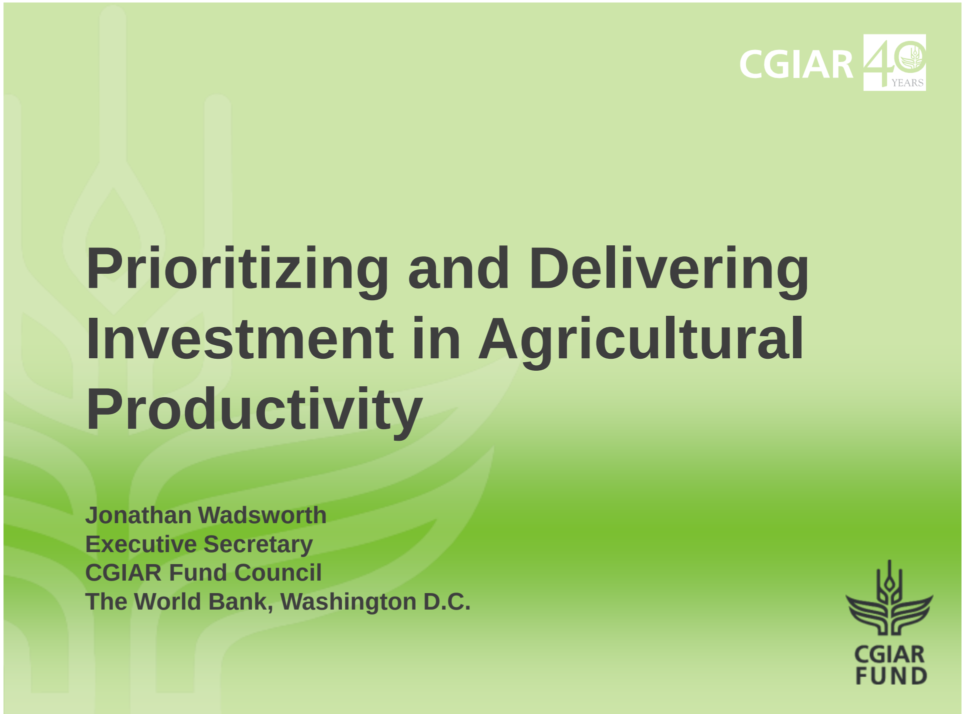
**Chatham House Conference: "Food Security 2011: Transforming the Food Production System"**
Presentation delivered on December 14, 2011 in London

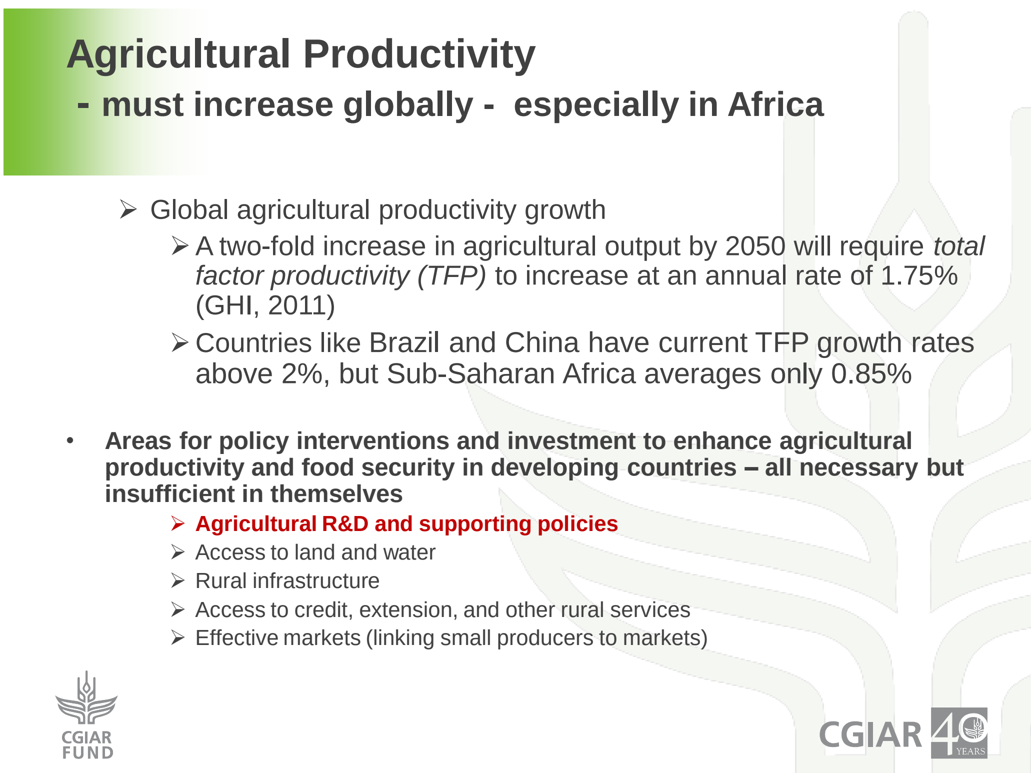



I would like to focus my remarks today on one of the major barriers to enhancing global agricultural productivity to achieve the projected 2050 requirement for global food supply, namely, the vital role of agricultural research and *particularly the need for adequate investment by both the public and private sectors*.

Over the past 50 years, agriculture has performed well: world population has doubled but global cereal output has outpaced it, increasing by 2.7 times. Most of the increase was due to yield growth, or, in other words, more tons per hectare. Global agriculture is now being called upon to produce as much in the next 40 years as it has over the past 8,000 years. But yield growth, measured as output per unit of land, is declining—from 3 percent/year 40 years ago to around 1 percent since 2000.

The big jump in developed country output in 2008 says more about farmers' responsiveness to world market prices than it does about productivity growth. Indeed, that 11 percent increment (see slide above) may reflect lower productivity due to even larger relative use of inputs, particularly land resources (i.e., land area expansion). Importantly, developing country farmers were not stimulated or were unable to increase cereal output despite higher world prices.

In the long term, to 2050, cereal yields will need to grow by 1.3 percent a year compounded on the same land area—with less water, less reliance on hydrocarbons, and lower emissions. It's worth remembering that productivity is the ratio of output over inputs. Depending on the marginal utility of different inputs and cost relationships, the points of economic optimum and biological efficiency maximization do not necessarily coincide. So when we think of production efficiency in terms of output/input ratio, high production efficiency is attainable at both high and low levels of outputs. We must aim at a ratio that would address both the need to increase global food supply and improve production efficiency. *So there is a twin challenge: to double output and improve productivity simultaneously--and not just in terms of crop yields*.

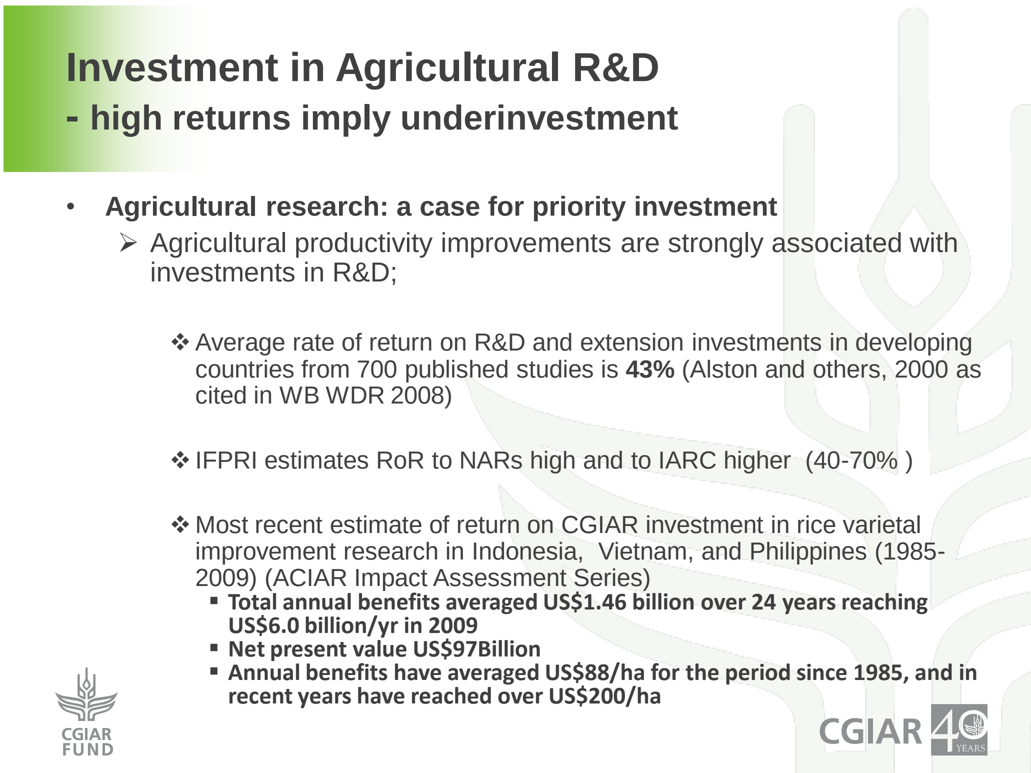



Total Factor Productivity (TFP) reflects the amount of total inputs used per unit of output. TFP growth is the difference between the growth rate of overall agricultural output and the growth of input use. If output grows faster than inputs, TFP is positive; if they grow at the same rate, it is zero; and if input use grows faster than total output, TFP is negative.

TFP growth is an indicator of the rate of technological change in agriculture by estimating changing efficiency of resource utilization. The TFP growth rate fluctuates from year to year depending on changing weather patterns, disease or pest outbreaks, etc.

Total Factor Productivity, rather than productivity to single factors of production, is a better way of comparing performance between years, regions, and countries. Numerous studies concur on a global figure of 1.75 percent annual growth in TFP to double agricultural output by 2050, but regional differences are large: Brazil, China, South Africa, Egypt, Colombia, and Chile are performing at over 2 percent, while Sub-Saharan Africa, the former Soviet republics, developing Pacific countries, and Caribbean nations are well under 1 percent. *A significant finding is that TFP growth is strongly associated with stocks of technology capital and investment in R&D*.

Although none of the factors listed here are magic bullets for increasing agricultural productivity, I would like to concentrate on the critical role of research investments on the prospects for a food secure world.

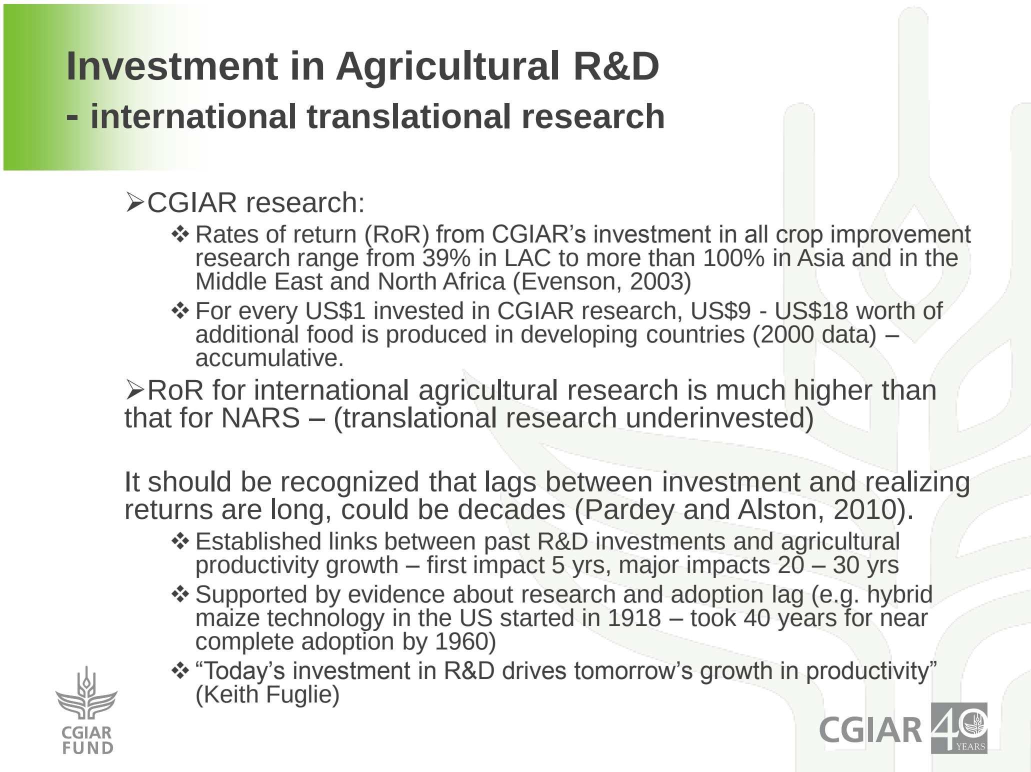



It is generally understood that investment in public goods is suboptimal. This cannot be more dramatically illustrated than by reference to the consistently high returns to agricultural research—the 2000 study by Alston and others being the classic example.

Studies by the International Food Policy Research Institute (IFPRI) have shown that returns to investments in developing countries' own national agricultural research systems regularly outperform investments in other sectors, such as transport infrastructure and education, while returns to international agricultural research are higher still.

Due to the non-rival and non-excludable nature of much agricultural research, the private sector has little incentive to invest in public goods. But when conditions, policies, or the technologies themselves facilitate appropriation of benefits by the research investor and research consumer, then private investment can be extremely high. The recent surge of investment in crops for biofuel feedstocks, for example, is running at a billion dollars a year in the U.S. for maize research alone.

*The example from a 2011 study by the Australian Government (see slide above) is by no means unique. It is just one of many examples that can be found in the literature demonstrating that the total benefits of long-term research can and do pay for themselves many times over. If only a tiny fraction of these public benefits could be captured and used for research, much of the underfunding problem could be redressed*.




I will not belabor the consistently high returns to CGIAR research; other institutions can also claim impressive results.

What I *would* like to draw attention to, however, is that research takes time: technological advancement for ever increasing productivity demands a constant cycle of knowledge generation, knowledge destruction as ideas become redundant over time, and knowledge re-creation. In the case of agriculture, it's particularly important to factor in this time lag.

The case of hybrid maize in the U.S. is a classic example that has been well documented; it took at least 40 years to reach near complete adoption, and even longer if you chart its inception from the late 1800s when research first began.  Serious agricultural research investments do not fit easily with short-term political budget cycles, creating *a huge barrier to consistent, incremental productivity gains.*

## Investment in Global Agricultural R&D
### - trends, who pays and where?

- **Global public investment in agricultural R&D**
  - grew by 35% between 1981 and 2000 to US$20.3 billion; developing countries account for about half the total public spending on R&D
  - R&D spending relative to the economic size of the agricultural sector (i.e. intensity of agricultural R&D e.g AgR&D/AgGDP) is much lower in developing countries (0.5% vs 2.4%)
  - Developed country R&D spending growth slowing and proportion for productivity enhancing research has declined rapidly
- **Private sector investment in agricultural R&D**
  - Estimated to be US$13.4 billion (about 40% of total global agricultural R&D investment) in 2000, 95% of which was in developed countries – benefit appropriation problem

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In the two decades between 1981 and 2000, total public investment in agricultural R&D increased by a third in 2005 international purchasing power parity (PPP) dollar terms. While about half this spending took place in developing countries, any meaningful comparisons must consider investment in relation to the size of the agricultural sector in the economy. This is measured by expressing agricultural R&D spending as a percentage of agricultural GDP, termed the intensity of R&D investment. Developing countries registered a mere 50 cents of investment for every $100 of agricultural GDP (AgGDP), while the intensity of public R&D investment was five times greater in developed countries. There are exceptions, however, such as Brazil, which had a 1.66 percent intensity ratio in 2005.

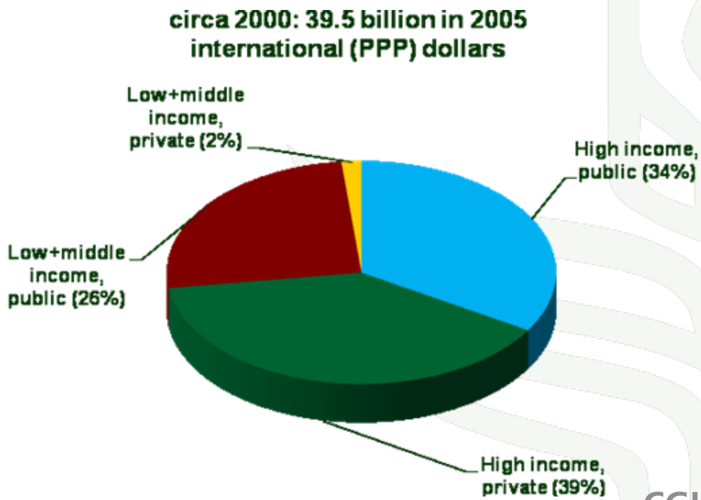
International public sector investment is heavily skewed, with just 5 percent of countries accounting for half the global total; the U.S. alone accounts for 20 percent of all global public investment in agricultural research.

The general slowdown in developed country research growth needs to also take account of the erosion of investments in productivity enhancing research; studies from the U.S., Canada, and the U.K. have shown that up to 60 percent of public research is now devoted to scientific areas unrelated to productivity enhancement. This has a significant impact for developing countries that rely on technological spillovers from developed countries, which have traditionally been a significant source of new technology and research for local adaptation.

Not surprisingly, the private sector invests in R&D where returns can be appropriated, which in 2000 was almost exclusively to be found in developed countries. Although the share of private sector investment in global agricultural R&D has increased from 40 percent to over 50 percent recently, it is almost all—95 percent—in developed countries.

When both public and private investments are added together, developed countries spend ten times more on research per $100 AgGDP than developing countries, or $5.28 per $100 AgGDP in developed nations compared to only 53 U.S. cents in developing countries—*highlighting the widening technological divide between North and South.*

## Total public and private spending in agricultural research (Bientema and Stads, 2008)

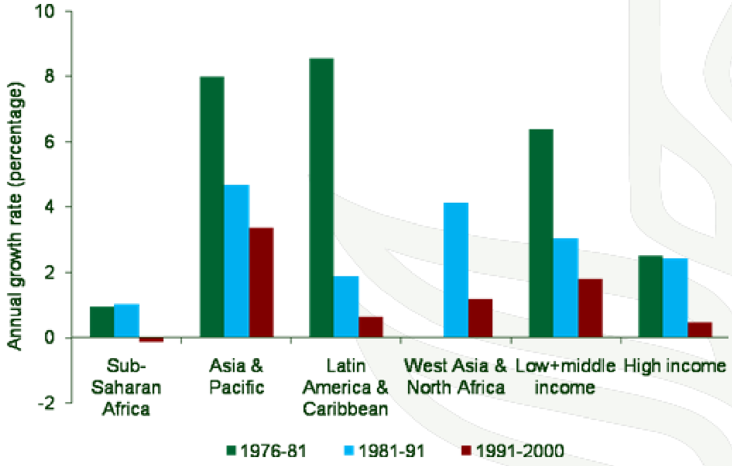



This pie chart illustrates the relative absence of private sector agricultural R&D in developing countries. In high income countries, private and public investments are fairly equally matched, but in developing countries it is the public sector that carries all the burden, which  probably has consequences for the overall research climate and dynamism around innovation, not to mention capability spillovers, researcher incentives, and training.

There are many reasons for private sector underinvestment in agricultural R&D, particularly in developing countries. One of the key factors is that private firms that develop technologies are not able to capture sufficient benefits accruing to them (due to weak IP protection, small and fragmented markets, low input agriculture, etc.). *If this imbalance is to change, greater incentives for private sector R&D in developing countries are imperative*.

## Declining growth rates of public agricultural research expenditures, 1981–2000

**(Bientema and Stads, 2008)**




Although total global R&D investment has increased, as noted earlier, the growth rate of public agricultural research spending has substantially slowed down in every developing region since the mid-1970s. In low and middle income countries, the growth rate slowed from an average of over 6 percent in the 1976-1981 period to an average of less than 2 percent from 1991-2000. In Sub-Saharan Africa, the growth rate became zero or negative from 1991-2000. In high income countries the slowdown in growth has been dramatic.

Given the long time lags, *the generalized deceleration in public R&D investment, exacerbated by the move away from productivity enhancing research, may not yet have fully impacted on the reductions in productivity growth. If true, this is a worrying hypothesis.*

## Closing the Global Agricultural Productivity Gap – how much will it cost?

- How much is the productivity gap?
  - As noted earlier, TFP will need to grow at an annual growth rate of 1.75% to double the global agricultural output by 2050 (Global Harvest Initiative GAP report; 2010, 2011)
- What level of investment to support agricultural development in developing countries will help close the gap?
  - An additional **US$90 billion** is required annually for developing countries (Source: GHI-commissioned 2011study)
- How much is needed for agricultural R&D in developing countries?
  - **US$16 billion** is projected to be the total investment needed by 2025 (IFPRI 2010)

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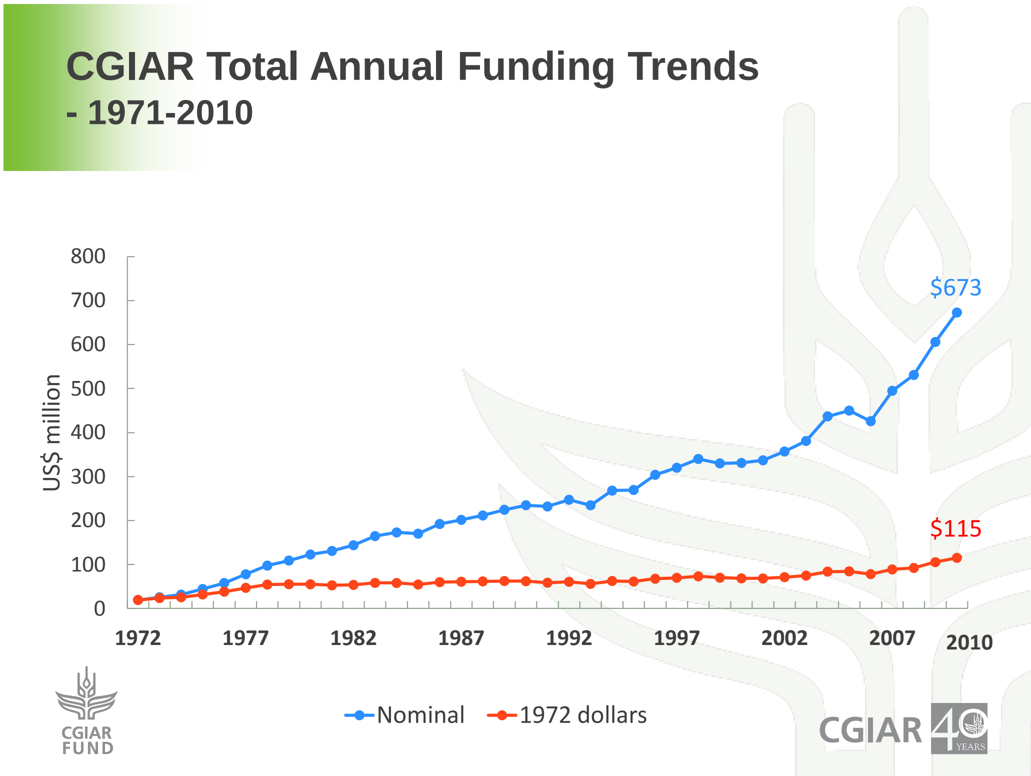
If global investment in agriculture research both public and private is considered to be too low, how much should we be spending to close the looming productivity gap? The Global Harvest Initiative publishes an annual Global Agricultural Productivity (GAP) report that compares global TFP performance with the target of 1.75 percent per year, every year, until 2050. In 2010, the global TFP estimate was 1.4 percent, and it rose to 1.74 percent in 2011. However, there are large differences between regions, especially in developing countries, where the bulk of population increase will occur. Sub-Saharan Africa has the lowest TFP growth, yet it is the region that is expected to have the highest population increase. Global food security is not simply a question of total output; *where* food is produced is also critical.

While many studies and commentators call for increased investment in agriculture, estimates of how much investment in agriculture is required are hard to find. The Global Harvest Initiative suggests that there is currently a US$90 billion annual investment gap in support for agricultural development in all developing countries, and that it will be necessary to fill this shortfall to help close the agricultural productivity gap. There are no estimates, however, of how much should go to research in developing countries, or how much developed countries should be investing in research.

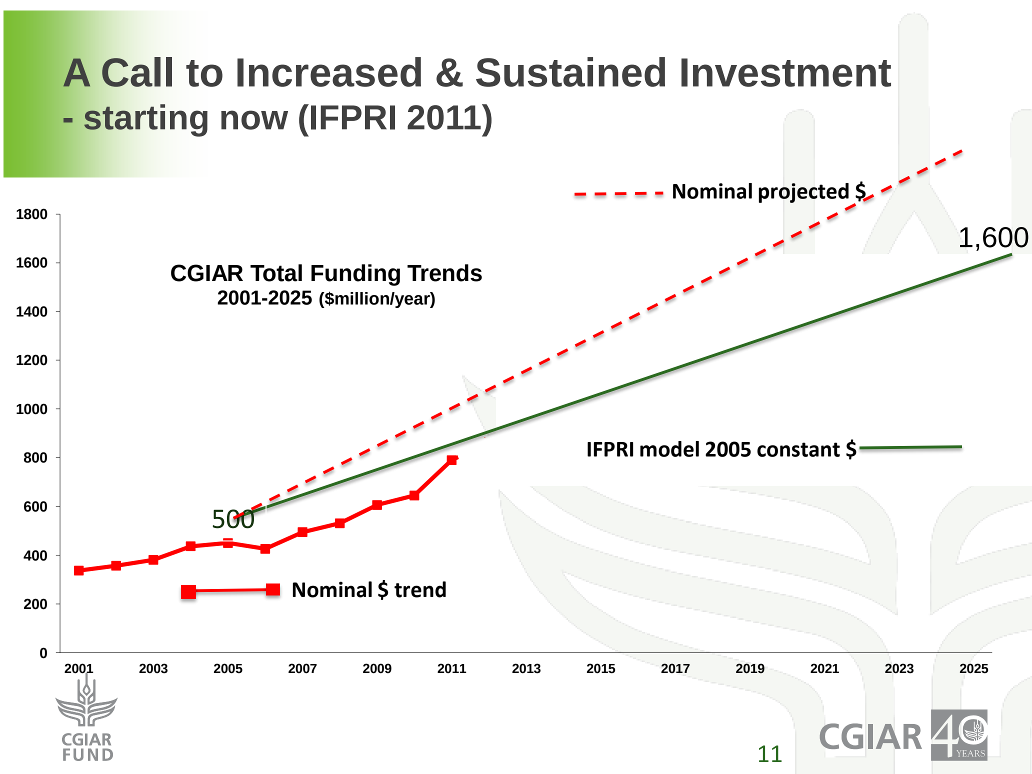
The Royal Society's 2009 report, *Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture*, proposed that the Research Councils UK (RCUK) establish a 10-year "grand challenge" on global food security that would need 2 billion pounds, roughly doubling the U.K.'s investment in this area. Exactly how this figure was derived is unclear.

The most detailed estimates come from modeling work carried out by IFPRI, which found that the level of investment for agricultural R&D in developing countries needs to increase to US$16 billion by 2025. The model is based on past performance as the baseline, plus an incremental TFP growth of 0.5 percent over the baseline.

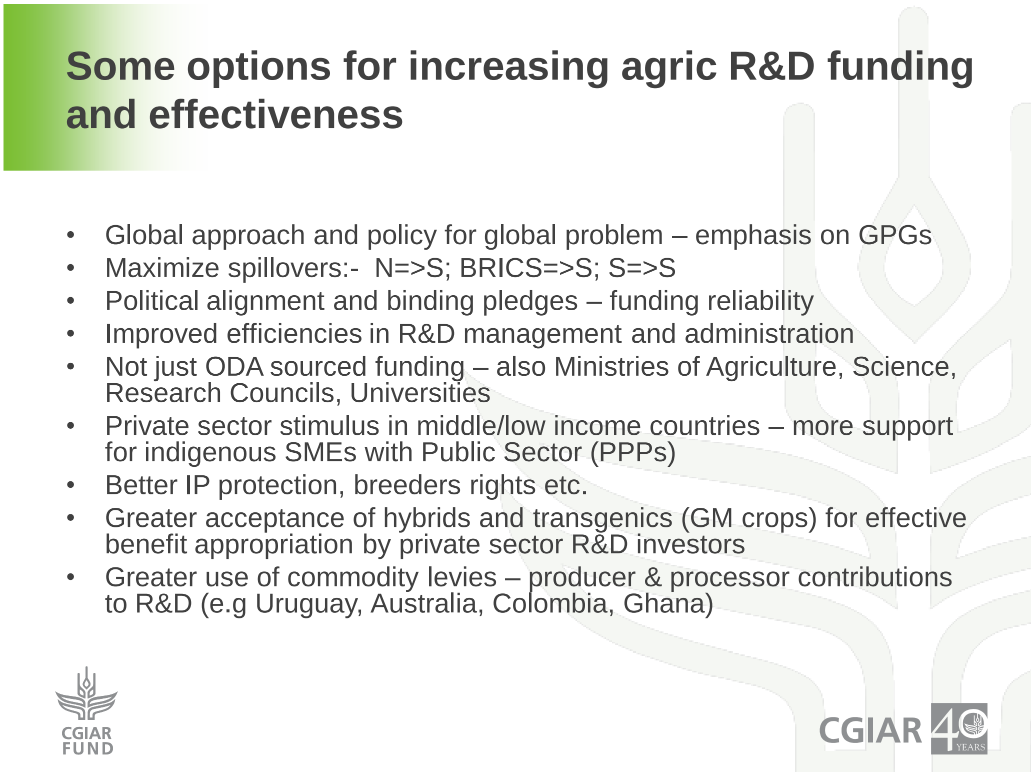
An interesting feature of this modeling work is that the regional distribution of where research investments should take place depends on the objective of research: *a poverty reducing strategy would emphasize investments in Africa, whereas a productivity optimizing growth strategy would direct more research resources toward South and Southeast Asia*.




International agricultural research investment has been strong through the CGIAR, which has grown 33 fold over the past four decades. However, in nominal terms, it was much lower, and was fairly flat for 20 years between 1980 and 2000. Since embarking on major reform of the CGIAR in 2008, growth has picked up and the target of doubling the total CGIAR budget from around $500 million in 2008 to $1 billion in 2013 seems reasonably achievable.



According to the IFPRI estimates mentioned above, it is assumed that 10 percent of the US$16 billion needed would constitute CGIAR research based on historical trends, but there hasn't been any work to determine whether this share is optimal.  These projected values are in 2005 constant dollar terms (see the green line in above slide). A rough estimate of nominal dollar needs is expressed by the red dashed line, although projecting such figures 14 years into the future is dangerously speculative.




Global food security is an essential public good; with a more connected world, it affects everyone. It is also closely linked to wider security concerns. Lack of food security, as we have seen, can destabilize governments and create severe conflicts. *Global food security must be addressed globally, and the common language of science can help facilitate this*.

Science and technology spillovers in all directions, including South to North, are well recognized but have been treated for too long as welcome consequences rather than necessary objectives.  *As yet, spillovers have not received the strategic and planned attention they deserve*.

Effective, long-term research in agriculture requires funding stability that stretches well beyond political budget cycles. For some global public good challenges, such as those pursued by GAVI (the Global Alliance for Vaccines and Immunisation), governments have come together to provide reliable resources and commitment over the long term, but so far this has been elusive in agricultural research.  *Although small scale, one step in the right direction has been taken with the creation of the CGIAR Fund. One of the major challenges we face is to increase funding predictability to match long-term planned resource needs*.

On the private sector side of the equation (notwithstanding a few examples of small- and medium-sized firms that have become involved in seed improvement and distribution in developing countries, despite facing tremendous barriers to establishing themselves, from lack of capital to burdensome regulatory frameworks), much more could be done to incentivize local entrepreneurs in developing countries and tap into latent innovative capacity. *Greater IP protection and measures that enable equitable benefit sharing between the originators and users of innovations need to be worked out to stimulate private investment*.

The generalized resistance to transgenic crops and even hybrids is limiting research in these areas. The international community could be more supportive of such technologies, which provide a means of benefit appropriation by investors. *Once this hurdle is passed, the private sector would be spurred to redress the North – South imbalance of research investment*.

And finally, agriculture, at all scales, is a private sector activity; even small farmers are willing to invest in research if they can accrue benefits from it. One way of increasing research investment is through producer levies, which have been used successfully in a number of countries, sometimes with government matching grants, *but always with a strong farmer voice in determining research priorities and evaluating resulting benefits*.

*More can be done to seek innovative ways of seriously increasing funding for agricultural research that does not always have to rely purely on public sector generosity. I hope this meeting will come up with better ideas than mine on how we can bring this about*.

Thank you.

Acknowledgement and disclaimer

I am grateful to Manuel Lantin, Science Advisor, CGIAR Fund Office, for his assistance in data analysis, suggestions and advice in preparing this presentation. The expression and content are those of the author and do not necessarily represent CGIAR policy. This text and associated slides were delivered under the Chatham House rule.

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