

# **Agriculture for Sustainable Economic Development: A Global R&D Initiative to Avoid a Deep and Complex Crisis**

Joachim von Braun

Director General, International Food Policy Research Institute

**Charles Valentine Riley\* Memorial Lecture**

**Capitol Hill Forum, Washington D.C., February 28, 2008**

## **Abstract**

World agriculture has entered a new, unsustainable, and politically risky period. Agriculture—and the natural resources it depends on—has been overexploited ecologically, has suffered from underinvestment, has recently been exposed to ill-designed bioenergy programs, and has been politically sidelined for too long. It is now at a critical point. Appropriate responses to the food and agriculture price and productivity crises are lacking. *A global initiative for accelerated agriculture productivity is necessary now; such an initiative makes economic sense, is pro-poor and sustainable, and serves security.* The initiative needs political leadership and coordination. There is no effective governance architecture at the global level and national levels to address the matter. Industrialized economies, including the United States, should substantially accelerate their investment in international agricultural research and development (R&D) in cooperation with new players.

---

\* **Charles Valentine Riley** was born in London on September 19, 1843 and moved to the United States at the age of 17. In 1868, he was appointed to the office of entomologist of the State of Missouri, where he studied the plague of grasshoppers that invaded many western states between 1873 and 1877. In 1878, he was appointed as an entomologist with the U.S. Department of Agriculture. He was one of the first to practice biological insect control, introducing a beetle that was the natural enemy to a scale that was damaging the California citrus industry. Riley is known as the "father of biological control." He was among the first to notice that American grapes (*Vitis labrusca*) were resistant to grape *Phylloxera*, and his work helped save the French wine industry. Riley received the French Grand Gold Medal for his efforts and was named a Chevalier of the Legion of Honor in 1884. Riley authored more than 2,400 publications, and died on September 14, 1895 as the result of a bicycle accident.

## **1. The issues at stake**

World agriculture has entered a new, unsustainable, and politically risky period. Agriculture—and the natural resources it depends on—has been overexploited ecologically, has suffered from underinvestment, has recently been exposed to ill-designed bioenergy programs, and has been politically sidelined for too long.

World agriculture depends mostly on small farms. More than 400 million small farms in the developing world do hardly appear on the radar screens of economic policymakers, though the households connected to these farms are home to the majority of the world's hungry and poor people. Pressures on food availability are particularly affecting those who can afford it the least—the poor and food insecure.

Agriculture is being re-identified as an essential element of economic growth in developing countries where food security also relates to broader security concerns, but this recognition has been too slow in coming. What is required now is a new vision for a transforming, productive and economically sustainable agricultural sector in the developing world.

When it comes to climate change, agriculture is part of the problem and part of the solution because it adds to greenhouse gases and offers opportunities for carbon mitigation. Emerging climate change impacts in developing countries, such as water scarcity and policies for biomass and CO<sub>2</sub>, further complicate the food supply and price situation.

Globalization of retail industries and high-value commodity diversification strengthen the geographical and cross-sectoral linkages in the food system. Though such global economic integration could help the poor, there will be not only winners but also losers.

How can agricultural growth be accelerated and translated into pro-poor and sustainable development in light of the new challenges and pressures? This paper will discuss some recent key changes in the world food system: rapidly globalizing agricultural markets, the integration of the agribusiness chain, increased trade, changing trade policies, high food prices, closer agriculture–energy sector linkages, sustainability threats, and security synergies.

Charles Riley's vision for agricultural advancement through new scientific knowledge is today more relevant than ever. The key message here is that a new strategic policy portfolio of science, trade, and rural services is needed at the national and international levels to ensure sustainable growth and to reduce the political risks.

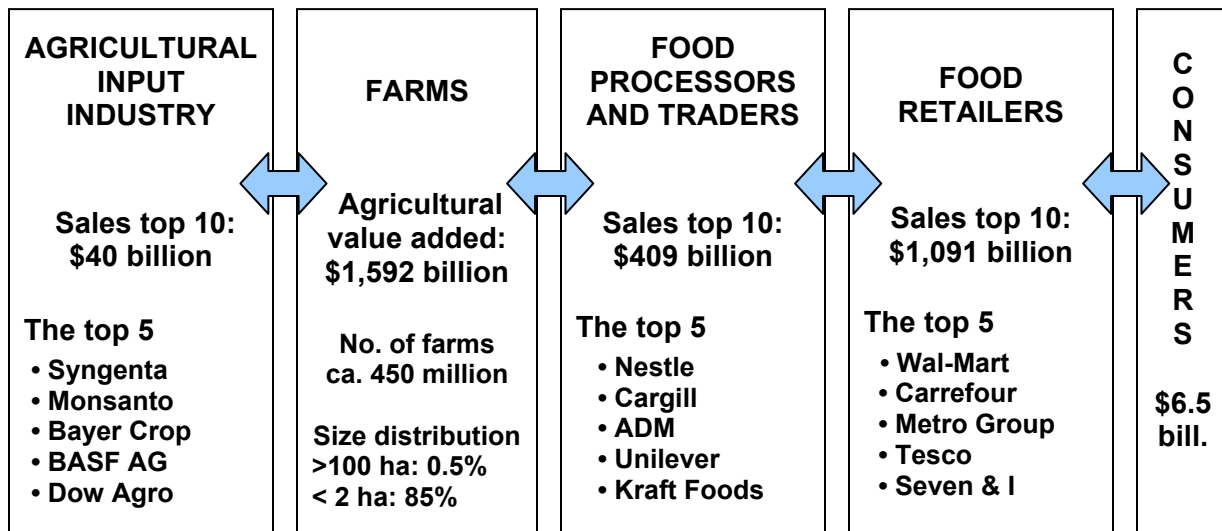
### ***Globalization of the agrifood system***

Agriculture growth is today very much driven by the demand side—toward consumers who are getting richer and the retail industries that cater to them. The regional and intercontinental integration of the agrifood system is both a consequence of and a factor in the larger process of globalization. The 6.5 billion global consumers are served by a variety of suppliers that include food retailers standing next to the road in Africa as well as modern supermarkets. Supermarkets are supplied by the food processing and trading industries, which in turn are supplied by the farm sector, which receives its inputs from companies producing fertilizers, agrochemicals,

seeds, and other inputs (Figure 1). In this system, international corporations have been increasing their power and leverage. Between 2004 and 2006, the sales of the top 10 food retailers soared by more than 40 percent, while the sales of the top food processors and agricultural input companies grew by 13 and 10 percent, respectively (von Braun 2007). The sustainability of agriculture can no longer be defined by fields or farms or ecologies. Today, agriculture sustainability spans the globe, the whole value chain of food- and agriculture-related inputs and outputs, and includes outcomes such as nutrition, health, and safety.

What and how is the small farmer doing in this time of change? On the one hand, globalization of the agrifood system and consumption of high-value agricultural produce could offer huge opportunities to small agricultural producers in developing countries. On the other hand, many farmers are faced with high barriers to market entry due to geographic distance to national market centers, the safety and quality standards of food processors and retailers. Contract farming and cooperation schemes are ways to overcome this dilemma. The disparity of scale between small farmers and the rest of the agrifood business chain is increasing due to further fragmentation of agricultural holdings in many countries. In India for example, the fragmentation of landholdings has continued to increase since 1991 (Birthal et al. 2007).

**Figure 1. The global agrifood business chain, 2006**



Source: von Braun 2007.

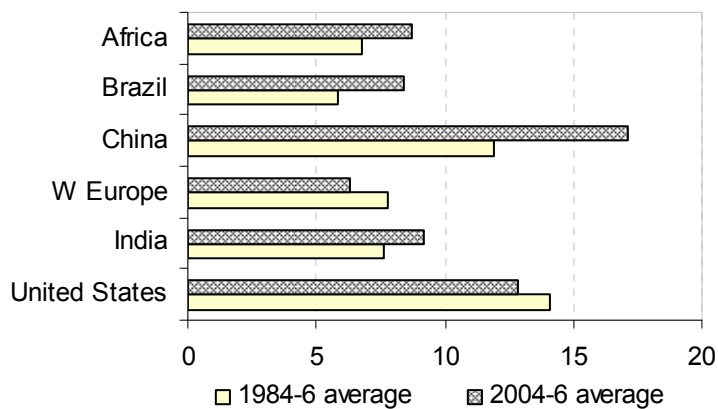
### *The new global power structure of agriculture*

Developing countries and middle-income economies are playing an increasingly important role in the global agrifood system. Higher incomes and urbanization are raising food spending in developing countries. In the past 20 years, the United States and Western Europe's share of world agricultural production has decreased by 9 and 19 percent, respectively, while the share of Brazil, China, and India has substantially increased (Figure 2). The share of agriculture in the economy has fallen in all of the sample countries; its share in the United States and Western Europe is currently at a mere 1 and 2 percent of Gross Domestic Product (GDP), respectively

(World Bank 2007a). In contrast, the agricultural sector in Africa currently contributes 20 to 40 percent of overall GDP and employs 60 percent of the labor force (World Bank 2007a, Beintema and Stads 2004).

The integration of the agrifood system becomes most evident in global agricultural trade. Between 1985 and 2005, world trade in agricultural products increased more than threefold (FAO 2008a). Trade is also an area that provides evidence for new developments in the global power system of agriculture. The share of world agricultural exports of one of the major producers—the United States—has declined by 33 percent since 1983-1985 (FAO 2008a). In some of the largest developing countries—China, India, and Brazil—the share has remained almost constant despite rising production due to increased domestic demand. A more open trade regime in agriculture would have far-reaching positive effects, but the negotiations through the Doha Round are currently stalled. Developed countries continue to be a major import market for agricultural commodities and their trade and domestic protection policies have major implications for developing countries.

**Figure 2. Agricultural production by country and region, % of total**



Source: FAO 2008a.

Note: W. Europe includes Belgium, France, Germany, Liechtenstein, Luxembourg, the Netherlands, and Switzerland.

Agriculture policy is today increasingly made outside of the domain of agriculture, and often as an offshoot of energy or infrastructure policy. While the U.S. farm bill includes some biofuel support programs, for example, most government support for biodiesel production is outlined in the energy bill and entails large subsidies. Developing countries are unable to provide agricultural support on such a scale, and especially not in new markets such as for biofuels and for CO<sub>2</sub> sequestration.

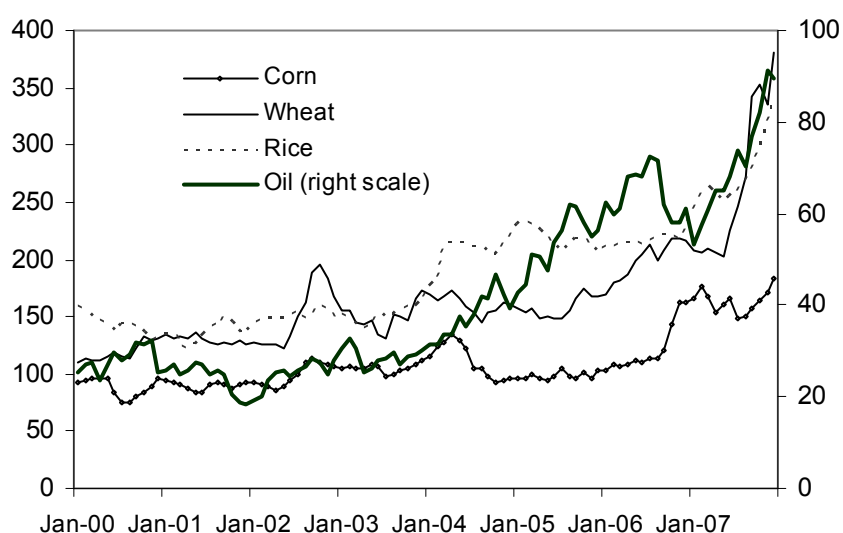
The global power system of agriculture now consists of a conglomerate of different players. The playing field includes new actors, such as energy and retail market players, and traditional ones, such as the input industries and food processors. However, global agriculture issues currently have only a limited decisionmaking architecture relating to public goods such as water, climate, and food safety. What is missing is a recognized governance platform that addresses the growth opportunities and sustainability threats on a global scale. The current state of multiple

agricultural agendas is risky and leads to serious lack of attention to the management of and investment in agriculture-related global public policy issues. This lack of a coordinated global response is visible in the field of agriculture-energy policies, climate change mitigation and adaptation policies for agriculture, food aid policies, and agriculture-health and food safety policies. It also is evident in the lack of a coordinated response to rising world food prices.

### ***Rising food prices***

Surging food and oil prices have turned the attention of policymakers and the public to the world food equation and food–energy price linkages. Between 2000 and 2008, the prices of wheat and petroleum in dollar terms increased more than threefold, while the prices of corn and rice more than doubled (Figure 3). When adjusted for inflation or reported in euros, the price increases are smaller, but also drastic.

**Figure 3. Commodity prices (US\$/ton), January 2000–January 2008**



Sources: Data from FAO 2008b and IMF 2008.

The major drivers of increases in cereal prices have been the high demand for food (and feed) due to income growth (and less so due to population growth), high demand for biofuels, and slow production responses to that rising demand. Between 2000 and 2006, cereal supply increased by mere 8 percent and stocks declined to low levels (von Braun 2007).

This inelastic response of cereal supply is characteristic of aggregate agriculture supply as well. Studies over the past several decades suggest that typically, a price increase of 10 percent results in only a 1-percent increase in aggregate agriculture production, and that response takes time. Today, the supply response takes even more time because it needs to come from higher yields (and not from area expansion) and from increased productivity in the livestock sector. These responses need prior investments in research and development (R&D), services, and input supply systems. Farms have become smaller in most of the developing world over past few decades. This trend leads to further challenges since the supply response in small-farm agriculture is impaired by constrained access to capital and innovation and a lack of organization among small

farmers. Furthermore, the higher but more unstable prices observed today trigger smaller production responses, while improved rural infrastructure triggers higher responsiveness. Still, underinvestment in rural roads, electricity, and communications infrastructure impairs supply response in developing countries.

A rise in cereal prices has uneven impacts across countries and population groups. Households that are net buyers of food, which represent the large majority of the world's poor, are negatively impacted (von Braun 2007). It is largely the poor who respond to food prices with reduced consumption and changed patterns of demand, leading to calorie and nutrition deficiencies. Since food accounts for a large share of their total expenditures, the impact on the poor can be dramatic. Faced with higher prices, the poor switch to foods with lower nutritional value and to foods lacking important micronutrients.

On the demand side, the consumption growth of cereals has been particularly high in industrial countries. Since 2000, cereal use for food and feed has increased by 4 and 7 percent respectively, while cereal use for industrial purposes increased by more than 25 percent (FAO 2003 and 2007). In the United States in 2007-08, corn for ethanol production is projected to account for more than 30 percent of domestic use in the country (USDA 2008). As calls for energy security remain strong, this high cereal demand trend is likely to continue and spread globally.

On top of these demand and supply changes come production shocks (such as Australia's drought) and reduced grain stocks, which make the markets more and more nervous the smaller the stocks become. Such nervousness invites speculative capital, and the trade restrictions triggered by high prices in many countries further narrow the global market and result in "starving your neighbor" policies. These are unsustainable policies which also undermine political security.

### ***Expanding biofuel production***

The expansion of new sources of biofuels such as ethanol and biodiesel has a strong effect on agricultural prices, since biofuel production largely draws on natural vegetation. Second-generation technology is still a long way away. Incorporating new developments in supply and demand, as well as actual biofuel investment plans IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)<sup>1</sup> projects that the prices of maize and oilseeds will increase by 26 and 18 percent respectively by 2020. A more drastic expansion scenario doubling the production levels assumed in the first scenario projects even more dramatic increases in the price of maize and oil seeds – by 72 and 44 percent (von Braun 2007).

In addition, biofuels have indisputably created new linkages, trade-offs, and competition between the agricultural and energy sectors. The concentration of demand in developed countries also implies potential for biofuel exports from the rest of the world. Removing trade barriers will facilitate the establishment and expansion of biofuel production in countries with a comparative advantage. On the other hand, distorting subsidy regimes for biofuels and agricultural products used as biofuel feedstock will undermine the comparative advantage of developing countries.

---

<sup>1</sup> The IMPACT Model is managed by IFPRI's Environment and Production Technology Division under the leadership of Mark Rosegrant.

Many countries have already established ambitious biofuel expansion plans and blending targets, yet biofuel production remains uncompetitive in many places of the world. Recent increases in the prices of cereals and oil seeds signal that as increased biofuel demand began to stimulate agricultural prices, the competitiveness of biofuels began to decline, because the feedstock price is critical for the competitiveness of biofuels. Maize ethanol, of which the United States is currently the largest producer, has been controversial because until recently, it had a negative energy balance—the amount of energy used to produce it was greater than the output of energy of the final product—and its impacts on greenhouse gas mitigation is limited, too. Recent research frequently finds a negative effect of biofuels on greenhouse gas emissions (Searchinger et al. 2008 and Fargione et al. 2008).

Whether expanded biofuel production is an environmentally sustainable source of energy depends on the choice of feedstock, cultivation practices, technologies employed, and the security, trade, and environmental policies that are adopted. Factoring in environmental and economic aspects, embarking on large-scale biofuel production with current technologies does not make sense at this time. For many developing countries, it would be more rational to wait for the emergence of second- and third-generation technologies, and “leapfrog” onto these technologies later. This will be an important area for sharing innovations between industrialized countries and developing countries in the future that could serve global sustainability. As the majority of patents in biofuels are held by the private sector, this is a promising area for public–private partnerships.

## **2. The threats to agricultural sustainability and resources**

Agricultural production has experienced impressive growth in many developing countries, but is this growth sustainable? In Sub-Saharan Africa, agriculture has been reaching almost 6 percent growth in recent years (IMF 2007). Yet, when it is driven by area expansion, this growth can undermine natural resources, forests, and water systems. In the main domains of natural resources that are key to agriculture, new threats have become more visible in recent years, and outlooks raise concerns.

### ***Water***

Climate change, population growth, irrigation, and industrial expansion increase competition for water. About 1.4 billion people now live in river basins where water use surpasses recharge rates. In many countries, developed water sources are almost fully utilized, and new sources are becoming increasingly expensive to develop (UNDP 2006). Irrigation provides productivity gains and greater food security, yet it also exerts substantial pressures on limited water resources. In developing countries, irrigated agriculture is the largest user of water resources, accounting for more than 80 percent of water use (FAO 2008c). However, this does not mean that irrigation in the developing world is widely or equally spread. Sub-Saharan Africa, for example, is highly dependent on rainfed agriculture and accounts for less than 5 percent of global irrigation (UNDP 2006). The potential for agricultural expansion needs to be evaluated against existing water resources and the constraints to their expansion. For agricultural growth to be sustainable, efficiency and equity of water use in agricultural production needs to be increased.

### ***Soils***

Overgrazing, deforestation, and inappropriate agricultural practices have been some of the major forces behind soil degradation. Inappropriate agricultural practices are often associated with insufficient use of mineral fertilizers, rather than overuse. Farmers apply about 9 kg/ha of fertilizer in Africa, compared to 142 kg/ha in Southeast Asia. Soil degradation affects one-fourth of the world's agricultural land and the pace of degradation has increased in the past 50 years. Soil quality is a major variable influencing agricultural yields, and erosion has already had significant impacts on the productivity of about 16 percent of the agricultural land in developing countries (Scherr 1999). The goal of simultaneously protecting the environment, assuring the sustainability of global soil resources, and increasing agricultural production should build on increased agricultural productivity and improved agricultural practices.

### ***Biodiversity***

Biodiversity conservation is severely impacted by the conversion of forests and wild lands to farmland and pastures. Maintaining the genetic richness of crops and varieties is of key importance to farm productivity. Crop genetic improvements have increased resistance to pests, diseases, and climatic shocks. Biotechnology can enhance these positive effects. As a result, yields have increased, but at the same time, crop genetic diversity is eroding as traditional varieties are being widely replaced by genetically uniform and stable modern varieties. Plants that have been guarded and bred by generations of farmers are in danger of being lost and many have recently been placed into storage in the new permafrost genebank in Spitzbergen, Norway.

### ***Climate change and climate risks***

As climate change increases climate vulnerability, temperature, and the risk of droughts and floods, agricultural productivity losses are imminent and the sustainability of agriculture is at risk. World agricultural GDP is projected to decrease by 16 percent by 2020 due to global warming. The impact on developing countries will be much more severe than on developed countries. Output in developing countries is projected to decline by 20 percent, while output in industrial countries is projected to decline by 6 percent (Cline 2007). In a group of more than 40 developing countries, mainly in Sub-Saharan Africa, cereal yields are expected to decline with mean losses of about 15 percent by 2080 (Fischer et al. 2005). As a consequence of climate change, low-income countries with limited adaptive capacities will be faced with significant threats to food security.

### **3. Underutilized opportunity: The agricultural growth and poverty-reduction link**

The vision of the future of agriculture in the developing world should not focus on conserving small farms, but should center on a measured and appropriate transformation toward viable farm units and clusters of part-time and specialized farms. Subsistence agriculture is not a viable option for getting out of poverty (von Braun and Kennedy 1994). Increasing rural–urban migration is affecting labor availability for agricultural activities and the flows of goods and money between rural and urban areas. Projections show that urban transformation will continue to occur at an increasingly rapid pace; 61 percent of the world's population is projected to live in urban areas by 2030 (Cohen 2006). Droughts, land scarcity, and low wages in rural areas, compared to better job opportunities and lower or different risks in urban areas, are increasing labor-related migration out of rural areas (von Braun 2005). However, three-quarters of the poor remain in rural areas and rural poverty is projected to be higher than urban poverty for decades to



come (Ravallion et. al. 2007). A massive transformation is in the making—global farm employment is estimated to decrease by about 300 million people by 2020, while employment in services and industry —both in urban and rural areas— is expected to grow by 400 million people.<sup>2</sup> Further development of labor-market institutions is needed to enable the participation of rural areas in the national economy.

Improving the livelihoods of people at the bottom of the income scale and including them in the growth process has proven difficult, especially in environments with high inequality and discrimination. The number of undernourished in the developing world actually increased from 823 million in 1990 to 830 million in 2004 (FAO 2006). A look beneath the dollar-a-day poverty line reveals that about 160 million people in the world continue to live in ultra poverty, on less than 50 cents a day (Ahmed et al. 2007). In a worrying trend, the most severe deprivation has increasingly been concentrated in Sub-Saharan Africa, which has experienced a significant increase in the number of the ultra poor since 1990 and is currently home to three-quarters of the world’s ultra poor people (Ahmed et al. 2007). These poorest are particularly hard hit by the high and volatile food prices.

#### **4. The underrated agriculture and security risks**

Sustainability of agriculture is today not only a matter of appropriate management and utilization of natural resources and eco-systems, but also a matter of sustainability of states and political systems. For example, energy security objectives led to subsidized expansion of biofuel production, driving up food prices around the world. The poorest suffer silently for a while, but the middle class typically has the ability to organize, protest, and lobby early on. Although domestic causes such as neglect of agriculture and the rural economy may play an important role, the people’s disenchantment is frequently diverted by political leaderships to external causes. The trivial energy security gain brought about by biofuel production here may be largely overwhelmed by broader losses in political security emerging from frustration and aggression. Increased engagement of the United States in international agriculture capacity strengthening could correct the problem.<sup>3</sup>

Making the world more peaceful is directly linked to making the world more food secure and affluent. It has long been recognized that social conflict increases food insecurity, but it also needs to be pointed out that food insecurity can be a key source of conflict. Some of the trigger conditions of violence can be directly related to change in the prices of staple foods or cash crops. Unchanneled frustration that is insufficient organized or repressed can lead to conflict (Messer and Cohen 2008). Rising prices of tortillas in Mexico City and bread in Uzbekistan have led to riots. The new food situation poses a threat to the basic dignity of large populations of

---

<sup>2</sup> Estimates based on ILO economically active populations projections and own estimates of sector shares.

<sup>3</sup> Robert Gates, U.S. Secretary of Defense, stated at the World Food Prize Symposium in Des Moines, Iowa, in 2006: “It could be argued that our inability to continue our investment in human capital on a scale that we did in the 1960s and 1970s is a factor that has contributed at least in some measure to instability in many places today and hostility to the United States. ...The United States was the key influence in developing the Indian agricultural university system, the key contributor to the African agricultural universities, and to Asian and Latin American agricultural universities as well. But such U.S. programs are now a pale shadow of what they once were. Science has disappeared. Human capital development has disappeared. And the investments for long-term institution building have nearly disappeared.”

people. Cutting food aid at the same time when it is needed more would add to the security problem.

## **5. A global R&D and technology offensive for agriculture**

The world is facing an agricultural crisis. This crisis is more complex than the ones of the 1960s or the 1880s because it is the result of a dangerous mix of economic, environmental, and political factors that have come together in a much more crowded and much better-informed world. Relative deprivation matters more today.

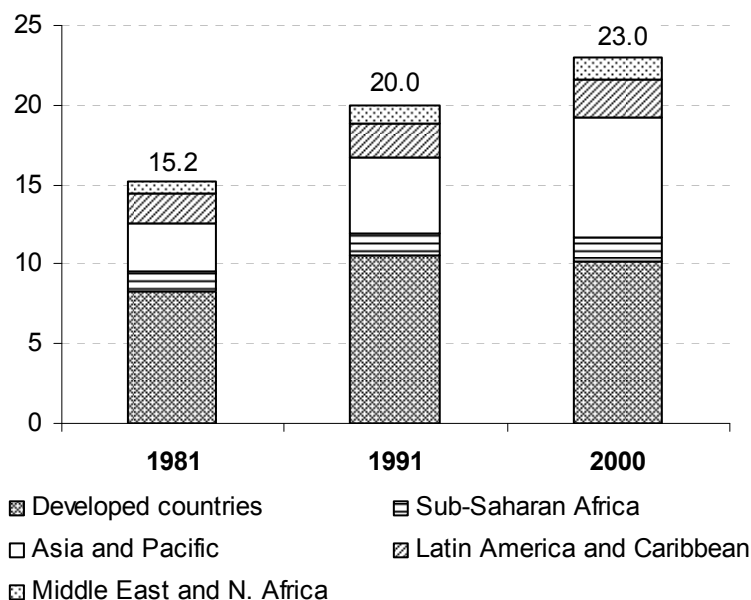
Technology has been a critical component in preventing Malthusian predictions of population growth outpacing agricultural production, instigating the Green Revolution in Asia in the 1960s and 1970s in which the centers of the Consultative Group on International Agricultural Research (CGIAR) played key roles. However, agriculture and technological innovation for agricultural productivity have not moved high enough on the agenda. According to the latest World Development Report, which focused on agriculture for development, agriculture R&D investments in developing countries have an average rate of return of 43 percent (World Bank 2007b). Yet, underinvestment in agriculture and agricultural R&D has prevailed for too long. The persistence of poverty in the rural areas of low- and middle-income countries, of high food prices undermining livelihoods, and of deficiencies in the sustainability of agriculture require large-scale global action. That response must have at its core R&D and technology, and the countries with strong science systems, especially the United States, Europe, China, India and others can lead in supporting such an initiative.

Technological breakthroughs, and their adoption on a large scale, has had high positive social pay-offs. In the area of agricultural production, technological advancements and improvements in information and communication technologies (ICTs) have increased productivity, reduced transaction costs, opened new markets, and provided additional positive network externalities (Torero and von Braun 2006). The quick spread of ICTs has been impressive, but low-income countries still lag behind. And whereas leapfrogging worked for the cell phone, that technology had unusual properties that do not apply to most other technology domains. Agricultural technology is not an easy candidate for leapfrogging. It needs persistence, patience, and commitment, as was so well demonstrated by Charles Riley. Agriculture biotechnology is no exception. It currently spreads relatively fast, but still slowly measured by leapfrogging standards— in 2007, about 11 million farmers in 12 developing countries were growing biotech crops (Clive 2007), but these farmers represent a small fraction of the ones working on the 400 million farms in developing countries. Dissemination of technology in agriculture requires much more up-front investment in effective technology utilization, including rural education, infrastructure, and extension services.

Since the mid-1990s, expenditures on R&D have increased at very low rates in developed countries. In the United States, Japan, and the European Union spending increased by less than 3 percent a year in real terms (OECD 2007). In contrast, spending in China grew by 18 percent per year since 2000 (OECD 2007). Surpassing Japan, China is currently ranked as second in the world in gross domestic expenditure on R&D. The United States, still at number one, invested more than US\$343 billion in R&D, almost two and a half times more than China.

The Agricultural Science and Technology Indicators (ASTI) initiative of the International Food Policy Research Institute (IFPRI) provides information on expenditures on agricultural science and technology in particular. Between 1981 and 2000, global public agricultural R&D increased from 15.2 to 23 billion international dollars, with slowed growth in the 1990s (Figure 4). Therefore, developing countries on the whole are currently undertaking most of the world's public agricultural R&D (66 percent), but this is largely due to China and India. The two countries are the largest investors, with spending growth in the 1990s averaging 6.4 and 5 percent, respectively, while R&D expenditures in developed countries at large stagnated and even slightly decreased (Pardey et al. 2006). Despite exceptions like China, Brazil, and India, most developing countries are still underinvesting in agricultural R&D and are dependent on developed countries for science and technology spillovers. In 2000, 80 developing nations accounted only for 6 percent of global R&D spending. In comparison, each one of more than 35 public universities in the United States spent more than this amount in 2004. In recent years, stagnation of agricultural R&D spending in the United States has continued. Agricultural research spending has decreased from 2.7 billion, or 12.4 percent of total discretionary spending in 2005, to 2.5 billion, or 10.4 percent of total discretionary spending in 2007 (OMB 2008 and OMB 2006). In contrast, spending in India from fiscal year 2004/5 to 2006/7 increased by 29 percent (adjusted for inflation, India Ministry of Finance 2008, Reserve Bank of India 2008).

**Figure 4. Public agricultural R&D, in billion of 2000 international dollars**



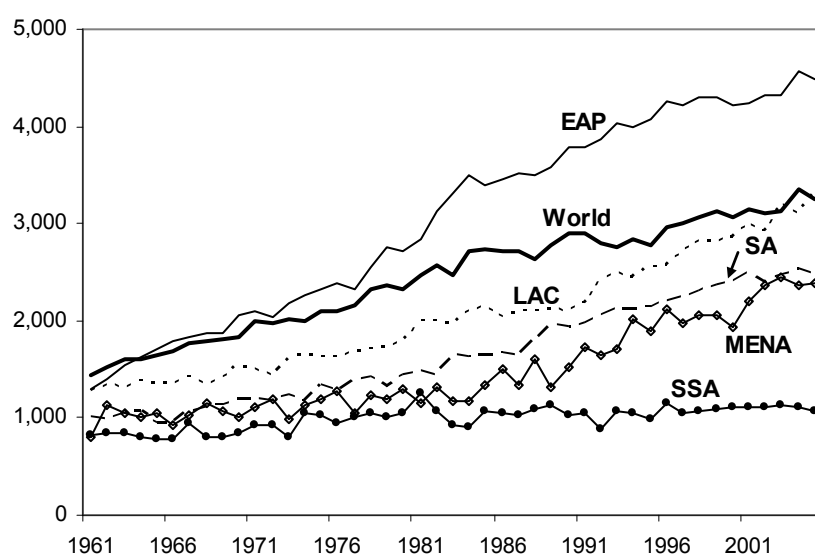
Source: Pardey et al. 2006.

As developed countries are switching from crop production to more multifunctional agriculture, they are increasingly investing in research that is not directly related to productivity enhancement and transformation of subsistence farming. Food safety concerns and rising demand for high-value commodities and processed foods redirect funds to organic farming and enhancing specific attributes of food. As a result of the reduced applicability of new technologies, the spillover pathways to developing countries for productivity enhancement are

reduced. Also, more expensive and advanced R&D needs to be undertaken for local adaptation and additional development. Some developing countries have become “technological orphans” as their traditional private- and public-sector benefactors cut their support (Pardey et al. 2006).

A critical element of sustainable agriculture is the increase in crop and livestock productivity. Yields per unit of land are only one such indication, and their trends do not look encouraging. Sub-Saharan Africa is lagging far behind the cereal yield growth and its gap with the yields in other regions has increased (Figure 5). Total factor productivity tends to be at about 1 to 1.2 percent per annum at current research expenditures; for China it is closer to 2 percent; at a global scale these productivity gains are simply too low to deal with the demand growth in sustainable ways.

**Figure 5. Growth of cereal yields by region in kg per hectare, 1961-2005**



Source: World Bank 2007a. EAP—East Asia and the Pacific, LAC—Latin America and the Caribbean, SA—South Asia, SSA—Sub-Saharan Africa, MENA—Middle East and North Africa.

The global environment for innovation is also changing. Under the agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), for example, patent rights for agricultural inventions are being introduced. Strengthening intellectual property rights would on the one hand increase the incentives for investing in R&D, but would on the other hand make technologies that had been freely available, much harder to access and use. At the same time, the need for more global research is increasing due to factors such as climate change, continuing population growth, and concerns about food quality and safety.

The CGIAR, which supports the work of 15 agricultural research centers and works with research institutions in the developing world to improve local research capacity, has a key role to play in addressing the global problem of underinvestment in agriculture research. To sustainably increase R&D, effective public-private partnerships increased efficiency of use of the resources already available, and political commitment at the national level are needed.

## 6. Serving Sustainability: Toward a Global R&D Initiative

### 1. **Global political attention at the highest levels**

Agriculture needs to move to the highest place on the political agenda. No longer can the global community afford to ignore ecological over-exploitation, massive underinvestment in agriculture and the consequences of ill-designed bioenergy programs. The world is now facing a new and historically different agricultural crisis resulting from a dangerous mix of economic, environmental, and political factors.

### 2. **Specific policy action to protect the poorest from excessively high food prices**

Agriculture today is strongly driven by the demand side; the demand for high-value foods has increased dramatically as large numbers of people in the developing world have gotten richer. While this is very good news for net sellers, most of the world's poor are net buyers of food and because food accounts for a large share of their total expenditures, the impact is dramatic. The poorest are being left behind; they are feeling the effects of higher food prices due to the policy actions and consumption power of their now more wealthy global neighbors, and are responding to the higher prices by reducing consumption and altering patterns of demand, which is leading to nutrition deficiencies.

### 3. **Major investments in services and input supply systems, as well as expanded access to financing and innovation for small farmers**

Productivity response and overall supply response are lagging because today, much of that response needs to come in the form of increased yields and productivity gains along the whole food chain, not just on the farm. These responses need prior investments in services and input supply systems. At the same time, farms have become smaller in most of the developing world over past decades, and small-farm agriculture is impaired by constrained access to financing and innovation and by a lack of organization among small farmers.

### 4. **An urgent global R&D initiative for accelerated agricultural productivity**

Central to the sustainability of world agriculture is a *global R&D initiative for accelerated agriculture productivity; such an initiative makes economic sense, is pro-poor and sustainable, and serves security*. The R&D initiative needs political leadership and coordination. Industrialized economies, including the United States, should substantially accelerate their investment in international agricultural research and development.

### 5. **Enhanced collaboration of old and new key global agricultural players**

In order to effectively implement such a global R&D initiative for accelerated agriculture productivity, a new agriculture, food, and nutrition governance architecture is needed to provide the appropriate political response to the global price and productivity crisis. A coordinated global response is needed in the form of agriculture–energy policies, climate change mitigation and adaptation policies for agriculture, food aid policies, and agriculture–health and food-safety policies. Agricultural power has become more spread around the world, with the result that there is no governance architecture that can generate appropriate political responses to the food and agriculture price and productivity

crisis at the global and national levels. Under such a new global architecture, new partnerships among old and new players such as the United States, Europe, China, India, Brazil, UN agencies, the CGIAR, and foundations, and the private sector must be facilitated.

## References

- Ahmed, A., R. Hill, L. Smith, D. Wiesmann, and T. Frankenburger. 2007. *The world's most deprived: Characteristics and causes of extreme poverty and hunger*. 2020 Discussion Paper 43. Washington, D.C.: International Food Policy Research Institute.
- Beintema, N. M., and G. Stads. 2004. *Investing in Sub-Saharan African Agricultural Research*. 2020 Africa Conference Brief 8. Washington, D.C.: International Food Policy Research Institute.
- Birthal P.S., P.K. Joshi, D.Roy, and A. Throat. 2007. *Diversification in Indian Agriculture towards High-Value Crops: The Role of Smallholders*. Discussion Paper 00727. Washington, D.C: International Food Policy Research Institute.
- Cline, W. R. 2007. *Global warming and agriculture: Impact estimates by country*. Washington, D.C.: Center for Global Development and Peterson Institute for International Economics.
- Clive J. 2007. Global Status of Commercialized Biotech/GM Crops: 2007. ISAAA Brief 37. Ithaca, NY: International Service for the Acquisition of Agri-Biotech Applications.
- Cohen, B. 2006. Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in Society* 28: 63–80.
- FAO (Food and Agriculture Organization of the United Nations). 2003. Food Outlook No.5 – November 2003. Rome.
- \_\_\_\_\_. 2006. *The State of Food Insecurity in the World 2006*. Rome.
- \_\_\_\_\_. 2007. Food Outlook– November 2007. Rome.
- \_\_\_\_\_. 2008a. FAOSTAT database. Available at: [www.faostat.fao.org/default.aspx](http://www.faostat.fao.org/default.aspx).
- \_\_\_\_\_. 2008b. International Commodity Prices Database. Available at: [www.fao.org/es/esc/prices/PricesServlet.jsp?lang=en](http://www.fao.org/es/esc/prices/PricesServlet.jsp?lang=en).
- \_\_\_\_\_. 2008c. AQUASTAT database. Available at: <http://www.fao.org/nr/water/aquastat/main/index.stm>.
- Fargione, J., J. Hill, D. Tilman, S. Polasky, P. Hawthorne. 2008. Land Clearing and the Biofuel Carbon Debt. Science Express Report.
- Fischer, G., M. Shah, F. Tubiello, and H. van Velhuizen. 2005. Socio-economic and climate change impacts on agriculture: An integrated assessment, 1990–2080. *Philosophical Transactions of Royal Society B* 360: 2067–83.

- IMF (International Monetary Fund). 2008. International Financial Statistics database. Washington, D.C. Available at: [www.imfstatistics.org/imf/](http://www.imfstatistics.org/imf/).
- IMF (International Monetary Fund). 2007. World Economic Outlook Database. Washington, D.C. Available at: [www.imf.org/external/pubs/ft/weo/2007/02/weodata/index.aspx](http://www.imf.org/external/pubs/ft/weo/2007/02/weodata/index.aspx)
- India Ministry of Finance. 2008. *Union Budget 2008-2009*. Available at: <http://indiabudget.nic.in/>
- Messer E. and Cohen M. 2008. Conflict, Food Insecurity, and Globalization. Chapter in J. von von Braun J. and E. Díaz-Bonilla. 2008. *Globalization of Food and Agriculture and the Poor*. Forthcoming.
- OECD (Organisation for Economic Co-operation and Development). 2007. *Main Science and Technology Indicators (MSTI): 2007/2 edition*. Paris.
- OMB (Office of Management and Budget). 2008. Budget of the United States Government: Fiscal Year 2009. Available at: <http://www.whitehouse.gov/omb/budget/fy2009/>.
- \_\_\_\_\_. 2006. Budget of the United States Government: Fiscal Year 2006. Available at: <http://www.whitehouse.gov/omb/budget/fy2006/>.
- Pardey, P. G., J. M. Alston, and R.R. Piggott, eds. 2006. *Agricultural R&D in the Developing World: Too Little, Too Late*. Washington, D.C.: International Food Policy Research Institute.
- Searchinger, T., R. Heimlich, R.A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes, and T.-H. Yu. 2008. *Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change*. Science Express Report.
- Ravallion, M., S. Chen, and P. Sangraula. 2007. *New Evidence on the Urbanization of Global Poverty*. Washington D.C.: World Bank.
- Reserve Bank of India. 2008. RBI Bulletin. Available at: [http://www.rbi.org.in/scripts/BS\\_ViewBulletin.aspx](http://www.rbi.org.in/scripts/BS_ViewBulletin.aspx)
- Scherr S. 1999. Soil degradation: a threat to developing-country food security by 2020?. 2020 Vision Discussion Paper 27. Washington, D.C: International Food Policy Research Institute.
- Torero, M. and J. von Braun, eds. 2006. *Information and Communication Technologies for Development and Poverty Reduction: The Potential of Telecommunications*. Baltimore: The Johns Hopkins University Press for the International Food Policy Research Institute.
- UNDP (United Nations Development Programme). 2006. *Human Development Report 2006: Beyond scarcity: Power, poverty and the global water crisis*. New York.
- USDA (United States Department of Agriculture). 2008. World Agricultural Supply and Demand Estimates No. 455. Available at: <http://www.usda.gov/oce/commodity/wasde/index.htm>.



von Braun, J. 2005. Agricultural economics and distributional effects. *Agricultural Economics* 32 (s1), 1–20. Malden, Mass.: Blackwell for IAAE

von Braun, J. 2007. *The World Food Situation: New Driving Forces and Required Actions*. Washington, D.C.: International Food Policy Research Institute.

von Braun, J. and E. Kennedy, eds. 1994. *Agricultural Commercialization, Economic Development, and Nutrition*. Baltimore: The Johns Hopkins University Press for the International Food Policy Research Institute.

World Bank. 2007a. *World Development Indicators 2007*. Washington, D.C.

\_\_\_\_\_. 2007b. *World Development Report 2008: Agriculture for Development*. Washington DC.