

Introduction

BJØRN LOMBORG

The Copenhagen Consensus approach is to look at global issues and to ask: how could economic science help us to improve decision-making?

Each day decisions are made about global political priorities. Governments, philanthropists, and international bodies choose to support some worthy causes while others are disregarded. Unfortunately, these decisions frequently do not take fully into account a comprehensive view of the effects, benefits, and costs of solving one problem instead of another. The conflicting demands of the media, stakeholders, and politicians mean that priorities are set in an obfuscated environment. The idea behind the Copenhagen Consensus is to render this process less arbitrary, and to provide more evidence upon which informed decisions can be made by politicians and others.

Much of the time, society is presented with a menu of choices, but with very little information on their costs and benefits. The Copenhagen Consensus process aims to put prices and sizes on the menu, making choice easier and more informed. To inform this process in practice, we ask: if you were to spend an additional \$75 billion over the next four years to do good for humanity and the environment, where would you spend it first?

This book constitutes a concrete contribution designed to improve the debate regarding global priorities: the questions of how we tackle the world's problems, where we start, and what should sensibly be done.

This Introduction sets out the methodological approach to the Copenhagen Consensus 2012 project and adumbrates the research that follows.

In 2004 and 2008, the Copenhagen Consensus Center gathered research on ten key global challenges – from malnutrition to terrorism – and commissioned a panel of expert economists to rank the investments. The research from the Copenhagen

Consensus 2004 and the Copenhagen Consensus 2008 is available in Cambridge University Press books, *Global Crises*, *Global Solutions* and *Global Crises*, *Global Solutions* (2nd edn.) (Lomborg, 2005, 2009a).

These projects attracted attention from all around the world. Denmark's government spent millions more on HIV/AIDS projects, which topped the economists' "to do" list in 2004. Micronutrient delivery programs in Africa and elsewhere received significant attention and greater resources after they topped the list in 2008. The World Bank quoted Copenhagen Consensus research and findings in 2006 when it created its new strategy on combatting malnutrition: "As documented by the Copenhagen Consensus, we know what to do to improve nutrition and the expected rates of returns from investing in nutrition are high."¹

In 2006, the Copenhagen Consensus United Nations brought together twenty-four UN ambassadors, including the Chinese, Indian, and American ambassadors, and set them the task of prioritizing limited resources along Copenhagen Consensus lines to improve efforts to mitigate the negative consequences of global challenges.

Consulta de San José in 2007 (the Copenhagen Consensus for Latin America and the Caribbean) was a collaboration with the Inter-American Development Bank (IADB). This project gathered highly esteemed economists to identify the projects that would best improve welfare in Latin America and the Caribbean. The research is available as *Latin American Development Priorities* (Lomborg, 2009b).

In 2009, the approach was applied to climate change. The Copenhagen Consensus on Climate assembled an Expert Panel of five world-class

¹ World Bank (2006).

economists, including three recipients of the Nobel Prize, to evaluate twenty-one research papers on different responses to climate change and to deliberate on which solutions would be most effective; this project was published in *Smart Solutions to Climate Change* (Cambridge University Press, 2009).

In 2011, RethinkHIV – funded by the Rush Foundation – saw the Copenhagen Consensus Center gather teams of economists and medical scientists to perform the first comprehensive, cost-benefit analysis (CBA) of HIV/AIDS investment opportunities in sub-Saharan Africa (SSA). This research was published in 2012 as *RethinkHIV* (Lomborg, 2012).

These projects generated considerable attention and discussion. They showed that an informed ranking of solutions to the world's big problems is possible, and that CBAs – much maligned by some – lead to a compassionate, clear focus on the most effective ways to respond to the real problems of the world's most afflicted people.

This book builds on several of these past projects – particularly the Copenhagen Consensus 2004 and the Copenhagen Consensus 2008 – which each gathered Expert Panels of outstanding economists to deliver ranked lists of the most promising solutions to ten of the most pressing challenges facing the world. Each project involved around sixty leading economists and specialists in ten global challenges.

This effort also draws on the research for the Copenhagen Consensus on Climate and RethinkHIV, to ensure that the most up-to-date and informed analysis is provided for the topics of global warming and HIV/AIDS.

The objective for the Copenhagen Consensus 2012 was to commission new research and data to deliver an informed, current perspective on the smartest investments to respond to global challenges.

Tremendous progress has been made in the fight against humanity's biggest ailments within our lifetimes. People in most countries live longer, healthier lives; air and water quality in the developed world is generally getting better; and a much larger proportion of the global population is being adequately fed.

But there are still many problems to tackle. The minority of us lucky enough to have been born in the developed world can sometimes take for granted universal education, an assured food supply, and clean, piped water. But billions of people are not so lucky. And although the world's problems fall disproportionately heavily on the developing world, rich countries also face problems.

When it comes to global welfare projects, it is easy for decision-makers to pay lip service to prioritization, but to act as though the pool of money is infinite, that all that is lacking is willpower, and that everything should be tackled all at once.

Many of the big decisions are made individually by the governments of donor countries, or by relatively specialist international agencies that receive money from rich nations and use it for the benefit of the world, especially developing countries. Each such organization has its own remit, scope of work, and funding base.

Of course, in principle we ought to deal with all of the world's woes. We should win the war against hunger, end conflicts, stop communicable diseases, provide clean drinking water, step up education, and halt climate change. But we don't do all of this at once. We live in a world with limited resources and even more limited attention for our biggest problems. This means we have to ask the crucial question: if we don't do it all, what should we do first?

This book focuses on the funding that the developed world spends on improving the world in general. Of course, most nations spend the vast bulk of their resources on themselves – perhaps 99 percent of developed nations' GDP. In a well-functioning political system, this internal system is prioritized according to a solid framework of economic principles, as well as by social and ethical concerns.

However, the last 1 percent of spending – the portion that goes outside a nation's borders – is less well developed. This spending ranges from the money that goes from donor nations as Official Development Assistance (ODA) to spending on peacekeeping forces, research into vaccines, and efforts to reduce environmental pollution.

Often, explicit prioritization is ignored altogether by policy-makers. The UN Millennium Development Goals (MDGs), which shaped much of this

funding for the first decade of this century, consist of a laundry list of noble causes with no consideration given to relative costs or benefits.

Relying on costs and benefits, as this project does, is a transparent and practical way to establish whether spending is worthwhile or not. It lets us avoid the fear and media hype that often dictate the way that we see the world. Carefully examining where an investment would have the biggest rewards provides a principled basis upon which important decisions can be made. Assigning a monetary value is the best way we have of introducing a common frame for comparison.

Some will argue that it is impossible to put a value on a human life. Yet, refusing to put a value on human life does not help to save lives. In practice, prioritization occurs every day in areas as disparate as health policy and infrastructure. When we decide on a national speed limit we are implicitly putting a price on human life, weighing the benefits of fewer lives lost with a lower speed limit against the dispersed costs of higher transport times. Making such trade-offs explicit allows us all to better evaluate our choices. In this book, we use tools such as the ‘Disability Adjusted Life Year’ (DALY) which allows economists – and thus, policymakers – to add up the years of life that are lost and establish the impact of disability, and then weigh these with other benefits and costs of different policies. Specifically, we have set low and high values of a DALY at \$1,000 and \$5,000, respectively, to ensure comparability across areas.

Another economic tool that informs this project is discounting, which allows us to balance our own needs against those of future generations, and ensure that we have a consistent approach across all of the challenges presented in the book. So, what discount rate have we used, and why?

Commercial projects typically discount at the rate of current or expected market interest rates. Economists often recommend a rate of 6 percent for discounting development projects, and we have suggested this as a baseline for the economists who wrote research for this project.

However, some argue that humanity should take a longer view and set a lower discount rate. Hence, we have also asked authors to use a rate of 3 percent for comparison. Such an approach makes virtually

all projects look more attractive but especially those (like education or global warming) which take longer to produce significant benefits. Which rate is more appropriate is something we leave up to the individual experts – and you, as a reader – but, crucially, it is important to have a consistent discount rate across all areas.

Using these economic tools, we can then gauge how the relative benefits and costs change as we alter discount rates, the value of DALYs, or change our assumptions about the relative likelihood of outcomes. Such results make the prioritization of different policies much more transparent.

The challenges chosen for the first Copenhagen Consensus exercise in 2004 were drawn from a larger list of areas that receive the attention of UN organizations and winnowed down by the suggestions from the Expert Panel. Likewise, for the Copenhagen Consensus 2012, we asked the panel of Nobel Laureates and economists to provide us with input on the challenges with the most promising solutions on the list, so that the 2012 list is fully updated.

Ideally the project would make a full examination of all possible challenges, but in a world of limited resources we identified the ten top challenges, ensuring a wide coverage of the most important issues of the time. Compartmentalizing all issues within these ten challenges is of course an approximation. This means we can ask a team of expert economists to address the individual area, examine the available literature, and make a proper CBA. However, in reality, of course, boundaries are not clearly defined. Action in one area will often have indirect positive effects in others.

As you will see in both Part I and Part II of this book, authors and the Expert Panel have taken such effects into account as much as possible.

Throughout all the analysis, we have asked authors to use a comparable economic framework. If each chapter is in the same “language,” then decision-makers – and you, the reader – will be able to establish what can be achieved with spending in different areas.

We turn now to the research, which forms Part I of this book.

In Chapter 1, J. Paul Dunne looks at armed conflict. Armed conflict is a major global problem that

disproportionately affects the world's poorest. Not a single low-income country afflicted by violence has achieved even one of the eight MDGs. Without peace there cannot be development, and solving other challenges becomes impossible. Seen in that light, the benefits of curtailing the costs of conflict are definitely worth considering.

There are now more states than ever and also more disputes, but still relatively few of these lead to war. The types of conflicts range from the ideological struggles that we see in Mozambique, Eritrea, or Nicaragua, to the more fragmented decentralized conflicts such as those of Somalia and Rwanda. Many are a mixture of both.

The nature of war has changed with a decreasing role for formal armies, lack of battlefield engagement, and increased involvement of civilians as victims.

The costs from conflicts can be immense and devastating – yet they are almost always understated because we ignore the legacies that violence leaves behind. The immediately apparent, direct costs are obviously loss of life and injury on the battlefield. But in many countries, conflict leads to far greater casualties because of economic collapse, so that fewer can afford health care, proper food, and education. Because of the long lag in economic recovery after a conflict, people will die for years after a conflict ends. In addition to the direct and legacy costs, there are spinoff costs such as the expense of looking after refugees displaced by one country's internal strife.

Clearly, the complex nature of conflict makes finding solutions immensely challenging. To be able to approach the problem more easily, Dunne focuses on the three obvious points at which we can try to reduce the devastating impact of conflict: preventing it in the first place, intervening to end it when it occurs, and helping to reconstruct a nation after it has ended.

According to Dunne's analysis, conflict prevention is the most cost-effective solution. The causes of conflict are hugely varied and the roots of war are multi-faceted, with important historical contexts. There are a number of factors that can be identified, including colonial legacy, military governments and militaristic cultures, ethnicity and religion, unequal development, inequality and poverty,

bad leadership, polity frailties and inadequacies, external influences, greed, and natural resources.

How can we stop conflicts before they occur? Dunne pinpoints early warning mechanisms, peace-keeping operations, economic sanctions, and aid as the tools that have proved most effective.

Dunne calculates that spending about \$56 billion over four years on a combination of these measures would lead to benefits on the magnitude of at least \$606 billion. Among these benefits, the avoided deaths, injuries, and other conflict-related violence are perhaps the most compelling arguments for the use of available funds for prevention.

Given the high possible benefits of avoided carnage and relatively low costs, conflict prevention has a benefit-cost ratio (BCR) of at least 11. This means that, when we frame it in economic terms so that it can be compared to other interventions, each dollar spent achieves benefits worth at least \$11.

If conflicts do break out, the next stage is intervention. At this stage it will be impossible to avoid a significant part of the cost of conflict, and the intervention itself will also be more costly. The projected \$100 billion cost of intervention includes better intelligence, economic sanctions, and aid, as well as most likely military intervention. This is nearly double the cost of preventing a conflict in the first place. Yet, with benefits of at least \$606 billion, there are still large pay-offs. For each dollar spent, we can avoid conflict damage worth about \$5, making intervention a cost-effective use of resources.

When conflicts end, what is needed for reconstruction is contingent on the nature of the conflict and the way that it ended. Most of the costs of conflict have already been incurred, but experience shows that it is possible to speed recovery and reduce the risk of relapse into further violence. Particularly important are the legacy costs of the conflict, such as more general violence within the society. Post-conflict policies can be costly but are also cost-effective in preventing suffering and building up economies that provide new markets and raw materials. According to research by former Copenhagen Consensus Expert Panel member and researcher Paul Collier and others,²

² Collier *et al.* (2009).

economic reconstruction reduces the risk of a renewed outbreak of conflict by 42 percent in ten years.

The cost of post-conflict policies is higher than intervention at around \$140 billion, and the benefits are also smaller, at \$404 billion. In total, it is estimated that each dollar will avoid at least \$3 of conflict damage. While post-conflict policies may not have the highest BCR, Dunne argues that they are crucial in ensuring that successful development can occur. For that reason, these policies are already attracting considerable resources from the international donor community.

As in past Copenhagen Consensus projects, there is more than one chapter for each topic. The aim of a Copenhagen Consensus Challenge Paper, such as Dunne's Chapter 1, is to present empirically based CBA studies of the highest academic standards within each challenge. These are the central source for the Copenhagen Consensus Expert Panel whose considerations form Part II of this book. Two more subchapters are provided for each main chapter, which are called "Alternative Perspectives." The purpose of these is to balance the Challenge Papers and to indicate any important issues that were not sufficiently dealt with within them. The Alternative Perspective chapters are short, reviewing published research that might have been left out in the original Challenge Paper, and providing alternate interpretations on the estimates or other strengths, weaknesses, and omissions in the economic models. Their role is primarily to spur discussion and reveal substantial professional differences regarding the subject.

In the case of armed conflict, for those wishing to understand the economics of this issue in more depth, an Alternative Perspective by Anke Hoeffler (Chapter 1.1) provides another view on the arguments used by Dunne, as does one by Andrew Mack (Chapter 1.2).

In Chapter 3, Prabhat Jha, Rachel Nugent, Stéphane Verguet, David Bloom, and Ryan Hum look at chronic diseases such as heart disease, stroke, and cancer. These are problems that we associate with rich countries, while infectious diseases such as malaria and HIV/AIDS are more commonly seen as the problems afflicting the poor. But 80 percent of global deaths from chronic diseases

occur in low-income and middle-income countries. Cardiovascular disease in low- and middle-income countries killed more than twice as many people in 2001 as did AIDS, malaria, and tuberculosis (TB) combined.

Yet, according to a recent review of donor health funding, chronic disease receives the smallest amount of donor assistance of all health conditions, having lost ground since 1990 relative to infectious diseases. Donor assistance for health was estimated at almost \$26 billion in 2009. The amount allocated to chronic disease was \$270 million, or a minuscule 1 percent of the total.

Although high-income countries currently bear the biggest economic burden of chronic diseases, developing countries (especially those that are middle-income) will assume an increasing share as their populations grow and the effects of the tobacco epidemic take greater hold. And the costs for governments of achieving maximal adult survival are rising, in contrast to declines in the costs of achieving child survival. This divergence is chiefly a consequence of the lack of tobacco control in most low- and middle-income countries (while smoking rates are declining in many developed countries, they are on the rise in the developing world), the lack of sustained investments in new drugs, and gaps in the strategies and program implementation for chronic diseases.

Jha and his colleagues identify five key priority interventions where the costs are relatively low compared to the benefits.

The most important action is tobacco taxation. Estimating conservatively that tobacco causes about one-third of the vascular disease, half of all cancers and 60 percent of chronic respiratory diseases, the researchers estimate a total economic loss from tobacco of about \$12.7 trillion over the next twenty years – or about 1.3 of global GDP annually. Already, tobacco kills up to 6 million people a year, including about 1 million each in China and India. Without increased cessation efforts, tobacco use could account for about 10 million deaths per year by 2030, with most of these occurring in low- and middle-income countries. With no change to current patterns, 1 billion tobacco deaths might occur this century, in contrast to 100 million in the twentieth century.

Reducing tobacco deaths in the next few decades requires current smokers to quit, and tobacco taxation is particularly effective at raising cessation rates: a 10 percent increase in price leads to a 4–8 percent drop in consumption. France, for example, tripled the price of cigarettes quickly (over a decade or so), and this cut consumption per adult in half, while more than doubling tax revenue in real terms. Lung cancer rates for young men in France have fallen sharply since. Tax hikes need not cost anything except the political will to overcome vested interests. Generously estimating a comprehensive tobacco control program including a tobacco tax rise to cost \$500 million annually, such a program would avert more than 1 million deaths each year. Put into economic terms, the benefits would be forty times higher than the costs.

The second initiative is using low-cost drugs to avert heart attacks. Jha and his colleagues argue that system-wide efforts to achieve high rates of appropriate drug use administered within hours of an acute heart attack should be a high priority. Up to 300,000 heart-attack deaths could be prevented each year at the cost of \$200 million. Jha and his colleagues calculate that, in economic terms, each dollar spent would generate \$25 of benefits.

Another approach to the same problem is to create a “generic risk pill.” In the absence of any drug therapy, adults with previous stroke, heart attack, diabetes, or any other evidence of some serious vascular disease have about a 7 percent annual risk of either dying or being re-hospitalized with a recurrence. This “generic risk pill” would prevent 1.6 million deaths annually. If the cost per adult patient per year were \$100, the total cost would then be \$32 billion per year. The higher cost is reflected in a lower “BCR”: Each dollar spent on this initiative would see about \$4 worth of benefits. Still, this remains an attractive investment.

Next, Jha and his colleagues propose efforts to reduce salt consumption, which is a significant cause of heart disease and strokes. This can be done in food processing or at the cooking or eating stages. The former approach is being tried in Latin America where Brazil, Argentina, and Chile are among the countries with industry agreements to reduce salt in processing. The researchers propose

a population-level intervention to reduce salt intake through voluntary manufacturing changes, behavior change using mass media, and other awareness-raising campaigns. An annual expenditure of \$1 billion would save more than 1.3 million lives a year from heart disease and strokes, meaning that the benefits are twenty times higher than the costs.

Finally, Hepatitis B is a viral infection that attacks the liver and is the major cause of liver cancer worldwide. The Hepatitis B vaccine can prevent 90 percent of liver cancer deaths, and the Hepatitis B vaccine is safe and very effective when given at birth or in early childhood. The vaccine could cost as little as \$3.60 per child vaccinated. Spending \$122 million to increase vaccine coverage by 25 percent would avert about 150,000 annual deaths from the disease, forty years into the future. Each dollar spent generates \$10 of benefits.

Julia Fox-Rushby (Chapter 3.1) and Marc Suhrcke (Chapter 3.2) present Alternative Perspectives on the topic of tackling chronic disease.

We take a slightly different approach to climate change, tackled in the four-part Chapter 4. This is because we have the results of the 2009 research project, the Copenhagen Consensus on Climate Change, to draw from, in which specialist economists detailed specific ways to respond to climate change, from targeting black carbon emissions to taxing carbon to planting more forests. So we asked some authors from *Smart Solutions to Climate Change* (Lomborg, 2009c) to update their research.

In three cases – geo-engineering, research and development (R&D), adaptation – these authors were chosen for the new volume because their proposed investments were given a relatively high ranking by the Expert Panel in 2009, and in one case (carbon mitigation) because this is the path that the world is currently on.

The latter is discussed first. In Chapter 4.1, Richard S. J. Tol makes the case that there is wide agreement in the economic literature that greenhouse gas (GHG) emission reduction is best done through a carbon tax. Climate policy, he notes, is not about spending money. It is about raising money (and, of course, about finding the best way to spend the revenues raised through a carbon tax).

Tol finds that a low tax of about \$1.80 on each ton of carbon would generate benefits (of avoided climate damage) worth between \$1.50 and \$9. However, a high tax set at \$250 would cost much more than it would gain, with benefits of just 2 cents to 12 cents, putting it in the category of “does more damage than it prevents.”

In Chapter 4.2, Isabel Galiana and Christopher Green propose a technology-led climate policy. This means dramatically increased R&D, testing, and demonstration of scalable, reliable, and cost-effective low carbon-emitting energy technologies. This will be funded by a low but gradually rising carbon tax, but unlike Tol’s proposal the main focus is on innovating cheap, green energy sources.

Galiana and Green argue that the size of the energy technology challenge is huge, and there is a current lack of technological readiness and scalability in low-carbon energy sources. They show that adopting a “brute force” approach to reducing emissions with a carbon tax before green technology is actually ready to take over from fossil fuels could generate economic costs ten times or more than widely published estimates of CO₂ mitigation cost estimates. The authors conclude that increased funding for low-carbon R&D would have benefits ranging from three to eleven times higher than the cost, depending on the rate of success and time horizon.

In Chapter 4.4, Carlo Carraro, Francesco Bosello, and Enrica De Cian look at what can be achieved with adaptation policies. They find that the most important impacts of global warming will be on agriculture and tourism, where nations will lose, on average, about half of 1 percent of GDP from each by the mid-century. However, they point out that much of this damage will actually be avoided by people choosing for themselves to adapt to the change in their environment. Farmers will choose plants that thrive in the heat. New houses will be designed to deal with warmer temperatures.

Taking this into account, rich countries will adapt to the negative impacts of global warming and exploit the positive changes, actually creating a total positive effect of global warming worth about half a percentage point of GDP. However, poor countries will be hit harder. Adaptation will reduce the climate-change-related losses from 5 percent of

GDP to slightly less than 3 percent, but this is still a significant negative impact.

The researchers find that, broadly, every dollar spent on adaptation would achieve at least about \$1.65 worth of positive changes for the planet.

Finally, in Chapter 4.3, J. Eric Bickel and Lee Lane look at geo-engineering. This essentially means cooling the planet by reflecting more of the sun’s rays back to space. There are several different ways to achieve this. One promising approach is stratospheric aerosol injection – where a precursor of sulfur dioxide would be continuously injected into the stratosphere, forming a thin layer of aerosols to reflect sunlight. Another suggested approach is marine cloud whitening, where seawater would be mixed into the atmosphere at sea to make the clouds slightly whiter and more reflective.

Bickel and Lane do not suggest actually implementing such programs at this point, but they look at the costs and benefits of preparing the knowledge of how they might be deployed in the future. They estimate that the cost of a climate-engineering R&D program is on the order of \$1 billion: a small fraction of what the United States alone is spending on climate change research each year. They estimate that each dollar spent could create roughly \$1,000 of benefits in economic terms.

Such high benefits reflect the fact that solar radiation management holds the potential of reducing the economic damages caused by both warming and costly CO₂ reduction measures (such as carbon taxes). These early-reduction costs tend to be higher than those of climate change; so by lessening the stringency of controls, climate engineering may also provide near-term benefits, compared to strategies relying solely on emissions reductions.

The two Alternative Perspectives tackle all four of the climate change chapters. These are by Samuel Fankhauser (Chapter 4.5) and Anil Markandya (Chapter 4.6).

Next we turn to another major environmental challenge, ecosystems and biodiversity (Chapter 2). The issue of disappearing biodiversity has increasingly received mainstream media attention in the past few years, and is starting to compete with climate change as the most-discussed environmental threat. Biodiversity campaigners have often attempted to capture our attention with

pictures of cuddly endangered animals or alarming figures about the rate of disappearing species.

In practice it is difficult to actually quantify the loss of biodiversity, let alone put a value on it. What scientists can do instead is measure “ecosystem services.” These are the natural processes by which the environment produces resources used by humans, such as clean water, timber, habitat for fisheries, and pollination of native and agricultural plants. Also included are genetic materials that can help make new life-saving drugs, the recreational and cultural uses of natural environments, the control of agricultural pests, and the value of biomass storing CO₂ (as a counter to global warming).

The links between biodiversity and ecosystem services are still undergoing research. But the most important known fact is that these services have faced major (and measurable) losses. According to the Millennium Ecosystem Assessment (MEA), during the twentieth century the planet lost 50 percent of its wetlands, 40 percent of its forests, and 35 percent of its mangroves. About 60 percent of global ecosystem services have been degraded in just fifty years.

Salman Hussain and his colleagues find that there will be a significant loss of biodiversity over the next forty years. They estimate that this loss could be about 12 percent globally, with South Asia facing a loss of 30 percent and SSA 18 percent. They look at three interventions, and compare these to doing nothing – a “business as usual” (BAU) approach.

The first solution focuses on increasing agricultural productivity through R&D. This may seem like a roundabout way to address biodiversity, but as the global population has increased to 7 billion, we have cut down more and more forest to grow our food. Between now and 2050, we will likely expand agricultural area another 10 percent, and that land will come from forests and grasslands. Thus, if we could increase agricultural productivity, we would need to take less and be able to leave more to nature. The authors estimate that with a \$14.5 billion annual infusion into research, we can achieve 20 percent higher annual growth rates for crops and 40 percent higher growth rates for livestock, which over the next forty years will significantly reduce the pressure on nature.

Looking just at tropical forests, this would save an area the same size as Spain, along with a similar amount of temperate forests and more than twice that area of grasslands. In total, the benefits will be on the order of \$53 billion. When we take into account that these forests will store more carbon, for every dollar spent, we will do about seven times the amount of good both for biodiversity and climate. And, of course, we will have made more food available and at cheaper prices for future generations, substantially increasing the total benefits. This option is very similar to the one suggested in Chapter 6 on hunger and malnutrition.

Hussain *et al.* note that currently about 10 percent of all land globally is deemed to be “protected” from destruction. They explore increasing protected land to about 20 percent globally (across a large number of ecological regions), over three decades. There are obvious benefits but also significant costs, principally the loss of output from the land that is taken out of use.

Land scarcity arising from such a policy would likely force an increase in agricultural productivity. The cost estimates for the newly protected lands have a big impact on the overall results. With higher assumptions, the program costs more than it achieves, even when the benefits of avoided climate change are included. With lower assumptions it only barely passes, with expenditure of \$1 achieving slightly more than \$1 worth of good.

However, Hussain *et al.* note that the main reason for this program would be to enhance biodiversity conservation; our current methods of estimation do not fully capture those benefits, so these estimates could be an underestimation.

Forests are one of the main homes to biodiversity. The final program Hussain *et al.* propose seeks to prevent all dense forests from being converted to agriculture over a thirty-year period. They do not attempt to assess the political viability of such an approach. To use the same measure as above, it would save more than seven times the area of Spain in tropical forests.

The benefits are very high, but it must be noted that there is considerable uncertainty about the costs. With estimates they find reasonable, the benefits exceed the costs even without including the CO₂ storage value, and the solution is attractive

because it will yield a minimum of \$7 for each dollar spent.

Alternative Perspectives are provided by John C. Whitehead and Paul E. Chambers (Chapter 2.2) and Juha V. Siikamäki (Chapter 2.1).

Over the past fifty years, remarkable progress has been made ensuring that children receive a basic education. In Chapter 5, Peter F. Orazem notes that more than 60 percent of adults in low-income countries can read and write, whereas in 1962 just one-third were literate. Today, nearly nine out of ten children globally complete primary school. Most children in developing countries are now already enrolled in school for at least some period, so Peter Orazem points out that we could focus on strategies that improve school quality, either by enhancing the learning that is occurring in school or increasing the number of years of schooling.

Unfortunately, there is very weak knowledge about which inputs actually generate quality schooling outcomes, and many investments are unlikely to generate the desired effects. There is widespread acknowledgment that resources are used inefficiently but, for instance, efforts to improve resource management by devolving authority to local jurisdictions are as likely to fail as succeed.

Peter Orazem thus considers three strategies that appear to offer the best evidence of success to date: nutrition supplements, offering information on returns to schooling, and conditional cash transfers (CCTs) for school attendance. All have been shown to succeed with benefits that exceed the costs.

It may seem surprising to focus on nutrition to achieve better schooling, but malnourished children learn poorly. Ensuring proper nutrition when brain development is occurring makes a significant difference. The benefits are not just educational but also increase health and the child's physical abilities. Provision of nutrient supplements and anti-parasitic medicines is very inexpensive: in Kenya the cost of deworming a child can be as low as \$3.50, with benefits twenty–fifty times higher.

Increasing the years a child spends in school simply by providing accurate information to children and parents on the returns of education is another

promising and relatively inexpensive intervention. Many children and parents, especially in rural areas, are simply unaware of the long-term benefits that may come from a better education. In Madagascar, for instance, providing children and their parents with accurate information on the value of schooling has been achieved at a cost of \$2.30 per child, resulting in total benefits of possibly 600 times the cost.

Although the costs vary across countries, such an intervention could conceivably be built into the standard curriculum at relatively low cost and has the potential of increasing academic effort while in school, as well as increasing years of schooling. However, because of the very few studies available, the benefits from a large-scale information campaign are less certain.

Finally, Orazem argues that the most consistent evidence of success in recent years comes from making payments to underprivileged parents conditional on their children attending school. CCTs have consistently increased child attendance, even when the transfer is modest. Administrative costs have been lower than those of other social interventions. In addition to positive schooling outcomes, these transfers have lowered the poverty rate, improved the nutritional status of poor households, and increased the proportion of children receiving vaccinations and other health services. While there is great variance in performance, a dollar spent on such programs on average produces benefits of about \$9.

Because the programs increase the intensity of child investment in school, as well as child time in school, they help to break the cycle of poverty whereby poor parents underinvest in their children's schooling and doom their children to poverty. By increasing child attendance, Orazem argues, we should see an increase in teacher attendance, which will increase the quality of schooling offered to the poorest children.

Yet, cash transfer programs are much more expensive than nutrition or health interventions. That might explain why cash transfer programs are concentrated in wealthier countries while nutrition programs typically focus on the poorest countries.

In general, the climate for all of these interventions is worse where the positive returns are

depressed by poor government institutions. Therefore, Orazem argues, the best places to try these interventions are countries that protect individual economic and political freedoms. Of course, those countries would also have better capacity to implement an intervention, whether by distributing medication, transfer payments, or information on the benefits of investing in schooling.

Alternative Perspectives are provided by Lant Pritchett (Chapter 5.1) and George Psacharopoulos (Chapter 5.2).

In Chapter 6, John Hoddinott, Mark Rosegrant, and Maximo Torero tackle the challenges of hunger and malnutrition. The planet creates more than enough food to meet everyone's needs. But there are still around 925 million hungry people in the world, and nearly 180 million pre-school children do not get vital nutrients.

In 2008, the global Copenhagen Consensus project focused attention on the problem of hidden hunger. The Expert Panel found that micronutrient interventions – fortification and supplements designed to increase nutrient intake – were the most effective investment that could be made, with massive benefits for a tiny price-tag.

In Chapter 6, the authors once more propose that decision-makers prioritize micronutrient interventions, and they update the analysis of the costs and benefits of doing so. They find that for a relatively small amount of money – less than \$700 million annually – it would be possible to eliminate vitamin A deficiencies in pre-school children, eliminate iodine deficiency globally, and dramatically reduce maternal anemia during pregnancy. But they also offer new solutions, including bundling nutrition interventions, increasing global food production, and improving market functioning through better communications and increased competition in fertilizer markets.

Chronic undernutrition has significant neurological consequences that can damage spatial navigation and memory formation, leading to loss of cognitive abilities and, in time, lower incomes. Hoddinott, Rosegrant, and Torero find that for about \$100 per child, by means of a bundle of interventions (including micronutrients and improvements in diet quality and behavior), chronic undernutrition could be reduced by 36 percent in developing

countries. Even in very poor countries such as Ethiopia and using very conservative assumptions, each dollar spent reducing chronic undernutrition has a \$30 pay-off when seen in economic terms.

Increasing global food production might seem a strange proposal given that, globally, food production actually exceeds food needs. But the researchers argue that lower prices are necessary to make food more affordable and to provide a buffer against some of the negative consequences of climate change. Hoddinott's team looks at how to speed up improvements in agricultural production. This means first and foremost increasing R&D to insure higher yields through extensive breeding. But the researchers also look at ways to increase tolerance to drought, heat, and salt; identifying and disseminating the best varieties of crops; addressing problems like wheat rust; developing resistance to cattle diseases like East Coast Fever; and focusing on soil diagnostics to ensure that optimal combinations of organic and inorganic fertilizers are used.

They propose an \$8 billion increase in annual global public investment in agricultural R&D (to \$13 billion total annual spending). They use economic modeling to calculate the results on yields, incomes, GDP growth, and prices. This investment would mean that in 2050, canola oil would be 68 percent cheaper, and rice would be nearly 25 percent cheaper than it would otherwise be. There would be 200 million fewer hungry people around the world. Taking global population growth into account, hunger would be 63 percent less prevalent in 2050 than it was in 2010, with the reduction most pronounced in South Asia and SSA. Spending an additional \$8 billion per year would, by 2050, reduce the number of hungry people in the world by 210 million and the number of underweight children by 10 million. Put into economic terms, the BCR of this spending is at least 16:1, indicating high returns to expanded investment in agricultural R&D. Moreover, they estimate that reduced price variability could more than double the benefits.

Roughly 80 percent of the global hungry live in rural areas and half are smallholders. The researchers propose a dual approach to improving