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Scientific Capacity Building To Improve Population Health: Knowledge As A Global Public Good

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SCIENTIFIC CAPACITY BUILDING TO IMPROVE POPULATION HEALTH:

KNOWLEDGE AS A GLOBAL PUBLIC GOOD

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ABSTRACT

We hypothesize that scientific capacity for improving population health has been neglected nationally and internationally because health has rarely been viewed as *strategic.* Systematic study of science policy and research capacity occurs primarily in those areas viewed as critical to national economic development and competitiveness. Inadequate scientific capacity for prevention and treatment imperils human health, especially in parts of the world where the disease burden is greatest. Our knowledge base for improving and sustaining scientific capacity, particularly for developing countries, remains weak. Few longitudinal and comparative studies target population health in contrast to the relatively robust literature that is relied upon worldwide to guide investment in science and technology for economic growth. Using a broad definition of scientific capacity for health (biomedical sciences, development of preventive and therapeutic products, epidemiology, health services and operations research, as well as economics, social and behavior sciences) we explore how knowledge about scientific capacity for health — building, strengthening and sustaining research locally, nationally, regionally and globally — could serve health systems in every country; how it could help guide cooperative, complementary and synergistic global health research.

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> Scientific research can and must help to solve the problems that confront us. However, research can only make a decisive difference if two preconditions are met. Firstly, the worldwide potential for scientific research must be more evenly distributed around the globe. Secondly, scientists, the public, and political and economic powers, must work together.
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> Both solidarity and common sense therefore demand that the capacity to do research in developing countries should be furthered to the point where it is possible to carry out, on a worldwide scale, the kind of cooperative research that has long been normal in industrialised countries. "Cooperation" here is not aimed at improving economic competitiveness, as was frequently the case in the past. It means a responsible common search for solutions to the problems confronting humanity as a whole. Competition is no longer appropriate – what is needed is complementarity and synergy. [Swiss Commission for Research Partnership with Developing Countries (KFPE)][1]

1. Introduction

A special session of the United Nations General Assembly recently devoted three days to the AIDS epidemic as the global health community continues to debate how to use new infusions of funds most effectively. Unanswered questions abound: How to balance investments in prevention and treatment? What therapeutic regime(s) to adopt given scarce resources and abundant disease? How to monitor therapeutic effects and respond to problems?

Such questions will surely be addressed by experts gathered in New York and Geneva, but can they be answered in every locality fighting the spread of HIV? Difficulties in maintaining an adequate flow of supplies, variation in delivery and support systems, and in patient responses, will confront every community. At best infection and death rates will plummet; at worst resistant strains will flourish and complicate every aspect of prevention and treatment. Vexing questions will challenge strategists at every level: local, national, regional and global. If an urgent aim of scientific activity today is to develop vaccines and therapeutics for use globally, and to assure that resources devoted to HIV/AIDS locally are constantly monitored and adjusted for optimal benefit at the individual and population levels, what scientific capacity will be needed to accomplish this? Control of HIV / AIDS is but one of the many important health problems that require a range of scientific capacities.

At least since the 1970s, when human reproduction and tropical diseases stimulated a new era of international cooperation in health research (see Section 4 for further discussion), such questions have driven efforts to enhance *research capacity* in developing countries. Since the 1970s significant expansion transpired – in research topics, disciplines brought to bear, training programs, application of knowledge in health systems, concern about the massive health inequities, methods developed for measuring disease burden, for identifying priority health interventions and for assessing the performance of national health systems. Thus, today's conception of research, or as we prefer to call it, *scientific capacity for health*, encompasses biomedical sciences from fundamental laboratory studies to the development of preventive and therapeutic products and their evaluation; epidemiology; health services and operations research; policy research; all applying economics, social, and behavioral sciences.

In those expanded efforts, what has been tried, succeeded, or failed in developing, strengthening, and sustaining scientific capacity for health in developing countries? As we searched for lessons, we were surprised by the relatively meager accumulation of knowledge.[*] Eager to find an analytic basis for evaluating investments in scientific capacity for health, past and future, we broadened our search to the history of science and technology policy more generally. We looked at science strategies adopted by countries – in all regions and economic circumstances. As we are still in an early phase of our project, we offer a preliminary diagnosis and a provisional prescription for more systematic analysis of scientific capacity for health – a capacity dedicated to advancing the ultimate purpose – global cooperation for improving health, especially for the world's poorest populations.

In this essay we contrast the historically intense study of scientific capacity for achieving national economic growth with the apparent lack of attention to scientific capacity for improving population health. Despite at least a decade of explicit effort to link development, health, and research worldwide, we find little inquiry into the role of scientific capacity. What analytic effort will be needed to advance development of scientific capacity for health beyond an art? Knowledge resides with a small generation of wise scientists and educators who have built research institutions and research systems, and are now approaching retirement. How might we create a more documented and empirical basis for predicting what are likely to be good investments for science capacity?

We then explore why health and health research have been neglected in most analyses of science, technology and development and offer a hypothesis. We review indications that health may be gaining a more prominent role in development strategies – but without a foundation of longitudinal and comparative studies analogous to those relied upon to guide investment in science and technology for economic growth. We explain that, in addition to placing certain *commodities* within the rubric of global public goods (e.g.

[*] Searches to identify the relevant bodies of published literature, gray literature and pertinent websites yielded less than we had imagined and contrasted markedly with the relative wealth of literature about science and technology in other sectors.

neglected vaccines), it will be important to enhance *knowledge* about building, strengthening, and sustaining scientific capacity for improving population health.*

2. Science and technology to support nationally strategic purposes – not including health

Science and technology policy in agriculture, military, manufacturing, transportation, energy and, more recently, the environment, have been subjected to intensive study. Using the terms *science and technology* to search the literature yields extensive bibliographies about prior experience[2,3,4,5,6,7] recent trends[8,9,10] and discussions of scientific capacity in industrial and (at least since the 1960s) in developing countries.[11,12,13,14,15] The studies include longitudinal and comparative ones by economists, sociologists, and historians. National policy debates and decisions have relied on this robust literature about national development.

Such studies,[16,17] and government science and technology plans,* give short shrift to health sciences and health researchers. We perused plans from or studies of countries early to industrialize (Britain, France, Germany, and the US), those later to do so (Australia, Canada, Finland, and Sweden), considered to be emerging industrial nations today (Brazil, India, Mexico, South Korea, and Thailand*), or struggling to emerge from less advantageous circumstances (countries in Sub Saharan Africa along with the poorest ones in the other regions). Health and health sciences are rarely even mentioned, whether the topic was education and training of researchers, strengthening of scientific institutions and infrastructure, national innovation systems, or generation of knowledge for strategic purposes.

Why, in industrial and developing countries alike, have health sciences been neglected in consideration of science and technology policies nationally and

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* There appears to be wide recognition that 'basic knowledge' is an 'international public good' and one that "will be underprovided without conscious, concerted, and collective efforts to provide..." (World Bank. World Development Report: The State in a Changing World. (New York): Oxford University Press; 1997, p. 131). That at least some health research and the knowledge it generates is global in scope (Bloom, Barry. Keynote address. Global Forum for Health Research, Bangkok, Thailand, October, 2000) and among those 'global public goods' particularly suited to benefit the poor has been similarly acknowledged (World Bank. World Development Report: attacking Poverty. (New York): Oxford University Press; 2000, p. 181-183).

* We reviewed a sample of science and technology plans from the last decade from countries in all regions and all circumstances with regard to industrialization.

* Thailand is an exception to the rule where by 1980s, scientific potential focused on agriculture, social sciences -- and health. See Gaillard J. The behavior of scientists and scientific communities. In: Salomon et al (eds); 1994. p. 208.

internationally? Our hypothesis is simple. Countries and policymakers have encouraged systematic study of science policy and scientific capacity primarily in those areas viewed as critical to national development, competitiveness, or survival. Historically these areas of national *strategic* interest included enhancing economic growth through assistance to manufacturing, transport, energy, and cash crop agriculture; strengthening military might through weapons development and production and assuring survival by protecting agriculture to avoid famine and starvation[18].

Health sciences have not been on this strategic list – with important exceptions for colonial and military health affairs. European colonial powers (and later the US) sought cures for major tropical diseases that hindered colonization and exploitation of the tropics. Around 1900, tropical medicine became a distinct scientific specialty.[19] During World War II, the US Armed Forces Epidemiology Board (AFEB), used extramural research grants to recruit eminent scientists for work on urgent health problems affecting the war effort. This research advanced science and technology for public health and medicine dramatically.[20] The fruits of AFEB's creativity later spilled into the civilian research community and bolstered intramural research, then extramural grant programs at the National Institutes of Health.[21] European countries rapidly organized national research councils starting in the 1950s. All other regions followed, the Asian and African countries as they achieved independence from former colonial rulers.[22]

Science and technology policy represented "the articulation of how the modern state and society at large view the relationships and instrumentalities between scientific and technology change and social and economic development,"[23] but only for those areas of science capacity that were strategic. Studies of science and technology were undertaken to inform national policies and decisions about education, building of infrastructure, generation of and the strategic uses of knowledge. Even where *social* development was a target for national planning along with *economic* growth, health in most instances, unlike education, has not been treated as a foundation of social development.[24] Hence, health sciences and technologies were rarely considered as "instrumentalities of development".[*]

In analyzing how Sweden moved from poverty to affluence, and considering whether Sweden serves as a useful example for development of poor countries, Dahl and Oden point out:

> The decades of industrially driven growth (1870-1930) in Western Europe and the USA, measured in GDP terms, were matched by an exponential growth of research, measured in terms of scientific journals, numbers of researchers, research funding, etc. The concept of connection between knowledge development and economic growth became

> firmly established among both researchers and politicians. During the Second World War, and for some time afterwards, research was successfully guided and planned in the direction of specified targets: the atom bomb, radar, the sputnik and putting the first man on the moon. A new field of politics developed: research policy. Research planning in the Western world was primarily concerned with technology for the space race, for defense efforts and for industrial needs.[25]

3. Science, technology and the role of knowledge – a quest for cooperation

By the 1960s, international discussions on development assistance began to consider the importance of research for developing countries. The first UN "Conference on the Application of Science and Technology for the Benefit of Less Developed Areas" in 1963 addressed the issue directly.[26] In 1970, the United Nations sponsored a discussion of the global action program for science and technology.[27] In 1971 an influential OECD report, *Science Growth and Society*, known as the Brooks Report, offered a fresh perspective: that research should also be planned with a view to solving the world's social problems.[28] Competitiveness as a driver of national science and technology policy did not subside, but the prospect for international cooperation in science and technology emerged as a concern at the United Nations.

In 1970, Canada established the first bilateral aid organization devoted to supporting research activities in developing countries (including training and some elements of infrastructure), the International Development Research Center (IDRC). Leaders of Canada's International Development Agency (CIDA) were "convinced that the gap between rich and poor countries and research and technological capability was a major hindrance to development".[29]

Shortly thereafter in 1973, Sweden's Parliament considered proposals for strengthening the role of research in development cooperation and issued the report, *Research for Development,* which presaged founding of the Swedish Agency for Research Cooperation with Developing Countries (SAREC) in 1975.[30] IDRC and SAREC were exceptions to trends in development cooperation in two respects: they featured assistance for strengthening scientific capacity; and included health sciences alongside activities to encourage economic growth.

In contrast, biomedical sciences funding organizations, such as the UK's Medical Research Council and the US National Institutes of Health, concerned themselves primarily with science, not development, even when they supported research in developing countries. Integration of health sciences into development strategies was not a prime objective of investment by research councils or scientific institutes.

In the 1970s, development aid typically supported creation or improvement of infrastructure, and by the mid 1980s efforts shifted to technical assistance and short term projects,[31] even for capacity building in the South.[32] Development agencies supported *capacity development* principally for managing program operations, not for creating knowledge. Thus, despite the existence of science and technology institutions organized by colonial powers or newly independent nations, "it has been difficult for science to take root, particularly since it was expected to produce economic growth."[33]

Analysts of Sweden's economic growth note that although knowledge played a central role over decades, research planning did not emerge until 1970 with establishment of research councils and 'sector area research institutes'. Only after 1982, did the concept of research planning appear regularly in proposals before the Parliament. This research policy legislation pushed Sweden firmly in the direction of becoming a "knowledge society".[34] It was not, however, until a ground breaking analysis was published in 1994,[35] that the knowledge perspective acquired a lasting place in the interpretation of Sweden's own development. Thus, even one of the world's foremost proponents of research capacity development for poorer countries had invested in research for many years before anyone clearly articulated the critical role of science and technology in its own development.

4. Health and health sciences contend for a place on the development agenda

The cooperative era of health research dates back only to the 1970s. It was initiated in 1971 by the Consultative Group on Agricultural Research (CGIAR),[36] housed at the World Bank, and focused more on agricultural issues than on human health. Then two research programs were attached to WHO: the Special Programme of Research, Development and Research Training in Human Reproduction (HRP) in 1972 and the Tropical Disease Research Programme (TDR) in 1976.[*] These new, multilateral collaborations were post-Colonial, international or global in character, public in spirit, backed substantially by public funds, not intended principally for military, national security, or economic competitiveness purposes, but meant instead to improve health status in developing countries. (Not surprisingly it was several Swedish scientists who played leading roles in founding of HRP and TDR.)[37,38] In 1987, when an expert committee reviewed the status of scientific capacity to address tropical infectious diseases, the members observed that despite recommendations to combine research and training, few of the arrangements were designed from the outset to promote collaboration among institutes of industrial and less developed

[*] HRP and TDR were the first two extra-budgetary programs and programs of research at WHO.

countries.[39] Compared to what came next from the Commission on Health Research for Development[40] this 1987 review focused narrowly on disparities among countries' scientific resources devoted to tropical disease research without much discussion of the relationship of scientific capacity to economic or social development in those countries bearing the burden of tropical (and many other) diseases.

Is development of scientific capacity for health, including in poor countries, working its way onto the strategic agenda, both within nations and globally? Many signs suggest it is, especially over the last decade. IDRC, SAREC and Sweden's Nobel Assembly helped sponsor the Commission on Health Research for Development. The Commission conducted a three year review, explicitly examining the potential role of health research in development. Their 1990 report took into account a more complex context than earlier reviews,[41],[42] focusing not just on science itself, but on the relationship between science and national development in a world ever more polarized by the growing gap in wealth and health between people of richer and poorer nations.

The Commission on Health Research for Development attempted, for the first time, to gather information systematically on health research. It conducted surveys in ten developing nations. For at least thirty years (since the 1960s) countries had already collected data on resources devoted to other areas of research and development.[43] In 1991, UNESCO published statistical maps of 128 countries using data from 1980 and 1985.[44] The Commission's own surveys revealed that 'country-specific' health research had been neglected as compared to topics of greater international interest. The Commission urged every nation to establish priorities for health research and to devote at least 2% of national health expenditures to country-specific health research and capacity[*] for the same.[*] The Commission defined global health research as a second element of *essential national health research* and encouraged countries to contribute as much as possible to discovering new knowledge and technologies to solve health problems of significance to its population as part of networks of peers worldwide.

[*] The Commission defined capacity building for science-based development as having four components: Individual competence; institutional infrastructure that supports research; the research component of policy formulation and field action; global health research. P. 71-72.

[*] The Commission used a target proposed by the Third World Academy of Sciences of "2 percent of GNP as a necessary minimum investment to develop a nation's science and technology capabities. Health might expect to receive at least 10% of such science and technology investments." Commission; 1990, p. 75.

Most memorably, the Commission quantified the global investment in health research, contrasting the investment for those living in rich versus poor countries:

> An estimated 93% of the world's burden of preventable mortality (measured as years of potential life lost) occurs in the developing world. Yet of the $30 billion global investment in health research in 1986, only 5 percent or $1.6 billion was devoted specifically to health problems of developing countries. For each year of potential life lost in the industrialized world, more than 200 times as much is spent on health research as is spent for each year lost in the developing world.[45]

In 1993 the World Bank put forward an explicit role for human health in national development.[46] Although it never mentioned research, the Bank chose population health indicators and cost effectiveness of particular interventions (rather than contribution to GDP) as the basis for directing countries' attention to setting priorities among health interventions or programs, especially those supported by governments. Building on earlier work,[*],[47],[48] this report invigorated the application of quantitative methods to understand the burden of premature death, ill health, and disability on societies.[49],[50] Before an audience of all of the world's ministers of finance and of health, the Report seemed to celebrate a marriage of epidemiology to economics.

In 1996, the World Health Organization convened a committee to conduct its first thorough review of research needs and opportunities, emphasizing global priorities.[51] The report identified "best buys" for research investment, based on the same sorts of epidemiologic and economic data that informed the 1993 World Development Report. Partly to avoid old debates about basic versus applied research,[52] and probably out of commitment to advance health and health research on the global agenda for development, the authors characterized the purpose of health research as *strategic*. WHO was promoting an effort to bring health research to the strategic agendas of its member states and to the agenda of international aid organizations. This notion of strategic national interest in science and technology policy brings us back to our hypothesis: that systematic study of science policy and research capacity has been undertaken principally in those areas long considered essential to economic development.

A year later, the newly established Global Forum for Health Research committed itself to continuing the evaluation of global allocation of research investments and to advocacy for redressing the dilemma wherein 90% of disease burden receives only 10% of research funding.[53]

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[*] Approaches upon which Lopez and Murray and others have drawn for disease burden analyses date back to the 1970s and the work of Samuel Preston and others. (David Gwatkin, Personal Communication, October 2000.)

By 2000 the World Health Report brought measurement to the performance of national health systems,[54] albeit with significant controversy.[55],[56],[57],[58] Today WHO is asking itself how to measure the productivity of national health research systems, so that the contribution of research may be included in the evaluation of performance of national health systems.[59] Their task will be all the more difficult because of the paucity of scholarship devoted to scientific capacity specifically for health.

5. Scientific capacity for improving population health globally: Addressing the gap in knowledge about health sciences as a global public good

As eloquently stated by the Swiss Commission in the quote with which we began, capacity to do research in developing countries is an essential ingredient of cooperative, complementary, and synergistic research among countries in the common search for solutions to the problems confronting humanity as a whole.[60] But as our preliminary review suggests, compared to other sectors which have long been considered *strategic* for national development and economic competitiveness, precious little effort has been devoted worldwide to collecting data, deciding what to measure or compare, shaping indicators, and documenting lessons about how to build, strengthen, and sustain scientific capacity for health – either within or among countries.

In the 1950's, when science and technology in developing countries was just becoming a topic of international interest, a commentator noted that, "Looking through the various national statistical yearbooks, one is impressed by how many countries have felt the need to count their donkeys and how few their scientists."[61] Even though the counting of scientists and measuring the performance of research and technological innovation in the service of economic competitiveness has advanced dramatically over the last half century, similar treatment of health sciences for improving population health lags far behind. Analysts working in the broader context of science and technology have considered and reconsidered indicators, moving from important, "elementary comparisons" among nations to more sophisticated models that link data on R&D and innovation with statistics on other economic and social activities, thereby creating new, more sophisticated indicators and ways to assess output, and more recently, impact.[62]

In their quest to measure the contribution of national health research systems to the performance of national health systems, our colleagues at WHO are working toward a first set of indicators.[63] Their task will be all the more difficult given the limited supply of internationally comparable data on any aspect of scientific capacity for health: workforce (technicians, clinicians, and scientists of all descriptions), their education, training and experience; the institutions (public and private) and roles individuals play in them; financial resources, plus links among collaborators nationally, regionally and globally. Better data will be needed to understand better how societies, where the scientific community remains on the periphery, can blend appreciation for science into their cultures and prepare for science to provide constant and sound guidance for health systems.[64]

Scientifically sound guidance is a prerequisite for finding our way through the AIDS crisis and the other daunting challenges to a healthier world. It will be required to assure that monumental discoveries, such as the genetic code for humans, benefit populations in the South as well as wealthy individuals in the North. Undoubtedly we must pursue 'big science'[65] for diagnostics, vaccines and therapeutics, but improving health and sustaining any gains will also require frequent monitoring and targeted interventions at both individual and population levels. Relative to development of technological *commodity* items (e.g. vaccines, HIV/AIDS therapies) attention to the scale up and sustenance of field capacity to effectively and safely deliver and monitor interventions (new vaccines, TB, malaria or HIV/AIDS control) has been meager.

Local success will depend on local scientific leaders' ability to review the appropriateness of interventions with critical eyes. Without discriminating scientific capacity, local populations are left to follow blindly protocols exported from afar, be it from national governments, international agencies, pharmaceutical and device manufacturers, or others. Local scientific leadership engaged in shaping interventions will be prepared to help their communities understand the purposes and underlying theories of health interventions. Drug resistance, for example to important tuberculosis drugs, has demonstrated all too clearly that insufficient scientific vigilance can unwittingly exacerbate well intentioned but poorly monitored disease control efforts — and remain undiscovered until the damage is widespread.[66]

6. Conclusion

Two observations provoked us to initiate this review. First, even when we asked our most experienced colleagues from different regions if they could confidently compare approaches to capacity strengthening for research around the world, and identify the possible significance of the differences, none felt in command of a comparative perspective at the institutional, national or international level.

Second (based on a very informal and not very scientific survey of colleagues with differing degrees of experience internationally), we have found that scientists educated or engaged in advanced studies in one country, do not necessarily identify the same issues as key to capacity strengthening as do others working in, or trained at, a scientific institution in other countries. Some stress training while others emphasize particular institutional needs or other aspects of infrastructure as vital; few describe the characteristics using the same terms. The same appears to be true of evaluation reports of programs designed to enhance research capacity for health.* Perhaps perspectives on building science capacity for health are integrated in the culture of the country, or institution, and may affect all scientists at the institution or in the country, irrespective of their national origin or reasons for being there.*

In view of national or institutional biases, we wondered what knowledge base supports the work of development specialists or scientists in developing countries wishing to compare approaches and learn which may be best suited to building their own nation's scientific capacities for health. Comparing experience from the other sectors long considered strategic might tell us how creation, strengthening, and maintenance of scientific capacity have been brought to bear on particular aspects of development, by whom, how, and to what effect. Societies have always mimicked and traded science and technology as part of national development and the conduct of foreign and military affairs, acquiring and adapting technologies from elsewhere. Experiences in *strategic* areas of science and technology policy also suggest that countries have developed creative scientific capacity following their understanding of what happened elsewhere. There is a rich history of examples including Japan's spectacularly rapid scientific and technological expansion once it emerged from isolation into the Meiji period, and again after World War II.[67]

Perhaps a more systematic, if preliminary review would entice scholars to enhance the modest collection of case studies that exist in the health field. Both longitudinal studies in particular countries and comparative analyses across research and training programs, institutions, and national systems in health and other sectors may be productive. The Commission on Health Research for Development wisely defined health research very broadly, as "the generation of

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* We have found few of these in the published literature. Some are available through the sponsoring agencies r on websites. For example, USAID's Center for Developing Information and Evaluation assess capacity using very different terms and measures than the International Food Policy Research Institute (IFPRE).

* We have discussed differences in approaches to 'strengthening scientific capacity' with experienced and wise colleagues from countries whose educational traditions and science policies are as dissimilar as those, for example, in Costa Rica and Cuba; Japan and the United States; Mexico and Thailand; Finland and its neighbor, the former USSR; Egypt and South Africa; China and India; Bangladesh and Mali; or Brazil and South Korea.

new knowledge using the scientific method to identify and deal with health problems."[68] Thus the range of activities worthy of review will be broad as well.

Lessons from the relatively long history of local and national experience can provide building blocks for cooperative, regional and global efforts to improve population health. Thus, studies of both developing and industrial countries are likely to be informative as the Swedish observers point out using their own example. As the history of international scientific collaborations directed at reducing disparities in health globally is short, national experiences provide a deeper well from which to draw data for enriching global cooperation.

Why take up this challenge now? Because awareness of the striking mismatch between the distribution of the world's burden of preventable mortality and investments in health research is growing at the same time that world leaders are intensely debating policies to guide investments, consideration of the inadequacies of the knowledge base for choosing the best investments seems particularly timely. At best, a new infusion of funds for global health may be directed at urgent, highly visible needs *and* used to strengthen human and institutional capacities needed to sustain and build upon health gains achieved. Vessuri asserts that, "The history of developing country science is full of examples of attempts at institutionalization followed by collapse, unbounded optimism followed by pessimistic indifference, and a lack of public trust in long-term intellectual endeavor."[69]

Parenthetically, it seems that certain questions are asked perpetually: To what extent can scientific capacity for health be teased apart from overall economic development? Can scientific capacity for health be enhanced even where economies are weak or growing weaker? During the 1980s, the global economic crisis forced many countries to reduce investment in science as well as health. That crisis tested the resilience of the most celebrated scientific institutions in developing countries;[70] the impact on local scientific capacity has never been tallied. As we pursue lessons about scientific capacity for health we must learn how institutions can transcend the short lives of individual leaders and national policies that may neglect the role of science for health. For population health to improve globally, science must survive the rising and falling tides of philanthropy.

Building the competence and knowledge that are needed to gain public trust in and support for health sciences programs cannot be a short term or one time endeavor;[*] nor can they be realized rapidly enough to guide investments in

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[*] Health organizations in democratic settings, be they local, national or global such as WHO, all face the difficulty of governance by representatives of governments operating with limited

health sciences and capacity immediately. But drawing similarly systematic analytic attention to science for health as has been brought to science for economic growth, national security, space exploration or weaponry—offers the possibility of attracting longer term, institutional support for investment in health. Every society and locality stands to benefit as Dahl and Oden's reflections suggest:

> Modern research into local knowledge, e.g. in the agrarian communities of the Third World, has shown that people do not differ all that much in their individual reappraisal of knowledge, but that different social environments vary in their institutionalization of the same – that is, in the extent to which the results of discoveries and insights by individuals are systematically accumulated and passed on.[71]

Judging from experience in the wider realm of science and technology, the social or institutional study of science remains "unfashionable" within the disciplines of history and sociology, appealing to only a handful of devotees.[72] There are far too few empirical studies to help us understand the behavior of scientists and scientific communities.[73] In profitable pursuits, such as pharmaceuticals and biotechnology, private firms regularly study how to enhance and sustain research capability. Almost certainly, their findings will remain a private rather than a public good, secret to all but those who pay for the studies. Therefore, knowledge about scientific capacity in both the public and private sectors for health must be seen self-consciously as a global public good. We must engage the global community in the quest for the knowledge that is needed for health research to join the *strategic* domain.

In sum, if we are to heed the lessons from other sectors – agriculture, energy, environment or transport – about the strategic role of science and technology in development, what wisdom about scientific capacity for improving population health could best inform future investment? Decisions about what is worth pursuing will certainly depend on much more careful thought than we have presented here. We do not mean our contribution to prejudge the ultimate results. We suggest only that knowledge to predict the consequences of investment seem pertinent and timely for:

- those making research investment decisions for research and for training programs, for research institutions and systems;

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tenure, and are thus under considerable pressure to emphasize investments for short over long term gains. Many have observed this is not the ideal culture for gleaning the greatest benefit from science.

- those wishing to influence research policy and investments and seeking to assess the effect of previous research investments and to predict the productivity of future ones;

- those anywhere in the world wishing to strengthen their own research efforts individually and institutionally;

- those wishing to advance health on the development agenda worldwide.

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[1] Swiss Commission for Research Partnership with Developing Countries (KFPE). Guidelines for Research in Partnership with Developing Countries: 11 Principles. (Bern) Swiss Academies of Sciences (CASS), Translated from the German version; October 1997, p. 3-4
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