic growth and the quality of life. However, the extent to which biotechnology can realise its potential is dependent upon several factors, a key one of which is provision of a sound infrastructure in education and training.

Nature and the skills required

There may be much variation in the particular level of skill needed from country to country and from region to region within a country. There is an immediate need in developing countries to recognize the increasing dependence on technology by concentrating on the provision of adequate supplies of basic skills. As an example, in fermentation and microbiology, it is desirable to promote the successful development of indigenous industries, particularly agriculture, to reduce pollution from industrial waste, and to improve the use of resources. There is also a pressure to introduce the new skills required to support the establishment of gene cloning techniques and modern fermentation technology to enhance agriculture, health care and environmental protection.

Promotion of public understanding of science and technology and out of school scientific activities

It is that, before the development of out-of-school scientific activities, science education was stereotyped and traditional, cast in the mould of the teacher-pupil relationship of a bygone age. The coming of out-of-school activities, and their successful development, has brought not only enlightenment and delight to the pupils, but also to the teachers; and it has profoundly altered the attitude of both to the educational process.

According to [2], the seminar considered the following out-of-school activities as constituting the field to be covered and it also adopted the following definitions of some activities

Science club: An association of young people advised by leaders and governed by rules constituted to promote among its members knowledge of science, the practice of scientific methods, and the development of activities tending to cooperate actively in the solution of problems related to science.

Science fair: A public exhibition of scientific work carried out by young people, at which the latter give explanations of and answer questions about their work, methods and conclusions. A jury judges the work on the basis of the knowledge, originality, scientific thought and skill in presentation shown.

Young people's scientific congresses: Events organized to give young people an opportunity to present, before an informed public, their reports on scientific work, on subjects freely chosen by each competitor, judged by a jury on the basis of their originality, creativity, knowledge and method to work.

Young People's Scientific Olympiads: Competitions involving knowledge and skills in pre-established subjects or fields.

Excursions: Journeys undertaken with young people to obtain data or collect material for study.

Science Camps: Excursions to carry out local scientific work.

These definitions are in accordance with practice in Latin America. However, it may be profitable for Ethiopia to consider carefully the definitions in relation to their own practice.

More funds for studies on social determinants of health and health systems research

Although money for physical resources was often in short supply, the government had the foresight to keep expanding its human capital by educating more and more highly trained laboratory scientists and then supporting them at the research institutes. Detailed research is particularly required on the operation of primary health care services to determine how they can better provide effective, equitable, and accessible services and promote the health of the communities they serve. There is also an urgent need for more research on why available and affordable technology and knowledge are not used – for example, to prevent millions of children from dying of diarrhoeal disease and acute respiratory infections [3]. Assessments of social determinants of health reveal that poor people, uneducated people and people living in marginalized neighborhoods are more likely to get sick and to die than those who are better off. This tells us that everywhere efforts should prioritize these people's health through prevention strategies, supported by appropriate technologies. In Ethiopia, sustainable health depends more on health promotion and disease prevention including application of technologies for broad health coverage that are appropriate for the socioeconomic environment than on application of complex technologies advertised by market-driven transitional manufacturers. For example, the infant mortality in Cuba in 2008 dropped to below 5 deaths per 1,000 live births [4]. This was because they have been able to bring the necessary technology closer to all pregnant women and newborns.

Appropriate technology

Poverty and isolation of the village people make it difficult to practice expensive sophisticated technology. As an alternative every attempt would be made to use materials and personnel and labor appropriate to the local situation. Hospital equipment that is readily available and can be maintained easily would be used. An X-ray machine was needed to help in the diagnosis of tuberculosis or for long bone fractures. A simple X-ray machine powered by ordinary domestic current is sufficient for the purpose. This choice of appropriate equipment and technology considerably reduced the cost for the poor villagers. To enhance this scientific knowledge must be applied to develop technology appropriate to the needs and resources of the community.

Biotechnology Results

Biotechnology is a group of technologies that share two common characteristics – manipulation of living cells and their related molecules for commercial purposes [5]. Traditional biotechnology has been used for thousands of years to bake breads, make cheeses, brew alcoholic beverages, and breed better crops and animals. Modern biotechnology focuses on four main areas in health care: medicines, vaccines, diagnostics and gene therapy. Biotechnology, pharmaceuticals, and medical devices produce innovations for biomedical sector [6]. Modern biotechnology focuses on the modification of cells at the molecular level. For example, genetic engineering is a technique of removing, modifying, or adding genes to a DNA molecule to change the information it contains [5].

Today, biotechnology aspects cover such area of innovations as: energy, food and drink chemistry, chemical engineering, materials, environment, genetics, medicine and biotechnology applications [7]. Industrial biotech is a more specific segment of the biotech sector that includes any molecule that improves the efficiency of industrial processes such as textile, paper, pulp, and chemical manufacturing. Now the biotech industry has become such an important part of Ethiopia's international trade that new research centers have been started to facilitate new kinds of cooperation of scientists, professors, and business innovators.

According to study by [8], six factors were shown to converge for successful commercial innovation

a. Technological knowledge;

b. Defined user needs;

c. Existence of an advocate;

d. Resource availability;

e. Favorable risk factors; and

f. Timing of the above factors

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Environmental biotech is used in waste treatment and to prevent and to remediate environmental pollution. In many cases this process is fairly simple; bacteria are inserted into polluted areas where the bacteria digest the polluted waste into harmless by products. After the bacteria consume the waste materials, the bacteria die off, and the ecosystem is restored to health. In the future, biotechnology will be characterized by consolidation of small companies with large companies, immobilization and downstream processing technology will play important roles in commercialization, molecular engineering will yield improved products, and monoclonal antibody technology will lead to improved human diagnostics and eventual human therapy. Biotech methods also produce proteins for pharmaceutical purposes. For example, a harmless strain of Escherichia coli bacteria can be used to make insulin. Biotechnologies are being studied in gene therapies to explore treatments for diseases such as cystic fibrosis, AIDS, and cancer. Biotech is also used for DNA finger printing which is used to determine human and animal origins by geographical regions, as well as paternity [5]. According to a 2010 Pharmaceutical Research and Manufacturers' Report, there are 633 biotech medicines in human trials or under review by the US Food and Drug Administration [9].

To combat against deadly meningitis outbreaks that World Health Organization (WHO) announced it in [10,11], Cuba and Brazil were ready with the capacity to manufacture 50 million doses of the only vaccine in the world that effectively neutralizes the type B meningococcal bacteria. The Cuban Center for Molecular Immunology outside of Havana has developed a number of promising anti-cancer drugs, including Nimotuzumab, a monoclonal antibody that has been proven effective in fighting neck, head, and brain tumors and has shown great potential for combating a number of other life-threatening tumors. It was clinically tested, then manufactured for patient application in joint efforts with companies in India, China, and other countries. In addition, the Center for Genetic Engineering and Biotechnology produced a vaccine to fight hepatitis B, which had been responsible for a significant amount of liver disease on the island, and within eight years had completely eliminated all early childhood cases of the disease.

Collaboration with industrialized countries

The intensification of postgraduate training programs with regional missions and outlooks is considered to be a very worthwhile effort for Ethiopian universities. It is suggested that new collaborative schemes be developed with the newly industrialized and other countries. School of Graduate Studies has made a remarkable progress by implementing various types of programs and producing graduates in various disciplines. This has led to increased research activities within the university. However, graduate training has to be started in a number of key fields. The expansion of such training in all fields and at all levels is a paramount importance because of its contribution towards enhancing the country's development efforts. A number of key issues have arisen with the increase in local graduate training programs.

These include

a. Evolving a sound and efficient management and organizational structure of graduate training and research,

b. Developing mechanisms for monitoring standards and evaluating programs of training and research,

c. Developing appropriate university-industry interaction for disseminating and applying research results, and

d. Fostering useful contacts and linkages with other universities.

Education and training in schools, universities and industry

It is being increasingly appreciated that the creation of a strong workforce depends on a sound educational provision in schools. Therefore, it is vital to give much more attention, at the school level, to generating interest in science and technology and to the provision of a sound education and training in the basic skills. This then provides opportunities for progression either to immediate employment or to technical or higher education. Practicing biotechnologists can also play an important role in supporting education in schools and in teacher training by providing appropriate support in the form of advice, materials and equipment in collaboration with the teachers.

The categories of trained staff needed in research, development and production extends widely from technicians to scientists, all of whom require appropriate training for the specific skills needed. There is also a need for industry to appreciate the value to its commercial success of sustaining the morale of the work force and retaining the services of employees by providing up-dating and re-training courses. Biotechnology is deeply grounded in fundamental science - because it is research based, biotechnology is much more deeply embedded the university system than many alternative disciplines such as information technology and engineering. Consequently, most of biotechnology's research is in university labs. Until recently, commercial organizations did not engage directly in basic research and universities did not engage in commercialization of knowledge to create economic value. The wall between research and commercialization - between universities and business - became much more porous with the passage of Bayh-Dole Act in 1980 because it enabled universities to capture some of economic value of publically funded research.

Various programmes and strategies are used in more developed countries for promoting the understanding of biotechnology among the general public in order to address the anxieties which are inevitably associated with the introduction of unfamiliar technologies, particularly gene technology. However, such programmes are not seen as being a priority for developing countries until a sound biotechnology industry is becoming well

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established. Industries in Ethiopia, both large and small should have their own research and development laboratories headed by well qualified personnel. These industries should be placed to know the research capabilities of the universities. In those areas where applied research is crucial such as engineering and agriculture, there is a need to a built-in mechanism in the universities to ensure smooth interaction with industries. Research should help to increase production by solving practical and realistic problems faced by present industries in Ethiopia, as in agricultural processing plants. In the university there is a need to appoint to head such an applied research group with adequate experience relating to industries.

Integrated skills training for self-employment

In recognition of the role of small and micro-enterprises as the main vehicle for employment generation, and to further integrate women into industry, upgrade indigenous technologies and increase use of local resources, the government has initiated a number of measures to provide full support for the development of the enterprise sector.

The Way Forward

Priorities for advances in education lie in strengthening the school sector, removing social and cultural barriers to work practices and enhancing interactions between scientists and decision makers. The main focus of training should be to enhance the exploitation of indigenous opportunities by introducing innovations, if necessary derived and adapted from appropriate technology and good practice in use elsewhere, this embodies improvements in the use of technology transfer.

There is much benefit to be gained from sharing experiences and expertise through joint ventures involving international, intra-national and inter-sector co-operation. Regarding the availability of financial support for forming co-operative ventures, it is apparent that there is a great need for scientists to gain a better understanding of the provision of funding from governments, international agencies and private sources and the means of access to them. ways should be found to sustain continuing interactions on the issues raised because rapid advances in education and training are vital to the success of biotechnology in developing countries as we enter a period of likely increase in dependence on technology.

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