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*2010 Annual Letter from Bill Gates*  
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BILL & MELINDA  
GATES *foundation*



*This is my second annual letter.* The focus of this year's letter is innovation and how it can make the difference between a bleak future and a bright one.

2009 was the first year my full-time work was as co-chair of the foundation, along with Melinda and my dad. It's been an incredible year and I enjoyed having lots of time to meet with the innovators working on some of the world's most important problems. I got to go out and talk with people making progress in the field, ranging from teachers in North Carolina to health workers fighting polio in India to dairy farmers in Kenya. Seeing the work firsthand reminds me of how urgent the needs are as well as how challenging it is to get all the right pieces to come together. I love my new job and feel lucky to get to focus my time on these problems.

The global recession hit hard in 2009 and is a huge setback. The neediest suffer the most in a downturn. 2009 started with no one knowing how long the financial crisis would last and how damaging its effects would be. Looking back now, we can say that the market hit a bottom in March and that in the second half of the year the economy stopped shrinking and started to grow again. I talked to Warren Buffett, our co-trustee, more than ever this year to try to understand what was going on in the economy.

Although the acute financial crisis is over, the economy is still weak, and the world will spend a lot of years undoing the damage, which includes lingering unemployment and huge government deficits and debts at record levels. Later in the letter I'll talk more about the effects of these deficits on governments' foreign aid budgets. Despite the tough economy, I am still very optimistic about the progress we can make in the years ahead. A combination of scientific innovations and great leaders who are working on behalf of the world's poorest people will continue to improve the human condition.

One particular highlight from the year came last summer, when I traveled to India to learn about innovative programs they have recently added to their health system. The health statistics from northern India are terrible—nearly 10 percent of children there die before the age of 5. In response, the Indian government is committed to increasing its focus and spending on health. On the trip I got to talk to Nitish Kumar, the chief minister of Bihar, one of the poorest states in India, and hear about some great work he is doing to improve vaccination rates. I also got to meet with Rahul Gandhi, who is part of a new generation of political leaders focused on making sure these investments are well spent. The foundation is considering funding measurement systems to help improve these programs. Rahul was very frank in saying that right now a lot of the money is not getting to the intended recipients and that it won't be easy to fix. His openness was refreshing, since many politicians won't say anything that might discourage a donor from giving more. He explained how organizing local groups, primarily of women, and making sure they watch over the spending is one tactic he has seen make a big difference. The long-term commitment to measuring results and improving the delivery systems that I heard from him and other young politicians assured me that health in India will improve substantially in the decade ahead.



From left: Visiting a smallholder dairy farm in Kabiyet (Rift Valley Province, Kenya, 2009); Indian politician Rahul Gandhi speaking in Raipur Phulwari (Uttar Pradesh, India, 2008); cassava research laboratory at the National Crops Resources Research Institute (Namulonge, Uganda, 2009).

## *Innovation: The Difference Between a Bleak Future and a Bright One*

In India, just like everywhere else we work, the needs of the poor are greater than the resources available to help them solve their problems. It is important to get more money, but that alone will not solve the big problems. This is why Melinda and I are such big believers in innovations that allow you to do a lot more for the same cost.

During the last two centuries, there have been a huge number of innovations that have fundamentally changed the human condition—more than doubling our life span and giving us cheap energy and more food. Society underinvests in innovation in general but particularly in two important areas. One area is innovations that would mostly benefit poor people—there is too little investment here because the poor can't generate a market demand. The second area is sectors like education or preventative health services, where there isn't an agreed-upon measure of excellence to tell the market how to pick the best ideas.

If we project what the world will be like 10 years from now without innovation in health, education, energy, or food, the picture is quite bleak. Health costs for the rich will escalate, forcing tough trade-offs and keeping the poor stuck in the bad situation they are in today. In the United States, rising education costs will mean that fewer people will be able to get a great college education and the public K-12 system will still be doing a poor job for the underprivileged. We will have to increase the price of energy to reduce consumption, and the poor will suffer from both this higher cost and the effects of climate change. In food we will have big shortages because we won't have enough land to feed the world's growing population and support its richer diet.

However, I am optimistic that innovations will allow us to avoid these bleak outcomes. In the United States, advances in online learning and new ways to help teachers improve will make a great education more accessible than ever. With vaccines, drugs, and other improvements, health in poor countries will continue to get better, and people will choose to have smaller families. With better seeds, training, and access to markets, farmers in poor countries will be able to grow more food. The world will find clean ways to produce electricity at a lower cost, and more people will lift themselves out of poverty.

Although innovation is unpredictable, there is a lot that governments, private companies, and foundations can do to accelerate it. Rich governments need to spend more on research and development, for instance, and we need better measurement systems in health and education to determine what works.

Melinda and I see our foundation's key role as investing in innovations that would not otherwise be funded. This draws not only on our backgrounds in technology but also on the foundation's size and ability to take a long-term view and take large risks on new approaches. Warren Buffett put it well in 2006 when he told us, "Don't just go for safe projects. You can bat a thousand in this game if you want to by doing nothing important. Or you'll

**Innovation Chart:** Examples of ideas the foundation is funding

INNOVATION	TIME FRAME	BENEFICIARY	BENEFIT	CONSTRAINTS	RISK	PARTNERS
<b>GLOBAL HEALTH PROGRAM</b>						
Pneumonia and rotavirus vaccine delivery	30 percent coverage in 5 years, 80 percent in 10 years	135 million children born each year—85 percent in poor countries	More than 490,000 lives saved per year; less disability and lower medical costs	Can it be made cheaply enough for countries to afford it? Will they have the approval and delivery systems in place?	Low	National public health delivery systems; the GAVI Alliance; UNICEF; WHO; vaccine companies
Invention of a very effective malaria vaccine	8–15 years	600 million people living in highly endemic countries in Africa	Prevent 207 million malaria cases and 770,000 deaths in Africa each year; much greater productivity and lower medical costs	Is it possible to make a highly effective vaccine? If so, can it be made cheaply enough? Can it be delivered?	High	Malaria Vaccine Initiative; nonprofit researchers; drug companies; the U.S. National Institutes of Health (NIH)
Invention of a pill or gel to reduce the risk of getting HIV	3–7 years	150 million people at high risk of getting HIV	60 percent reduction in HIV incidence in the groups that use it	Will it be effective? Will it be cheap? How quickly can it be approved? Will countries adopt it? Will people use it frequently?	Medium	NIH; nonprofits; drug companies
<b>GLOBAL DEVELOPMENT PROGRAM</b>						
Invention of a more productive corn seed that can tolerate droughts	6–10 years	4 to 8 million farming families	24 to 35 percent increase in food to eat and sell, even during drought periods	Will regulatory agencies approve it? Will seed companies be able to make it cheaply enough? Will countries accept genetically modified seeds? Will farmers use them?	Medium	Seed companies; nonprofit research centers; African crop scientists and policy experts
Financial tools to make it easy for poor people to save money	3–5 years	50 million poor households	Less hardship in tough times and more money to invest	How can transaction costs be low enough for small amounts? Can shops or mobile phones replace visits to bank branches?	Medium	Financial regulators; banks; mobile operators; retail chains
Sanitation systems as good as flush toilets without needing sewers	5–10 years	Poor people worldwide	30 percent reduction in diarrhea in children; better living conditions	How much will they cost to make and to maintain? Will people really want to use them?	Medium	Scientists; universities
<b>UNITED STATES PROGRAM</b>						
Measure of teacher effectiveness and systems for helping teachers improve	10–15 years	3 million teachers and 27 million less-privileged students in the United States	800,000 more highly effective teachers; 63 percent increase in well-qualified less-privileged high school graduates (500,000 more per year)	Will teachers, including their unions, schools, districts, and states, be willing to change? Will budget cuts slow the work?	High	U.S. Department of Education; school districts; charter schools; teacher groups
Great online courses with video and interactive learning	10 percent in 3 years and 80 percent in 8 years	Students and teachers worldwide	Teachers learning from the best and assigning pieces to students as well as independent students using the material on their own	How appealing are the courses? Can they be integrated with traditional schooling?	Medium	Great teachers; software partners; online community
All libraries having PCs with Internet connections and the training to use them	U.S. installation project was 1997–2006; now focused on maintaining access	People without Internet PCs at home	49,000 computers installed to provide Internet access for 20–27 million people	Will local communities sustain funding for keeping libraries open, maintaining connectivity, and refreshing hardware?	Low	Libraries; librarians; library supporters; local governments; telecom companies

bat something less than that if you take on the really tough problems.” We are backing innovations in education, food, and health as well as some related areas like savings for the poor. Later in the letter I talk about why we don’t currently see a role for the foundation in energy.

We have a framework for deciding which innovations we get behind. A key criterion for us is that once the innovation is proven, the cost of maintaining it needs to be much lower than the benefit, so that individuals or governments will want to keep it going when we are no longer involved. Many things we could fund don’t meet this requirement, so we stay away from them. Another consideration for us is the ability to find partners with excellent teams of people who will benefit from significant resources over a period of 5 to 15 years.

Our framework involves funding a range of ideas with different levels of risk that they could fail. The ones with low risk are where the innovation has been proven at a small scale and the challenge is to scale up the delivery. High-risk innovations require the invention of new tools. Some are at the frontiers of science, such as finding a new drug and running a large trial to see how well it works. Other high-risk efforts involve changing social practices, such as persuading men at risk of getting HIV to get circumcised.

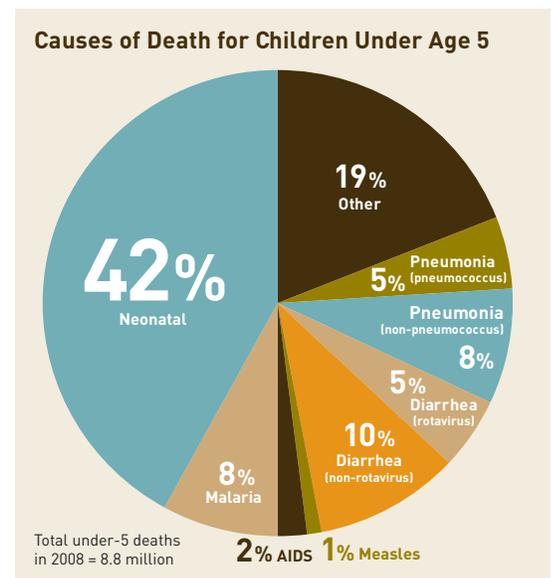
It is critical that we understand in advance what might prevent an innovation from succeeding at scale. For work in developing countries, the lack of skilled workers or electricity might be a key constraint. For work with teachers, we need an approach to measuring their effectiveness that they will welcome as a chance to improve rather than reject because they think it’s more overhead or fear that it might be capricious. Even with the best efforts to make sure we understand the challenges, we need intermediate milestones so we can look at what we have learned about the technology or the delivery constraints and either adjust the design or decide that the project should end. We are focused on strong measurement systems and sharing our results where we have successes but also where we have failures. Innovation proceeds more rapidly when different parties can build on each other’s work and avoid going down the same dead end that others have gone down.

To provide some examples, in the chart on page three I show nine innovations we are investing in, broken into sections for each of the foundation’s three divisions. Overall we have about 30 innovations we are backing. Although the chart includes only one new vaccine and one new seed, we are funding vaccines for several diseases (malaria, AIDS, tuberculosis, etc.) and new seeds for many crops (corn, rice, wheat, sorghum, etc.). For each innovation I show the time frame, beneficiaries, and constraints. A few things we do, like disaster relief and scholarships, do not fit this model, but over 90 percent of our work does.

## Childhood Deaths

The improved health of children in poor countries is a great example of the power of innovation. In 2008, for the first time fewer than 9 million children under age 5 died. In 2005, the last time the number was measured carefully, it was just below 10 million. This is huge progress, and it is due to improvements like increased vaccinations and better malaria treatment and prevention.

The pie chart to the right shows the primary causes of these deaths. Notice that all deaths for children under 30 days of age are grouped into a single category called “neonatal.” Because the world is making very little progress in reducing these deaths, but is making progress in reducing deaths from other causes, the percentage of neonatal deaths has grown to account for more than 40 percent of all deaths in children under 5. If we make the progress we expect in preventing deaths from



Preliminary estimates by the Child Health Epidemiology Reference Group of WHO and UNICEF.



Mother with her one-month-old girl in the village of Rampur Ashu (Uttar Pradesh, India, 2007).

other causes, and still make no progress in preventing neonatal deaths, they will soon represent 60 percent of all deaths for children under 5.

Most charts showing childhood deaths don't group all of the neonatal causes together. They are broken out into categories like birth asphyxia, pre-term births, or neonatal infection. This is partly because the field of children's health used to be very siloed. The nutrition experts, for example, didn't talk to the pre-term birth experts. But this is changing. In the past decade, public health experts have realized that having separate groups focused on each of these is not the best way to improve the situation. Now leaders in global health are talking about how all these problems are connected, and they are seeing the need to focus on these deaths in an integrated way that includes interventions to reduce mothers' deaths and improve voluntary family planning. The foundation's strategy has evolved in the same way. Over the past four years we funded several pilot projects and built a strong team to lead this work. The pilots showed that the right integrated approach made a huge difference. It involved educating the mothers and the birth attendants as well as giving them some new tools such as easy-to-use antibiotics. Based on some of the early success we're seeing, we are now increasing our investment to see if we can scale up these approaches.

Melinda has a particular interest in this area and has several trips planned for 2010 to see these projects. Our working partnership makes it very comfortable for one of us to focus more intently on a particular area but always share what is being learned so we can work together in figuring out how it should fit into the overall strategy. I've always had a strong partner in the work I have done. In the early days of Microsoft it was Paul Allen, and in the later days it was Steve Ballmer. Although some people don't need this kind of partnership, I have found that only when I have a partner who knows my strengths and weaknesses can we together have the confidence to take on projects that take a long time and are high risk. When one of us is being overly pessimistic or optimistic, the other can provide a balanced view.

In the next few sections of the letter, I'll write about how innovation can help the world make progress on the other causes of childhood deaths.

## The Miracle of Vaccines

Vaccines are a miracle because with three doses, mostly given in the first two years of life, you can prevent deadly diseases for an entire lifetime. Because the impact is so incredible, vaccines are the foundation's biggest area of investment—more than \$800 million every year—and the return is substantial. We are working to get other donors to put more resources into vaccines because we still have big challenges. The first challenge is to invent them, and the second is to make sure they reach everyone who needs them. Achieving full coverage is hard in poor countries, where cost and delivery are big barriers.

Various innovations can simplify the delivery. Sometimes it's possible to combine different vaccines into one. A great example of this is the vaccines for diphtheria, tetanus, and pertussis (whooping cough). They were first introduced in the 1920s. In 1942 they were combined into a single vaccine, called a trivalent vaccine because it has three active elements. The price of all three doses of this vaccine is now less than 50 cents, and over 77 percent of children in the poorest countries of the world get all three of the doses they need to be protected. Since the trivalent vaccine was introduced in developing countries, tetanus deaths are down nearly 88 percent and pertussis deaths are down 70 percent. Almost all deaths from the three diseases would be stopped altogether if vaccine coverage were improved to 95 percent everywhere.

Even when a vaccine can't be combined with others, you can still improve distribution by making it free for poor countries, or cheap enough that they can afford to buy it. This has been a key focus for the GAVI Alliance, which we helped create almost 10 years ago. GAVI gives grants to poor countries to improve vaccine coverage and to help pay for new vaccines. GAVI has worked to get two new vaccines into widespread use since it was started. One prevents hepatitis B, an infection that eventually causes liver cancer in adults and kills over 600,000 people per year. The other prevents HiB (or *Haemophilus influenzae* type B), a type of bacteria that causes meningitis and other life-threatening problems during childhood. By the end of 2008, 192 million children had received the hepatitis B vaccine and 41.8 million children were protected against HiB.

Now the hepatitis B and HiB vaccines have been combined with the trivalent vaccine to create a vaccine with five active elements—a pentavalent vaccine. GAVI's work in helping to provide both the stand alone and pentavalent vaccines has raised hepatitis B coverage to 68 percent of newborns and HiB coverage to 24 percent of newborns in the poorest countries.



From left: Francis Pérez Mejía receiving her third and final dose of rotavirus vaccine (Pantasma, Nicaragua, 2009); a technician confirming that rotavirus vaccine has remained cool during transport and is safe to use (Pantasma, Nicaragua, 2009).

Cost is still a problem. Today a full set of doses of the pentavalent vaccine costs over \$8 more than the trivalent vaccine. But as manufacturers produce more vaccine and additional competitors come into the market, the cost premium should drop by half in the years ahead. This is why the global health community has a goal of raising coverage of HiB vaccine to over 80 percent by 2015, which could then save 250,000 lives per year in the poorest countries in addition to eliminating lots of suffering and disability.

With the progress on these vaccines, GAVI will add a focus on two vaccines that are already being used in rich countries: one for rotavirus, which causes diarrhea, and another for pneumococcus, which causes pneumonia. You can see in the childhood death chart what a large impact these new vaccines can have if widely used. Rotavirus vaccine could save 225,000 to 325,000 lives per year, and pneumococcal vaccine could save 265,000 to 400,000 lives per year.

In last year's letter, I said that I thought we could get the rotavirus vaccine out to over half of the kids who need it within six years. I still think we can achieve this in the five years we have left, but it is going to be a lot harder than I expected. Many countries have not added a new vaccine for over 20 years. Incredibly, some countries don't even have a process for deciding whether to add a new vaccine. In others, the process is still there on paper, but no one remembers who is supposed to do what. We avoided this problem with HiB and hepatitis B by creating the pentavalent vaccine, but it won't be possible to combine rotavirus and pneumococcus with other vaccines. In addition, countries understandably hesitate to add an expensive new vaccine until they have specific proof of the disease burden in their country. Sometimes they accept data from similar countries, but sometimes they don't.

This year the foundation helped launch a new approach to encourage a high-volume, low-cost supply of a pneumococcus vaccine that meets the needs of poor countries. This approach is called an Advance Market Commitment, and it involves a group of donors pledging \$1.5 billion to help pay for the vaccine for poor countries. We expect that manufacturers will commit to building factories much earlier than they would otherwise in order to compete for this money. During 2010 the negotiations with manufacturers should come to a conclusion. We believe this will make a big difference in how quickly this vaccine gets to poor children and show how this approach can be applied to other medicines.



## *Malaria*

Two years ago, Melinda and I challenged the health field to set a goal of eventually eradicating malaria. Because it is such a widespread disease, the foundation has backed a number of different types of innovations. In 2005 we helped fund a medium-risk pilot project in Zambia to test having most people in an area sleep under insecticide-treated bed nets and spray the inside of their house with insecticides. These interventions have proven to reduce malaria



Mother and child resting under an insecticide-treated bed net (Chongwe District, Zambia, 2009).



From left: Administering polio drops to a child during a visit to a Bini health clinic (Sokoto, Nigeria, 2009); woman delivering vaccines house-to-house on Immunization Plus Day (Sokoto, Nigeria, 2009).

substantially, and other partners have now taken the lead on the large-scale delivery of these interventions. There has been a dramatic increase in bed net usage thanks to donations from individuals (some through church organizations and Nothing But Nets), the Global Fund, and rich governments. The countries that have had these interventions in wide-scale use for several years are seeing large reductions in malaria deaths: Rwanda has seen a 45 percent decline, Zambia 50 percent, Cambodia 50 percent, Eritrea 80 percent. These interventions are being scaled up rapidly, which will have a big impact.

But malaria is a particularly tricky disease. The current tools alone will not be enough to eradicate it, so we are funding new medium- and high-risk innovations. For example, we are funding the invention of new insecticides for use on bed nets, because some mosquitoes are developing resistance to the current one. And because bed nets aren't accepted in some locations, we are also investing in new ways of delivering insecticide in a house—perhaps using candles or chemical sticks. We are also investing in cheaper ways to make the drugs we already have, as well as new drugs because we know the parasite will develop resistance to the current treatments.

Finally, to eradicate the disease, we will almost certainly need a malaria vaccine, which is the highest-risk malaria work we fund. The key here is that researchers are pursuing a lot of different ideas, so that if one fails, there are still several other options. One partially effective vaccine candidate, known as RTS,S, has started its Phase III trial, which is an important step. Other vaccine approaches are at an earlier stage and they also look very promising. Scientists are combining some of these other vaccine efforts with RTS,S to raise its effectiveness and duration, an approach that could lead to a highly efficacious vaccine in 8 to 15 years.



## *Polio Eradication*

Polio is down to fewer than 3,000 cases a year—a 99 percent reduction in 20 years—but getting rid of the last 1 percent is the hardest part of eradicating a disease. When we increased our investment in polio two years ago, we viewed it as a challenging delivery problem rather than something requiring a new tool, because the oral vaccine worked quite well. Most of our funding has supported innovative approaches to delivery. But when we saw that in some places the oral vaccine wasn't totally effective, we also funded the creation of new forms of the vaccine, which are targeted at subsets of the three different varieties of polio virus. This is a good example of needing to stay open-minded about the best approach to solving a problem, because the new forms of the vaccine have been critical in the progress that has been made this year.

In last year's letter I mentioned that there are four countries that account for most of the remaining cases. One was Nigeria, particularly in its northern states, where polio has been especially problematic. In 2009, thanks to new money and political support from some state, local, and traditional leaders, they were able to vaccinate more children in most states. This led to a 50 percent decline in the overall number of cases and a 90 percent decline in the most virulent strain. In 2010, they will need to get the vaccination rate up in every state.

The three other countries—India, Afghanistan, and Pakistan—shrank the geographical areas affected by the virus. Some of the toughest remaining areas are the ones where the security situation is bad, like parts of Afghanistan and Pakistan.

When outbreaks did occur, countries responded faster and more effectively than they had before. Last year, poliovirus from Nigeria and India spread to more than 15 African countries that had been considered polio-free. But because many countries had begun using better laboratory techniques, they identified the virus quickly and started immunization campaigns right away, which limited the spread of the outbreak. Still, we haven't gotten these countries back to zero cases yet, especially in west Africa and Chad, where the outbreak is still widespread. I will be traveling to some of these countries to meet with health leaders, and I expect I'll be able to report even more progress in next year's letter.



## HIV/AIDS

There is some encouraging news here. HIV isn't spreading as fast as it was. The number of new people getting infected with the virus peaked in 1996 at 3.5 million and was down to 2.7 million in 2008. Prevention efforts, like the foundation's work in India to get sex workers and their clients to use condoms more often, are part of the reason for this reduction. But 2.7 million is still 2.7 million too many, and in some places, the disease rate is still incredibly high. In South Africa, 18 percent of adults are infected, and in parts of the country more than half of the women are infected by the time they are in their mid-20s.

The number of people worldwide receiving antiretroviral (ARV) therapy for HIV increased to 4 million last year, which is a great achievement. In the early years of AIDS, it was not clear whether a large-scale treatment effort would work in Africa. Beginning in 2001, the foundation helped fund treatment in Botswana, one of several projects showing that it could work. The Global Fund and the United States' PEPFAR program (a \$50 billion program to help combat AIDS in Africa) have since taken the lead in scaling up ARV delivery. They are both doing a great job, although there is a lot of concern that limited funding will restrict the number of new patients they can treat.



From left: Patient undergoing a circumcision operation (Lusaka, Zambia, 2009); circumcision patients at the YMCA New Start Clinic (Lusaka, Zambia, 2009).

Treatment is important, but we urgently need innovations to prevent the spread of HIV, which is where the foundation has focused a lot of its efforts. Trials are in progress on pills and gels that we hope will substantially reduce the chance of getting infected. We will begin to see the results from these trials late this year.

Another approach to reduce the spread of HIV is male circumcision. I mentioned in last year's letter that studies have shown that male circumcision reduces the odds of transmission from a woman to a man by over 60 percent. In areas where transmission is widespread, if you circumcise most of the men over 14 years old you can significantly reduce the spread of HIV. The foundation funded pilot efforts to scale up circumcision, but I viewed it as high-risk because I was doubtful that enough men would volunteer to be circumcised. That is why last December I went to visit Bertran Auvert, a French scientist working in a South African township called Orange Farm. Bertran conducted one of the key studies on the effectiveness of circumcision, and now he has set out to show that doubters like me are wrong.

He and his co-leader, Dirk Taljaard, are modest about their work but, amazingly, they are getting over 750 men a month to come to their facility. They have already circumcised 14,000 men, and within a year they think they will be able to circumcise almost all of the men in the community. It looks like a very high percentage will participate. Bertran's approach is very efficient, with costs of only \$40 for the surgery. Based on this success, a number of facilities are being set up in South Africa and in other countries with high HIV prevalence to do the same thing. In many African countries, if a high percentage of men volunteer for circumcision, it will reduce the number of cases at least 30 percent over time, which shows what an impact a great scientist like Bertran can have.

The major news in AIDS this year, which you may have read about, concerned an HIV vaccine. A trial done in Thailand reported its results in September. The foundation's biggest spending on AIDS focuses on vaccine work, but we didn't fund this trial. Although there are several ways of analyzing the data and the vaccine had only modest effects, the results of the trial were good news. They showed the scientific community that a vaccine is possible.

The AIDS community is working on a number of candidate vaccines, many of which show better results in tests on monkeys than the vaccine used in the Thai trial. Since only a few vaccines can be picked for a trial, the community will have to collaborate and figure out which ones should go forward. Although a vaccine for widespread use is still more than a decade away, the scientific progress this year was better than most people expected.



## *Helping Teachers Improve*

The foundation works on health in poor countries because we think it's the best way to improve lives globally. In the United States, we believe the best way to improve lives is to improve public education. America's education system has been fundamental to its success as a nation. But the way we prepare students has barely changed in 100 years. If we don't start innovating in education to make it better and more accessible, we won't fulfill our commitment to equal opportunity, and our competitiveness will fall behind that of other countries.

In last year's letter I wrote about the evidence that helping teachers teach more effectively is the best way to improve high schools. It is incredible how much the top quartile of teachers can improve the skills of even students who are quite far behind. This was a new effort for us at the time, so in 2009 I spent a lot of time trying to understand more about teaching: How do you identify the best teachers? How can they help other teachers be as good as they are? What investments are made to raise the average quality of teaching?

It is amazing how little feedback teachers get to help them improve, especially when you think about how much feedback their students get. Students regularly have their skills measured with tests. The results show how they compare to other students. Students know how to improve because they see where they did well and where they didn't. They can talk to other students and learn from those who mastered the material.

Students get more feedback on their work than people in most jobs. One job where the worker is provided almost no feedback is the teacher at the front of the class. In a teacher's personnel file there is rarely anything specific about where the

teacher is strong or weak. Often there is just a checklist of basic things like showing up on time and keeping the classroom clean. In places where there is a rating system at all, 99 percent of teachers are rated satisfactory. Although this personnel system has the benefit of low overhead and predictability, it doesn't help identify best practices and drive improvement.

The alternative is a system where time and money are invested in evaluation with the goal of helping teachers improve. Making this work requires both resources and trust. A new system needs to be predictable and help teachers identify weaknesses and give them ways to improve, and it should not make capable teachers afraid of capricious results.

A key point of contention about an evaluation system is how much it will identify teachers who are not good and don't improve. A better system should certainly identify the small minority who don't belong in teaching, but its key benefit is that it will help most teachers improve.

A new system requires more than just taking the test scores of the students and seeing how they improve after a year with a teacher. It also involves things like feedback from students, parents, and peer teachers and an investment of time in reviewing actual teaching. Tools like video can be used so that a teacher can send peers a video showing him trying to do something hard, like keeping a class focused, and ask for advice. Instead of people coming into the classroom, which is quite invasive, a webcam can be used to gather samples for evaluation.

To help develop an evaluation system to improve teacher effectiveness, in November we committed \$335 million to partnerships in Memphis, Tennessee; Hillsborough County, Florida; Pittsburgh; and Los Angeles. The involvement and support of the union representatives in each of these locations was a key part of their selection.

This is an instance where there isn't a clean separation between the creation of the innovation—ways to evaluate teachers and help them improve—and the delivery of the innovation, which requires teachers to embrace a change to the personnel system. We are working on both at the same time. Teachers will be evaluated and given incentive pay based on excellence. If most of the teachers in these locations like the new approach and they share their positive experience, then these evaluation practices will spread. The goal is for them to become standard practice nationwide. The benefits of this would be unbelievably large, which is why we are pursuing it even though we know there is a high risk that it could fail. Previous efforts along these lines seemed to thrive for a few years, but if the system is not well run or if teachers reject differentiation, it gets shut down.

The filmmaker Davis Guggenheim, who directed *An Inconvenient Truth*, has a new documentary about American education coming out this year. *Waiting for Superman* tells the story of several kids trying to get into schools with high-quality teaching—it's literally a lottery that will decide the fate of these young people. Although I may be biased



From left: Visiting an Algebra I class at West Charlotte High School with Melinda (Charlotte, North Carolina, 2009); Living Environment science class at the Urban Assembly Academy of Government and Law (New York, New York, 2008).



From left: Student at the Durham Performance Learning Center, Durham Public Schools (Durham, North Carolina, 2009); speaking with Danny Gilfort, principal of the Durham Performance Learning Center (Durham, North Carolina, 2009).

because I appear in the movie, I think it is fantastic and hope it will galvanize a lot more political will to improve teaching effectiveness.

Melinda and I visited a number of schools in North Carolina during the fall and had a chance to see some amazing principals and teachers. In one inner-city Charlotte school, teachers look at test results each week to understand who is teaching which concepts the best way so they can learn from each other. In Durham, we visited a special high school called the Performance Learning Center, which is for kids who have dropped out of a typical public school but want to get their high school degree. One reason we visited them was to see how they use online learning. There are no lectures, and kids can move ahead at their own pace. A lot of the kids start out making progress more slowly than they would in a traditional class, but with the support of the teachers in the school and as they get used to the online approach, almost all of them move through the courses a lot faster than normal classes would let them. This is very motivational to the kids because they can do more than a year's worth of schoolwork in a single year.



## Online Learning

The foundation has made a few grants to drive online learning, but we are just at the start of this work. So far technology has hardly changed formal education at all. But a lot of people, including me, think this is the next place where the Internet will surprise people in how it can improve things—especially in combination with face-to-face learning. With the escalating costs of education, an advance here would be very timely.

Most of us have had a teacher whose lectures made a subject seem fascinating even though we didn't expect that it would be. If you are going to take the time to listen to a lecture, you should hear it from the very best. Now that finding and watching videos is a standard part of the Internet experience, we can put great teachers' lectures online.

A number of universities are already putting lectures online for free. You can find a lot of these courses at sites like [www.academicearth.org](http://www.academicearth.org). I particularly like the physics courses by Walter Lewin and the solid-state chemistry course by Donald Sadoway, both from MIT. When I want to learn a new concept like the Carnot limit on getting usable energy out of heat, I often will watch lectures from different courses to see how it is explained and test my understanding.

But online learning can be more than lectures. Another element involves presenting information in an interactive form, which can be used to find out what a student knows and doesn't know. This makes it possible to tailor the learning session to the individual student. Think about what happens to students who get into community college but are told to take remedial math because their test scores are below a cutoff level. The students have to spend time

on the things they already know and don't get to focus on the areas they are confused about. They get very little positive reinforcement from sitting in lectures. Most kids who are put into remedial math drop out before they ever get a degree because it is such a discouraging experience for them. On the other hand, the online system can quickly diagnose what the students know, provide positive feedback, and make sure their time is spent really improving the conceptual areas where they are weak.

We need to bring together the video and interactive pieces for K–12 and college courses. We should focus on having at least one great course online for each subject rather than lots of mediocre courses. Once we have this material in place, it can be used in many different ways. A teacher can watch and learn how to make a subject more interesting. A teacher can assign subsets of the material to students who are behind and finding something difficult. A teacher can suggest online material to a student who is ahead and wants to learn more. A teacher can assign an interactive session to diagnose where a student is weak and make sure they get practice on the areas that are difficult for them. Self-motivated students can take entire courses on their own. If they want to prove they learned the material to help qualify for a job, a trusted accreditation service independent from any school should be able to verify their abilities.

There is a lot of online material being developed, but it isn't organized in a way where it is easy to find the best material that fits what you want to do. If you search online for a video on photosynthesis, you get tens of thousands of results, including a lot of student projects. Which one is best for teaching kids of different ages and different pre-existing knowledge? We need a simple way of taking all of the education pieces and organizing them and then rating them in context.

One step that would help is having course standards that break down all of the various things to be learned into a clear framework and connecting the online material to this framework. Over time I think a large community of contributors and reviewers will develop and allow the online material to be easy to access and a crucial resource for all types of education. There will need to be a number of pilots to see how to take this resource and blend it into the classroom experience. I plan to spend a lot of time on this to see what would help get it to critical mass.

There is a question of how much of the online material will be free and how much will be paid for. Some of the best interactive software for K–8 learning is being done by startups using interactivity in innovative ways. These companies are licensing the software on a per-classroom and/or per-student basis. Ideally we would get market forces and nonprofit work to complement each other, but given that schools budget very little for software, it isn't clear whether the marketplace will be large enough for the for-profit model to make a large contribution.



## Agriculture

In the past few years, the foundation has begun to invest heavily in innovations that can increase agricultural productivity for the world's poor. More than 1 billion people suffer from chronic hunger, and most of them are small farmers. We need to raise their productivity so that they have extra output, which can be saved for lean years, or sold so they can have money to send their kids to school. We will also need to feed the additional 3 billion people who will populate the earth in the next 50 years. People involved in agriculture care about both improving farm productivity and making sure farming is done in a sustainable way. Although these needs are often seen as mutually exclusive, they are actually quite complementary. They both depend on innovation, including new seeds, better training for farmers, and better access to inputs and markets. Some of the recent successful innovations in agriculture are documented in a book called *Millions Fed*, which you can download at [www.ifpri.org/publication/millions-fed](http://www.ifpri.org/publication/millions-fed).

To make better seeds, scientists find two seeds, each with attractive characteristics—like being adapted to a local environment or having better productivity or disease resistance—and make one seed that combines the good traits. Breeding to get better seeds has been going on for thousands of years. When you see the original teosinte corn plant that is the father of today's corn, it is hard to believe the two are related. But the change is due entirely to breeding controlled by humans.

There are three things that modern agrotechnology brings to this seed improvement process. The first is simply the ability to gather plant samples from all over the world and use databases to keep track of thousands of plants grown under different conditions. This has accelerated the progress in conventional breeding. The second is the ability to genetically sequence plants, just like we do with humans. We have some understanding of which parts of the genes control which characteristics, so when we cross two seeds we can look at the gene sequence of the resulting seed and know whether it has the characteristics we want. This is called marker-assisted breeding and it dramatically speeds up the cross-breeding process, because researchers don't have to wait for the seed to grow before they know whether they've succeeded. The final technique is transgenics, where instead of just allowing cross-breeding to create the new seed genome, you actually take a gene and insert it. This is the approach that is still controversial for some people. But with the proper safety reviews, this technique can help create disease-resistant and drought-tolerant crops that could not be created any other way, protecting billions of dollars of harvest and increasing the food supply by millions of tons each year.

These modern techniques have been applied most aggressively to the big cash crops in rich countries. Just like in health, there isn't a lot of market incentive to use the latest science for the needs of the poor. The foundation's approach is to fund projects focused on the specific growing conditions in developing countries and the crops that are grown by poor farmers. Most of our grants involve marker-assisted breeding, but a few involve transgenics.

In December I visited the BECA Laboratory in Nairobi, Kenya, which is headed by a scientist named Segenet Kelemu. Their laboratory is doing state-of-the-art marker-assisted breeding to improve sorghum, cassava, and corn so the crops yield more food and resist pests, drought, and diseases. Segenet grew up in Ethiopia, moved away for graduate school, and worked in other countries for 25 years. But she chose to come back to Africa in 2007 to help develop a generation of plant scientists working to end Africa's food insecurity. I was very impressed with the teams she has put together and the work they are doing with plant breeders throughout Africa. For products like sorghum, even when they can tell that a seed has all the right characteristics, they still have to develop varieties that also match local tastes, since unlike corn or wheat in rich countries there isn't one standard form that everyone prefers.

The picture below shows you what a dramatic difference this kind of work can make. On the left you see sorghum that has been attacked by *Striga*, a devastating parasitic plant. On the right you see high-yield sorghum that has genes to prevent *Striga* from attacking. The difference to a small farmer between having the old seed and the new seed is the difference between starving and thriving.



A high-yield, *Striga*-resistant variety of sorghum [right] growing alongside a nonresistant variety infested with *Striga* (purple-flowered plants) [Fedis, Ethiopia, 2006].



Giving the “LIVING PROOF: Why We Are Impatient Optimists” talk with Melinda at Sidney Harman Hall (Washington, D.C., 2009).

## Rich Countries’ Aid Generosity

Improvements in agriculture and health have relied heavily on the generosity of rich countries. But this generosity represents a much smaller portion of foreign aid than many people realize. Aid for health rose from \$5.6 billion in 1990 to \$21.8 billion in 2007, which was less than 14 percent of all foreign aid from rich countries that year. This money was incredibly well spent—saving a life for far less than a tenth of what is spent to save a life in rich countries.

### Government Deficit as a Percentage of GDP

COUNTRY	2008	2009
Canada	-0.1	4.9
France	3.4	7.0
Germany	0.1	4.2
Italy	2.7	5.6
Japan	5.8	10.5
United Kingdom	5.1	11.6
United States	5.9	12.5

■ Shaded figures are forecasts

Source: IMF World Economic Outlook, October, 2009.

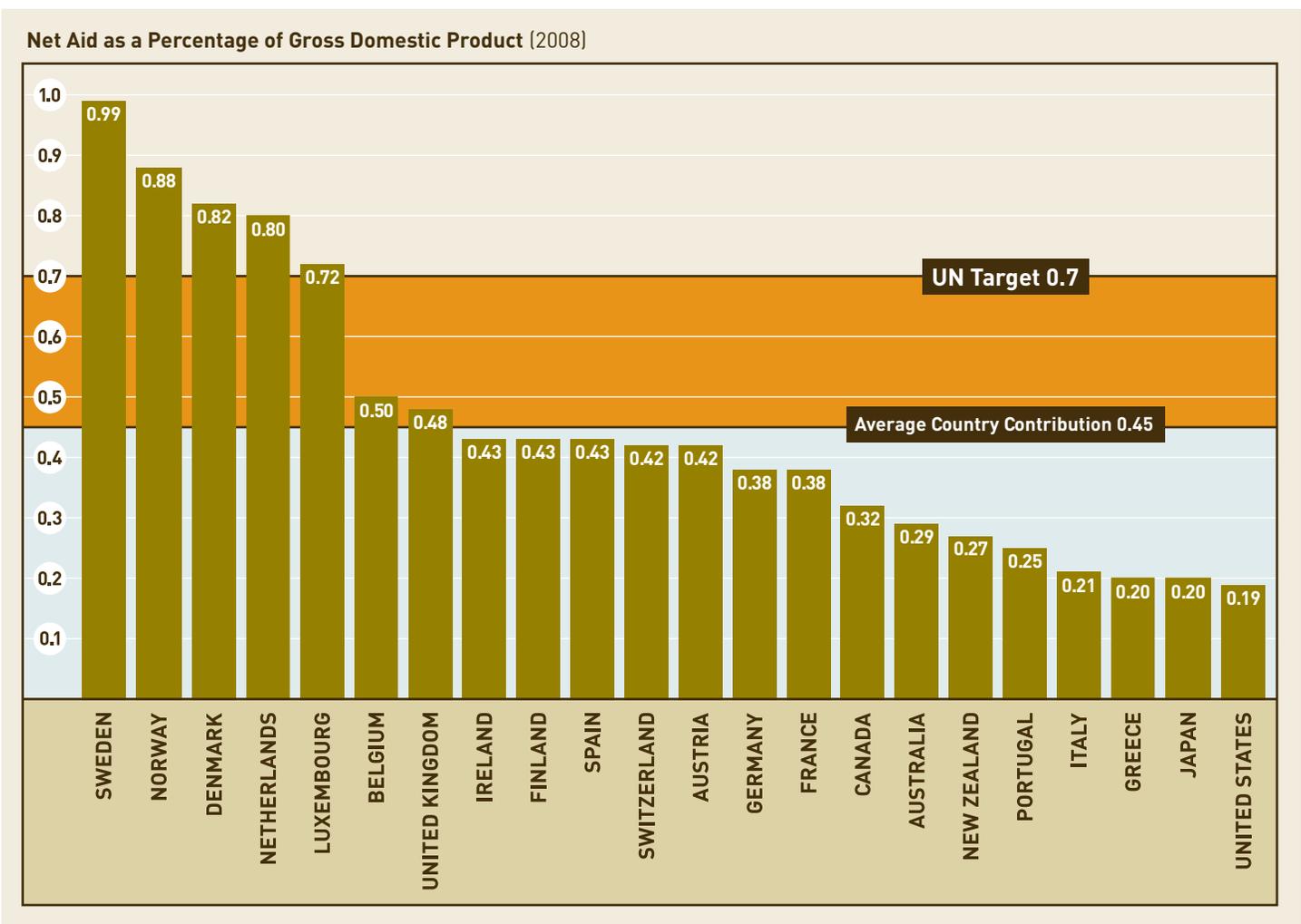
In total, foreign aid from the richest countries in 2008 was \$121 billion. Specific data is available at [stats.oecd.org/qwids](http://stats.oecd.org/qwids), and it’s something I watch closely because the generosity of these governments is key to long-term success.

Because of budget deficits, there is significant risk that aid budgets will either be cut or not increase much. In the table on the left, I show some countries’ budget deficits as a percentage of gross domestic product (or GDP, a measure of the overall size of the economy). Many of these percentages represent unprecedented peacetime deficits.

The public may not prioritize keeping foreign aid at high levels because so many of them have not heard how effective it is. Some formed their image of foreign aid during the Cold War, when money was sent to buy the allegiance of a dictator with very little control to make sure it was well

spent. We need to get the successes to be far more visible than they are today. The organization ONE is a key partner in helping with this, and they have Bono’s brilliance as well as a strong staff. In October Melinda and I did a presentation we called “LIVING PROOF: Why We Are Impatient Optimists” to show how well government investments in health are working. You can watch it at [www.livingproofproject.org](http://www.livingproofproject.org). This version was focused on U.S. giving, but the message is even more appropriate for the rich countries that are even more generous than the United States.

The best way to measure aid generosity is to look at it as a percentage of GDP. The most generous countries—Denmark, the Netherlands, Norway, Sweden, and Luxembourg—give 0.72 to 1 percent of GDP to foreign aid, which is phenomenal. Most other European donors give between 0.3 and 0.5 percent, and a majority have committed to get to 0.51 percent by 2010. France has traditionally been the strongest giver of this group, but in the mid-2000s their aid actually decreased a bit. Germany, Spain, and the United Kingdom have all made significant increases over the last few years and are now close to or ahead of France. Italy was at the low end of European givers even before the Berlusconi government came in and cut the aid by over half, making them uniquely stingy among European donors. These cuts



Based on aid numbers and GDP in current U.S. dollars, as reported by the OECD.

will show up in Italy’s 2009 aid figures. Bob Geldof put it well when he said the Italian government is suggesting “they want to balance their budget on the backs of the poor—how shameful.” In June, I met with Prime Minister Berlusconi personally to make the case for more support, but I was unsuccessful. This is a huge disappointment since I still think the Italian public wants to be as generous as people in other countries.

Canada and Australia are significant givers, at about 0.32 and 0.29 percent, respectively. Japan used to be a generous giver and has made some strong promises, but they are down at 0.20 percent. Unless the new government changes things for the better, they will fall short of their commitments.

There has been an effort to get Russia, China, and the rich oil countries to do substantial giving, but so far the numbers have been modest. South Korea, however, has become a significant giver, providing over \$800 million last year, which is 0.09 percent of its GDP, with a commitment to increase to 0.25 percent by 2015.

The United States is the biggest giver in absolute terms, but in percentage terms gives only 0.19 percent. In recent years, a significant portion of this assistance went to reconstruction in Iraq, Afghanistan, and Pakistan. If Congress passes President Obama’s proposal to double giving, however, the United States will get up into a very respectable range.

Deficits are not the only reason that aid budgets might change. Governments will also be increasing the money they spend to help reduce global warming. The final communiqué of the Copenhagen Summit, held last December, talks

about mobilizing \$10 billion per year in the next three years and \$100 billion per year by 2020 for developing countries, which is over three quarters of *all* foreign aid now given by the richest countries.

I am concerned that some of this money will come from reducing other categories of foreign aid, especially health. If just 1 percent of the \$100 billion goal came from vaccine funding, then 700,000 more children could die from preventable diseases. In the long run, not spending on health is a bad deal for the environment because improvements in health, including voluntary family planning, lead people to have smaller families, which in turn reduces the strain on the environment.



## Looking Ahead

There are a lot of important topics I didn't get around to in this letter. One area that I have been spending a lot of personal time on is energy and its effect on climate. The most important innovation required to avoid climate change will be a way of producing electricity that is cheaper than coal and that emits no greenhouse gases. There will be a huge market for this, and governments should supply large amounts of funding for basic R&D. Because the foundation invests in areas where there is not a big market, I have not yet seen a way that we can play a unique role here, but I am investing in several ideas outside the foundation. I am surprised that the climate debate hasn't focused more on encouraging R&D since it is critical to getting to zero emissions. Still, I think it is likely that out of the many possible approaches, at least one scalable innovation will emerge in the next 20 years and be installed widely in the 20 years after that.

I have decided to take the notes I make after taking a trip, reading a book, or meeting with someone interesting and pull them together on a web site called [www.gatesnotes.com](http://www.gatesnotes.com). This will let me share thoughts on foundation-related topics and other areas on a regular basis. I expect to write about tuberculosis, U.S. state budgets, creative capitalism, and philanthropy in Asia, among other things. The trips I will document will include Nigeria, to check on the status of polio eradication; northern India, to understand more about improving vaccine coverage; and school visits in the United States. The site will complement my annual letters as well as the foundation's web site, [www.gatesfoundation.org](http://www.gatesfoundation.org), which has a lot more information about the topics in this letter.

My job is fun and interesting because of the great people I get to work with. Besides Melinda, this includes our other co-chair—my dad. He is a tireless champion of making sure we keep listening to the people we want to serve and not letting our size get in the way of that. Jeff Raikes, CEO of the foundation, is doing an excellent job evolving how we run, making sure we hire great people, and creating an environment where they can do their best work. And I am always impressed with the dedication and in-depth knowledge of the foundation team, starting with the division presidents—Tachi Yamada, Sylvia Burwell, and Allan Golston. I feel very lucky to get to work with all of them.

Bill Gates  
Co-chair, Bill & Melinda Gates Foundation  
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