1. Science, technology and innovation for whom?

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1.1 INTRODUCTION

With the rise of organized scientific research, we have grown accustomed to an unceasing delivery of new scientific results and technical improvements that resolve even seemingly unsolvable problems. The share of humanity that reaps the fruits of this tremendous technological progress, however, has been and continues to be unevenly distributed around the globe as research efforts are typically directed towards solving problems facing an urbanized Western population. In the 1990s, the Global Forum for Health Research estimated that only 10 per cent of the world research effort is devoted to meeting the health needs of 90 per cent of the population. Although progress has been made since then (GFHR, 2004), this bias towards population groups with higher purchasing power persists and is not confined to the health area.

Perhaps more surprising is that research done by researchers in developing countries also has a similar 10/90 gap. Knowledge exists, but there do not seem to be enough interest or incentives in the innovation system to solve urgent problems of poor communities. This begs the following questions: Who sets the research agendas? Are they mostly decisions of the researchers themselves? Are they the priorities of the funding agencies? Is the research agenda the demand of those who are able to pay for research, for instance, pharmaceutical companies, or is it user-driven and inclusive, set by those most in need of the research results? And last, but not least, how are the scientific results used to inform policy makers?

This book addresses these questions by examining how science-based research and innovation is designed, implemented and applied in developing countries in support of development and poverty alleviation. The relatively scarce resources devoted to higher education and research in these countries are in many cases not directed squarely towards addressing pressing developmental issues and poverty alleviation. Even in cases of successful local research and innovation outcomes, appropriate

framework conditions for supporting the application of the innovation may be lacking.

In the following chapters we provide examples of how the research agenda is set by the major actors involved in the national innovation system in four developing countries – Bolivia, Vietnam, Tanzania and Mozambique – and discuss how the results of the knowledge creation process can be better integrated into a national development strategy. In doing so, we focus on the expectations that are increasingly linked not only to the roles of science, technology and innovation (STI) in the development process but also to its results. There is an increasing concern among governments, policy makers, donors and other stakeholders that there is a mismatch between research and development (R&D) input and its results. Much money might be spent on R&D facilities without producing a dividend that is significant, or perhaps cannot even be measured. For developed countries it can be frustrating to not get the sought-after mileage of the investment. For developing countries the effects may be more sinister and, in the worst case, prevent development.

Bridging the gap between the production of knowledge and the application of knowledge in support of development is thus vital for the efficiency of the innovation system and its ability to address problems in development. Throughout this book we shall use the concept of 'Closing the Loop'[1] as a euphemism for efforts to align the output of the research community with the intentions of the policy makers and, thus, make research matter more to developmental goals. By Closing the Loop, the relevance and utilization of research outputs increases, which in turn enhances the influence of researchers and institutions in the development process. Likewise, the prospects for evidence-based decision making and informed policy formulation increases, thereby supporting a process of mutual reinforcement between the research community and the policy-making sphere.

The book thus contributes to a better understanding of how the process of knowledge creation and innovation in developing countries can be made more conducive to the development efforts pursued. More specifically, it presents evidence on the emergence of innovation systems in developing countries, including an analysis of the converging or diverging expectations of the main actors in the innovation system in the case countries. Further, it identifies the main impediments to enhancing the relevance and quality of research outputs for the productive sector, and offers suggestions on how the process of applying research outputs and innovations in support of developmental goals can be enhanced.

1.2 BACKGROUND AND RATIONALE

Addressing the impact of limited resources has been a preoccupation for decision makers and policy for a long time. Since the dawn of the economist profession, the idea of a self-regulating market system in which the use of productive forces is maximized by itself has had numerous and vocal proponents among economic thinkers. But, as shown by critical voices from different shades of the political spectrum, most recently by Thomas Piketty (2014), an unrestrained economy tends to lead to economically and socially suboptimal and inequitable outcomes. The prescribed antidote by legislators has been the introduction of varying degrees of redistributional mechanisms into the economy to alleviate undesirable effects. This calls attention to the role of public policy. History tells us that policy indeed matters and examples abound of successful public policies, be they aimed at fostering up-and-coming, fast-growing firms or creating competitive advantages of entire regions or nations. The phenomenal economic growth and technological catching up of some Southeast Asian countries in the 1970s and 1980s and, more recently, China are a case in point. In such cases, policy makers have clearly been successful in 'picking the winners' rather than leaving it to the market to 'create through destruction' in Schumpeterian terms. Whether or not such examples of successful public policy are the result of informed decision making and prudent interventions by an entrepreneurial State or just instances of pure luck is a bone of contention among economic scholars. Disastrous examples of failed industrialization policies can indeed also be found, such as the Great Leap Forward in China in the late 1950s or the blanket import-substitution policies of India up to the 1990s, which point to the risks involved in excessive or damaging State regulation. Moreover, the failed interventionist policies in the West in the 1970s in attempting to breathe new life into sunset industries implies that the case can be made for an exceptional and very specified role for State intervention rather than to mitigate private industry shortcomings. Or as Mariana Mazzucato puts it in her advocacy of the entrepreneurial State: '[W]hile the State needs to take risks, it should not be simply absorbing . . . . the risk of the private sector, but taking the kind of risks that the private sector is not willing to take' (Mazzucato, 2013, p. 194). We can extract two essential components for successful governance – an effective policy that is properly designed to achieve what it sets out to do and which rests on relevant knowledge capturing the state of the art of evidence on the particular problem it is meant to address. The process of turning such knowledge into policy is at the core of this book.

The area of STI is one of the few areas where there is almost total consensus for governmental intervention (be it for slightly differing reasons)

for guiding scientific efforts today. Depending on the view, without government support the production of new knowledge will either be quantitatively suboptimal as a result of a market failure, fail to materialize in strategic basic research areas or even result in the 'wrong kind' of technology from a societal perspective.

The impact of STI on growth and development is increasingly being recognized. In the Organisation for Economic Co-operation and Development (OECD) countries this has been part of the agenda since the 1960s. It is more recently that STI policies are receiving the same attention in developing countries although a few pioneers such as Michael Moravcik had already in the 1960s argued that a broad range of pressing problems in developing countries could not be solved without an indigenous capacity for technological development (Moravcik, 1966). Today, however, such policies are seen as a *sine qua non* also in the South. We can see a growing interest in and need for measuring R&D input (R&D human resources, R&D expenditures and so on) as well as R&D output indicators (for example, patents, scientific publications and so on). Weighing these two aspects against each other one could get an approximation of the efficiency of 'the innovation system'. This has led to discoveries of so-called paradoxes, or mismatches. It started with 'the European paradox' when Dosi et al. (2005) claimed that while European Union (EU) countries were doing seemingly well in scientific output, this was not reflected in innovative performance. A year later attention was drawn to the 'the Swedish paradox' (Ejermo and Kander, 2006; Jacobsson and Granberg, 2006), with a discussion of the reasons why Sweden, topping the league of R&D expenditures as share of gross domestic product (GDP), apparently did not do so well in terms of innovative capacity.

These controversies that started as typical developed country problems/debates are now followed by similar discussions in developing countries. While there has been a growing concern about the need for R&D and innovative capacity building in the South, little attention has been given to the output, and the efficiency (and even relevance) of the R&D systems in these countries. It is in this context that innovation systems in developing countries are being addressed (see Lundvall et al., 2009) and it is also in this context that this book is placed. The relatively limited resources that developing countries devote to R&D make the efficiency and internal functioning of the innovation system an even more pressing issue. Of the four case countries in this book, Mozambique, Tanzania and Vietnam spend around 0.5 per cent of their GDP on R&D with Bolivia trailing with 0.11–0.25 per cent. This can be compared to the 2.9 per cent of GDP devoted to R&D in the USA, the OECD average of 2.4 per cent and to top spending Finland and Sweden investing 3.9 per cent and 3.4 per cent, respectively, according to OECD statistics for 2010.

1.3 CLOSING THE LOOP INCREASES THE RELEVANCE AND UTILIZATION OF RESEARCH OUTPUTS

Given the limited resources in developing countries as well as a limited policy formulation capacity, how can the scientific community in developing countries better support the developmental goals formulated in national development plans? Evidence on such a knowledge-to-policy process indicates that there is a sometimes hard-to-bridge chasm between the research community and the policy-making community and that there exists a degree of mutual distrust between the two worlds. The reasons appear to be quite universal. In studies from different countries and levels of development on the use of academic research by policy makers, a number of common reasons for not relying on academic research is provided. First, the relevance of academic research may be perceived as not having a direct bearing on the problem at hand, either because of a level of certainty too low to make it relevant (Jefferys et al., 2007), quality that is too low (IDRC, 2002) or due to researchers tending to overanalyse problems and not able to produce research results in time (Hy et al., 1995). Second, research is often regarded with suspicion by policy makers who may see it as theoretical exercises with little or no practical applicability in the real world. Or, put slightly differently, '[S]ignificant elements [of policy makers] seem to regard "research" as the opposite of "action" rather than the opposite of "ignorance"' (Surr et al., 2002, p. 1). Third, it is important to point out that policy makers have a host of other information sources and political realities to adhere to, making research only one, albeit vital, of several potentially influencing factors in the policy-making process.

For the research community, the most often mentioned factor hampering the provision of policy-relevant information to policy makers is the lack of institutional incentives (Jefferys et al., 2007; SPP, 2009). Academia functions with its own internal logic with an incentive structure that predominantly rewards publication in academic journals and can act as a deterrent to researchers' involvement in advisory or other extra-curricular activities. Researchers and policy makers rarely move in the same circles, pointing to the lack of established channels through which research results can be presented (Court and Young, 2006). Additionally, researchers in general are not trained or experienced in communicating with policy makers (Carden, 2004; Start and Hovland, 2004).

Bringing these and other issues together in an analytical framework for bridging research and policy, Court and Young (2006) identify four overlapping areas where a number of factors influences the likelihood

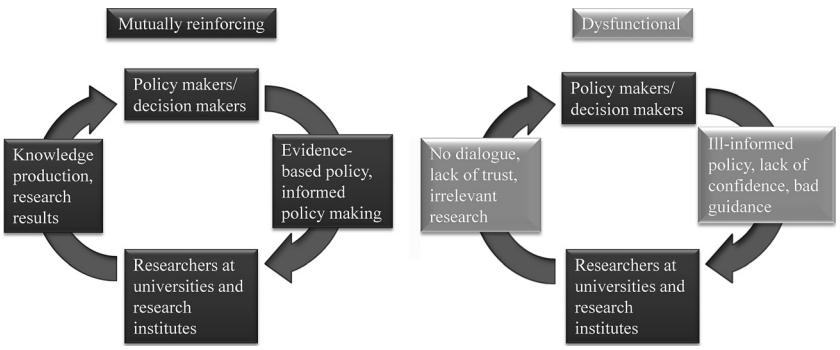

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Figure 1.1 Representations of the process of policy – research feedback loops

of research being adopted by policy makers in development: the *political context* defined by the degree of openness and political freedoms as well as local history and vested interests; *evidence* referring to the quality, usefulness and problem-solving properties of research as well as how it is packaged and presented; *links* between the research and policy communities in affecting policy formulation; and, finally, *external influences*, such as donor strategies and international politics and processes.

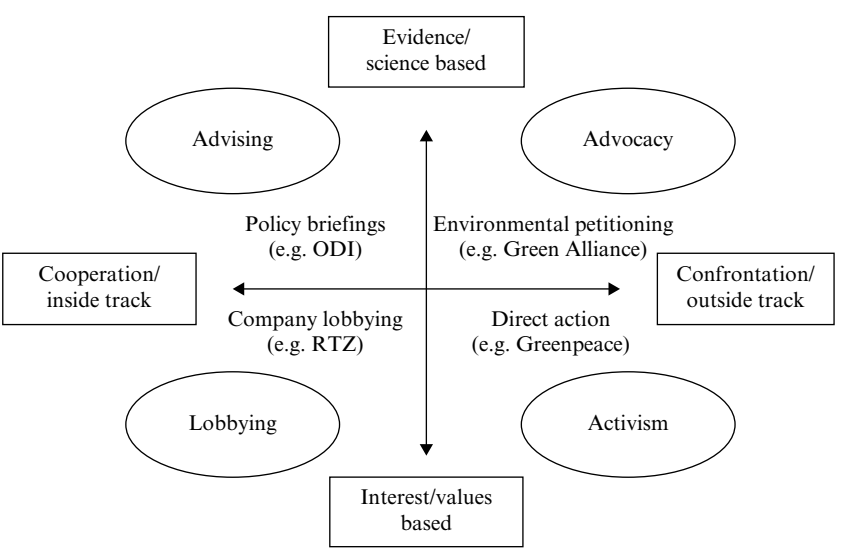
This analytical framework points to a dynamic relationship between researchers and policy makers. In a well-functioning relationship, the activities of the two sets of actors mutually reinforce the activities of the other in a positive feedback loop as depicted in the left-hand side of Figure 1.1. An innovation system where such a dynamic interaction takes place has – in our terminology – been successful in Closing the Loop.

In cases where, for reasons discussed above, the feedback mechanisms do not function properly, the process of research-to-policy and policy-to-research is dysfunctional and cannot provide either set of actors with the needed information (the loop is not closed).

So how can a virtuous cycle of mutual reinforcement between researchers and policy makers be achieved? It would seem that most countries in the world are situated somewhere between the ideal state and the system breakdown represented by the two flowcharts in Figure 1.1 and struggles with improving the dynamics. However, if it can be difficult for developed countries, it can be harder still in developing countries. Carden (2009) lists a host of problems why policy making in developing countries is harder than in developed countries. Chief among them are:

- policy makers have less autonomy
- staff turnover weakens both research and policy influence
- lack of intermediary institutions
- implementation challenges are greater
- 'personal' relationships can lead to misgovernment
- policy makers lack confidence in their own researchers
- researchers in development often lack hard data
- demand for research can be missing.

Addressing these problems is a formidable task for any country. Luckily, all barriers are not present at the same time and every country has its own path to follow and ways to cope with these issues. Two key requisites for moving forward are that there is a genuine interest from both sides of the two sets of actors and that proper mechanisms for dialogue and communication between them exist. Figure 1.2 describes the basic tools available for researchers and organizations trying to impact policy formulation. The methods range from purely cooperative measures to outright confrontation through direct action. In the narrative of this book we shall be exploring primarily the upper left-hand side of the figure; a cooperative relation providing evidence-based and science-based advice through policy



Source: Start and Hovland (2004).

Figure 1.2 Tools and organizations on the cooperation/evidence axes

briefings and other research outputs for decision makers. Thus, we are concerned with the research community's impact on the policy-making process as well as the dynamic interaction between research and policy.

The other side of the loop, how policy can influence research, is somewhat more straightforward – but no less controversial – given the sway policy makers typically hold over the funding of research. By providing earmarked grants for strategic or needs-driven research, funding agencies can influence the research direction as well as size. A global trend in research funding is the decrease of core funding for universities and research institutes in favour of external, project-based funding from research councils and foundations. However, as we discussed above, the internal academic incentive system may not always be in tune with the demands of the granting agencies.

1.4 STRUCTURE AND CONTENT OF THE BOOK

In Chapter 2, the socio-economic context for the study is presented. The chapter discusses the recent developments in the case countries of using the Millennium Developmental Goals (MDGs) as a yardstick for how well attuned to the development objectives are the national systems of innovation. It provides the background to the country case studies presented in the following chapters by examining the progress made in meeting socio-economic goals such as eradicating extreme poverty and diseases like HIV/AIDS and malaria, lowering infant and maternal mortality rates, increasing literacy and proving universal primary education, and promoting gender equality. All four countries have made considerable progress in meeting the MDGs although Bolivia and Vietnam have done relatively better than Mozambique and Tanzania. On the other hand, it is shown that Mozambique and Tanzania have been more successful than many sub-Saharan African countries.

Chapter 3 traces the origins of the national innovation systems (NIS) approach and discusses how the concept has been incorporated and applied in the context of developing countries. The emergence of NIS in developing countries is discussed and exemplified by tracing the history of STI policies and institutional infrastructure in the four case countries (Bolivia, Vietnam, Tanzania and Mozambique). The evolution of the NIS in the case countries indicates that although they are organically different and path dependent, there are similar features and common lessons to be drawn from their respective experiences.

Bolivia was early in recognizing the role of science and technology (S&T) in development, as was indeed the whole Latin American region. The Latin

American School of Thought in Science and Technology emerged in the 1950s when many Latin American countries initiated the process of incorporating S&T into national development plans. Bolivia was one of the first countries in the region to establish a policy-making body by the founding of the National Academy of Sciences as an autonomous public organization in charge of the formulation of science policy. Moreover, Bolivia was the first country in the region to formally make the system's approach operational. The emergence and growth of the institutional set-up was not problem-free. Turf disputes resulting from overlapping or unclear areas of responsibility between leading institutions in STI policy formulation and knowledge production have periodically hampered the efficient functioning of the system. To some degree this still persist, with science policy agendas and research agendas being set by different agents of the Bolivian innovation system.

For Vietnam, the emergence and development of an innovation system took place over a period of several decades, with the concept of innovation slowly but gradually becoming integrated into mainstream thinking in policy-making circles. The work on building up S&T capacities in the 1960s provided the basis for the gradual evolution into an innovation system approach in the 1990s. In this process, collaboration with foreign partners has proved instrumental for the policy-making process in the country by providing new analytical tools and frameworks. In particular, the major shift from a preoccupation with S&T to innovation aspects, as clearly seen today, owes much to this collaboration. Vietnam also differs from the other case countries in that in the 1980s the country went through a complete overhaul of the system of managing the S&T sector. The Soviet style of organizing S&T activities was gradually changed and replaced by new institutions, laws and policies allowing the country to adopt more of a mainstream thinking in NIS policy making and more active integration in the international market system.

Tanzania was also early in recognizing the importance of developing policies for guiding S&T efforts in the country and actively participated in international and regional attempts to promote the understanding and usefulness of S&T policies for development. Despite the early insights into the role of S&T, the historical record has been rather disappointing both in terms of policy consistency and the application of the results of S&T where the achievements of the sector have not been translated into tangible products, processes and services for development purposes. A large number of factors still impede the efficient creation and utilization of new knowledge, such as a weak multi-disciplinary interaction and collaboration between R&D organizations, weak social and economic research, inadequate mechanisms for including new and emerging research areas into

the national research agenda and low participation of the private sector in research activities. These limitations are further exacerbated by inadequate human resources and an over-dependence on foreign funding for research. Moreover, as in the case of Bolivia, Tanzania has experienced its share of turf wars between competing STI organizations with overlapping areas of responsibility. The latest National Research and Development Policy is designed to address these shortcomings by strengthening the research capacity, establishing an appropriate coordination and management system of research activities and setting clear and realistic priorities for research on short-, medium- and long-term bases.

Although Mozambique, as indeed most African countries, early on acknowledged the importance of S&T for development, it was not until after the end of the devastating civil war in 1992 that work on building up the NIS could start. Thus, the emergence of the innovation system approach in Mozambique came some time later than in many developing countries. It was triggered by extensive discussions at the national and regional levels and the contribution of several national researchers' work. Being late can work as an advantage in the sense that it is possible to leap-frog to a well-defined policy leading the development of the innovation system by taking advantage of the experiences of other countries and avoiding costly mistakes. Mozambique has introduced definitions and concepts from more developed countries and added some local ingredients, such as the case of the local communities as strong actors. In doing so, and unlike other countries in Africa, Mozambique has a very solid potential base for its build-up.

However, despite the government's efforts in developing various initiatives to implement S&T policy, establish a legal framework and mobilize financial resources, the Mozambique innovation system is still new and much effort needs to be made in order for it to operate successfully. Chief among these are issues related to linkages between the different actors of the system as well as the financial and legal autonomy of the research institutes.

The overviews of the emergence of NIS in the four countries indicate that the process has been both long and contentious. Bolivia, Tanzania and Mozambique all experienced conflicts to differing degrees with the establishment of a Directorate or Ministry of Science and Technology taking over responsibility for the area of STI. Already established institutions fought the perceived usurper; in Bolivia at the end of the 1970s, in Tanzania in the 1980s and in Mozambique in the 2000s. In Vietnam, the Ministry of Science and Technology does not seem to have met such resistance given the 'silo-structure' where each ministry has its own funds for R&D, but the creation of the National Council for Science and

Technology Policy in 2003 seems to indicate the need to sort out areas of responsibility and jurisdiction in STI in Vietnam.

After the historical overview of the emergence of the NIS in developing countries discussed in Chapter 3, the following four chapters go deeper into the present state of the innovation system in the case countries. First, each of these chapters discusses the main properties of the NIS and analyses the structural and organizational weaknesses of the innovation system as well as the main challenges for the system. Second, the chapters focus on the sectoral innovation systems for health and agriculture and analyse the results of a survey on experiences of researchers in aligning project work with overall development goals and in influencing policy.

Chapter 4 discusses the case of Bolivia. It is argued that 'Closing the Loop' in Bolivia is indeed possible as there exists considerable human potential for obtaining research outputs for social and economic innovations. There is, however, a set of conditions that must be met in order to complete the process, in particular the need to adopt a more flexible evidence-based policy, allowing all actors to support the co-evolution of all the elements that make up the NIS.

STI policies are only effective when government can formulate and implement them. In Bolivia it is clear that the main reason for the difficulty in building up an adequate capacity has been insufficient government capabilities and effectiveness. Thus, a stronger compromise of the State is needed with the NIS in the way of increased resources and infrastructure.

Several indicators show that the NIS is at present weak in Bolivia. The causes for this situation are well known, and discussed in depth in Chapter 4: lack of financial inputs, limited efforts of the business sector, weak human resource base and so on. However, talent exists and significant research outputs from public and private research centres are diffused through scientific publications and technical reports as well as in relation to specific economic and social developments. In recent years, private sector associations have become more active in promoting technology and innovation within their networks and together with public and private universities.

The systems of innovation in the sectors analysed operate at varying degrees of efficiency. As discussed in the chapter, the traditional agriculture production model has indeed produced innovations, but is criticized by policy makers as not having valued the local knowledge and wisdom of indigenous people, nor the wealth of the existing biodiversity. This new approach in Bolivia distances itself from an innovation strategy oriented towards competitiveness, value chains and productive specialization and instead tries to construct sustainable management of natural resources and the promotion of biodiversity based on an endogenous development model.

The health system has always been considered a priority in Bolivia and consequently much effort has been placed on research, however falling short of innovations. The health innovation system is today composed of a large number of public and private organizations and a research agenda has been defined.

Research into renewable energies has been conducted for several years and there are already research outputs that have 'Closed the Loop' and can serve as benchmarks. Research and innovation in the informal sector have not been analysed in detail, although characterizations have been made in the studies on small and medium-sized enterprises (SMEs) and training and innovation requirements have been identified. This latter sector is key to the Bolivian economy.

In the sectors analysed it is found that 'Closing the Loop' has been possible when dealing on a product-by-product basis. Considering existing experiences, it is clear that selective interventions must be sought that focus on strategic areas that can help accumulate the know-how and capabilities for further refinement. It is pointed out that although alternative approaches are important they cannot be the sole approach, as suggested by the proponents of an endogenous development model. An overemphasis on such a model disregards conventional approaches that have already been shown to work.

In Vietnam, the alignment of development plans with the activities of knowledge producing organization is quite strong. As deliberated in Chapter 5, R&D institutes, universities and even some companies have intentionally oriented their missions to address societal needs in development. It appears that at least some of them have sufficient capabilities to deliver relevant scientific research results as well as evidence-based support to policy making. Working closely with farmers is one of the most preferred modes of operation in order to ensure that needs in agriculture or health are properly addressed. However, there are severe policy and institutional problems that hinder the full potential of this process from to be reached.

The government has adopted a policy of creating a selective number of strong public universities in an attempt to create 'centres of excellence' for university education and research. However, the quality of research in Vietnam is still comparably low with a number of weaknesses and shortcomings. Wars and isolation from the international scientific communities have hampered the gradual build-up of physical infrastructure and human resources. Many universities are far from being considered R&D centres of excellence and lack an autonomous status to pursue their own strategies for quality improvements. Their staff, especially in public universities, face constraints in terms of salary ceilings, human resource

management regulations and financial incentives set by the government. Despite the introduction of research as a complementing mission at universities, there is still a well-documented lack of research and weak linkages between research and teaching. Moreover, the present incentive scheme does not promote collaboration within the university, nor does it provide mechanisms to encourage interaction with other institutions and firms. Cooperation is usually short term, and relies mainly on personal and informal relationships. Consequently, the relevance of much of the R&D carried out at universities and research institutes may be called into question.

In the business sector, the technology level of the enterprises is in general outdated and the capacities for adopting advanced technological equipment rather limited. This applies particularly for SMEs, but large state-owned enterprises also tend to pay insufficient attention to the search for technical information, improving S&T knowledge and investing in technology innovation. Enterprises do not express long-term visions, having little interest in technology innovation for sustainable development with a consequent low rate of investment in new technology.

In spite of such shortcomings, S&T has made remarkable contributions to economic growth and social development in Vietnam. Specific cases presented in the chapter reveal that many organizations were indeed able to deliver what they were expected to do in terms of producing relevant research results and training for development needs. In some instances, the achievements are quite extraordinary like the self-sufficiency of vaccines for national vaccination programmes or new species and crops in rice and maze production.

For such achievements to become the norm rather than the exception, and for the relevance of the R&D sector in Vietnam to improve, the responses to the survey of researchers offer some clues. One important factor to emerge is the fact that development goals are sometimes perceived to be formulated in too general and broad terms, often resulting in a R&D agenda based on the specificity of the involved organizations, particularly the ones who fund the research, rather than in compliance with overall developmental goals. The survey also reveals that a systematic structure to support a dynamic interaction between researchers and policy makers is sorely lacking despite some recent initiatives.

In Tanzania a poor record of knowledge-to-policy can be observed. In Chapter 6, the overall assessment points to the fact that the NIS in Tanzania is in grave disorder despite examples of isolated best practices and successful cases. It would appear that the way science-based research is designed, implemented and applied in the country does not easily lend itself to 'Closing the Loop'.

An important feature of the research environment in Tanzania is the dominating position of the international donor community in research funding, with the majority of the research in the country being funded by external sources. Obviously this impacts the way research is formulated and conducted and there is a general perception in the country that donor funding is bad because it does not focus squarely on national development goals. The survey confirms that this is a prevalent notion, although it also notes that there might be large differences between scientific fields – in agriculture the majority of the researchers feel that donor funding comes with objectives not necessarily tied to national development plans, whereas in the health sector only one in four researchers expressed such sentiments. In this case, the universality of global health issues appears to better align donor funding in the health sector with development plans compared with the specificity and local requirements of other research areas.

The survey identifies additional challenges facing the research community, including a paucity of funds from government and donors, limited opportunities for collaboration with other researchers in the region or sub-region, inadequate protection of intellectual property rights and a persistent gap in collaboration between researchers, policy makers and end users of research results.

Remedying this situation requires action on several levels. To align knowledge generation to the social and economic needs of the country, the respondents to the survey expressed a desire for a clear national research agenda developed sector-wise, coupled with an adequate budget. To ensure that the generated knowledge is relevant in meeting national goals, research projects should be negotiated with the users during the design stage. Most importantly, mechanisms for presenting research results in non-confrontational ways need to be developed.

There are some positive signs of change. The government has recently decided to increase funds for research and the Commission for Science and Technology, which is responsible for national research priority setting, is currently reviewing its national priorities for research in different sectors. Responses to the survey indicate that while these developments are indeed good news, they are not a panacea. If Tanzania's stated ambition to become a middle-income country by 2025 through the application of science, technology and innovation is feasible or even credible, the restrictions facing the research community must be addressed and overcome.

Of the four country cases discussed in this book, Mozambique is the poorest in terms of GDP per capita and also has the least developed NIS. Chapter 7 discusses how the main coordinating body for S&T-related activities in Mozambique, the newly restructured and re-named Ministry of Science and Technology, Higher, Technical and Professional Education

and its predecessor Ministry of Science and Technology (MCT), have struggled to create a supportive infrastructure and collaborative environment for the actors of the NIS. Despite some encouraging progress, the overall results have been meagre. One reason is that of the unresolved issues of areas of responsibility of the Ministry. It is argued that turf wars and conflicts of interest between MCT and other ministries and public institutions have seriously hampered the implementation of the ten-year master plan for science and technology (MOSTIS) adopted by the government in 2008. The absence of coordinated efforts, coupled with a lack of metrics for measuring outcomes and outputs and indicators for attainment of targets, constitute major obstacles for the implementation of MOSTIS and an efficient S&T policy.

A second problem in the implementation of MOSTIS is the lack of continuous updating and scrutiny of activities under the plan. Some parts of the strategic programmes have become unsuitable under present conditions while others have not even been implemented since 2008. Furthermore, the plan for enhancing the NIS rests on the assumption that the participating institutions are bestowed with appropriate financial and human resources. Evidence shows that most institutions do not have those prerequisites and lack a clear understanding of what they are tasked with in the field of STI.

To compound the situation there is a general lack of qualified human resources in the NIS. Systematic inclusion of science, technology and innovation issues in developmental plans is relatively new in Mozambique and many planners, policy makers and actors of the NIS demonstrate difficulties in understanding and implementing the sometimes complex programmes envisaged in MOSTIS. This is also evidenced by the lack of collaboration among different institutions of the NIS and by the weak institutional linkages between them.

In spite of systemic and management problems, relevant research is carried out by universities and specialized research institutes. However, as the survey of researchers in Mozambique indicates, most of the technology developed in the agrarian sector is not used or delivered properly to the target group, the farmers, due to systemic failures. A complicating factor is the heavy reliance on international donors for the funding of research projects with over 70 per cent of gross expenditure on R&D in Mozambique coming from international sources. Many of the researchers feel that the interests and visions of external funders are not always compatible with national development plans. In order to qualify for competitive donor grants, it is important to obey the criteria, rules and most important the research interests and area set by the funder, which may not always coincide with the national programmes.

The final chapter provides a synthesis of the empirical results discussed

in Chapters 2 to 7. The surveys of the perception of the researchers on the functioning of the NIS in the four countries are analysed and compared. The respondents' perceptions of quality, relevance and impact of research point to the fact that the research communities in these countries are both willing and able to contribute to generating relevant research results and informing policy. However, the results of the surveys also point to a systemic failure in the ability of the NIS to make this happen.

NOTE

1. The concept of 'Closing the Loop' originates from the International Development Research Centre (IDRC), which defines it as 'an approach to programming and projects that seeks to ensure the awareness, understanding, and ownership of research outputs by decision-makers at all levels. Its goals are to increase the relevance and utilization of research outputs, thereby enhancing the influence of the researchers, institutions, and work we support' (IDRC, 2002, p. 1).

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