Public spending and private sector investment in agricultural research in Latin America and the Caribbean (LCR) is low, and often lacks long-term strategic planning as well as budgetary transparency. However, investing in agriculture can benefit the poor 2–4 times more than investing in non-agriculture, as both the World Development Report 2008 as well as the region’s substantive 2005 publication “Beyond the City” emphasize. Given this high return on investments in agriculture for pro-poor growth, the three key messages that are conveyed here are: (a) current investments in agricultural research in LCR are low and need to be increased in order to effectively address the poor in a context of climate change; (b) the region needs to invest not only in agricultural research but also in the innovation system in general in order to effectively match supply and demand for innovations. This requires strengthening of agricultural institutions, organization of producers, consumers and other groups; and (c) agricultural innovation is a joint responsibility of the public and private sectors. Developing general and country-specific models that allow sharing of responsibilities is a major challenge.

The World Development Report 2008 emphasizes the need for sustainable technologies in LCR countries to increase productivity, stability, and resilience of their production systems and confront climate change. A broad basket of technologies is available in many countries in the region, though often they only partially satisfy market demand or user needs. Public expenditure and private investment in research and development (R&D) must increase and partnerships with the private sector, farmers, and civil society must be strengthened in order to stimulate user demand for R&D, increase market responsiveness and competitiveness, and ensure that the rural poor benefit from technological interventions. Greater and diversified investment in agricultural R&D is essential for an effective transformation of traditional, low productivity agriculture into a modern commercial sector (World Bank, 2006a).

Box 1. Faces of Agricultural R&D in LCR

Despite the small share of agriculture in national growth in LCR countries (7% from 1993 to 2005), several agricultural subsectors with strong comparative advantage have sustained spectacular growth. Notable innovative technology driven examples are:
- Fruits and salmon in Chile
- Biofuels in Brazil
- Soybeans in the Southern Cone countries and Brazil
- Vegetables in Peru and Guatemala
- Organic horticultural products in Peru, Colombia
- Cut flowers in Ecuador and Colombia

Agricultural R&D demand in LCR is determined by country typology (urbanized, transforming, and agriculture-based):
- Generally, the region is largely urbanized and has a dynamic peri-urban sector
- Central America and Paraguay have characteristics of agriculture-based countries
- Mexico has states that fall under all three typologies
- Brazil has states that are both urbanized and highly dependent on agriculture for growth

Adoption and use of high end technologies (e.g. GMO varieties) is variable but increasing:
- Argentina – GMOs (Roundup ready soybean, Bt corn, Bt cotton) widely adopted
- Colombia – increasing use of a variety of GMO crops (corn, soybean, cotton) and a functional regulatory process
- Peru – No field-grown GMOs (officially)

Note: Genetically modified crops are the result of transferring one or more genes, usually from a wild species or a bacterium, to a crop plant; or are the result of a precise modification of a crop’s own gene using genetic engineering techniques.
Investments in agricultural research must be increased to effectively address the poor in a context of climate change

Public expenditures on agricultural R&D have been closely linked to agricultural productivity improvements. Published estimates of rates of return on research and extension investments in LCR average 46% for extension and 47% for agricultural research. Despite this high return on investment, agricultural science, R&D and related extension systems remain seriously underfunded in LCR countries and the time has come to improve not just the quantity but also the quality of spending.

Since the 1960s, scientific plant breeding to develop improved high yielding and pest resistant varieties, also known as the Green Revolution, has been one of the major success stories of the impact of R&D. However, despite the successes of the Green Revolution and the fact that three international agricultural research centers have their headquarters in LCR (CIMMYT, CIAT and CIP), not all countries and farmers in the region have benefited equally. In general, large scale farmers have had easier access to new technologies and improved varieties due to higher income and better access to information than smaller farmers. Also, prioritization of R&D on certain traits has caused some farmers to benefit more than others.

For example, progress in developing varieties that perform well under drought, heat, flood, and salinity has generally been slower than that for pest and disease resistance. This in turn adds greater concern in terms of the vulnerability of farmers to global climate change events. Notable environmentally friendly technologies that have been successfully adopted in recent years are: (i) integrated pest management practices, including the use of Bt-crop varieties, which reduce the use of pesticides; (ii) zero tillage to lower production costs while reducing greenhouse gas emissions and soil conservation; (iii) use of nitrogen-fixing legumes or trees to improve soil fertility; and (iv) technology stacking: improved varieties as described in point with zero tillage or nitrogen fixing trees in agroforestry with Bt-corn.

After a period of strong public support to agricultural R&D in the 1960s and 1970s, public funding for research and extension in LCR began to decrease in the 1980s and 1990s (Roseboom et al, 2006). In general, agricultural research expenditures have gone up since then but in many instances a declining real-term trend in R&D investments is due to a decision making emphasis on short term payoffs rather than longer term benefits, and for small country economies to reap the advantages from free riding on R&D investments in larger, more affluent countries (e.g., GM technology spillover benefits to Bolivia, Uruguay, and Paraguay from Argentina).

Greater R&D spending is required for maintenance research to deliver continued yield stability (with periodic changes in localized weather patterns) and to insure against outbreaks of new pathogen races or strains. The recent reemergence of wheat stem rust (Puccinia gramis tritici, strain UG99) is a case in point.

In short, the need to increase the funding for agricultural R&D in the LCR region cannot be overstated. Most urgently the stagnation of funding for agricultural R&D in most countries has to be reversed. This can only be done with full engagement of national leadership at the highest level. It also requires a substantially increased and sustained support from regional and international organizations mandated to (e.g., CIFOR, ICRAF) or located in the region (e.g., CIP, CIAT, CIMMYT). For broad-based productivity growth, technological innovations that are often location-specific must be combined with institutional innovations to ensure that input and output markets, financial services, and farmer organizations are put in place. The post structural-adjustment agricultural bureaucracies, who are too weak to build partnerships with the private sector and civil society, are often in need of far-reaching reforms to redefine their roles and develop new responsibility linked capacities.

![Fig. 1. LCR’s public agricultural R&D spending is slightly up](image)

Table 1. Economic and Environmental Benefits from Bt cotton

<table>
<thead>
<tr>
<th></th>
<th>Argentina</th>
<th>Mexico</th>
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<tbody>
<tr>
<td>Added yield (%)</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Added profit (%)</td>
<td>31</td>
<td>12</td>
</tr>
<tr>
<td>Reduced chemical sprays (number)</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Reduced pest management costs (%)</td>
<td>47</td>
<td>77</td>
</tr>
</tbody>
</table>

Source: ASTI, preliminary data, 1981-2006

Greater R&D spending is required for maintenance research to deliver continued yield stability (with periodic changes in localized weather patterns) and to insure against outbreaks of new pathogen races or strains. The recent reemergence of wheat stem rust (Puccinia gramis tritici, strain UG99) is a case in point.
Box 2. R&D in an Innovation Systems Framework

Recent attention has focused on the demand for agricultural research and technology for development of innovation systems. This has occurred due to the fact that strengthened research systems may increase the supply of new knowledge and technology, but they may not necessarily improve the capacity for innovation within the agricultural sector.

The innovation system is broadly defined as a network of organizations, enterprises, and individuals who are focused on bringing new products, new processes, and new forms of organization into social and economic use, together with the institutions and policies that affect their behavior and performance. It is composed of the public sector, private and third sector comprised of producer organizations, nonprofit service providers, and other civil society organizations.

The innovation systems perspectives for reforms and modernization of the agricultural sector in LCR is important as it permits the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways – for example, in linking the upstream knowledge creators to the mid-downstream demanders/users with the necessary adjustments in complex processes.

Innovation systems concept is being applied in LCR countries, e.g., Colombia, Nicaragua, and Peru, and it is offering exciting opportunities for strengthening agricultural sectors to make better use of new knowledge and to design alternative interventions that are larger than research system investments. The use of the innovation concept permits better inclusion of smallholders in new food markets and helps them to remain competitive.

Box 3. Opportunities in LCR: Institutional and technical innovations

Institutional innovations—a fertile field (with gaps)
- Land administration and markets, with use of IT
- Financial services: microfinance, use of IT
- Risk management: weather insurance
- More effective producer organizations & new approaches to extension using IT

Technological innovations—progress (with under-investment)
- Continued spread of improved varieties to rainfed areas and better pest resistance
- GMOs—potential but only Bt cotton is widely adopted by smallholders
- Conservation agriculture—especially zero tillage
- Improved livestock and fish breeds

Partnerships between R&D and farmers’ organizations aim to enhance the demand for innovation by bringing farmers’ voices into R&D decision-making. A good example is the new and decentralized approaches to plant breeding that involve farmers in the early stages of breeding and varietal selection that can both speed varietal development and dissemination to 5-7 years, which is half of the 10-12 years in a conventional plant breeding program, e.g. Mexico and Peru. Another example is farmers leading research (see Mexico case in Box 4).

Box 4. Farmers leading research in Mexico through PRODUCE Foundations

Mostly commercial farmer-led NGOs, also known as PRODUCE foundations, have proved to be effective, incremental finance leveraging entities in cash-strapped national agricultural research system in Mexico. Created in 1996 these foundations have helped to set up priorities and approve and cofinance research projects in each state. These state-based foundations successfully have lobbied for agricultural R&D. On average about 75% of the funding comes from the federal government and 25% from the state governments. Advances in biological sciences and information sciences must be harnessed to enable smallholders to access markets and thereby increase the resilience of production systems that are important to the rural poor. They are effective in managing a trust fund which has also a mechanism of matching funds between the state funds and producers. Operational strength of these foundations to lead research is dependent on organization history, e.g. patronato system in Sonora, aptitude and effectiveness of foundation representative, transparency of fund management and resource allocation.

Sources: PRODUCE Foundation reports, Ekboir et al.
Extension. Agricultural extension helps farmers learn how to increase their productivity, raise their incomes, and collaborate with one another, with agribusiness and with agricultural research. New world extension programs are shifting from a delivery model that prescribes technological practices to focusing on building capacity among rural people to empower them to identify and take advantage of available technological and economic opportunities (empowerment model). New mechanisms are being tested and used for strengthening the extension services. New skill sets are required from extension agents, such ability to mobilize farmers, tapping market intelligence, and managing farm and non-farm businesses. Old extension systems of training and visit (T&V) and decentralization to local governments have been successful and sustainable in only a few instances. This has led to adding additional elements to the approach such as involving farmers in decentralized governance (see Box 4), farmer-to-farmer learning and knowledge sharing, use of farmer promoters on specific crops and technologies, and marketing partnerships with private sector.

Extension specialists increasingly recognize the importance of ‘best fit’ approach for a given social and market conditions from a ‘best practice’ or ‘one-size-fits-all’ model. This includes technology plus technical know-how delivery using mixed public-private systems involving farmer organizations, NGOs, and public agencies contracting out extension services. As in research, building demand is a part of successful extension. Producer organizations are increasingly playing a key role in extension delivery that goes with other elements of improved technologies such as input supplies, technical know-how, marketing and irrigation. Recent approach to demand led extension services attempts to reduce productivity and profitability gaps (e.g. COFUPRO, Mexico).

Agricultural innovation is a joint responsibility of the public and private sectors. Developing general and country-specific models that allow such sharing of responsibilities is a major challenge

Many public research organizations face serious institutional constraints that inhibit their effectiveness as well as their ability to attract funds. Recent study done in LCR indicates that the institutional reforms of the last two decades were not sufficient and that they require continued and serious reform. Research is costly therefore a challenge is to strengthen institutions that finance and organize research using novel ways: regional centers of excellence, multinational institutions, increased participation of the private sector.

The operationalizing efforts of WDR08 on “more and better” spending on agriculture for development include the redefinition of the role of public sector in agriculture and rural development, and innovations in public-private partnerships. Such efforts are expected to lead to investments to build institutional capacity of clients such as Ministries of agriculture and rural development to help create conducive environment for market-led growth and poverty alleviation. They will also lead to better linking strategic agricultural concerns with the setting of strategic national agendas, e.g., CASS/CPSs (Country Assistance Strategy/ Country Partnership Strategy), PRSPs (Poverty Reduction Strategy Papers), and CEMs (Country Economic Memorandums).

In short, technological challenges facing agriculture in this century in LCR have turned the agricultural sector into a dynamic sector, with rapid technological innovation accelerating growth and reducing poverty. The biotechnology led technologies such as GMO soybean in Argentina, Uruguay and Southern Brazil or the quality of wine industry in Chile are good examples. The technological challenge in LCR is to satisfy increased demand for food and agricultural products through gains in productivity.

References
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About the Authors
Indira Janaki Ekanayake is a Senior Agriculturist and Willem Janssen a Lead Agriculturist with the World Bank’s Latin America and the Caribbean Region Agricultural and Rural Development Unit

The 2008 World Development Report (WDR) “Agriculture for Development” characterizes agriculture as vital development tool for achieving the Millennium Development Goal that calls for halving by 2015 the share of people suffering from extreme poverty and hunger. The report provides guidance to governments and the international community on designing and implementing agriculture-for-development agendas that can make a difference in the lives of hundreds of millions of rural poor. This brief is part of a series prepared by LCSAR that summarizes and interprets the principal messages of the WDR 2008 and discusses region-specific implications for Latin America and the Caribbean (LCR). The series comprises the following topics: (i) Agricultural Innovations in Science and Technology, (ii) Value Chain Development and Integration of Small Farmers, (iii) Agricultural Trade Policy, (iv) Land Administration and Access, and (v) Territorial Development.