

Review

Application of science and technology in rural areas (ASTRA): An Ethiopian context

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Developing countries face the challenge of improving living standards of rural people for their sustainable livelihoods. Majority of developing nations are agrarian economies characterized by low productivity operating on smallholdings with inadequate and poor infrastructure. There are several interventions for development and one such potential instrument is the “application of science and technology in rural areas (ASTRA)” which intends to transform rural areas towards development for sustainable and profitable livelihood. It is evident that science and technology has to be adopted to increase efficiency in production, productivity and marketing phases of rural sector. What obstructs science and technology to transform rural areas? The authors of the paper have analyzed taking Ethiopian context to derive the status and other relevant issues on ASTRA in Ethiopia. Ethiopia is one of the poorest countries in the world struggling to transform its rural areas. The country has a well-articulated science and technology policy however; much progress has not been witnessed due to the slow social and economic development process. In generic sense the paper also focuses on the different aspects of the application of science and technology in rural areas. A base document for development workers on ASTRA was the felt need for this publication. This paper will be a pedestal for professionals working on teaching, research and extension on different aspects of ASTRA.

Key words: Application of science and technology in rural areas (ASTRA), economic development, Ethiopia.

INTRODUCTION

There is a need for taking advantage of the recent developments in science and technology in rural areas which is the need of the hour to increase the socio-economic status of the rural population. It is felt long back due to its potential in converting laggard rural areas to the most progressive. Science and technology are two crucial components of all efforts aimed at fostering growth and socioeconomic development of nations (Herz, 1993). Many developing countries face the challenge of increasing incomes of rural sector through different approaches and to minimise the gap between the urban and rural. Most of the developing countries are agrarian economies, which are understood to be low productive

and operating in smallholder capacities. The question before us is that what hinders science and technology to be applied in rural sectors - rural areas. However, there are different reasons according to the contexts. Science and technology has been widely criticized for being a two-edged weapon. Technology has been central and crucial towards attaining food security. The Green Revolution in Asia and Central and Latin America in 1965's are stark examples. Many of the third world nations have been quick absorbers in applying science and technology as a tool for rural development. The necessity of harnessing science and technology in rural Ethiopia is found to be very recent. The present

government in Ethiopia has drafted a science and technology policy aiming to transform rural Ethiopia on identified thrust areas. However, much water has not flown with the vibrant science and technology policy in Ethiopia due to the slow social and economic development process. It was realized by the authors to have a desk based work on the different aspects of the Application of science and technology in rural areas which will be as a base document for teaching, research and extension in this subject. Realizing these facts it was felt to have a publication suitable for lease developed countries nations to understand the different generic aspects of application of science and technology in rural areas (ASTRA) with Ethiopia as a case study.

RURAL ETHIOPIA

Ethiopia is one of the poorest countries in the world endowed with rich natural resources. Different information sources were taken into account for drawing conclusions on certain specific data sets for this part of the work. The total population living in Ethiopia has touched 70 million with an annual growth rate estimated at around 3.2%. Almost 80% of the population in Ethiopia lives in rural areas. With an estimated gross national product (GNP) of \$120 per capita, the number of people living below poverty line is about 45% and the key characteristic of the Ethiopian population is its youthfulness. People under the age of 15 account to 49.1% of the total population; those between 15 and 59 years old account to 46.1%; and those of 60 years or older account to 4.8%. The sectoral distribution of the labour force reflects the agrarian nature of the economy: agriculture and allied activities engage about 88.6% of the labour force; manufacturing, 1.6%; construction, 0.3%; wholesale, retail trade, and catering, 3.8%; transport, 0.4%; and public administration and social, cultural, recreational, personal, and household services, 5.3%. In rural areas, 96.3% of the labour forces are "own-account" workers and unpaid family workers. Life expectancy at birth is only 53.8% of years. Communicable diseases and malnutrition account for the highest proportions of morbidity and mortality. Communicable diseases now constitute 60 to 80% of all diseases in the country. Access to modern health services is very poor. Sources inform that only 46% of the population has access to health facilities, 21%, to safe drinking water and proper sanitation facilities. The overall levels of participation are about 15% for pre-primary education, 22% for primary education, and 20% for secondary education. The overall level of participation in primary education (22%) is one of the lowest in Africa, and it has fallen sharply in recent years as a result of crisis, civil war, and rapid population growth (Yiemene, 1997). From different critic views the social and economic development in Ethiopia has been slow because of:

- (i) Severe structural weakness,
- (ii) Poor economic performance,
- (iii) Inappropriate policies,
- (iv) Short in skilled manpower and higher dependency of expatriate sources to perform many skilled and non skilled jobs,
- (v) Donor driven projects,
- (vi) Limited resources to build national science and technology capability,
- (vii) Absence of a Science and technology policy in the past and
- (viii) Inadequate research capacity in solving the fundamental development problems

Social and economic progress in Ethiopia depends on many factors. In analysing the factors, the country needs appropriate capacity to develop, organize and execute research on the basic rural development issues in Ethiopia. Brain drain in Ethiopia is one of the reasons for this crisis in the decline of research standards. Rural development in Africa is constrained by neglect of the rural non-farm sector (Reardon, 1997), urban bias, in public and private investments and by unfavorable geographical and social institutions (Ali and Thorbecke, 1998). This holds well in the case of Ethiopia too. The United Nations has been working on this aspect for a long time. One of the main goals of the United Nations is to promote advances in the developing countries in order to narrow the material gap that separates them from the industrialized countries. The generation of new knowledge through science and the use of that knowledge for development through technology have been recognized as essential steps in the pursuit of this goal. In 1964 the UN created an Advisory Committee on Application of Science and Technology (ACAST) to advise the Secretary-General on this topic. ACAST recommended that a UN Conference on Science and Technology be convened. The Committee ceased to exist shortly after that conference was held in Vienna in August 1979. The Conference adopted the Vienna Programme of Action on Science and Technology for Development. This had as its principal thrusts: strengthening the capacities of developing countries; restructuring international relations; strengthening the role of the United Nations system; and increasing the financial resources for these purposes (Herz, 1993).

TECHNOLOGY MISSIONS FOR RURAL DEVELOPMENT

The history of technology is no longer than and distinct from science. Science is the systematic attempt to understand and interpret the physical and biological world. While technology is concerned with the fabrication and use of devices and systems, science is devoted to the conceptual enterprise of understanding and

describing the physical and biological world. By the 15th century the emergence of a commercial structure caused some merger purpose of science and technology. This development in science and technology never targeted specially for the rural or urban sector. Later on there were voices from several learned men to diffuse and apply science and technology in rural areas for development. The first of its kind is unknown, with the debate of ASTRA. One of the great leaders in the world, Mahatma Gandhi from India had clearly shown an appreciation of the need to apply science and technology in rural areas. As early as 1935, at the All India Village Industries Association, Mahatma Gandhi has initiated a movement called 'Science for People', with a set of well-known scientists from India (Reddy, 2004). Experiences from developing countries inform that there are two important aspects of ASTRA for promotion:

- (i) Emphasis on research and development of appropriate technology or rural technology for rural development (some differentiate appropriate technology with rural technology, in common they are almost similar with the characteristic feature of being sustainable).
- (ii) Development of the establishment of a new technology extension service system (which may differ from the common technology transfer system for natural resource exploitation and management).

The experiences from different nations who have witnessed rapid development infer that the above mentioned two aspects are the key for progress in rural areas. Many of the nations due to structural adjustments are facing threats with failed attempts towards technology transfer. Huge budget cuts for public extension system are a serious concern. Developing agriculture and rural areas, there is an urgent and concentrated demand for applicable technologies. The issue of inadequate location specific technology for promoting rural areas has been a criticism in several nations. Though public participation in research and development has reversed the situation many countries are serious criers for appropriate technology. It is therefore essential to put emphasis on appropriate science and technology in the process of promoting agricultural production, raising farmers' income and ensuring sustainable rural development. Experiences from different parts of the world are that "it matters at the adoption stages". There are instances where appropriate technologies are promoted through capacity building activities, but are in vain when end users are not provided with critical inputs. Mushroom culture is promoted by many institutes however; the whole technology depends on the regular supply of the critical input "spawn".

Hence, attempts should be directed and given priority of generating and supplying appropriate science and technology to rural areas. A Chinese promoter of ASTRA explains that governments have to work out the strategy of modernizing traditional agriculture under the principles of "high quality, high yield, high efficiency, eco-

friendliness and safety" and building a new socialist countryside according to the overall standards of "growing production, relative prosperity, high ethical standards, clean and orderly villages and democratic management". In this context, the rural science and technology endeavor should not only focus on agricultural production, such as increase of food grain output, but more on promoting urbanization, protecting rural ecosystem, improving farmers' living conditions and building a long term mechanism for raising farmers' income. It derives that rural development is not exceptionally agriculture centered development. Relation to urban has to be strengthened providing more opportunities for greater rural-urban relationship. According to the requirements of building a harmonious society and the objective of building a new countryside, research and development of appropriate science and technology for comprehensive development of rural areas should top the agenda of our science and technology endeavor.

BENEFITS OF APPLICATION OF SCIENCE AND TECHNOLOGY IN RURAL AREAS (ASTRA)

Numerous examples of technological success are evident in our daily lives. Perhaps the most glamorous and widely hailed success is from the fields of medicine, space technology, information and communication systems. There are a number of benefits that rural areas can have while applying science and technology in rural areas at different levels. Adoption of science and technology in rural areas can benefit an individual, a group and largely to the whole society.

The paybacks that ASTRA can support are:

- (i) It helps weaker sections of society including landless labour, migrant labour, slum dwellers etc.
- (ii) It promotes increased productivity without displacing labour,
- (iii) It leads to fuller employment,
- (iv) It facilitates equitable distribution and social equality,
- (v) It motivates people towards self - help and self - reliance and
- (vi) It removes drudgery and helps in improvement of the quality of life of the people.

There are quite good number of cases to illustrate that ASTRA has promoted rural areas balancing the available resources.

POTENTIAL AREAS OF APPLICATION OF SCIENCE AND TECHNOLOGY IN RURAL AREAS (ASTRA)

Some of the potential areas for development is elaborated which has been identified as the possible areas of ASTRA to be applied in different sectors:

(i) Agriculture: The potential areas for the application of ASTRA in Ethiopian agriculture are improving land use, reclamation of waste land, introduction of new cropping patterns, dissemination of improved techniques of cultivation, supply of improved seeds, agricultural tools and marketing facilities, post-harvest technology.

(ii) Animal husbandry: Improvement in livestock, dairy, improvement in fodder supply, development of new fodder, development of poultry, fish culture, etc. are the possible areas for the application of ASTRA in livestock and dairy sectors of Ethiopia.

(iii) Rural and cottage industries: One of the key areas that ASTRA can be applied in rural sectors are the cottage industries that is, Rural engineering.

(iv) Health: Application of ASTRA in health sector is one of the prominent areas and the applications are towards improving health services, supply of pure drinking water, improvement in sanitation, supply of low cost balanced diet.

(v) Water-minor irrigation: Application of ASTRA in water and irrigation are on the Water management including storage and conservation coupled with equitable distribution systems - repair and maintenance of water supply systems.

(vi) Energy: Development of practical application of renewable sources like solar, wind and water power, gobar gas, introduction of improved / smokeless chulhas are the areas that ASTRA can be applied in the energy sector.

(vii) Rural housing: Developing economies need to work on rural housing strategies and the areas to apply ASTRA are towards designing, constructing and fabricating cheap and affordable houses in rural areas using locally available material and local labour.

(viii) Roads and communication: There has been a large thrust provided towards roads and communications in the recent decades in several countries however, the application of ASTRA is on the improvement in village roads, transport and communication systems.

(ix) Rural Education: Computer technology, literacy campaigns, improvement in attendance, reduction of dropouts, etc.

ETHIOPIAN CONTEXT

Amongst the eight "Millennium Development Goals" set by Ethiopia, the first goal calls for halving the proportion of people living in extreme poverty and hunger by 2015, relative to a baseline of 1990. Poverty in Ethiopia is persistent. In rural Ethiopia, over 45% of the population is below the national poverty line and 49% are malnourished. Clearly, achieving the poverty and hunger goals in Ethiopia requires a focus on rural development including environmental conservation and rehabilitation, increasing agricultural productivity; and, improving income generation opportunities. In addition, alleviating

hunger requires targeted nutritional interventions. Expert opinions agree that an expanded investment in the areas of promoting increased agricultural productivity, market development, employment creation and food security is required if the hunger and poverty goals are to be achieved in Ethiopia.

Ethiopia is still a victim of several problems with drought and famine, scarce employment opportunities, shortage of energy and other pressing needs. Hence, Ethiopia looks forward to

- (i) Envisage massive social and technical changes,
- (ii) Accelerate agricultural and industrial productivity,
- (iii) Facilitate the means for a rational conservation and use of natural resources,
- (iv) Provision of basic necessities of life (food, clothing, shelter, education, energy, etc),
- (v) Modernize communication networks,
- (vi) Improve the standard of living of people ,
- (vii) Keep abreast with the technological advancement of the 21st century and
- (viii) Extensive popular participative and sustained Science and Technology (S&T) capacity building is a requirement.

The scientific and technological advances of the past years have made most third world governments well aware of the important role of science and technology for national development. However, least developed countries like Ethiopia have limited resources to allocate for their science and technology capability building. This leaves no choice for these countries other than to plan and commit a share of their limited resources for a long term Science and technology capability building. Such a long-term undertaking, however, can only succeed if it is guided by a clearly enunciated S&T policy. According to an assessment conducted on the prevailing S&T situation in Ethiopia, lack of a clearly articulated policy has handicapped the growth, and application of S&T at the national and specifically rural development. Hence, the situation is characterized by

- (i) Unnecessary duplication of efforts,
- (ii) Programme redundancy,
- (iii) Uneconomical/wasteful/ use of limited resource,
- (iv) Continued dependency on foreign technology and above all,
- (v) Absence of national capability to bring about sustained, self reliant and popular-based socio-economic development.

Thus, to reduce the level of dependency and to increase the supply of locally required technology, the development of a planned technical infrastructure becomes a necessity. The government of Ethiopia issued the science and technology policy in order to build the country's science and technology capability, to coordinate

related activities and to enhance their contribution to national economic development. Although the intention of the government is to promote balanced and integrated development, it is difficult to build all the necessary science and technology capability owing to limitations for investment. Therefore, based on the country's development policy directives and in view of the need to alleviate the basic and urgent problems of the people, the science and technology policy accords priority to the following sectors and programmes. It has been noted that sectoral science and technology policies and programmes are formulated by the respective sectors on the basis of this national science and technology policy.

APPROPRIATE TECHNOLOGY AND APPLICATION OF SCIENCE AND TECHNOLOGY IN RURAL AREAS (ASTRA)

Development and dissemination of appropriate technology for rural areas is considered to be crucial in ASTRA. The equation balances with appropriate technology and the characteristic features of rural setting. A technology that is appropriate to the environmental, cultural and economic situation that it is intended for is normally defined as appropriate technology. In this sense an appropriate technology, typically requires fewer resources, which means lower cost and less impact on the environment. In practice, it is often something that might be described as using the simplest and most favorable level of technology that can effectively achieve the intended purpose in a particular location. Appropriate technologies are:

- (i) Suitable for use in developing nations or underdeveloped rural areas of industrialized nations, which may lack money and specialised expertise to operate and maintain high technology.
- (ii) Labor-intensive solutions usually preferred to capital-intensive ones, although labour-saving devices are also important where this does not mean high capital or maintenance cost.

The terminology is not very precise. Isolated rural communities in developed nations may also benefit by using some of the same technologies. On the other hand, large cities in developing countries may find it more appropriate to use technologies usually found in wealthy countries. An expensive technology may be the most appropriate in a wealthy community with the ability to pay for and maintain it. What exactly constitutes appropriate technology in any given case is a matter of debate, but generally the term is used by theorists to question high technology or excessive mechanisation, human displacement, resource depletion or increased pollution associated with unchecked industrialisation. The term has often, though not always, been applied to the

predicaments of developing nations or underdeveloped rural areas of industrialized nations. It could be argued that "appropriate technology" for a technologically advanced society may mean a more expensive, complex technology requiring expert maintenance. Appropriate technology came into some prominence during the 1973 energy crisis and the environmental movement of the 1970s. The economist (and former British Coal Board advisor) E. F. Schumacher of the UK was one of the originators of the concept.

Characteristics of appropriate technologies

Appropriate technologies possess certain characteristics that are unique and are of utmost important for rural development workers to understand in identification and for its promotion.

a. Idea, operation and maintenance

- (i) Low cost and low maintenance
- (ii) More frequent maintenance can be considered appropriate, if the maintenance can be done with locally available skills, tools, and materials.
- (iii) It is usually "appropriate" to use only technologies that can at least be locally repaired.
- (iv) Not necessarily "low" technology-appropriate technology can benefit from the latest research, as with the cloth filter, which was inspired by research into the way cholera, is carried in water. It may use very recent technology too.

b. Sustainability

Features such as low cost, low usage of fossil fuels and use of locally available resources can give some advantages in terms of sustainability. For that reason, these technologies are sometimes used and promoted by advocates of sustainability and alternative technology.

Examples of appropriate technologies

Some technologies that may be considered as appropriate technology in the right context are discussed below. Below are some examples of appropriate technologies from different fields using different resources, ranging from individual human to community needs.

1. Information and communication technology

The **2B1** and the **Simputer** are computers aimed at developing countries, their primary advantage being low

cost. Other relevant factors include resistance to dust, reliability and use of the target language.

2. Construction

Adobe (including the variation called super-adobe), Rammed earth, Dutch brick, and Cob could be considered appropriate technology for much of the developing world, as they make use of materials which are widely available locally and are thus relatively inexpensive. The local context must be considered as, for example, mudbrick may not be durable in a high rainfall area (although a large roof overhang and cement stabilisation can be used to correct for this), and, if the materials are not readily available, the method may be inappropriate.

3. Energy

- (i) Electricity can be provided from solar cells (which are expensive initially, but simple), wind power or micro hydro, with energy stored in batteries.
- (ii) Biobutanol, biodiesel and straight vegetable oil can be appropriate, direct biofuels in areas where vegetable oil is readily available and cheaper than fossil fuels.
- (iii) Biogas is another potential source of energy, particularly where there is an abundant supply of waste organic matter.

4. Cooking

- (i) Smokeless and wood conserving stoves promise greater efficiency and less smoke, resulting in savings in time and labor, reduced deforestation, and significant health benefits.
- (ii) Solar cookers are appropriate to some settings, depending on climate and cooking style.

5. Health care

A phase-change incubator, developed in the late 1990s, is a low cost way for health workers to incubate microbial samples.

6. Refrigeration

The pot-in-pot refrigerator is an African invention, which keeps things cool without electricity.

7. Water treatment

The Life Straw is a small manufactured device, which allows the user to drink straight from unclean water.

8. Sanitation

BiPu is a portable system suitable for disaster management, while other forms of latrine provide safe means of disposing of human waste at a low cost.

BOTTLENECKS IN ADOPTION OF APPLICATION OF SCIENCE AND TECHNOLOGY IN RURAL AREAS (ASTRA)

Technology is central in reducing rural poverty and to achieve rural development. In 1965 - 1985, rice, wheat and maize, in Asia and Central America, experienced a big technology shift, the 'Green Revolution', that increased yields, enhanced employment and brought about a rapid fall in poverty. Technical progress has by-passed hundreds of millions of poor people – many of the remaining hardcore poor – in specific regions (including most of Africa), agro-ecologies (dryland, upland), and products (sorghum, yams, cassava, smallstock). Water resources in many areas, and land in some areas, face serious threats of depletion and pollution, which appropriate technical change can reduce or reverse. Recent scientific advances bring new prospects for spreading to laggard areas and crop the technical progress that can reduce poverty and conserve resources. There is no dearth for technologies to be adopted by the rural sector for changing lives of rural people. To adopt and apply science and technology at different levels (individual, groups or society as whole) there are different problems or impediments, which has to be critically analyzed.

Impact of technology on societies

When a technology is introduced into a society, it forces other parts of society to give way. In fact, a new technology can reshape an entire society. There are five ways that technology changes society.

a. Replacing the old technologies

The first impact is felt by the technology that is being displaced. For example: the rotary dial telephone is an exhibit in many instances. Some of us still use these machines, but they are clearly condemned to extinction in the wake of newer, more efficient telephones. Similarly the IBM electric typewriters "state of art" equipment just a few years ago, have been rendered practically useless by computers.

b. Changes in social organization

Technology also changes social organization. Machine technology gave birth to the factory. Prior to machine

work, most workers labored at home, but the advent of power driven machinery made it more efficient for people to gather in one place to do their work.

c. Change in ideology

Technology also changes ideology. Karl Marx saw the change to the factory system as a source of separation. He noted that workers who were assigned repetitive tasks on just a small part of a product and could therefore no longer take pride in it. They became separated from the product of their labour. Marx said, which bred dissatisfaction and unrest. Marx also noted that the new mode of production, factories, gave powers to owners to exploit workers.

d. Transformation of values

Just as ideology follows technology, so do values. If technology is limited to clubbing animals, then strength and cunning are valued. So are animal skins. No doubt some man and women of the primitive age walked with heads held high as they wore skins of some especially dangerous animals-while their neighbors looked on in envy as they trudged along wearing only the same old sheepskins.

e. Transformation of social relationships

Technology also changes social relationships. As men were drawn out of their homes to work in factories, relationships changed. No longer present in the home on a daily basis, the husband father become isolated for many of the day-to-day affairs of the family. One consequence of husband becoming strangers to their wives and children was a higher divorce rate.

Factors responsible for non success of application of science and technology in rural areas (ASTRA)

There are several reasons for non-success towards the application of science and technology in rural areas. Amongst many of the reasons one of the strongest has been the bias towards urban, industrial and defense needs. By and large many of the colonized and non-colonized nations fashioned and imitated their research and development activities as westerners do and the technology focused on the needs of urban settlements and industry. It is reported that many of the S&T efforts from the developing world was not in favour of the needs of rural areas. The commercialization of improved technologies in rural areas has been shown to involve a number of actors operating at various levels and the

impediments faced by the actors are described below. In South Africa the government has taken criticism, particularly from the NGO sector, for not doing enough to address the abject poverty in some rural communities, with the result that these communities continue to be excluded from the mainstream of economic activity. The critics have accused the government of deploying all its scientific resources in pursuit of high-level industrial activities, rather than harnessing technology to help alleviate poverty and improve the quality of life. Marias (2005) reports that "the key question is what contribution science and technology can make to improve the level of quality of life in such communities". The dual nature of the South Africa's economy poses complex challenges to its national system of innovation (including Science and Technology (S&T) policy). On the one hand, the system must stimulate and support internationally recognised scientific excellence, high tech development and (international) technology transfer. On the other hand, it also has to contribute substantively to the development of the disadvantaged section of society, through research, technology development and transfer. Both these strategic objectives are accounted for in South Africa's science and technology policy. A systems model of innovation and technology transfer identifies an innovation chasm at the lower end of technology transfer. Bridging that chasm is as much the challenge of optimising the transfer of available technology, as it is of developing new technology. Based on the selected data from own empirical studies, literature and policy, two approaches are suggested by Marias which are as follows:

- (a) That raising the knowledge and skills levels in deep-rural communities and
- (b) Addressing social factors and dynamics in development (social hierarchy, values) should enhance the transfer of innovation and technology in rural areas.

The arguments lie in certain contexts a chasm at the lower end of technology transfer has become a great challenge. To override the chasm it is essential that nations develop exclusive systems of technology transfer for rural areas.

Commercialization of rural technologies

Rural technology users

Rural people, however, are unaware of the advantages of the technology and of its cost-effectiveness. This hampers for the adoption of technology.

a. The issue of investment and poor: Though the user is knowledge about the technology, the difficulty in adoption lies with the investment. Rural poor may not be

able to adopt the technology. This hampers the adoption of technology in rural setting.

b. The issue of benefits: Do the benefits of the improved technology justify the increased investment? The answer to this question depends upon whether the technology user is prepared to invest capital resources now in order to reap the regular benefits in the future. In other words, is the technology user prepared to postpone current consumption for the sake of future benefits? Normally, when there are questions, if not answered properly may hamper the adoption of technologies.

d. The issue of operation and maintenance: There is the class of technology users who are knowledgeable, can afford the improved technology and are motivated, but are nevertheless completely helpless in the face of all the problems that must be tackled in identifying, procuring, installing, operating and maintaining the associated devices and equipment.

Technology manufacturers

Further, in many technologies, the design of the product/process may have to be modified to suit local conditions. The engineering for manufacturing involves a considerable product/process development effort. Further, the effort requires competent manpower, technical facilities and substantial funds.

There are two categories of barrier to the effective commercialization of rural technologies:

Endogenous barriers: They are internal to the process itself at the level of technology users and technology manufacturers; and

Exogenous: Barriers, which arise out of non-supportive elements in the environment for the process of commercialization at the level of resource producers and distributors, financial institutions and government decision makers.

Case of application of science and technology in rural areas (ASTRA), India

Though, the importance of science and technology for rural India was appreciated in the 1930s by Gandhi, giving rise to the work of the Centre for Science for Villages, advanced institutions of education, science and technology turned their attention to this area only in the 1970s. The most well-known of these efforts was from the Indian Institute of Science with its programme for the application of science and technology to rural areas known by its acronym ASTRA.

ASTRA (recently renamed as Centre for Sustainable Technologies) was based on a model of science -

technology interactions in a 'dual society' like India with small affluent elite amidst a large economically deprived majority living primarily in rural areas. The model showed that *inter alia* an extension centre and a mission-oriented programme would be required to develop technologies to address the normally ignored needs of the rural population (Reddy, 2004)

The Department of Science and Technology of India informs that societal programmes have aimed at deriving optimum benefits by careful management of resources, S&T experience and skills vis-a-vis needs of the people. India has worked with specific intervention packages for the benefit of people in rural areas, particularly weaker sections such as women, tribals and people belonging to scheduled castes. The attempts have been with individual research projects to professionals in developing sustainable technology models, large numbers of replicable models demonstrated over a few years have started getting recognition from various agencies. Such models are now being replicated in very large numbers through various ministries as well as international agencies like United Nations. The interface between technology institutions and S&T field groups has also been promoted specifically to encourage voluntary organizations to adopt S&T as part of the process of change. Capacity to organize such research projects leads to development of viable technologies for rural and weaker communities.

One of the pioneering attempts in the technology generation for rural development has been the core support programme of the Department of Science and Technology in India. This programme has provided unique opportunity of pursuing action oriented research and development work by interested scientists, especially from the younger generation, committed to work in the field of rural development. It has also helped in local networking and coordination amongst various science and technology based voluntary organizations and developmental agencies. Core grant was continued to 18 field groups during the year. Two new groups have been selected for core support this year. These core supported organizations are working in different geographical locations at the grassroots level focusing on cost effective technological interventions on location specific problems covering sectors such as sustainable agriculture and agro-processing; micro-watershed management; rural housing and sanitation; renewable energy; artisanal technology and rural industries covering rural engineering aspect as well.

A case study of the core support programme - Tapioca chipping machine

Society for S&T Application in Rural Shelters (STARS) developed a design for a machine, which can be operated either by electricity or hand for chipping opera-

tion of tapioca tubers with minimum time and labour. This also helps in increasing the output as well as the operational convenience. The system developed consists of (i) driving mechanism (ii) blade assembly (iii) feeder assembly and supporting assembly. Development and introduction of this new technology reduces the drudgery and cost. The chipping operation makes the bulky tuber more manageable and also reduces the sediment traces of hydrogen cyanide present in certain variety of tuber.

TECHNOLOGICAL BACKWARDNESS OF ETHIOPIA

The technological backwardness of a country can be explained in different ways. However, the common understanding is that "technological backwardness is that a country lagging behind the progress and development of others of comparable status". In the field of science and technology (S&T) of Ethiopia the scientists, engineers, technicians, and skilled workers are in short supply, which indicates the development technologies is very limited and which makes to be interdependent for foreign technologies.

Agriculture

- (i) In Ethiopia, agricultural production is very low compared to several developing nations and countries even in Africa. The major crops maize and wheat yield about 1.8 and 1.2 t/ha against the world average of 5 and 2.5 t/ha respectively.
- (ii) Ethiopia has to improve its agricultural practices and provide farmers with incentives to use their existing resources to the fullest extent for maximum production.
- (iii) Although the R&D infrastructure appears solid and research efforts are being made in many spheres, agricultural production is still faced with many problems.
- (iv) Although the peasant is the main contributor to agricultural production, the socioeconomic and technological setup has not been transformed.
- (v) The peasants and their production systems have not been studied well enough to identify the real bottlenecks and determine possible solutions for improvement.

Environmental protection and rehabilitation

- (i) The accelerated population growth and its uneven distribution in the country have placed considerable pressure on natural resources, such as the soil, water, plants, animals, grasslands, and forests
- (ii) Lack of efficient sewage-disposal and sewage-treatment systems in areas of concentrated settlement has resulted in the deterioration of environmental quality.
- (iii) Human resources and appropriate S&T services are not well enough developed in Ethiopia to meet the

requirements for environmental protection and development.

Water

- (i) Ethiopia possesses rich water resource but Ethiopia has not made much use of its water potential. Adequate clean water is available to only 19% of the population.
- (ii) Hydropower exploitation stands at less than 2% of its potential.
- (iii) Potential for sustainable yield of inland fish resources at 30000 t/year.
- (iv) The involvement of S&T in the development, conservation, and management of water resources is a recent phenomenon in Ethiopia and is at a low level.
- (v) The impact of these R&D activities is far from significant. However, the recently established Arba Minch Water Technology Institute is expected to supply intermediate- and high-level training in water technology and strengthen and promote R&D activities in the field

Energy

- (i) Ethiopia's energy resources are said to be plentiful, but the level of exploitation is very low.
- (ii) 94.1% of the energy is drawn from traditional biomass fuels, such as firewood, charcoal, crop residues, and cow dung.
- (iii) The nation's traditional biomass resources are quickly depleting. The country once had up to 16% forest coverage, but now this is estimated to be only 2.7%
- (iv) The use of S&T is a top priority in the exploitation of available energy resources, reduction of energy waste, and substitution of nontraditional energy resources for traditional energy resources, whose excess use is resulting in catastrophic environmental damage.
- (v) The absence of clear policy and strategy, a weak institutional capacity, and a lack of coordinated effort in the application of S&T are manifest in the energy sector.

Industry

- (i) Ethiopia's industrial sector is backward in its sectoral structure, employment, and technological content. The current contribution of the sector to the GNP is about 12%, about one third of which comes from handicrafts and small-scale industries.
- (ii) Basic industries, such as design, fabrication, and metallurgy, which are crucial for the development of the industrial sector, are hardly existent.
- (iii) This situation is due to the absence of an S&T policy and strategic master plan and effective coordinating and promoting mechanisms.

Construction

- (i) Construction is second to agriculture in generating employment in Ethiopia.
- (ii) Capacities in construction, as well as in manufacturing of construction materials, are in a better setting than in other sectors. This is because fairly reasonable institutional and infrastructural bases exist for design and construction in both the public and private sectors. The sector can also be said to have better developed skilled labour.
- (iii) At present, R&D in the construction sector is conducted mainly in the production of wall and roofing materials.
- (iv) R&D on domestic raw materials to reduce the sector's dependence on imported materials is far from what it should be. R&D has been conducted by various institutions, departments, and units in a scattered and uncoordinated manner. Little progress has been made in generating efficient and effective indigenous technologies to fit the available material and human resources, especially in low-cost housing construction.
- (v) The sector has no centrally organized institution to support and carry out R&D.

Transport and communication

- (i) Road transport is very important for Ethiopia, which accounts for 93% of cargo and passenger transport. Road transport is widely used but is possible in only a limited portion of the country. Currently, every 1 000 km² of land area has about 12.3 km of roads.
- (ii) All the machinery and equipment and almost all the spare parts used in this sector are imported. There are few local industries and workshops engaged in bus and truck assembly, sheet-metal bodywork, parts rectification, or general maintenance.
- (iii) The promotion of R&D, design, and technology-acquisition capabilities is virtually nonexistent, in institutional form or otherwise, although these are needed to solve the technological problems of the sector. Only the Ethiopian Air Lines and Ethiopian Telecommunication Authority have clearly set criteria for acquiring new equipment and developing human resources to operate and maintain new technologies. The sector's problems that could be solved by indigenous R&D will continue unless RDIs are set up and people are trained.

Mineral

The mineral wealth of Ethiopia has not been extensively assessed. Most of the technologies used in the mining sector for mineral exploration and development are imported. This has led to the accumulation of a variety of technologies that cannot be effectively used because of a lack of spare parts and maintenance capability.

Health

- (i) The major health problems in Ethiopia are communicable diseases and disorders arising from nutritional deficiency.
- (ii) The prevalence of intestinal parasites and infections reflects poor sanitary facilities and a lack of education.
- (iii) The sparse coverage of health services can be illustrated by the population - bed ratio, which stands at about 4300: 1, and by the population - doctor ratio, which stands at about 31000: 1.
- (iv) S&T is especially important in the development of health services. The world is fast advancing in the use of S&T for both the diagnosis and the treatment of health problems. Disease prevalence is not universal but depends very much on socioeconomic and ecological variations, so research is needed on treating area-specific diseases. Little research has been done on using modern S&T to improve and develop traditional medicine.
- (v) Ethiopia is known for its fauna and flora, which are the basic inputs to traditional or modern medicine. Ethiopia has made no use of this wealth.
- (vi) As a result of a lack of conscious effort to make use of S&T in health services, even the few R&D activities undertaken are uncoordinated.

Education

- (i) The country has more than 18 technical and vocational schools and institutes.
- (ii) Training is dispersed and uncoordinated and emphasizes the short-term requirements of their respective enterprises, rather than the overall systematic building of technological capability.
- (iii) The universities suffer heavily from inadequately equipped and furnished laboratories and a lack of workshop equipment and teaching materials. A conducive environment for learning and effective R&D hardly exists.
- (iv) About 14 specialized research institutes, inside or outside the higher education system, undertake R&D. Like the higher education system itself, these research institutes lack adequately trained staff and research materials. It has been established that within these 14 institutes, only 6% of the staff have doctorates.
- (v) The educational system neither lays the required foundation nor provides the right type of trained personnel for R&D. Based on the fact that R&D is not coordinated with production and development programs, little use is made of R&D results. To date, with only a few exceptions, research results end up merely as reports or as published articles in periodicals and journals. Because of the lack of research coordination and the absence of a clearing mechanism for research activities, duplication of research is common.

Problems of science and technology in Ethiopia

The major problems in S&T development of Ethiopia elicited below is from the extract of the work done by Yiemene (1997). The experience of the authors is also inculcated in this discussion.

There is an absence of action oriented S&T policies and strategies, at national and sectoral levels, to build national S&T capability:

- (i) Lack of a well-defined plan based on identified priorities and integrated with the national economic planning process;
- (ii) High dependence on foreign sources of technology;
- (iii) Low priority given to R&D activities and absence or underdevelopment of S&T terms and concepts in different languages;
- (iv) Low productivity of traditional technologies and inadequate attention given to their improvement and development;
- (v) Nonexistence of a strategy to build managerial and administrative capability in S&T;
- (vi) Non existence of a systematic linkage between research and extension systems;
- (vii) Absence of conscious effort to increase the participation of women in S&T activities;
- (viii) Low priority given to S&T activities to address women's needs;
- (ix) Poor-quality S&T education at the primary, secondary, and tertiary levels and inadequate availability of vocational training institutes in various technical fields (in general, the educational system fails to inculcate curiosity about research and a sense of the priority of inquiry);
- (x) Inadequate university programs and facilities for postgraduate research;
- (xi) Absence of conditions conducive to technological culture in society and absence of rewards or an effective incentive system to enhance S&T activities;
- (xii) Insufficient S&T human resources at all levels of activity and underuse of the existing S&T human resources;
- (xiii) High dependence on expatriate human resource in the field of teaching, research and extension;
- (xiv) Lack of effective S&T institutions at the grass-roots level (for example, field experimental stations and production and service centres) for creating site-specific technologies; Inadequate research facilities for undertaking S&T activities in the critical new and emerging technologies;
- (xv) Inadequate support services for R&D or for development, dissemination, acquisition, or application of technologies.
- (xvi) Lack of capability in identifying, transferring, and adapting technologies appropriate to the country's needs;
- (xvii) Weak engineering and consultancy capabilities;
- (xviii) Lack of a well-coordinated and strong S&T information system;

- (xix) Lack of effective S&T popularization programs, resulting in inadequate promotion of S&T in the society;
- (xx) Lack of appreciation in various production and service sectors of the importance of building S&T capabilities; and
- (xxi) Lack of effective coordination among scientific establishments, leading to the fragmentation of national research efforts.
- (xxii) The degree of deficiency in S&T capability varies from one sector to another and may vary among subsectors. Where serious inadequacy or complete lack of capability can be perceived, it is imperative to formulate strategies, measures, and programs to build and bring specific elements of S&T capability to the required levels rapidly and then harness these elements for sustainable development.

CONCLUSION

A project on the popularization of science and technology in Ethiopia concluded that there are a number of ministries and other governmental and non-governmental organizations in Ethiopia which have initiated programs to popularize science and technology related to their specific areas of concern. They have used different media such as radio, newspapers, television, pamphlets, newsletters, illustrated materials, and films, for communicating with their audiences. However, such measures have been partial and uncoordinated and no attempts have been made to evaluate their effectiveness in contributing to development (IDRC,1992). It is evident that theoretically arguing ASTRA would be ease with relevance to rural development. Practically arguing one may be tended to ask a vital question though realizing the potential and need in rural areas why it's not happening? The western fashion of research and development initiatives, investments on research on urban needs and more on defense purposes are some of the often quoted reasons for the non success of ASTRA in several developing nations. Some of the measures that can merit ASTRA are:

- (i) Escalation in the total expenditure on R&D,
- (ii) Augment in number of S&T agencies/organizations,
- (iii) Increase in the number of constituent S&T institutions,
- (iv) Increase in the number of technical personnel,
- (v) Fair allocation of R&D investment towards rural needs,
- (vi) Fair distribution of R&D allocation in rural areas,
- (vii) Fair distribution of R&D technical personnel and
- (viii) Fairness in the focus of plans.

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