

From Inventors to Innovators: An Investigation into Individual Inventors in Tanzania

**Bitrina D. Diyamett
Richard Mabala**

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newtec@mitsumi.net

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Acronyms

COSTECH	Commission for Science and Technology
IFIA	International Federation of Inventors' Associations
IPRs	Intellectual Property Rights
NSI	National Systems of Innovation
R&D	Research and Development
TAI	Tanzania Association of Inventors
TASTA	Tanzania Awards for Scientific and Technological Achievement

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Abstract

Although technological innovation has lately been accepted as a key aspect in socio and economic development and therefore poverty reduction, poor countries such as Tanzania have largely been left out of the process. One major reason for this has been the concentration on technology transfer that does not take into account a conscious and deliberate effort in building indigenous technological capability. However, despite this fact, there are individuals, especially in the informal sector, who are inventing and innovating to the extent of coming up with inventions which have been declared new to the world. But the diffusion of these inventions is largely constrained by factors that include: level and nature of science education, and a research system that creates and reinforces dichotomy between science education and system, and societal needs; globalization and privatization; recognition and hence reward by the government; tax incentives; venture capital and Intellectual Property Rights (IPR) system.

Lastly, the study is proposing long and short term measures that will reduce the effects of system obstacles.

Introduction

1.1 Background to the Research Problem

The world today is in a process of rapid transition. Political alignments, economic systems and social values are all being transformed and it is increasingly being recognized that, at the base of these transformations is the acceleration of scientific and technological advances in some areas of the world. This has also added strong impetus to the trend towards globalization. However, in such a situation, those who benefit most are those who own and control the process. Thus, one of the chronic problems facing most poor Third World countries such as Tanzania and other countries in Sub-Saharan Africa is the conspicuous lack of technological innovation, especially indigenous innovation. Technological innovation has been recognized by scholars as well as politicians and economic practitioners as having a crucial role to play in creating a better life for people in these poor countries, yet the reality on the ground shows that such recognition has not been translated into appropriate action.

One of the reasons for this has been the belief that the best technological road to a better life for poor developing countries was technology transfer. There was no need to reinvent the wheel and any wheel invented somewhere else could easily be adapted to local conditions. While this is true, a certain level of indigenous technological capability, especially absorptive capacity is a prerequisite. The problem has been that those responsible for such transfers often do not take this fact into account. Consequently, technologies were transferred wholesale with little or no attempt to build local technological capability. As Fransman (1986) succinctly stated in regard to the Third World: "Previously, attention was focused largely on the question of choice of technique and cost of transferring foreign technology". As a result, little or no attention was paid to indigenous innovation capacity building.

1.2 Statement of the Problem and Research Questions

Despite the lack of attention on indigenous innovators and inventors, such people do exist. In the course of our previous research on *Diffusion of Technological Innovations to Rural Women: the Role of Entrepreneurship* (1997), in a mere 16 villages in four districts of Tanzania, we stumbled upon several potential and actual technological inventors and innovators at all levels of society right down to the community level. In most cases, they have invented new technology (even though not in the area of high technology) or made radical adaptations to existing ones. What is interesting is that

most of them are not employees of research and development (R&D) institutions or similar organizations, and therefore have none of the institutional advantages of other researchers. In addition they have, to date, gained little significant profit from their inventions and innovations as a result of unfavorable system factors such as venture capital to turn inventions into innovations, economic hardship and a general lack of recognition and support for their activities from both state and private enterprise. Yet they still continue to experiment and innovate.

In one sense, a preliminary step has been made. The Tanzania Commission for Science and Technology (COSTECH) for instance, tries with very limited resources, to identify and even award a few technological inventors and innovators. However, such an initiative is inevitably limited. First, as observed by Wangwe (1996):

The recognition through TASTA (Tanzania Awards for Scientific and Technological Achievement) seems to be a symbol of recognition once the results of an invention is out, but support before and after the invention (for example, in terms of financing R&D is not ordinarily provided for).

Second, there has been no systematic effort to make a comprehensive inventory of such people, and more importantly for any sustainable technological development, there has been no in-depth study of these important individuals and their environment. They tend to be treated like a 'black box' out of which inventions and innovations naturally come out. The primary objective of this work is therefore to open the black box and examine its contents with the intention of identifying what specific characteristics of inventors and environments emerge under which the inventions took place in relation to Tanzanian technological inventors and innovators, and maybe for other African countries as well. The intention is to establish concrete policy directives that would enable inventors to turn into successful innovators.

Specifically, the research will address the following questions:

- (a) What made them inventors/innovators? Where did the original impetus come from? What encouragement did they receive from family, community or educational environments?
- (b) For those who have turned their inventions into innovation, what facilitated the process?
- (c) What motivates them to continue inventing and/or innovating, both from within themselves and from the environment in which they live? What support have they received from institutions and individuals?
- (d) What constraints have they faced/do they face in their work? What do they feel they need in order to be more successful and effective?

On the basis of the answers to the above questions, an attempt has been made to come up with the necessary educational background and environment that can enable inventors and innovators to emerge and succeed.

Two groups of people have been dealt with:

- The inventor who, as a result of either personal or environmental factors has failed to turn his/her invention into an innovation.
- The inventor who succeeds in transforming her/his invention into an innovation (technological entrepreneur).

1.3 Research Objectives

The broad objective is to identify special characteristics of innovators, innovations or inventions and the environment that leads to successfully moving an invention to an innovation. The specific objectives were to find out from the inventors and innovators and document:

- (1) The influence of family and society, including significant role models.
- (2) Educational background (subjects preferred, academic progress, level of education).
- (3) Previous work experience and factors which have facilitated or constrained their innovative activities.
- (4) The institutional support and general environment they require in order to be successful innovators.

2. Literature Review: Some Theoretical and Conceptual Issues

Even though there is a dearth of literature on indigenous technological innovation in the African context, the available literature on technological innovation, though largely based on studies of the environment of the developed world, can guide the study by taking into account differences in the socio-economic environment.

2.1 Definition of Technological Innovation

The essence of innovation is novelty; innovation is both the process of introducing something new and the new thing itself. Thus technological innovation refers to newly introduced technologies (whether in terms of skills, processes or equipment). It should also be remembered that innovation can either be radical (completely new) or incremental (small modifications). Sometimes accumulation of small increments results in a radical innovation (Rosenberg, 1982). If the invention is a new piece of equipment, the first to sell the equipment and the first to use it are both innovators (Rosenberg, 1982). The first person is a product innovator while the second is a process innovator.

Normally a commercial connotation is attached to technological innovation as it is sometimes defined as a creation of a new marketable commodity. However, for the purpose of this work, innovation also includes non-commercial practical use of an invention.

The definition of innovation is derived from an important terminological distinction between invention and innovation, which are sometimes wrongly taken to be one and the same. However, these are two distinct processes. Invention refers to the creation of something new (which may or may not be then introduced into the market place) whereas innovation is the process whereby an invention is successfully introduced into the market place and diffused. According to many scholars (Coombs, 1987; Resenberg, 1982; Fransman, 1986 inter alia) the process of innovation actually starts with the most basic laboratory investigation although in most cases this is prompted by some market or need signals. Invention is therefore one step in the innovation process and inventors are those who start the process by creating something new, while innovators are those who commercialize the invention. In some cases, the inventor and the innovator are the same person.

In an economic context, innovation can also be equated to technological entrepreneurship. According to Adeboye (1995), technological entrepreneurship refers to the creation of a new business based on the exploitation of a technological innovation or the expansion of an existing business through the

acquisition and marshalling of resources for the creation of a small (at arm's length) venture through a spin-off from the parent company. This is also similar to Schumpeter's argument, based on his technology push model that innovations are brought about by entrepreneurs.

With regard to technological entrepreneurship, a distinction can be made between the entrepreneurial act of an inventor and that of another entrepreneur who merely uses the invention of another institution, individual or firm. An innovator who goes on to start a business on the basis of his invention is referred to as an "inventor entrepreneur". In the case of more developed countries, a good example is spin-off companies that are normally started by university professors based on their own research outputs. On the other hand the term "surrogate technical entrepreneur" can be used for the entrepreneur who takes inventions made by others to launch an independent new venture (Adeboye, 1995). This research concentrated only on inventors and innovators who use their own inventions to come up with an innovation. We consider them more important than innovators who use inventions made by others or surrogate technical entrepreneurs for two reasons.

- The inventors are the initiators of the innovation process.
- In Tanzania, where the standard of living is very low and the means of communication are very poor, the inventors have the highest potential for starting the process since they often invent in response to their own environment and then translate their invention into a commercial venture or any other practical use at the local level. By contrast, because of the environmental problems mentioned above, it will be much more difficult for surrogate entrepreneurs to identify and develop inventions of others.

2.2 Origins of Technological Innovations: The Context of the Developed Nations

Forces behind innovative activities are still a headache for scholars of technological innovation, and still a major subject of inquiry in the innovation literature. In the recent past, two oversimplified theories of innovation dominated the debate — technology push and demand-pull. According to the demand-pull theory, innovation arises out of perceived and often clearly articulated market needs. This leads to focused R&D activities creating a host of products for the market (Rothwell, 1985). The rationale behind the theory is that production units within the markets recognize customer needs and direct their efforts to fulfill those needs through technological activities (Dosi, 1984). The actors in the market, that is the adopters, can be private firms, government or domestic consumers.

According to the technology push theory, discoveries in basic science eventually lead to technological development, which results in the flow of new products and processes to the market place (Rothwell and Zegveld, 1985, cited in Diyamett, 1993. See also Mallecki, 1991 and Rothwell, 1992). Here the market plays a minimal role in the innovation process and only acts as a repository for R&D results.

In this theory, the entrepreneur occupies a central position (Schumpeter, 1934, cited in Coombs, 1987, Rosenberg, 1982, Kaplinsky, 1990, Diyamett, 1993, Diyamett and Mabala, 1998). According to Schumpeter's economic perspective, the drive to innovate comes from the work of an entrepreneur who discovers, often in the existing pool of knowledge, commercially untried ideas, which he or she

introduces into commercial life. Although the entrepreneur has to overcome barriers caused by old techniques, and existing habits and institutions, he or she is motivated above all to run the risk inherent in introducing a new idea and overcoming these barriers by the expected large profit to be gained from a temporary monopoly by being the first to introduce the idea, as well as secondary motives such as recognition, service to the community and so on.

From the foregoing discussion, it can be seen that innovation is mainly determined either by market forces or by technology as an autonomous factor. There is empirical evidence to support each of these claims. For instance, there was no user demand during the development of the atomic absorption spectrometer. Only the scientists envisaged its application. Conversely, it was demand from potential users that led to the invention and development of synthetic rubber (Freeman, 1982). Evidence notwithstanding, these two extreme classifications have been criticized by many scholars, most of whom argue that each claim is inadequate.

On the one hand, as Fransman (1986) rightly argued:

The argument that market demand will influence the firm's technological activity is trivial since firms must market their products in order to survive.

In addition, great emphasis should be given to Rosenberg's argument (1982) that most proponents of demand-induced innovations have failed to give adequate explanation to the process, thereby implicitly treating firms as printers that receive demand signals and print out innovations to order.

Nevertheless, both the aforementioned authors agree that, while the generation of new technology may be more supply than demand determined, the diffusion of the technology will be to a greater extent demand determined (Fransman, 1986). This concurs well with Coombs (1987) when he argues that technology push tends to be relatively more important in the early stages of development of the industry, while demand tends to increase in relative importance in the mature stage of the product cycle. This is largely for radical innovations. For incremental innovations the market is the major determining factor, where technologies are continuously being improved as a result of the changing market demand and other environmental factors.

At this stage, the most basic question to ask ourselves is: "how are inventions and innovations organized in the context of the poor developing countries where scientific infrastructure is largely poor and markets underdeveloped? Where do inventors and innovators, especially the individuals, come from? How are they motivated?"

In relation to the developed world, Mallecki (1996) argues that, before the year 1900, individual inventors dominated the course of technological process whereas, of late, R&D has been formalized and institutionalized. Coombs (1987) makes a similar point and proceeds to define these institutions as follows:

- a) Institutions generating new knowledge (universities, private and government, R&D laboratories, etc.);
- b) Institutions both generating and using new knowledge as an input for their main activity;
- c) Institutions using technological change 'embodied' in products (hardware) and working practice and techniques.

In most developed countries, R&D is an industrial endeavour and in most cases privately funded; there is therefore an organic relationship between R&D and the productive sector. R&D sections and institutions are staffed with care and workers are well motivated. The major goal is commercialization of inventions as a result of which they have been highly instrumental in technological progress. By contrast, in the developing world, especially Sub-Saharan Africa, organized R&D effort has not been very fruitful in generating technological innovations. According to Vitta (1992), the region's record of putting existing knowledge to use (that is, turning inventions into innovations) is poor. He mentioned major obstacles as institution and resource related. In relation to this point, Adeboye (1995) argues that it would be difficult to turn inventors from the aforementioned institutions into innovators because their main concern is with academic inquiry, not commercial profit. This argument was supported by a recent study (Diyamett and Mabala, 1997), which found that Tanzanian R&D institutions manifest the same preoccupation with academic performance rather than commercial orientation in their research activities. This is why it is interesting to also study the individual inventors and innovators in the informal settings free of academic motives.

2.3: Systemic Approach to Innovation

In the last section we identified two major interactive forces behind innovative activities as technology push and market pull. However, while it is generally agreed that these two forces are the major determinants, in reality there are several other interactive forces at work, depending on the national environment. Innovation, whether originating from an individual or institutions is basically a collective endeavour, and is largely a process facilitated by the interactive learning, which is socially conditioned, between and among different actors, that is, it is systemic in nature. This system is made up of elements and their interdependent relations. The system elements are basically made of two types of institutions. First, are the organizations, which include R&D organizations, firms and farms, the academia such as the universities, and the financial institutions. Second, are rules and regulations; these are either formal or informal. Examples of formal are government policies, laws and regulations, and informal includes norms, customs and traditions. These are unique for a given national environment hence the concept of National Systems of Innovation (NSI) (North, 1991 cited in Edquist, 1997). Sometimes, these elements mutually reinforce the learning process; and sometimes they block such a process. Cumulative causation and virtuous or vicious circles are characteristics of innovation systems and sub systems (Muller, 2000).

Of particular importance in the context of a country like Tanzania is what Muller (2002) referred to as a matrix of four salient features of the NSI in the context of the South (see Figure 1).

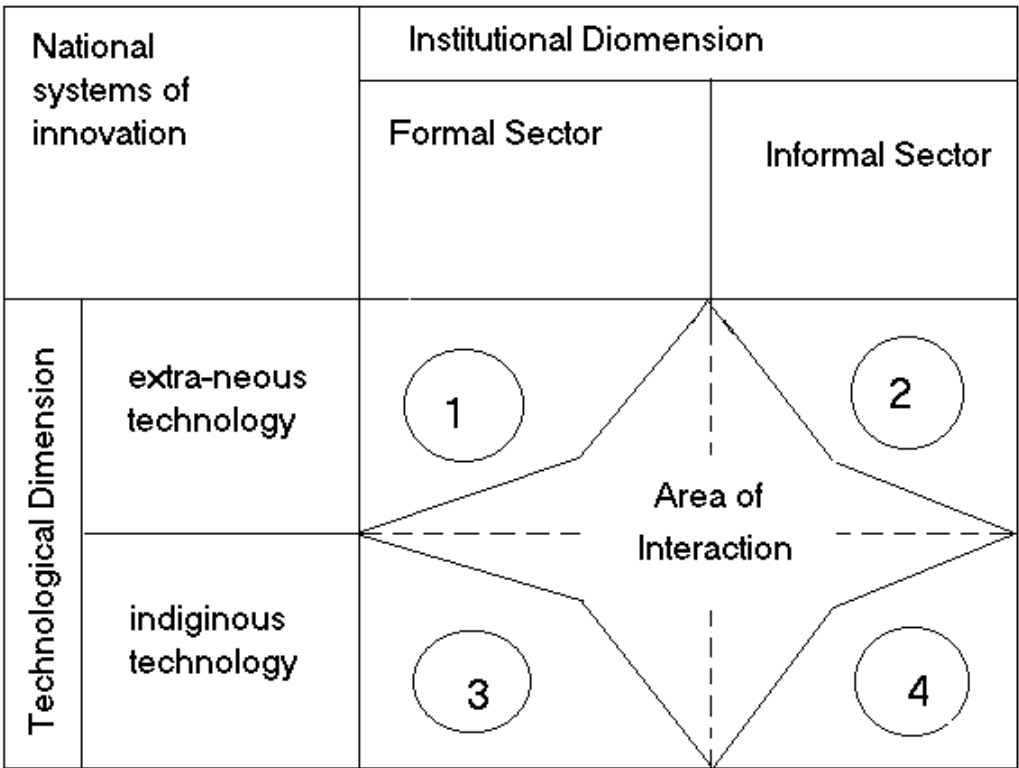


Figure 2.1: National Systems of Innovation Matrix

Key:

1. Large scale industries of foreign origin in the formal (modern) sector – here extraneous knowledge is at work
2. Mixture of all sorts of things, for example, the repair workshops.
3. Largely, area consisting of medium scale industries where most of the spare parts are of local origin.
4. Small scale in the informal sector – indigenous knowledge.

As rightly put by Muller, sustainable technology development is possible only when the above extraneous and indigenous technologies merge, particularly 4 and 1.

3. Research Methods

3.1 Sampling Procedure

3.1.1 Sample size

To reach valid conclusions and outline an acceptable model for the development of technological innovations, we found it necessary to identify and talk to at least 30 technological inventors and innovators in the capital goods' sector. However, because of difficulty in following up the inventors and innovators¹ and because we had already established a certain trend in the characteristics of inventors and innovators and their environment, we stopped after identifying about 23 individuals. Given the trend, the remaining seven would not have made much difference in the findings.

3.1.2 Sampling methods

The research used purposive sampling since the primary aim was to identify a fairly rare category of people. A two-pronged method was used:

- Use of existing records in COSTECH and the Ministry of Trade and Industry as well as previous winners of the TASTA awards (Tanzania Awards for Scientific and Technological Achievement)
- In each of the regions identified, a search was carried out through interviewing district government officials, religious and non-governmental organizations, local private sector business persons and entrepreneurs, donor organizations, and market and hardware sellers.

Although our major thrust was to identify those inventors and innovators who have produced something appreciably new (rather than minor adaptations to existing machines), we did not restrict our search to the TASTA awardees, but also sampled those who were not aware of the award or those who may not qualify for the award in any way. This is because our major interest here is not the newness of the idea per se but the spirit of the innovator and supportive environment.

¹ There was an incident in which we had to follow up one entrepreneur for about 10 days, covering a distance close to 600 miles. He was moving from one village to the other. For those who were located at industrial firms, we found that they had already been retrenched as a result of privatization of parastatal organizations. We therefore had to ask about their whereabouts and follow them. Most of them had moved miles away from their work places. In short the project was the most difficult and challenging that I have ever been involved in. But it was worth the trouble.

3.1.3 Choice of regions

The following regions were chosen.

Iringa

Iringa was one of the research regions in our previous research and several technological innovators have already been identified in the fields of agriculture and construction. In addition, Iringa has several large private workshops in the regional headquarters.

Arusha

Arusha was also one of the research regions in our previous research and several innovators have already been identified in the field of agriculture. At the same time, Arusha has an extensive small-scale industrial estate (consisting mainly of private sector manufacturers) and several of the largest R&D institutions in the country as well as being one of the most dynamic and developing towns in Tanzania.

Dar es Salaam

Dar es Salaam is by far the largest city in Tanzania with a long history of small-scale production and entrepreneurship. It would thus be the best place to identify urban-based innovators working for an urban market with possible greater potential for market expansion.

In addition to the regions chosen, TASTA award winners from other regions were followed up and interviewed.

3.2 Research Techniques

3.2.1 Use of secondary sources

- COSTECH (Commission for Science and Technology) records on TASTA awards.
- Ministry of Trade and Industry records on requests for patents.
- Institutions, which collaborate with COSTECH in disseminating information concerning the TASTA awards.
- Curricula for science and technical subjects at primary and secondary levels.

3.2.2 Primary sources

Semi-structured interviews

A semi-structured interview with each of the inventors and innovators identified, based on the issues outlined in the research problem, was the primary research instrument. It required enough time for an extended discussion with the inventor or innovator.

Interviews were also carried out with curriculum developers and practitioners in the field of science and technology in formal educational institutions. This was in order to:

- Ascertain to what extent the syllabi encourage or impede innovation.
- Record their views on the success and failures of the current system and how they believe it can be improved.

Case studies

After the original interviews were carried out, five of the most contrasting (three failures and two successful inventors or innovators) were selected for a more in-depth probing on their work. The other criteria used for selection was that the inventor or innovator must be a recipient of the TASTA award.

Observation

The semi-structured interview was supplemented by observation of the conditions and potential for entrepreneurs, the business environment, the educational institutions, and so on.

4. Research Findings and Analysis

4.1 Background to TASTA Awards

The Tanzanian Award for the Scientific and Technological Achievements (TASTA) is an ongoing award instituted by the government in 1981 to promote and encourage the development of science and technology in the country with the following aims and objectives:

- To develop technological capability in the country
- To encourage creativity
- To foster the utilization of such creativity in accelerating socio-economic development in the country.

The following are the conditions governing the award:

- Originality of the claim
- The potential impact of the claim on socio-economic development, especially in relation to the national development goals
- The potential of the claim to increase productivity and efficiency.

Eligibility: any individual or group of individuals is eligible to apply for the award.

The award is processed through a committee of experts appointed by the minister responsible for science and technology.

Table 4.1: The list of Interviewees (Both TASTA and non TASTA)

	Invention/Innovation	TASTA/ Non TASTA	Status	Inventor/ Innovator	Educational background	Year of Award
1	Net winding and net unchaining machine	TASTA	Not in use	Mr. Omary	Secondary technical education	1995
2	Locally made bicycle	Non	Still in business	Mr. Shilla	Primary, Trade Tests	
3	Locally made duplicating machine	TASTA	Never diffused – He is using it, however	Mr. Nyirenda	Secondary education, Teachers College	1988
4	Mini Hydro Electric Plant	Non	Serving two families in the village	Mr. John Fute	Std VII	
5	Use of waste oil as source of energy in heating	TASTA	Has been improved by the use of waste oil & compressed air instead of water. But currently not in use.	Mr. Sherif Dewji	Engineer	1982
6	Punch press machine Tobacco fine treatment line	TASTA	Currently not in use	Mr. Vedustus Byoma	Diploma (technical college)	1986 2001
7	A simple machine for small scale sugar production	TASTA	Still in use though trade liberalization has reduced its profitability	Group of five IPI engineers	Degree in engineering	1991
8	Amalgam retort for mercury recovery	TASTA	Highly diffused	Group of IPI Engineers	Degree in Engineering	1995
9	Water powered solar scanner	TASTA	Not fully developed	Dr. Mbogoma	Masters in Engineering	1991
10	Tractor driven oil press	Non	Still in use, upgraded to motor powered	Mr. Mbise	Form II, Trade Tests	
11	Planter	TASTA	Not developed	Mr. Msigwa	Never been to school	1983
12	Mechanical saw	Non	In use	Mr. Mbuya	Never been to school	
13	Welding machine	Non	In use	Mr. Andrew Kilibika	Std VII	
14	Brick making machine	Non	In use	Mr. Romanus Mlowe	Std VII	
15	Tile making machine	Non	In use	Mr. Emanuel Lubuka	Std VII	
16	Sewing machine	Non	In use	Mr. Luwala	StdVII	
17	Bamboo pipes	TASTA	Not in use	Mr. Lipangile	Diploma (tech college)	
18	Teaching aid: 4 stroke petrol engine operation	TASTA	In use (in one school only)	Mr. Mazzuki	Form IV	1989
19	Shuttle manufacturing machine	TASTA	Not in use	Mr. Mlaki	Degree in Engineering	1986
20	Hand operated pneumatic drive	TASTA	Not in use	Mr. Chale	Std VII and Trade Tests certificate	1982
21	Automatic blastering unit	TASTA	In use	Mr. Douglass Akwilapo	Diploma (Technical College)	2001
22	Flat-ceramic biogas iron	TASTA	Using it himself, could not market	Mr. Jaustine Mungure	Std VII and Trade Tests certificate	1995
23	Plough	Non	Not fully developed	Mr. Mlowe	Std VII	

4.2 Level of Education and Family Background

There is no clear pattern of the educational level of the inventors and innovators in Table 1. They range from those who did not go to school at all to those with PhDs in Engineering. Surprisingly, the invention which was found patentable and original to the world belongs to the inventor who never had formal education (Mr. Msigwa and his planter). It is also important to note that a large number of inventors and innovators are those who did not go beyond primary or at least ordinary level secondary education. This is interesting because one would expect more TASTA awards to go to R&D institutions, which have individuals with higher levels of education and a more favorable work environment.

However, what is common for all the inventors and innovators is that in one way or another they have worked as engineers or technicians or at least helpers in garages. Most also had role models in their field of interest. For instance, Mr. Byoma's grandfather was a foundry and his father was a carpenter. Mr. Mbise was closely working with an expatriate who invented the first oil press (the Bielenberg press).

The foregoing points to the importance of technical education in the innovativeness of a nation. There is also the issue of support and role modeling from the society surrounding the innovators. This is possible only when the society at large is scientifically and technologically literate. Recently, Science and Technology Public Attitude and Public Understanding has been used as one of the indicators of the level of technology development in a country. One aspect of this importance, according to Kathryn Kissam, the Director of Public Affairs at Monsanto, is the support the scientifically literate society gives to young scientists. "As societal understanding of science is improved, people in all professional backgrounds are better equipped to support those students who bring us the next generation of scientific discoveries", said Kissam (see MONSANTO News Release 2002, on the web- <http://www.ed.gov/databases/ERIC>).

4.3 Original Forces behind Studied Inventive and Innovative Activities

Many of the innovators were employees who were inspired or rather forced to innovate because of bottlenecks caused by the breakdowns and unavailability of spare parts in their work environment due to the economic hardship of the late 70s and 80s and macroeconomic policies on import restrictions. Thus to a large extent, innovations were demand driven (though it was a temporary demand or rather, as in the old saying: "necessity is the mother of invention"). This applies to the shuttle making machines, punch press machine, the fishnet machines; the hand-operated pneumatic drive, the small-scale sugar-processing machine as well as the bamboo pipes. There was also a determination to save scarce foreign exchange as well as overcome the obstacles related to import restrictions. This in our views was the major contributing factor towards the government's policy on TASTA awards. It also suggests that some degree of import restriction is important even under the current free market environment, to spur innovative activities in the private sector.

The rest of the technologies evolved as a result of the felt needs of the community in which the innovators live. For instance, Mr Mbise invented the tractor-driven oil press because of the complaints about the hard work required by his manually operated Bielenberg press. Mr Msigwa developed his planter because of his awareness of the tedious and unremitting work faced by the farmer, while Mr Nyirenda's seminal work on the duplicating machine was the result of his experience as a teacher in rural schools, which did not have access to any kind of technology for photocopying.

Two other innovators also stated that they developed the technology as labour saving devices for themselves, such as the mechanical saw and welding machine.

Several also saw the technology as a means of personal income generation, although only one stated specifically that he was looking for a gap in society so that he could make money by filling it. When he saw that imported bicycles were too expensive for most people, he developed his own bicycle, which is much cheaper, and he has already sold several of them. All the innovators hoped that the machines they developed would be more widely diffused.

On the part of the government, the major impetus for the TASTA awards was the shortages of the 1980s.

4.4 The Enabling or Disabling System Elements

4.4.1 Education system

Even though in the original development of an idea, the level of education does not seem to matter (especially with those with innate special qualities), education does matter when it comes to successfully turning an idea into a viable prototype. This is because this stage requires complicated technical drawings, which can only be done with a high-level knowledge of engineering. Some of the first class inventions like Mr. Msigwa's planter got lost because of this problem (see Box 1).

Box 1: Mr. Msigwa

He spent seven years developing a planter which was able to measure, dig, plant and deposit fertilizer. When he completed it, it was examined by international experts (from America, India and Sweden) who pronounced it to be original and he was given a medal and a prize by the President (the late Mwalimu Julius Nyerere) in 1983 (together with Mr. Lipangile). Since he was not able to mass produce the planter himself, he was asked to take the machine to the University of Dar es Salaam which would dismantle and draw the machine so that the production process could start. He was also advised that it was important to take out a patent and that the people in Dar es Salaam would do this for him. He believed them and returned to Njombe. There was no communication at all for about six years after which they came and asked him for another planter. After much probing they admitted that the machine had been 'lost' and that they suspected that some English lecturer had taken it to Kenya. Mr. Msigwa refused to give them another until they showed him where the previous one had gone or paid him for the original one, neither of which has been done to date.

Mr. Msigwa's planter would probably have been developed into a useful innovation if he himself were able to make technical drawings of the planter and had venture capital to turn his invention into an innovation, and perhaps might have sought for the patent himself. It is also important to note, in this connection, that the technologies which found their way to the market place are those which are relatively simple and therefore did not require any complicated technical drawings and large investments in monetary terms.

Another related issue with education is the existing dichotomy between science curricula and the real needs of the society. As argued by Vita (1992) and Adeboye (1999) and many others, in most of the SSA countries, science has largely been divorced from the mainstream of economic and social activities and it is either sought for its own sake or to copy what is happening in the developed world. Most of the science curricula and related textbooks emphasize theoretical learning and reproduction of memorized facts that are unrelated to and out of context with simple and real life experience of the communities. As a result, most of the inventors who are responding to real problems of the community are those with minimum level education (those who did not have a chance to be brain washed by the current curricula).

In addition, there is also a tendency on the part of those responsible for spearheading science education, to at best neglect (as happened with Mr. Msigwa's planter) and at worst despise those technologies originating from the real life experience of communities. To drive this point home we quote part of the presentation made by the eminent professor scientists from the University of Dar es Salaam during the university's convocation symposium in 2000:

....."Not long ago the Tanzanian national science awards were being given in appreciation of the "discoveries" of antiquities! How can scientific advances be taken seriously by school children this way? While others in science-conscious societies are engaged in advances and inventions of the state of art technologies like satellites, we in Tanzania orchestrate the use of bamboo for water distribution or fabrication of wooden duplicating machines. Indeed these are examples of the dubious concept of appropriate technology, that has been used by some external funding agencies to substantiate motives towards scientific underdevelopment of developing countries. It tends to marginalize the conceptual thinking of policy makers and some scientists who may be victims of this concept. Hence relevant science (emphasis mine) suffers through government and policy makers getting indulged supporting mediocre research that perpetuate what may be termed as traditional ways of doing things that goes down to antiquity. This effectively thwarts prospects for developing science and technology in developing countries." (The Multi-Dimensional Crisis of Education in Tanzania: A Preliminary Call for Public Debate and Action, 2000, p.129)

Such attitudes have been translated into the mistreatment of the inventors (see example in Box 2).

Box 2: Mr. Nyirenda

He is a teacher. In 1972, he developed a duplicating machine using local materials (wood, sponge and cloth) which could be used in rural schools which would never have the money to buy an imported machine. It was shown at trade fairs in 1977 and 1982. When he entered for the TASTA awards in 1982, his forms were lost. He did not lose heart but continued to correspond with COSTECH until 1988 when, with some improvements suggested by the University of Dar es Salaam workshop, he won the award (16 years after the original invention!).

He then asked for some money to carry out field-testing. This money was sent instead to the university, which made 10 machines that did not work and took them to be tested in urban secondary schools, instead of rural primary schools from where the idea for the innovation came and to which it was directed. The report came back that the machines could not cope with the volume of work and could not compete with the imported machines to which the urban schools had access. As a result, Mr. Nyirenda still has his own duplicating machine but the idea has never been disseminated and primary schools still have no access to duplicating machines.

As discussed in the theoretical section, innovation is largely a product of interactive learning between different actors, and it is evolutionary rather than revolutionary in nature. The most sustainable path, according to most scholars of technical change, is that which takes into account the social economic environment of the community and evolves with the knowledge of the indigenous people. The Nyirenda duplicator might seem an 'antiquity' now but has a potential to grow into something better than anything that ever existed with the necessary support. In this connection, COSTECH has the tradition of linking the TASTA awardees to the University of Dar es Salaam for cross fertilization of ideas, especially since most of the awardees are limited in the educational level required to provide technical drawings for their initial ideas. But they are very useful in the sense that, in contrast to the higher learning institutions such as the universities, the individual inventors are in touch with, and are therefore responding to, the real needs of the society. However, because of the attitudes of most of our scientists, such interactive learning is being hampered as demonstrated in Box 2. We think to a large extent this has contributed to the current problem facing TASTA awards and the whole issue of dichotomy between indigenous knowledge and modern knowledge. This is similar to what Muller (2002) referred to as *formal-normal dichotomy*. He was referring to the dichotomy that exists between large-scale industries employing foreign technology and the informal sector with indigenous technology. We take the analogue to refer to formal education with foreign textbooks with foreign illustrations, foreign aspirations and so on, as against individual inventors and innovators who acquire knowledge through informal means such as apprenticeship.

Two issues are obvious from the case of Mr Nyirenda. First, it was wrong to try to develop the prototype in the absence of the individual with the original idea. He also was denied the chance to upgrade his knowledge through interactive learning with the university scholars. Similarly, the university would have learnt a lot from Mr. Nyirenda. Second, the machine was tested in an environment different from that where the original idea was conceived. It is true that the machine would not have

worked in large cities such as Dar es Salaam where teachers have access to computers and photocopying machines, but in the rural areas where there is not even electricity! Mr. Nyirenda's idea is indeed a brilliant idea. However, on the contrary, the machine was dumped as a useless antiquity.

On the other hand, this is the result of the current convergence between science and technology, especially in the areas of biotechnology, nanotechnology and information technology. For developed countries with advances in technology, there is little problem in the usual coupling between science and technology; and there is therefore some appreciable degree of complementarities between university science and technology in the productive sector. For poor developing countries, however, a big dichotomy exists between science pursued at the universities and technology. While science and the scientific community is one and global, scientists in poor countries therefore have to be at par with their colleagues worldwide, technology is local, and unfortunately at a very low level compared to contemporary science.

Of course, even for the developed countries, a high level of technology does not necessarily ensure automatic relevance of science to socio-economic development. There has to be deliberate policy effort to make science relevant. For instance, there are currently worldwide movements in an effort to make science responsive to the needs of society. Examples of such movements are the new science education programmes emerging in different parts of the world. To mention but a few, these are: ASEP (Australia), CORST (Canada), SATIS and Salters Science (UK) and ChemCom (USA) (Solomon and Aikenhead, 1994; EijKeholff, 2001).

What the above programmes advocate in general is to make science more responsive to the needs of the society. According to Yarger and Luz (1995, cited in EijKeholff, 2001) this can be done by including societal issues in school sciences courses. If this is done, the following is most likely to be achieved:

- Justifies information included in science courses
- Allows students to find sciences relevant to their daily lives
- Enables the teachers to evaluate students' success at application and synthesis of ideas
- Redefines the teacher's role to the "facilitator" and relegates the text books' status to information sources
- It may allow for increased scientific understanding of concepts, based on cognitive theories of learning
- Provides a vehicle for tying the whole school programme together.

4.4.2 Lack of appreciation and support of inventors and innovators by the Government

Most of the inventors or innovators, especially those who made their inventions as part of the production lines of large-scale industries, by then belonging to the government, have now been laid off as a result of the privatization exercise. Some of them like Mr Mlaki and Mr Byoma were able to set up their own offices, and with minimum capital, are struggling to produce a few gadgets. However,

inventors like Christopher Charles, formerly of Ubungo Farm Implements and Mr. Omary of Tanzania Fishnet are in a very desperate situation. We had an opportunity to visit them at their homes. Mr Charles especially seems to be undergoing serious economic hardship. What he had to remind him of those good old days are the front pages of newspapers he had frequently appeared on in 1982 as a famous inventor. When we inquired as to why he did not attempt to set up a business using his experience, his replies were: “no space, no funds, etc”. He also bitterly complained of the low level of remuneration he was given when he was retrenched. Mr Omary and Mr Lipangile also had their own story to tell (see Box 3).

Box 3: Mr Omary and Mr Lipangile

Mr Omary

He was working for Tanzania Fishnets, which was a government parastatal. There were insufficient machines and the workers were subjected to very hard labour so he decided to develop machines for netwinding which produced more with less labour and which are continuing to work until today. He succeeded and was given some money by the management after two years. However, he feels that the money was in no way commensurate with the contribution made by the machine to production in the factory. His supervisor was actively opposed to him and deprived him of loans and his fellow workers were also jealous of him. Before he retired he was working on a new machine. He offered to continue developing it but nobody listened; and he retired with no continued connections with the company management.

Mr Lipangile

He was the regional water engineer in Mwanza. There was a severe water shortage in one area and no hope of getting water pipes. He therefore developed bamboo water pipes which are five times cheaper than plastic and fifteen times cheaper than metal. His idea was enthusiastically received and he won a national award, and the issue was forwarded to the ministry responsible for water for further action, but when the economic situation improved and the more expensive imported pipes were available, he and his technology were forgotten.

Mr. Lipangile also initiated the Tanzania Association of Inventors (TAI) and was able to obtain TAI's membership in the International Federation of Inventors' Associations (IFIA). According to Mr. Lipangile, he only has contact with the 10 leaders. He has lost contact with the other innovators. They once asked for funds from the Ministry of Technology and Higher Education so that they could identify more inventors and their inventions but their request was turned down.

Despite the foregoing cases, the government still offers TASTA awards, but more because of a tradition than necessity as during its inception in the early 1980s.

4.4.3 Inefficient patent law

Patenting is still a very cumbersome process in Tanzania, and most of the potential inventors are not aware or conscious of the Intellectual Property Rights (IPR).

Inefficiency of the patent law, especially in protection of the indigenous technology, is revealed by the loss of Mr. Msigwa's novel invention.

To some extent it is also contributing to the lack of innovativeness. Mr. Mbise who originally made the first version of the tractor-driven oil press, and later on improved it to become a motor oil press had to stop producing the machine and move to a very distant village which was recently electrified, to set up a business for producing sunflower oil with his machine instead of producing machines. According to him, he had to move and stop producing machines because of the declining profit he was getting from machine production, as other people had freely entered his line of business. If Mr. Mbise's prototypes were protected in some way, and earned enough capital from his designs, he would have been motivated to do something more advanced, expecting more protection and more profit.

The same thing also happened to Mr. Thomas who was producing his version of a locally made bicycle, based in Singida. He had to move to Haydom (recently electrified village) to continue earning profits from his work. Some people in Singida had already started copying his designs. Although this in a way has facilitated diffusion of this innovation, it will most likely kill the inventor's creativity.

4.4.4 Tax disincentives

This problem was mentioned by most of the innovators who at least tried to set up a business. Mr. Mbuya, who developed a mechanical saw and is currently using it for his own business, expressed this problem in a very interesting way. When asked whether he had ever tried to commercialize his invention, he replied as follows: *"we tried but stopped because when you try to advertise anything, the first person to visit you is not a customer but people from the Revenue Authority and your advertisement effort will produce more tax demands than customers"*.

4.4.5 Lack of venture capital

Innovating is a risky business even for a well-established company, let alone an individual. Most of the inventors have no starting capital and have not been supported in any way. Working premises and facilities were not available either. As a result, relatively successful inventors were those who invented within their production line with support from the company where they were working. One innovator (Mr. Mbise) had to work for a garage in order to have access to the machinery and space he required. Additionally, innovations, even if market driven, require vigorous advertisement to achieve wider diffusion and this requires money.

The effect of availability of space and venture capital is also demonstrated by success of the two innovations made with the formal R&D structures (sugar-processing machine and mercury recovery amalgam retort). These two inventions had access to donor money through their institutions, good working environment, and all the necessary support system. They had all the above-mentioned inadequacies of the individual inventors and innovators.

According to inventors from IPI the two innovations are doing well, especially the amalgam retort. The sugar-processing machine is facing very stringent competition from imported sugar, and its profitability and hence diffusion has radically been reduced.

4.4.6 Globalization and privatization

This study has shown that most of the innovations that were developed as part of the production lines in the industrial firms, which were by then owned by the government have been abandoned after the privatization exercise. Worse still, not only were the innovations abandoned but also the respective inventors. Important innovations such as the sugar-processing machine are facing serious competition from cheap imported sugar, and according to the researchers from the IPI, its profitability has radically been reduced such that its existence and further development are seriously threatened.

As privatization and globalization are good for efficiency and innovativeness, in the case of a poor country such as Tanzania, these provide a serious challenge and have to be embraced with caution. At the very least, some form of protectionism approaches are important, especially for a few selected areas or sectors.

5. Summary, Conclusions and Recommendations

This study has demonstrated that both the technology push and demand pull are fundamental forces at work in the beginning of the innovation process. However, for successful and wider diffusion, many of the other interactive forces which are unique for every nation come into play. For the Tanzanian environment and for this study in particular, the following factors or forces were found important: Science education, both level and nature; recognition of the inventors, especially by the government machinery; tax incentives; globalization and privatization; venture capital, and Intellectual Property Rights (IPR) system.

The findings also indicate that very few of the identified inventions and innovations are currently being utilized or achieved wide spread diffusion, largely because of the blockage caused by the above environmental factors. We therefore preliminarily recommend the following, divided into long-term and short-term measures:

Long term measures:

- Popularize science and its role to the wider society.
- Work towards reducing the dichotomy that exists between science and social and economic needs by radically overhauling the current higher education and research systems. By proposing so, however, we do not suggest that university science should come down to the kind of low science input technologies we have identified, but rather, even the high level science should be made relevant to social and economic needs of the country through contribution of knowledge to intermediary institutions that conduct more applied research commensurate with the demands of low technology private investments.
- Increase opportunities for high quality and high level technical education.

Short term measures:

- Continue with TASTA awards but at the same time provide a venture capital in terms of matching grant for those inventors who can move their inventions to the market place themselves or who can identify an entrepreneur interested in investing in the invention.
- Support a forum where innovators can air their views and exchange ideas on issues of interest and provide a forum to market their products. Recognizing and supporting the initiatives started by Mr Lipangile could be a starting point.

- Popularize the Intellectual Property Rights (IPR) to the wider society and reduce the bureaucracy in patenting.
- The whole issue of Free trade and Privatization has to be rethought to protect and develop indigenous knowledge.
- Tax incentives such as tax holidays should be given to emerging technological entrepreneurs.

References

- Adeboye, T. (1999). "The Interface of Science with Society in Africa". In: Proceedings of the Conference on Basic Science for Development in Eastern and Southern Africa, Arusha, Tanzania, 1999.
- Coombs, R.; Saviotti, P. and V. Waloh. (1987). *Economics and Technical Change*, London: Macmillan Education Ltd.
- Diyamett, B.D. (1993). "Appropriate Technology, Rural Women and Development in Sub-Saharan Africa: Problems and Prospects in Adoption of Appropriate Technology", M.A. Dissertation, Lund, University of Lund.
- Diyamett, B.D., R. Mabala and R. Mandara. (1998). "Poverty and Diffusion of Technological Innovations to Rural Women: the Role of Entrepreneurship", REPOA, 1998.
- Dosi, G. (1984). *Technical Change and Industrial Transformation*, New York: St. Martins Press.
- Edquist, C. (1997). *Systems of Innovation, Institutions and Organizations*. Pinter Publishers, London.
- Eijkelhoff, H.K. (2001). "Recent developments in science education: Research and Curriculum Development". In: K.M. O-Saki et al., eds, *Reflection on Research Issues in Science Education in Tanzania* (in press).
- Fransman, M. (1986). *Technology and Economic Development*, Brighton: Wheatsheaf Books.
- Freeman, C.; Clark, J. and L. Soete. (1982). *Unemployment and Technical Innovation*, London: Frances Printers.
- Kaplinsky, R. (1990). *The Economics of Small: Appropriate Technology in a Changing World*, London: Intermediate Technology Publications.
- Komba, A.Y. (1990). "Technological Innovation and Public Policy in Tanzania". Research Report submitted to IDRC, Ottawa.
- Muller, J. (2000). "Making Ends Meet: Reconciling Indigenous & Extraneous Systems of Innovation". Aalborg University, Denmark, IDM, Mzumbe and University of Dar es Salaam, Tanzania.
- Rosenberg, N. (1982). *Inside the Black Box: Technology and Economics*, Cambridge: Cambridge University Press.
- Rothwell, R. (1992). "Successful Industrial Innovation: Critical Factors for the 1990's", *Research and Development Management*, Vol. 22, No.3, pp. 221-231.
- Rothwell, R. and Zegveld. (1985). *Reindustrialization and Technology*, Longman: Harlow.
- Solomon, J. and G. Aikenhead, Eds. (1994). *STS Education: International Perspectives on Reforms*, New York: Teachers College Press.
- "The Multi Dimensional Crisis of Education in Tanzania: A Preliminary Call for Public Debate", University of Dar es Salaam, Tanzania.

Vitta, P. (1992). "Utility of Research in Sub-Saharan Africa: Beyond the Leap of Faith". In: Science and Public Policy. Vol.19, No.4.

Wangwe, S.M. (1996). "Technology Development in Tanzania: Some Challenges for the 21st Century. In: Leading Issues in Development Studies, A Reader, Vol. 11,

(IDS, Dar es Salaam).

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