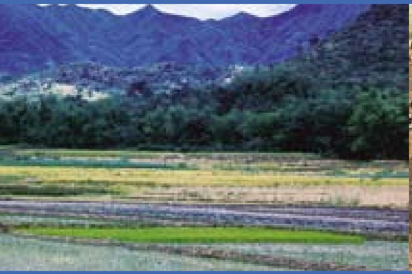
Chapter 3: Perspectives on the Future of International Agricultural Research




Introduction

What are the prospects for international agricultural research at the national and international levels? What are the views on international agricultural research of the future?

This final part of the publication provides several perspectives solicited from economists, agronomists, ecologists, sociologists and a philosopher. The nuances and contrasts presented in these papers reflect various disciplinary and interdisciplinary approaches, and of methods based on deductive and inductive reasoning. Together, they seek to explain the profound and perhaps unique complexity of the relationships that link agricultural modes of production and present-day and future societies, their social development and their environment. Each paper, presenting its own specific vocabulary and special reasoning, is consistent with the others in underscoring the fact that there is no clear science of the future, and that projections inform us that the future depends first on the will of people and communities, who are enlightened, thanks to the ongoing search for solutions that meet actual needs.

This ongoing quest for adaptations to needs is equally important for agricultural research bodies whose missions have evolved in recent years. While the objectives of world food security — the primary objective of the Green Revolution of the 1960s and 1970s — have not changed, it is now equally important to combat poverty in the context of the so-called "doubly green revolution," which takes into account environmental issues, and within the framework of sustainable development.

Scientific capacity, economic growth and agriculture: Implications for the CGIAR

Francois Bourguignon[1]

The Consultative Group on International Agricultural Research (CGIAR) can play a huge role in low-income countries by building the scientific bases for stronger and more competitive agricultural sectors. However, this effort requires some difficult choices in terms of research priorities — choices that are not always made explicit. In particular, an important choice is between improving the competitiveness of traditional food crops produced in less favorable zones in developing countries or, alternatively, increasing the production of high-value commercial crops cultivated in more favorable areas.

Theories of economic growth emphasize the role of research in science and technology (S&T) as the main engine of development. This is certainly the case for developed countries, which find themselves at the frontier of production possibilities. For them, increases in total factor productivity — that is of labor and private and public capital — can come only from technological innovations arising from investments in scientific and technological knowledge. The situation is slightly different for middle- and low-income countries, which generally find themselves within the production frontier, rather than on it. This is because they have not yet been able to adopt and adapt production techniques available in advanced countries.

For middle-income countries, transferring technology and adapting innovative techniques to their own environment is a strong way to progressively improve productivity and foster growth. Low-income countries, by contrast, are unlikely to have the necessary resources to invest sufficiently in S&T, whether to adopt new techniques or to adapt them to their own environment. Moreover, it is not clear whether they would really gain from such strategies given the gulf between them and rich countries, where new techniques have been designed, in terms of the factors of production available in agriculture, and given the importance of traditional agriculture.

Investing in S&T is costly and complex. It requires large amounts of capital, educated labor and sophisticated equipment. The process of investment also involves very diverse activities like identifying potentially beneficial technologies in a timely fashion, building capability in these technologies in, for example, government-owned research and development institutes, or, where appropriate, relegating this capacity to the private sector as rapidly as possible.

Member countries of the Organisation for Economic Co-operation and Development (OECD) have invested significant portions of their gross domestic product (GDP) in S&T. In 2003, the United States invested more than US$284 billion in R&D — almost 3% of its GDP — and employed more than 1.3 million scientists. European Union countries invested $211 billion on research, which was carried out by about 1.2 million scientists, and Japan invested $114 billion employing more than 675,000 scientists. Practically all OECD countries are now in the S&T race, and a remarkable convergence is appearing in the ratio of their R&D expenditures to GDP. Overall, the investments of OECD countries in S&T now account for about 93% of such expenditures globally.

The structure of the S&T expenditures in developed countries has evolved considerably during the last 5 decades. The share occupied by the private sector has expanded and is currently more than 60%. Leading sectors these days are communications, information sciences and medicine. Together, they now absorb resources on a par with more traditional sectors like industry, transportation and, to a much lesser degree, agriculture (3 per cent of total spending). These investments in knowledge are driven on the one hand by the development of fundamental knowledge and signals perceived in the market, and, on the other hand, by the need of firms to maintain a competitive edge.

The growth and evolution of investment in S&T in emerging countries has followed a different path. Several developing countries, notably China, India, Korea and Malaysia, have made progress through investments that focused first on the entry stage of technical imitation and adaptation before moving on to innovation. By adopting and adapting developed countries' technologies, reallocating productive resources towards dynamic sectors, and attracting foreign direct investment in key activities, several middle-income countries have achieved relatively fast rates of economic growth. In selected fields, they have even been able to bridge the technology gap to join the more advanced countries. Yet, S&T

activity in middle-income countries relies more on the public sector than on private investment. The public sector provides, on average, more than 74% of middle-income countries' expenditure on S&T, nearly double the average of 40% in developed countries. Also notable is that public spending on agricultural research in emerging countries is relatively higher than in OECD countries.

The case of investment in S&T in low-income countries is more complex. Imitation and adaptation are less effective than in middle-income countries for several reasons:

- A very different combination of productive factors — including low availability of capital and skilled manpower, as well as small markets — make it difficult for low-income countries to use techniques developed in or for more advanced countries.
- Low-income countries have limited resources to use for domestic innovation.
- Technological progress in the rest of the world has little connection with the goods that are traditionally consumed or exported by low-income countries. Likewise, these goods receive little interest or support from research conducted in developed countries.
- As a result, most productivity gains in low-income countries come from adopting a more efficient allocation of resources, achieving progress in governance and integration in world trade, and exporting a limited range of commodities.

Because it can help overcome some of the constraints mentioned above, the CGIAR System plays a considerable role in advances in S&T that match the needs of low-income countries. By providing scientific expertise, achieving economies of scale by effectively federating the interests of several countries, and innovating techniques for producing crops with a focus on locally important products, the CGIAR System has greatly contributed to achieving sustainable food security and reducing poverty.

Very much remains to be done, however. Although successful in attracting donors, the CGIAR System still works with only limited resources, necessitating some tough strategic choices. An important choice it must make is between improving the competitiveness of traditional food crops produced in less favorable zones in developing countries or, alternatively, increasing the production of high-value commercial crops cultivated in more favorable areas. The first option directly reduces poverty by allowing farmers to get more from their land both for their own consumption and for sale on local markets. The second option reduces poverty indirectly through spillover effects from increasing the economic potential of the country in larger domestic and foreign markets.

The development logic behind the two options is quite different. Low-income countries will find it increasingly difficult to compete with developed and emerging economies that produce cereals or similar food crops for international markets. Research conducted by the CGIAR on maize, rice and wheat is paralleled by private and public research in OECD countries. The two lines of research must necessarily be different because of the huge differences in the natural and economic environment of the two sets of countries, as well as in the availability of infrastructure — the presence or absence of irrigation in particular. The question thus is whether the CGIAR, with more severely limited resources, can give low-income countries a comparative advantage in those crops. If this is not the case, investing in productivity enhancements in these crops may reduce absolute poverty in low-income countries by improving the food intake of rural population in less favorable agricultural areas. This would undoubtedly be quite an achievement. But such a strategy will not allow those farmers to increase their welfare further by successfully integrating domestic and global markets. Conversely, researching how to increase the competitiveness of high-value commercial crops for which low-income countries have a comparative advantage will improve their inclusion in global trade but might delay the relief of poverty in less favorable areas.

This question of research priorities is central to improving agriculture in low-income countries, but it is under-analyzed. Related questions address the need for infrastructure in the rural economy. If CGIAR research on food crops in developing countries shifts to high-value crops, valorizing that research may not be possible without some specific infrastructure investments, for instance into rural roads that allow farmers to transport their output to market. Establishing research priorities thus depends on factors that go beyond simply deciding on which line of products research should focus. It may also depend on the overall development strategy of the country, and on the availability of resources to finance accompanying policies.

At a time of increasing globalization and expanding international trade in agricultural commodities, the CGIAR needs to reflect on its research agenda to assist low-income countries. There is a need for systematically exploring new opportunities jointly created by scientific advances and new markets, and the CGIAR is the rational network to lead such efforts.

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Agriculture and sustainable development

Jean Boiffin,[1] Bernard Hubert[2] and Nicolas Durand[3]

France launched a research program in 2005 that assembled multidisciplinary research teams, currently involving 10 French national organizations, to address issues pertaining to agriculture and sustainable development. This paper describes five complementary themes on which future research should focus. The next step is to develop multilateral collaborations with similar programs in other European countries and international agricultural research institutes around the world.

Raising questions about the role of agriculture, in the broadest sense, in sustainable development requires that one first see agriculture as part of a social and political dynamic. Since the Rio Summit in 1992, this has been an increasingly recognized frame of reference. In addition to this need, the issue arises from the changing relationships between agriculture and society that we have seen and still see in Western Europe, but which is also starting to appear in many other parts of the world, including developing countries. France launched a research program on Agriculture and Sustainable Development in 2005 to assemble a relevant scientific community by committing multidisciplinary research teams to these issues. The intention is to follow up on this first stage with an enlarged proposal at the international level to take in account how agriculture is concerned with sustainable development on a global scale. This paper presents the general framework of this research program.

Set aside any autonomist vision of agriculture

Generally speaking, the status of agriculture is increasingly determined by the type and importance of its interactions with other users of rural areas and with the numerous activities arising from other economic and social sectors. The importance of these interactions is clearly not recent; the involvement of agriculture in the movement of labor among different sectors is a longstanding phenomenon. However, more recently there has been an undeniable renewal, enrichment and increase in the complexity of these interactions. Current changes with respect to agricultural policies and allocations of state support, the diversification of expectations with respect to agriculture, and the notion of multi-functionality are corollaries to this evolution, which finally lays to rest any autonomist vision of the agriculture and agri-food sectors.

For agriculture and its practitioners, this major change raises some difficult questions, particularly since it follows a period marked by relative stability in general goals and unquestionable successes with respect to the performance criteria associated with them. As for agricultural research, it also raises many questions and problems that go beyond the need to take into account its environmental and health objectives. It is now necessary to pay greater attention not only to sustainable agriculture itself but also to agriculture's role in, and importance to, sustainable development.

The term "agriculture" should in this case be understood in its broadest sense, i.e., covering not only strictly farm production but all production activities that exploit renewable natural resources in rural, peri-urban or even urban areas (silviculture, aquaculture, etc.). In this respect, processing foods or non-food products and distributing agricultural products, including services that are more or less directly linked to them, form an integral part of this field of scientific investigation. Indeed, these activities themselves have a role that is at least as important as production when it comes to development. Furthermore, it would be illusory (and contrary to the principles referred to above) to study the role and importance of production activities in development processes without taking into account each industry as a whole.

Major scientific challenges

These questions and doubts make it necessary to pay greater attention to the reciprocal relationships between agricultural activities and development processes. Overuse of the term "sustainable development" may, as was the case with "multi-functionality," lead to its losing any meaning; signs of this are already perceptible today. It is therefore essential to return to the important challenges raised by this concept.

Development follows a variety of trajectories that can be characterized and evaluated using economic, social and environmental criteria related to the notion of sustainability. Beyond economic viability and social equity, sustainable development requires, in particular, that account be taken, with a view to preserving resources, of the relationships that exist

between, on the one hand, biotechnical and economic processes and, on the other hand, changes to the environment. This must be done at different scales, including in some cases up to the level of the planet as a whole.

Without trying to be exhaustive, we would like to highlight here five of these challenges:

1. The notion of sustainable development implies that the processes of development should be understood from three standpoints: ecological sustainability, economic viability and social equity.

   This combined view cannot be seen merely as a multi-criteria approach. It must be based on an understanding of the interdependence of ecological, technical, economic and social processes. Thus, with respect to the principle of social equity, it is necessary to study how this objective is modified by the emergence of environmental questions and the new criterion of scarcity they raise. Similarly, environmental objectives must not be considered solely in terms of criteria for impact or restrictive standards; researchers need to study how ecological dynamics can be taken into account in social and economic development, so that they may indeed become driving forces, as is now being seen in the field of energy.

2. The notion of sustainable development requires that both the short and long term be taken into account.

   The notion of sustainable development indeed implies that the short-term effect of a simple action should be seen in the long-term context of inter-generational processes and the evolution of natural resources. As for the previous point, this requires that the processes and their impact be understood conjointly and at different timescales, and that their study should not be compartmentalized (as is often the case at present) as a function of their characteristic timelines. The modeling of biogeochemical cycles (which must include both the emission of greenhouse gases and the long-term accumulation of organic matter in the soil) provides an example of this type of requirement. Similarly, the notion of sustainable development implies that both local and distant interactions (through market mechanisms, public policies, biophysical transfers, etc.) are taken into account simultaneously.

3. Sustainable development is an intentional dynamic that implies the emergence and implementation of collective projects.

   This dynamic (which is not always explicit or official) constitutes an independent study objective that should not involve only social scientists. It calls for novel and specific types of innovations and research practices (e.g., action research) that may also exhibit a degree of specificity. In this respect, the actors in development (producers, consumers, industrialists, public decision-makers, etc.) merit particular attention, notably with respect to strategies, different types of collective organization and action, alliances, and the approaches they adopt towards these development dynamics. This subject offers an opportunity for improving links connecting research and development projects, taking into account the diversity of the actors involved and ensuring that this partnership is the subject of sufficient critical review and experienced assessment.

4. The study of development processes and their sustainability implies taking into account several types of spatial and organizational entities, some of which are specific to this field of research.

   In this respect, entities such as production systems, farm enterprises, regions and industries must be taken into account, often simultaneously, to verify the compatibility of the dynamics studied or recommended. In this context, farm enterprises constitute an unavoidable organizational entity, as an interface of public policies and market mechanisms and economic, environmental, social and territorial challenges. However, the instruments and models built up during recent decades to study and monitor the development of farm enterprises need to be reviewed to take into account current changes, whether regarding their context or the objectives pursued. Similarly, it is undoubtedly necessary to invest or reinvest in entities such as productive areas, where some decisive links between economic efficacy (competitiveness) and environmental impact are determined.

5. Sustainable development requires a new approach by agricultural research with respect to innovation, which needs to be both more committed and more global.

In its present form, the system of research and development in agriculture has difficulty fulfilling the need to reactivate and reorient the innovation process as required by ongoing changes in the agricultural sector. The empirical approaches that were successfully adopted during the phase of boosting productivity are ineffective in the face of new environmental and territorial challenges. Sectoral and standardized technical advances must be replaced by innovation that is much more systemic and diversified, based on knowledge acquired from more varied fields and inferences that are not easily discovered through traditional experimentation.

Research is thus of crucial importance and must act as a motor for renewing the approaches and tools made available to the actors concerned. At the same time, and more so than in the past, research must be aware of its own ambivalence and, more generally, the ambivalence with which society views technological innovation. This awareness requires a critical approach to technical creativity targeting sectoral objectives, assessed using unambiguous performance criteria and dependent upon sometimes narrow socio-professional partnerships.

Better anticipation of the risks brought by new technologies should lead to the same degree of effort being devoted to studying their effects as to their design, and the need to take into account not only the technical and economic dimensions but also the social and ethical aspects of these effects. To achieve this, it is necessary to reintroduce the views and actors missing from the social and technical networks that govern technological design and selection. It is also necessary to develop the scientific skills (which are often not the same as those usually deployed to design new technologies) and methodologies that will allow account to be taken of the most relevant timeframes.

Put greater emphasis on five complementary themes

The issue of agriculture and sustainable development can be described on the basis of five major themes that do not correspond to independent areas but rather to different points of view concerning the links between agriculture and sustainable development.

a. The dynamics of development and agriculture.

   The processes and paths through which the types and localizations of activities and spatial use evolve are marked by movement towards globalization (the globalization of markets, standardization of food products, internationalization of agricultural policies, etc.) and, at the same time, a strengthening of local dynamics and interactions. All dimensions of development contribute to this equilibrium, whether with respect to the competitiveness of companies, the quality of living conditions, the organization of production systems, commercialization or how government powers are exercised.

   An understanding of these processes and paths constitutes a major scientific challenge, notably in terms of the resulting structural, organizational and functional changes that will affect farming activities. In contrast, it is necessary to pay closer attention to the roles played by agriculture with respect to other activities, and notably those linked to local interactions. More globally, researchers shall thus contribute to identifying and understanding the importance of agriculture to the differentiation and development of regions.

b. Use and preservation of renewable natural resources.

   Work must focus on the practices that link societies to the ecosystems from which they derive their resources: land-use patterns and the management of crops and animals, forests, water resources, waste, etc. Upstream of these practices, particular attention must be paid to the systems and methods according to which the use of resources is regulated, and situations requiring collective decision-making. In this respect, it is essential to place these practices in the context of the production systems where they are implemented, seeking to render intelligible their design and technical deployment by the different actors concerned. Similarly, the spatial organization of different activities and uses related to exploiting natural resources represents a major challenge.

   Finally, the notion of sustainability implies that more attention must be paid to the evolution of these practices and forms of organization, the factors governing these changes, and their effects on the level and quality of resources. In this case, a link must be established between the short-term effects of human activities and the long-term context of deploying major biophysical processes (biodiversity, damage to the soil, accumulation of pollutants in deep water bodies, etc.). These approaches must ultimately result in identifying the critical points and pressures (notably with respect to government actions) affecting the sustainable management of resources.

c Evolution and adaptation of systems for production and agricultural and agro-industrial change.

This area of study covers a broad range of productive entities, from crop-management sequences to transformation processes, from productive regions to industry, and including cropping and animal production systems. In this respect, it is necessary first of all to analyze how these entities are likely to react to contextual changes. For this purpose, the different types of constraints, perturbations and influences that external factors exert on production systems need to be explained. It is also necessary to demonstrate the factors and internal mechanisms that determine their degree of flexibility, notably in the face of exceptional circumstances.

To evaluate this flexibility, it is necessary to characterize and understand the structure and functioning of the different aspects of production and transformation systems: material, organizational, economic, social, etc. In this respect, it seems essential to reactivate research on agricultural work, which is of unquestionable importance to the future of vast areas of production.

Finally, it seems necessary to highlight and encourage innovations that may render possible and/or facilitate the adaptation of production systems to the objectives and demands of sustainable development. This implies not only the adoption of new technologies, but also, and more globally, the emergence of new technical systems and organizational methods, both individual and collective.

d. Systems and processes for innovation and research and development.

As described above, the contribution of agriculture to sustainable development supposes both reorienting innovation and renovating the systems that generate or disseminate it. Hence there is a need to include, in this general pattern of thinking, a field of investigation that considers processes and systems for innovation as subjects for research and experimentation. The challenges of sustainable development imply, in particular, new types and modes of collaboration among the different actors in research and development.

Several themes are covered by this field of investigation, such as *ex ante* and *ex post* evaluation of innovations; the analysis of research and development systems and their outcomes (with particular emphasis on the increasing importance of regional challenges); the design and development of innovations that respond to the criteria for sustainable development; and renovation of the tools, methods and systems involved in the innovation process, at the stages of both invention and adoption, including aspects regarding intellectual property rights.

e. Public policies and markets: respective roles and coherence with respect to sustainable development.

If agricultural activities are to be aligned with a context of sustainable development, public policies and private strategies (and, more globally, government actions) should be conjugated and rendered synergistic, while appropriately and coherently taking into account long-term objectives.

The research to be undertaken must therefore target the methods and conditions needed to achieve these objectives in different situations. For this, it is necessary to question the theoretical guidelines and reference systems that underlie the development of public policies, and particularly those affecting agriculture, the environment, water, regional development and market regulation, etc. It is also essential to take into account industrial strategies and the behavior of citizens and consumers towards the challenge of sustainable development and towards the institutional arrangements (contracts, regulations, establishments, etc.) that might regulate these different behaviors. With respect to these challenges, increased attention must be paid to evaluating the most effective incentives and the cost and complexity of implementing government regulations. For this purpose, information systems and appropriate methods to evaluate policies aimed at promoting the challenges of sustainable development seem to be more necessary than ever.

One of the novelties of the work to be carried out in this context lies in explaining the cascades of effects resulting from different measures and that, in many cases, counterintuitively modify the functioning of technical and biophysical systems. It is possible that the results obtained from the measures implemented may be entirely the opposite to what was anticipated. Studying this complexity will likely entail these processes being considered using a combination of biotechnical, sociological and economic approaches.

To address these issues, a research and research-development program was launched in France in January 2005. The program will run for 4 years (2005-2008) and have a budget of around €10 million. This program, called Agriculture and Sustainable Development (ADD in French) involves, at present, 10 French national organizations, including ministries and national agencies, research organizations and research and development agencies. The next step is to develop multilateral collaborations with similar programs in other European countries. Ultimately, this could lead to establishing a program involving national and international agricultural research institutes around the world.

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Millennium Ecosystem Assessment

Robert T. Watson[1]

Human-induced impacts on ecosystems have had significant but largely unquantified impacts on the production of ecosystem goods and services. The Millennium Ecosystem Assessment concluded that conserving and sustainably using ecosystems requires (i) a change in the economic background to decision-making; (ii) an improvement in the policy, planning and management of ecological systems; (iii) the development and use of environmentally friendly technologies; and (iv) a change in individual behavior.

The Millennium Ecosystem Assessment (MA) was a multi-scale assessment, comprised of interlinked assessments conducted at different geographic scales, ranging from local communities to the entire globe. It focused on three issues: the current and historical trends in ecosystems and their contribution to human well-being; options for conserving ecosystems and increasing their contribution to human welfare; and future scenarios for change in ecosystems and human well-being. The "value added" of the MA was its cross-sectoral and cross-scale analysis.

Human well-being and progress towards sustainable development depend upon improved management of the Earth's "ecosystems." Ecosystems affect human well-being directly through the supply of goods such as food, timber, genetic resources and medicines, and services such as water purification, flood control, coastline stabilization, carbon sequestration, waste treatment, biodiversity conservation, soil generation, pollination, maintenance of air quality, and the provision of aesthetic and cultural benefits, and indirectly through impacts on poverty, health, livelihoods, security and economic development.

Important progress has been made in reducing poverty and improving the quality of life over the past several decades, with life expectancy increasing, infant mortality decreasing, real per capita income increasing and the fuller involvement of civil society in decision-making, but significant progress is still required. Billions of people, especially the rural poor, still lack access to nutritious food, clean water, sanitation, electricity or a healthy environment. Equally, there are disenfranchised groups who lack empowerment, opportunity and security as evidenced by the inequitable distribution of benefits from globalization; the limited access which many poor people have to productive resources and technological innovation; and exclusionary land tenure arrangements found in many countries. Environmental degradation at the local (e.g., water pollution) and regional (e.g., land degradation) scale continues unabated in most developing countries depleting natural capital, undermining the livelihoods of the poor, and limiting rural economic growth. In addition, at the global scale, the Earth's climate continues to change and biological diversity is being lost at an unprecedented rate, undermining the ecological basis for sustainable development.

The magnitude of human-induced changes in terrestrial and marine ecosystems is unprecedented. For example, some 40 to 50% of land is now transformed or degraded, some 60% of the world's major fisheries are over-fished, natural forests continue to disappear at a rate of about 14 million hectares of forest each year, and other ecosystems such as wetlands, mangroves and coral reefs have been substantially reduced or degraded. Other human-induced impacts on ecosystems include alteration of the nitrogen and carbon cycles causing acid rain, eutrophication, and climate change and increased rates of species extinction. In all cases, these changes have had significant but largely unquantified impacts on the production of ecosystem goods and services.

Projected demographic changes and economic growth will lead to an increasing demand for biological resources implying even greater impacts on ecosystems and the goods and services that flow from them. For example, projections suggest that an additional one-third of global land cover will be transformed over the next 100 years; world demand for cereals will double within the next 25-50 years, demand for freshwater will increase to an equivalent of more than 70% of runoff, and demand for wood will double over the next half-century.

It is now well recognized that there is a trade-off among ecological goods and services. For example, while food production can be increased by converting a forest to agriculture, it may decrease the supply of goods that may be of equal or greater importance such as clean water, timber, biodiversity or flood control. Consequently, an integrated approach to agriculture, land use, and coastal and ocean management must be adopted to encompass the differing ecological, economic, social, cultural and institutional implications of sustainable use and conservation.

Given that the capability of many ecosystems to provide essential goods and services is being diminished, many governments are now beginning to recognize the need for more effective management of these basic life support systems, which is particularly important as a tool for poverty alleviation. The importance of improved management of ecosystems is also recognized in the private sector, by both those industries dependent directly on biological resources, such as timber, fishing, or agricultural firms, as well as companies not directly dependent on biological resources, e.g., extractive industries such as mining. Companies increasingly recognize the importance of being good "corporate citizens" by focusing on the triple bottom line of economic growth that is environmentally and socially sustainable.

The Millennium Ecosystem Assessment concluded that to conserve and sustainably use ecosystems there needs to be (i) a change in the economic background to decision-making; (ii) an improvement in the policy, planning and management of ecological systems; (iii) the development and use of environmentally friendly technologies; and (iv) a change in individual behavior.

There is a need to (i) make sure the value of all ecosystem services, not just those bought and sold in the market, are taken into account when making decisions; (ii) remove subsidies to agriculture, fisheries and energy that cause harm to people and the environment; (iii) introduce payments to landowners in return for managing their lands in ways that protect ecosystem services, such as water quality and carbon storage, that are of value to society; and (iv) establish market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way

There is a need to improve policy, planning, and management of ecological systems. There is a need to (i) integrate decision-making between different departments and sectors, as well as international institutions, to ensure that policies are focused on protection of ecosystems; (ii) include sound management of ecosystem services in all regional planning decisions and in the poverty reduction strategies being prepared by many developing countries; (iii) empower marginalized groups to influence decisions affecting ecosystem services, and recognize in law local communities' ownership of natural resources; (iv) establish additional protected areas, particularly in marine systems, and provide greater financial and management support to those that already exist; and (v) use all relevant forms of knowledge and information about ecosystems in decision-making, including the knowledge of local and indigenous groups.

There is a need to develop and use environment-friendly technology by (i) investing in agricultural science and technology aimed at increasing food production with minimal harmful trade-offs, (ii) restoring degraded ecosystems, and (iii) promoting technologies to increase energy efficiency and reduce greenhouse gas emissions.

Lastly, there is a need to influence individual behavior by (i) providing public education on why and how to reduce consumption of threatened ecosystem services, (ii) establishing reliable certification systems to give people the choice to buy sustainably harvested products, and (iii) giving people access to information about ecosystems and decisions affecting their services.

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Striking a balance between economic efficiency and solidarity: Using agriculture to promote sustainable development

Jacques Loyat[1]

Institutions and governance play key roles in sustainable development and poverty reduction. A new framework for development assistance proposed by the World Bank and called the Comprehensive Development Framework advises, in the area of food and agriculture, against pursuing market access and liberalizing agricultural economies in a bid to resolve food security and poverty problems, provided that certain issues are addressed. This framework is an invitation for discussing and implementing recommendations to promote the notion of using agriculture as a mechanism to foster sustainable development.

A new theoretical framework for development assistance

In the late 1990s, both the planned and neoliberal theories of economic development were eschewed as a consensus emerged regarding the need for the market and the state to join forces to guarantee development, as noted in the World Bank paper entitled *Development and Poverty Reduction*.[1] Based on this approach, governments should ensure that investment guarantees growth, while the state should assume responsibility for capacity building through education, health, social protection and mechanisms for fostering participation. The conclusion has been reached that, to achieve development, states must be in a position to help markets function effectively. In such a context, institutions and governance play key roles in sustainable development and poverty reduction.

To better integrate the social and economic aspects of development, give due consideration to equity issues, and take cognizance of global interdependence, this report underscores the risks associated with globalization, an undeniable reality, particularly for poor countries. It rests on the new framework for development assistance of the World Bank, the Comprehensive Development Framework. The Framework promotes four principles: (i) development efforts should be rooted in a long-term, holistic vision of country's needs, not just macroeconomic but also social and structural; (ii) it should focus on results rather than inputs; (iii) it should be based on country-owned strategies; and lastly (iv) development actors should foster partnerships to support the country-owned strategy.

In the area of food and agriculture, this framework advises against the pursuit of market access and the liberalization of agricultural economies in a bid to resolve food security and poverty problems, provided that these issues are assessed in greater depth.

The structural nature of agriculture and poverty

Not all countries are in the same situation insofar as agricultural liberalization is concerned. For most middle income countries, which face stiff protectionism from big markets, liberalization could result in a significant surge in market opportunities and prices in a relatively well-performing export sector. For the poorest countries, however, more expensive imports and fewer preferential trade benefits spell considerable gloom.[2] This acknowledgement, although important, is not sufficient. The contrasts among different forms of agriculture within each country could be added to the differences among countries, which would then transcend the differences between importer and exporter countries.

Of the 6 billion people living on the planet, 2 billion suffer micronutrient deficiency, and 840 million are malnourished (800 million of whom are in developing countries). Of people living in abject poverty, 75% live and work in rural areas, and most live by agriculture or related activities. For this reason, achieving a sustained reduction in poverty requires that the problems that plague small farming are tackled directly and effectively.

[1] Wolfensohn JD, Bourguignon F. *Development and poverty reduction: Looking back, looking ahead*. Presented at annual meetings of the World Bank and IMF in October 2004.

[2] Bureau JC, Gozlan E, Jean S, *La libéralisation du commerce agricole et les pays en développement (Agricultural trade liberalization and developing countries)*, Third Annual Forum on Agriculture and Globalization on 7 October 2004., Institut français des relations internationales: Paris.

From a structural standpoint, agriculture is highly heterogeneous, depending on the use of inputs (land, capital and labor), the relationship with the ecosystem (landscape, natural resource management and biological diversity) and the final product (raw materials or processed products). An illustration of this heterogeneity is provided by MS Swaminathan.[3] India is the biggest producer of milk in the world, with 75 millions tons being produced by a little over 80 million farm families. By way of comparison, in developed countries, the same quantity of milk can be produced by fewer than 800,000 people. Given such disparities — a ratio of 1 to 100 in this instance — the solution to the problem posed by these micro-farms cannot be a single development model proposing the most productive form of agriculture.

Inappropriate responses

The economic approach derived from Walras's general equilibrium theory, which dominates discussion in academic circles and international organizations, is that any policy that has impact on the prices and quantities of goods or services produced creates trade distortions and a loss of well-being for society as a whole. The only way to avert this loss is to return to a competitive situation, with markets being the sole force capable of achieving optimal general equilibrium.

In reality, experience shows that, in global agricultural production, the theoretical general equilibrium economic model cannot be espoused for at least three reasons.

The first reason is linked to the fact that some of the conditions for competitive equilibrium are not met, as markets function imperfectly, information availability is asymmetrical and huge differences in productivity exist among farmers, thereby making optimal equilibrium unattainable. In addition to market imperfections, no international markets or institutions exist to regulate trading in public goods. This applies to food security, landscapes and protecting biodiversity. While, for example, the widely held view is that biodiversity is essential for human survival and that agricultural biodiversity is a major component of overall diversity, the market alone does not seem capable of guaranteeing adequate biodiversity conservation.[4]

The second reason is that this theoretical model is incapable of covering the broad spectrum of agricultural economies. In an ideal competitive economy, agricultural prices are determined on the basis of input costs associated with the marginal or least productive land. Such prices yield differential rents on the the most productive land. However, in the case of the global market, it must be noted that the reverse occurs. The opening of markets is inevitably reflected in price alignment for products from the most productive land, a phenomenon that dissociates prices from actual input costs. Because the global economy is not competitive in the manner described in the theoretical model, this openness can prove devastating for the least productive forms of agriculture. Excessively low prices cannot cover expenses and guarantee minimum remuneration to farming families. This is the situation facing more than a billion producers the world over.

The third reason is also critical and stems from agriculture being an activity that supports and directly impacts the living world, while a complete understanding of the complexity of interactions over the short and long term is lacking.

Agricultural diversity and public policy

Agricultural diversity is inherent to the sector because of the heterogeneous nature of resources (land, water, climate and ecosystems). This diversity is generally perceived as an obstacle to development. Could it not be viewed instead as an asset? Homestead production and the production of staple foods are essential not only for the subsistence of the rural poor but also for food security for both urban and rural populations.

Because of this diversity, there is a need to cover the costs of production under highly heterogeneous productivity conditions, both natural and structural. Consideration of global public goods require sustaining long-term agricultural productive capacity all over the world. Here again, these matters cannot be guaranteed by the one-size-fits-all solution of trade globalization and deregulation.

[3] Swaminathan MS. 2000. *Community-led approaches to ending food insecurity and poverty*. MS Swaminathan Research Foundation: Chennai, India. UNESCO Chair in Ecotechnology: Rome, Italy.

[4] *Paris Declaration on Biodiversity. Proceedings of the International Conference on Biodiversity Science and Governance*, 24-28 January 2005. Paris.

Scherr S, Frison E, Baudry J. *Agriculture and Biodiversity, Policies, Institutions and Practices*. General Report, Workshop 2, Proceedings of the International Conference on Biodiversity Science and Governance, 24-28 January 2005. Paris.

New approaches in the public policy sphere have prompted the reconsideration of current development models, that is, of the main technical and economic choices that, as a whole, drive trends in agriculture. The functioning of societies, in particular agricultural societies, should be the subject of reexamination to understand the dynamics at work in each region of the world. Small farmers must be given the opportunity to participate in market economies. According to the International Fund for Agricultural Development,[5] this calls not only for a change in material factors (land, water and infrastructure) and access for the poor to technology and information, but also for a change in social and economic relations. If globalization and decentralization are to help the poor, broad-based partnerships must be mobilized to establish equitable and efficient trade relations as well as transparent social and political institutions.

In other words, issues such as access to inputs, markets and human development resources, and the existence of appropriate forms of governance, are prerequisites for the sustainable development of rural areas.[6]

Some individuals, like MS Swaminathan,[7] call for solidarity to achieve more equitable trade:

> *"If trade and not aid has to become the pathway of poverty reduction, affluent nations must assist the developing countries in overcoming their handicaps in infrastructure, post-harvest technology, and sanitary and phytosanitary measures. National and international agribusiness enterprises should foster contract cultivation of a wide range of crops, on the basis of assured and remunerative buy-back arrangements. Commercial contracts should take the form of a new social contract with resource-poor farm women and men and landless labor families in terms of technology upgradation, training in new skills and information, and knowledge empowerment. Integrated commercial and social contracts alone can help to generate the synergy needed to provide small-scale producers a level playing field in competitive global trade. If this happens, trade starts assuming a higher purpose than making profit alone."*

As far as markets are concerned, the proposed solution lies in a contractual arrangement aimed at encouraging countries to promote trade anchored in the principles of ecology, economic efficiency, employment and social equity.

Given the broad range of issues covered and the objectives set, it is not possible for the World Trade Organization to be the lone international organization with the expertise to tackle issues related to food security and, more broadly, those related to sustainable development. Indeed, trade, which creates short-term balances in private goods, cannot be fully incorporated into decisions that are long term in nature (particularly regarding investment and such public goods as ecosystems) or about structural or institutional factors.

Lastly, food security and sustainable rural development call for new forms of regulating production and trade by adopting regional and global perspectives and incorporating sustainable development into this perspective. This calls for[8]

(i) a forward-looking analysis to anticipate social, scientific and technological changes;

(ii) consideration of the long term, of inter-generational solidarity, and of expanded local and global spaces, as well as of connections linking these factors, with a holistic approach being adopted toward the environment, society and economy; and

(iii) harmonization of varying requirements, with a view to participatory planning that paves the way for reinstating a balance of powers among the market, state and society.

It is against this backdrop that seminars bringing together French public research entities and representatives of the government and the economic sector have highlighted the need to forge stronger links among agriculture, nature and

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[5] IFAD. *Rural Poverty Report* 2001.

[6] See also: Sobhan R. 2001. Eradicating rural poverty: Moving from a micro to a macro policy agenda. Centre for Policy Dialogue. Dhaka.

[7] MS Swaminathan, op.cit. p.23.

[8] According to the report coordinated by Roger Guesnerie, *La recherche au service du développement durable (Research aimed at promoting sustainable development)*, Ministry responsible for research and new technologies and the Secretariat for sustainable development, 16 January 2003.

society by taking into account the diverse nature of situations. In effect, recommendations cover[9]

(i) more in-depth knowledge of diversity in the agricultural sphere;

(ii) the design and implementation of news models of food systems that seek to promote good human nutrition and health;

(iii) recognition of biodiversity as an integral part of agricultural ecosystems;

(iv) consideration of the vulnerability of agriculture in relation to such global phenomena as climate change and epizootic and zoonotic risks; and

(v) establishing a shared vision of agriculture among partners and creating new tools and methods to improve decision-making processes.

In conclusion, the World Bank's new development assistance framework, known as the Comprehensive Development Framework, seems to be the right mechanism for discussing and implementing these recommendations and so to promote the notion of using agriculture as a mechanism to foster sustainable development.

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[1] Jacques Loyat, agricultural engineer and PhD in Economics Science is a scientific advisor to the French Ministry of Agriculture and Fisheries general director for education and research. He is also involved as lead author in the International Assessment of Agricultural Science and Technology for Development (IAASTD).

[9] Loyat J (ed.). *Ecosystèmes et sociétés: Concevoir une recherche pour un développement durable (Ecosystems and societies: Designing research with sustainable development in mind)*. Editions Quæ; Paris. In preparation.

The future and prospects for agricultural research

Michel Griffon[1]

The 2 billion plus farmers throughout the world have, in large measure, the future of the biosphere in their hands. It could be said that when they produce agricultural goods, farmers also produce public goods when they follow the proper course, but public "bads" if their activities bring about degradation for ecosystems and societies. Public policy thus necessarily has an essential role to play in providing incentives to encourage farmers to produce only public goods. Farmers will also have to increase production and productivity using new environment friendly technologies. To these ends, public policy research constitutes a critical factor in bringing about ecologically and economically sustainable development.

It is difficult to chart out a long-term course for agricultural research. This is because research can take a new direction at any time and create new scientific and technological opportunities that are hard to predict today. But it is nevertheless quite necessary to define long-term courses because of the need both to address the major questions facing us today and to anticipate those that will inevitably arise for the future.

The technological history of agriculture shows clearly that societies almost always face the same generic issue: meeting the food and other requirements of society by increasing the production of cultivated ecosystems through expanded area under cultivation and intensified use of natural resources. But addressing this need is becoming increasingly difficult as the availability of virgin land is greatly reduced, replenishment of renewable resources is in jeopardy, and intensive production techniques are often found to engender environmental risks.

The Green Revolution as a general horizon for research in the 1960s

This question was very much at the forefront in the 1960s, when Asia was experiencing serious food shortages. It led to the creation of the first international agricultural research organizations, then to the Consultative Group on International Agricultural Research (CGIAR), and finally to the group of research Centers now known as the CGIAR System. Work by the International Maize and Wheat Improvement Center (CIMMYT by its Spanish abbreviation) and the International Rice Research Institute (IRRI) also laid the groundwork for the Green Revolution. Alongside these activities, and in particular since the years immediately following World War II, French institutes for tropical agricultural research were pursuing comparable aims, especially in Africa. The research results during this period made it possible to steadily increase yields for almost 30 years, principally in the humid tropical zone. Beginning in 1994, the first signs of stagnation in grain yields were observed in the areas where the Green Revolution had begun. A CGIAR task force chaired by Gordon Conway[1] immediately set about proposing new objectives.

Research issues for 1995

The thinking at the time was that the Green Revolution would probably continue to be applied for many years in regions it had yet to reach. This meant that the stagnant yields in regions where it had been applied for 30 years was very bad news indeed. Rapidly analyzing the causes of this stagnation in yields was therefore necessary to define the research programs needed to overcome the problems. The causes of the stagnation were rapidly diagnosed[2] as soil salination, excess water use (waterlogging), higher costs for pumping irrigation water as water table fell and, in particular, higher prices for inputs, prompting producers to reduce the amounts of fertilizer applied. These price increases were attributable to the implementation of structural adjustment policies.

This halt in the pattern of increased yields also constituted a longer-term threat. Indeed, the Green Revolution was being relied upon to deal with growing demand associated with the rising population of the planet. Between 2000 and 2050, the global population was expected to grow by 3 billion inhabitants. As the malnourished population was already very high, over 800 million in the developing countries, new productive responses had to be identified rapidly.

[1] Conway G (ed.), Carsalade H, Griffon M, Hazell P, Holmberg J, Lele U, Ozgediz S, Pineiro M, Peacock J. 1995. Sustainable agriculture for a food secure world. CGIAR Secretariat: Washington, DC.

[2] By, among others, Prabhu P, Rosegrant M. 1994. Environmental consequences of the Green Revolution. International Rice Commission, FAO: Rome, Italy.

The group assembled by Gordon Conway then recast the central issue for future research as follows: How can production be increased, with higher yields in multiple and highly varied locations and agricultural situations, principally in poor agricultural areas, while reducing environmental impacts? This ultimately called for defining a new Green Revolution, a "doubly green revolution," green once because it should be able to bring production increases proportionately equivalent to those of the first Green Revolution, and green a second time because it should be capable of providing satisfactory responses to environmental concerns.

The CGIAR Centers adopted this orientation in various ways. Particular successes were recorded by the Rice-Wheat Consortium for the Indo-Gangetic Plains and in research in agroforestry. CIMMYT and the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) jointly invested in the agroecological techniques of direct-seeding mulch-based cropping systems. CIRAD research in this area made particular progress in association with Brazilian research. The results are often impressive in humid tropical zones and in savannah areas. Mulches derived from waste biomass provide nutrition, limit weed growth, make it possible to prevent erosion and contribute to the conservation of groundwater. It also reduces the prevalence of some diseases and pests. The Doubly Green Revolution is thus under way.

Research issues for 2006

Indeed, the areas under cultivation with zero tillage techniques and recycled crop residues are increasing throughout the world. This kind of farming has acquired the name of "conservation agriculture." The term encompasses a number of different technical approaches, as shown by the findings of the Knowledge Assessment and Sharing on Sustainable Agriculture project carried out by CIRAD in 2005 at the behest of the European Commission. However, many new avenues remain to be explored.

Even as conservation agriculture became more widespread, the sudden hike in oil prices raised new questions. This increase appears to be a lasting one. It will likely be reflected in higher prices for nitrogenous fertilizers and fertilizers derived from fossiliferous deposits that are transported across great distances. It will hence be necessary to consider using every possibility offered by the biological fertility of soils. It is known that biomass is an important raw material for the soil ecosystem and that, after it decomposes by the activity of a wide variety of plant and animal species, crop plants can benefit from the resulting nutrients. The complex biological reactor present in the soil could be used considerably more, and its use should be optimized to provide the bases for plant nutrients. There should also be investigation of the capacity to further explore the deep mineral resources of soils by tapping the pedogenic potential of natural mechanisms. Similarly, additional research should focus on mastering capacities for the symbiotic fixation of nitrogen and phosphorous. Knowledge of soil bacteria, the genomes of which are virtually unknown, also raises the hope that many natural processes could be of value to improving soil fertility.

It is also known that the systematic analysis of the effects on ecosystems of industrial substances, in particular chemicals used in agriculture, runs the risk of being identified as new dangers to the environment. There is scope for reducing their number. It is therefore essential to begin greater investment in alternative crop-protection techniques. Many integrated pest management techniques are still in their infancy, and much remains to be studied in the area of prey-predator and host-pathogen relationships to identify enhancements to biological control. Similarly, there is considerable potential in genomic knowledge and using plants' natural resistance to diseases and pests. Finally, a more detailed understanding of the genome and proteome of plants should make possible identifying new and effective natural substances that could be produced by the bioindustries of the future.

Water is becoming more scarce in many countries. Many solutions are conceivable in the area of irrigation techniques. Rapid progress in improving the drought resistance of plants may also be expected. Moreover, improved eco-landscapes and the adaptation of improved crop management also have significant potential for conserving groundwater and surface water sources that have yet to be studied extensively.

The fact is that farmers throughout the world will gradually have to adopt a new production logic. Until the present day, their role has been to produce as much as possible using sizable quantities of inputs. In the future, it will be necessary to recognize that producers have a much broader role to play than just producing food or energy products. As indicated by the Millennium Ecosystem Assessment, agricultural producers, by using land ecosystems, also produce genetic resources, natural products (such as pharmaceuticals) and water. Moreover, they produce many regulating services affecting climate, air quality, water resources, erosion, diseases and pollination. Finally, they produce cultural services such as spiritual, religious and aesthetic values, or recreational and ecotourism amenities. Their role is thus a complex one. It could be said that they produce public goods when they follow the proper course but public "bads" if their activities bring about degradation for ecosystems and societies. For these reasons, the 2 billion plus farmers throughout the world have, in large measure, the future of the biosphere in their hands. Public policy thus necessarily has an essential role to play in providing incentives to encourage farmers to produce only public goods. To this end, public policy research constitutes a critical factor in bringing about ecologically and economically sustainable development.

Accordingly, the new core question for future research could be phrased as follows: How can yields be increased in multiple locations, in a context of more costly energy and limits on the use of chemical inputs, while making the greatest possible use of the natural functionalities of ecosystems, in particular by using natural substances and improving species genetically? How can agricultural and environmental policies serve as incentives to producers to manage the ecosystems they use in an integrated and satisfactory manner?

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[1] Michel Griffon, an agricultural economist at the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) and special advisor–office of the D.G., joined the Agence nationale de la recherche (ANR) in 2005 where he manages the Ecosystem and Sustainable Development Department. He chairs the French Global Environment Facility and the Economic and Social Development Studies Institute (IEDES Paris Sorbonne).

Development and interdisciplinary action: one and the same cause

Marcel Jollivet[1]

Never before has there been such a rich palette of tools available for imagining and implementing ways to improve agriculture, in all its diversity. The many factors to be considered require the involvement of multiple disciplines from different broad areas of science. The goal is not simply to place the various disciplinary contributions end to end, but rather to construct a comprehensive framework that is firmly rooted at the intersection of a number of disciplinary issues and that is therefore able to attack a question by considering it simultaneously, or one could say unitarily, from many different angles.

Agriculture, rural societies and the rural space that these societies both create and inhabit have always evolved in keeping with general change in the larger societies to which they belong. And through these larger societies, they are also tuned in, more or less directly, to change at the international level.

As a result of its specific characteristics as a productive activity, agriculture reacts to such general change in its own particular ways. In addition, it is closely tied to change in the rural societies of which it is part. In reciprocal fashion, agricultural change has a decisive effect on change in rural societies.

But rural societies also evolve under the influence of larger transformations in the societies to which they belong and, in particular, any changes that alter relations between cities and the countryside.

For their part, transformations of agriculture and rural societies greatly contribute to change in the societies of which they are part, first because of the place agriculture holds and the role it plays in the national economy, and second because of the place rural societies hold and the role they play in the national patterns of territorial population distribution, the political system and the country's national ideology.

The multiplicity of these analytical dimensions, which must be combined to understand the realities of agriculture and rural life in a given country, explains the diversity of observable scenarios. This diversity is further enriched by that which stems from either history or geography.

It is still important to restate these general facts, even though they are well known to all researchers working in the fields. They are, in fact, generally ignored in policies of so-called agricultural or rural "development." This is particularly true of international organizations (e.g., World Trade Organization, World Bank and International Monetary Fund) that base their actions on general models rooted in liberal economic theory and based on the historical experience of developed countries and then impose these models on realities to which they usually do not apply. The results are mixed at best.

To take into consideration seriously the multidimensional nature of the phenomena dictating agricultural and rural change in a country, along with the complexity of the resulting situations, efforts must be made to seek avenues of change specific to each situation and appropriate to that situation's particular characteristics and constraints. It thus makes sense to speak of "agricultures" and "ruralities" in the plural, rather than agriculture and rurality in general, as if the latter were essences that exist by themselves. They are historical and contingent realities, so the issue is to understand the reasons why they are what they are in a given country at a given time.

Globalization and technical innovation

This reminder is all the more necessary because the status of these "agricultures," considered from a worldwide perspective, is now highly unstable, and perhaps more unstable than ever before. This results from the combination of two phenomena: globalization and technical innovation.

The current world context accentuates the pressures for change in national and local agricultures. Globalization is not, of course, a brand new concept, but the recent shape assumed by these old international dependencies means that its influence is spreading in new ways through increasingly diverse channels. At the same time, confrontations are more and more

direct between different agricultures, because of either the growing openness and proliferation of trade in agricultural products or else the elimination of the special treatment hitherto given to them in international trade rules governing agricultural products. This accentuates the inequalities and calls established situations into question, wherever they are and whatever the type of agriculture involved.

In addition, technical alternatives are proliferating as the range of options steadily expands, with genetically modified organisms at one extreme and "softer" ecologically based techniques at the other. There has never before been such a rich palette of tools available for imagining and implementing ways to improve agricultures, considered in their full diversity, or for taking into account their specific characteristics, as well as those of the societal context in which they exist. But the technical alternatives have also never before been so contradictory, sensitive to uncertainties and perplexing. And the debate on what is commonly called "agricultural development" has probably never been as wide open as it is today.

The emergence and widespread expansion of reference to the concept of sustainable development not only contributes to broadening the debate but also substantially modifies its terms. This concept does in fact call into question a vision of development that is too narrowly focused on the sole function of production and, indeed, based on too narrow a conception of production, in terms of inputs (selected seeds, fertilizer, etc.) and mechanization. On the contrary, it reintroduces the idea of the intrinsically multifunctional nature of agricultural activities, simultaneously encompassing environmental matters (the best possible management of natural resources and ecosystems), social issues (insurance against hunger and the social inequalities faced by poor farmer classes) and economic concerns (positive contribution to the national economy). These are the three pillars of sustainable development, but at least one other pillar should be added, referring to the political, ideological, symbolic and cultural role of farm populations. Such a holistic view of agriculture could even be described as anthropological. All the dimensions noted in the opening lines are found again here.

To escape this complexity and move forward with action means either running the risk of failure or playing God by engaging societies in uncontrollable changes that can have serious consequences for them. There is no shortage of examples. It is thus critical to understand the entanglements of cause and effect surrounding agriculture and rural life in a given social context so as to act upon these factors with full knowledge, i.e., with appropriate policies for a perspective of sustainable development.

Interdisciplinary action

To achieve this level of understanding, the diversity of factors to be considered requires the involvement of multiple disciplines from different broad areas of science. The range of disciplines goes all the way from ecology to the social sciences and includes a number of fields in between: soil and water sciences, agronomy, agricultural engineering, chemistry, atmospheric physics — and the list goes on. Each of these disciplines contributes its own skills and knowledge, which are indispensable and irreplaceable.

However, taken separately, these skills and knowledge are limited to the perspective of the discipline to which they pertain. In trying to respond to an issue based on the expertise of their respective discipline, specialized researchers make maximum use of their expertise but, in so doing, tend to present themselves as being the only ones to hold the necessary and sufficient explanation for the issue, or as the only ones able to propose a solution to the problem at hand, if there are courses of action to be established. In the best-case scenario, they are aware of their limits and know how to confine themselves to their area of expertise, by leaving the broader question open and referring relevant aspects of the question to others. But even so, they will have defined the scope of their investigation on the basis of facts and variables that enter into the scope of their discipline, thus rejecting as irrelevant a number of other facts and variables that, however, tie into the same research purpose or issue. All this makes it difficult to adjust their conclusions (considered untouchable by definition because they are justified by the canons of their discipline) to other disciplinary approaches addressing the same facts or issues from another point of view.

To avoid what clearly appears to be an artifact resulting from the disciplinary reduction of a complex purpose or issue, different disciplinary approaches must be linked together in research on a mutual issue. The issue should therefore be clearly articulated to encompass specific questions that can be addressed by each of the associated disciplines. This means, first of all, that it should be defined in unison so that each discipline can make sense of the issue in one way or another and develop a sense of ownership.

This is a critical moment in the research, because it is when researchers all call upon their respective disciplines to build together the research approach that they will share. This of course means, as an initial step, working together to develop the mutual issue and the collective research approach that will govern their individual approaches; it could also mean adopting a common research method, such as modeling, or even a common theory, such as systemic analysis. But it also means participating in fine-tuning the matters specific to each of them, and thereby understanding and sharing these matters, in which their collective issue is embodied. And it means participating, for the same reasons, in designing the objectives specific to each discipline and selecting its particular research methods.

This is the start-up phase of all research. But the originality of its content, which emerges from the factors described above, makes it a special phase as well. The quality of this initial work will determine the quality of the research that follows and its importance. But comparing the disciplines of which the research consists also points to the difficulty of this phase, especially when the disciplines belong to areas of research or scientific cultures that are far apart, perhaps even based on different epistemological principles.

Thus, the goal is not simply to place the various disciplinary contributions end to end, but rather to construct a comprehensive framework that is firmly rooted at the intersection of a number of disciplinary issues and that is therefore able to attack a question by considering it simultaneously, or one could say unitarily, from many different angles. For researchers from the various disciplines involved, this means engaging in a joint effort to clarify the basis of their cooperation, define its terms (i.e., formulate the terms in a common framework), and identify and share the means to reach their end. This is a research phase in itself, focusing on the specific disciplines at play, and it is part of — or actually a prerequisite for — research on the particular problem.

Development

The value of this type of approach to development research lies in its acceptance of the full complexity of development processes. As a result, the interdisciplinary challenge that it entails addresses the conditions and uncertainties of the action. The actor, the manager, whether administrative or professional, public or private, individual or collective (an organization, institution, organized social group, etc.), is constantly confronted with this complexity and these uncertainties when decisions are to be made. The multiple synergies, tensions and even contradictions that may arise between different dimensions of the development process mean that actors must operate within a framework of probability, not certainty. And this probability is tied to the specific actions of each actor, the manner in which these actions influence each other and combine together, and the way in which the actions therefore evolve.

The status to be given to an action is thus one of the critical questions that the research framework must address, since this is an intrinsic element of the issue at hand. Furthermore, in this scenario, research on development themes inevitably amounts to research for development, even when the scope of the research is broad and involves the accumulation of knowledge about how societies function. This type of approach thus meets the conditions for research on development themes to be transformed into research for development. It provides the necessary foundations.

In absolute terms, the importance that should be given to an action can be conceived in two ways: either through an analysis of the interplay of actors, holding the latter at a distance, or else by directly incorporating the interplay of actors into the actual research through their participation in the research. This second approach has two advantages: first, it does not freeze the representations of actors, since they are placed in a situation where they face the implications of their own actions while simultaneously situating their actions within the interplay of the actions of others, resulting in a reflective exercise; second, it ties the actual research to a learning exercise shared by actors and researchers alike. Thus, the approach shuns traditional fragmentation and falls instead along a continuum of basic research, targeted research, research/action (or participatory research) and research/intervention.

The originality of this type of approach raises the issue of the training to be given or to be obtained in order to master the approach. In higher education, this question has long been considered simply taboo. While it is perhaps not quite so taboo today, it still runs into a conception of training that focuses on the acquisition of knowledge, with a heavy emphasis on the fragmentation of learning into specific disciplines, meaning that instruction, as practiced, is limited to the latter. In addition, the epistemological and educational advantages ascribed to the latter lead to the argument often put forward that interdisciplinary action is a difficult art, reserved solely for experienced senior researchers. Yet there is ample debate and experience to show that training the mind and acquiring skills can follow other paths, in which disciplines have their place — an essential place, to be sure, but not exclusive, and not even necessarily the leading role. Training in the analysis of complex systems through an interdisciplinary approach provides the opportunity for a radical renewal of ideas in this area. But there is still a need to develop the means to take up this challenge in full.

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Innovation and Futurology

Dominique Lecourt[1]

The need for a genuine innovation policy has been intensely recognized internationally since the early 1970s, when major questions relating to the environment and biotechnological impacts on societies gained public standing. Today, two extreme positions, one technocentric and the other demonizing innovation, complicate the formulation of such a policy. The necessary first step is to eliminate the requirement imposed by both of the opposing camps: *a priori* certainty of fully validated clarity. This would entail re-examining the notion of futurology.

It is probably of interest to note that the word "innovation" was initially exclusive to the legal vocabulary and remained so until the 18th century. It is defined in terms of changing a tradition into something new. In the present day, however, since what we call the Industrial Revolution, innovation is understood primarily in the sense of technical innovation.

Everyone who has reflected on technical innovation has observed that it is not to be confused with invention. Joseph Schumpeter (1883-1950), for example, shows that innovation is the discontinuous introduction of "new combinations" of products and means of production. Notwithstanding a few exceptions, such as Thomas Edison (1847-1931), the innovating entrepreneur is usually not the inventor. Furthermore, inventions as such do not necessarily lead to innovations and may well have no economic consequences at all — think of all the patents for inventions that will never be brought to market. In addition, there are innovations that do not involve any particular invention, such as the containers that have revolutionized shipping. To borrow from history, take the prototypical example of the steam engine. It was not the inventors, Denis Papin (1647-1712) and James Watt (1736-1819), who innovated, but rather the British industrialist Matthew Boulton (1728-1809), who transformed the industrial order and triggered the development of steam engines by opting to rent these devices out instead of selling them. In his excellent book on technological destiny, *Le destin technologique* (1992, Balland, Paris), Jean-Jacques Salomon retained this notion of "new combinations" in defining innovation, thus denying any technocentric approach to the history of technology.

This raises the issue of what an "innovation policy" can and should be. This is a question that has long been effectively banished from serious examination for two reasons, one of them philosophical and the other political.

Philosophically, an originally positivist notion held sway until the late 1960s, according to which technical innovation was regarded as strictly routine in the industrial context because it was assumed to result from the simple application, ever more rapidly and extensively, of the physical and chemical sciences. This overlooked the always somewhat random nature of the process of innovation. It had been forgotten that the logic behind the uses of an invention is not predetermined by the logic of the invention itself. This is nicely illustrated by returning yet again to the case of the steam engine. The craftsman and inventor Watt could never have imagined that his invention, intended for mining, would so radically alter transportation, in particular thanks to locomotives, not to mention its contribution to the triumph of industrial electricity owing to the turbines used in power plants. Jean-Jacques Salomon has similar comments on the fate of the battery, invented by the Italian Alessandro Volta (1745-1827), which led to the development of the telegraph (the starting point for the communications revolution), the gramophone of Thomas Edison (1847-1931), the film projector of the Lumière brothers, Louis (1864-1948) and Auguste (1862-1954). The principle of all these innovations had unexpected aspects from the standpoint of the inventor. What distinguishes innovation from invention thus appears to require the implementation of a policy that sets priorities for achieving a given objective.

Here, however, is where we find the second (historical) obstacle to the proper appreciation of the role our societies play.

This obstacle has a name: what was called "actually existing socialism" in the Soviet Union. It appeared that state planning of innovation, the replacement of the entrepreneur by the functionary, and the idea that the former policy of a "government of men" had to give way to the "administration of things" (Engels) had the consequence of paralyzing innovation, or at least seriously reducing capacities, when men were effectively governed as if they were things being administered.

There have long been efforts to counter the Soviet anti-model, the disastrous ecological consequences of which have also been observed since Chernobyl, with a free market model we call "liberal" in France, which precludes any state intervention in research and development.

Ethics: New institutional committees providing clarity

Toward the end of the 1990s, the growing attention to ethical matters, in particular to bioethics, that has resulted from the relationships between scientific advances and the cultural and philosophical contexts in which they appear, spurred the establishment of ethics committees responsible for clarifying the code of conduct that researchers and organizations should follow. In France, the Centre national de la recherche scientifique (CNRS), Institut national de la recherche agronomique (INRA), Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) and Institut de la recherche pour le développement (IRD) have set up such committees. Some of the suggestions made by these committees address "ethics and evaluation" and "ethics and expert assessments" (www.cnrs.fr/fr/presentation/ethique/ethique.htm), "partnerships" and "the patentability of living organisms" (www.inra.fr/actualites/comepra), "genetically modified organisms" and "training" (www.cirad.fr/fr/le_cirad/ethique).

With regard to IRD, its consultative committee on professional and general ethics, which highlights its willingness to create a professional code of ethics and introduce the ethical dimension into the daily concerns of the establishment, has made available to the public its guide of good practice in research for development (www.ird.fr/fr/ccde/pdf/guide_bonnes_pratiques_17052005.pdf). Fifteen principles in this guide consider how to:

(i) conceive, design and construct a development research project in equitable partnership with countries of the South;

(ii) implement the program and execute it while respecting everyone's culture and adhering to conditions that are acceptable to everyone;

(iii) use, disseminate and improve on the results for the benefit of all partners; and

(iv) work to maximize the chances that these results will translate as quickly as possible into political decisions with the twofold objective of improving standards of living and respecting the environment.

However, even in the United States, beginning in World War II, the share of the federal budget allocated to support research in both private universities and industry expanded considerably. This increase was specifically justified by the innovation imperative, which mandated public-private cooperation. The same shift occurred later in Japan and has been confirmed there in recent years.

The need for a genuine innovation policy was then recognized. This recognition has become more intense internationally since the early 1970s — that is, since major questions relating to the environment and biotechnological impacts on societies gained public standing. The list of problems raised by the dynamic of innovations has continued to grow longer ever since. The urgency of regulating this dynamic is manifest internationally, though it is not possible today to state that the process has been fully fleshed out institutionally, notwithstanding all the treaties signed and declarations published.

It is here that the question of a "political innovation" probably needs to be raised.

How is it possible, given political practices and institutions, to organize "new combinations" that would make possible a regulated innovation dynamic? How will it be possible to move forward from the present situation, in which basically we see a clash between two extreme positions?

Those holding one view are heavily influenced by the old approach of modern technocentrism and believe that technology supported by the sciences will ultimately overcome all present problems. In the final analysis, it is this spirit of technical expertise that drove the creation in the United States of the first institutions devoted to technology assessment (e.g., the Office of Technology Assessment in 1972). This position is obviously very much in line with the technocratic path of democratic policy that is still prevalent today.

The other position is the one taken by civil society that demonizes the dynamic of innovation, denouncing scientists as sorcerers' apprentices and manufacturers as motivated solely by greed.

More moderate voices argue that it should be possible at the outset to address all the possible negative consequences of the slightest innovation. They wish not to acknowledge the share of randomness that has always affected technical innovations. It has often been observed that most of the innovations that have transformed our world in recent decades could never have satisfied such demands (think of the birth control pill, television and others).

Flanked by a frenetic process free of any controls and by regressive prohibition, what is the course to take?

By all evidence, first eliminate the requirement imposed by both of the opposing camps: *a priori* certainty of fully validated clarity. This would entail re-examining the version imposed by the notion of futurology.

I have already had occasion to underscore the peculiar status of this "science of the future," defended by engineers in the late 1950s with a view to controlling the major technological, economic and social disruptions about which there was so much apprehension. Even as major businesses and large governments almost all introduced offices devoted to such studies, nothing or almost nothing essential that has happened to us was predicted, and nothing or almost nothing essential that was predicted has actually occurred.

There is merit in taking another path — one that has been opened by an unjustly forgotten French philosopher and man of action: Gaston Berger (1896-1960). Academically, he is remembered for having introduced futurology in France. Indeed, in 1957 he founded the Centre international de prospective in Paris where, thanks to his charisma, he was able to bring together researchers, engineers, government officials and businessmen, who produced the review *Prospective* until well after his death.

But simply introducing this French word *prospective* (futurology) falls short of bringing its meaning to the fore. It bears some relation to other semantic suggestions: after all, does not the Latin word *prospicere* mean "see from afar"? Did not the word mean, until the times of Leonardo da Vinci (1452-1519), what we now call "perspective"? To see from afar is neither to see in advance nor to advance in order to see. Instead, it is a matter of adjusting one's point of view in order to see what is coming arrive or, more precisely, to determine what of this future we regard as suitable or unsuitable.

Berger's approach aimed specifically to separate the notion of futurology from its positivist interpretation in the United States. As a recognized specialist in the thought of Husserl, Berger objects to the notion of time that silently supports, behind its calculation techniques, the so-called "science of the future." To make extrapolations and content oneself with them is to accept a linear and abstract conception of human time. This was acceptable to the science of the 19th century, but at the cost of a number of grave illusions. One cannot but acknowledge, Berger writes, that we must "overcome the excessively narrow conception of positivist forecasting which was content with extending the past into the future. Tomorrow will not be like yesterday. It will be new, and it will depend upon us."

To make himself heard, the philosopher works from a twofold finding that still speaks to us directly. The transformations of the world we live in are occurring at an ever more rapid pace, and man is now able to take action that is irreversible. In the past, the future was a source of concern to us because we were impotent. Today, it frightens us because we lack the means to see clearly the consequences of our actions.

The linear conception of time is associated with a notion of man's behavior in society that is built on the rationality of a chess player. In the match we must play, however, "the rules are changing constantly, even as the number of chess pieces and their properties are changing, even as the match is in progress."

While it does not discard recourse to statistical methods and probabilistic calculations, "futurology" thus conceived cannot be characterized as a science in the sense given to that term by American specialists. Bertrand de Jouvenel (1903-1987) reiterated this view in 1964 in his book *L'art de la conjecture* (*The art of conjecture*, Rocher, Monaco): the predictor must be "wary of suggesting that there is a 'science of the future' capable of identifying with assurance what will come to be." As a man of action, Berger addressed those we refer to as decision-makers to deplore the fact that, "crushed by petty tasks," they emerge from their slumber only for enough time "for hasty reflection." He invited them to place the notion of invention at the core of their thinking, because "today, everything, everywhere is being called into question anew."

Like it or not, there are always several possible future worlds, only one of which will eventually come to be. The real cannot be regarded as a given but must be explored, sought out, as a field of virtualities. Gaston Bachelard (1884-1962) observed along these lines that "the world is my provocation." Of the possible worlds, the one that will come to pass will always be the one we have taken the risk and responsibility of promoting. Futurology thus appears to be an "ethic" predicated on an anthropology. Its call for vigilance takes the specific form of the desire to unmask what are becoming the "future-bearing facts" and hence be open to the unexpected so as to make the best of it. By rejecting it, we condemn ourselves to bringing about the worst. Nothing exposes us more to insecurity than the desperate desire for security.

It may well be that, around such human nature and such an ethic, a genuine political innovation could reorganize society around an innovation dynamic that would gather together scientists, ordinary citizens and manufacturers in the hope that we can make ourselves heard by policymakers.

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France, the CGIAR and the evolution of the research-for-development mission

Yves Savidan[1]

When the Consultative Group on International Agricultural Research (CGIAR) was founded 35 years ago, its mission was to increase food production in developing countries. Sustainability was added in the 1980s. Today, poverty reduction is at the core the CGIAR mission. The French research system should re-examine its mission to combat poverty and thereby contribute — with its unique strengths, and with the other major national and international stakeholders in the sector — to achieving the Millennium Development Goals.

The mission and priorities of the Consultative Group on International Agricultural Research (CGIAR) have evolved considerably since its foundation in 1971. This has come in response to how the major international organizations perceived the major challenges to the planet and their interaction with agriculture in the broad sense.

When the CGIAR was founded 35 years ago, its mission was clearly to contribute to increasing food production in the countries of the South, consistent with Norman Borlaug's Green Revolution, itself the outgrowth of postwar efforts supported by the Ford and Rockefeller foundations. The aim was simply "to increase the pile of food in developing countries."[1]

Sustainability was added to the mission of the CGIAR in the 1980s. The solutions proposed by agronomists and geneticists were required to take conservation and/or better management of natural resources into account.

The mission was then altered extensively in the 1990s, in response to, and in harmony with, the international discussions at the time that led, with the United Nations Millennium Summit in September 2000, to the unanimous approval of the Millennium Development Goals (MDGs). Alongside the renewed objective of contributing to food security in a context of sustained development, the CGIAR took to heart the main MDGs, poverty reduction in particular. Its mission became "to achieve sustainable food security and reduce poverty in developing countries through scientific research and research-related activities in the fields of agriculture, forestry, fisheries, policy and environment."

Even as the CGIAR was embarking on a long period of structural reform, there was a sudden change of direction that had a very uneven impact, more or less rapidly, on the missions and programs of the various international agricultural research Centers supported by it. Major cross-cutting programs emerged, known as Challenge Programs, representing a marked opening of the System to international research partnerships, both upstream and downstream. The reality and scope of the change were probably felt even more clearly after the emergence of the new CGIAR System priorities, approved at the Annual General Meeting in Marrakech in December 2005. These priorities are tantamount to recognition, considered belated by some, of the value of diversity in plants and products, whether food crops or otherwise, that can boost the incomes of the poorest rural families. The CGIAR is firmly committed to intensifying small-scale family farming. Alongside the 22 food plants in the CGIAR's original mandate, a full range of "new" plants and products, such as fruits and vegetables, have been added to the priorities of the System. This is implicit recognition that the rural poor are not likely to emerge from their poverty by producing only a bit more rice, wheat or maize, but are more likely to do so by producing something else alongside the staples that are essential to their food security. This product must have a market and sell well.

The French research and development system has itself undergone many reforms during the same period. The restructurings resulted in a two-pronged approach with two large dedicated bodies, the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) and the Institut de la recherche pour le développement (IRD). France is now the last developed country to maintain targeted research and structures on a scale comparable to that of the CGIAR.

[1] www.cgiar.org/who/history/index.htm

In 2006, poverty reduction is clearly at the core of the CGIAR mission. But where does it stand in respect of French research for development? It is not yet expressly listed in the mission of any French research organization. Why not?

Is poverty not regarded as a question to which research should be devoted in France? Certainly, there is acknowledgment that poverty is one of the key challenges of the 21st century. It is known in this connection that the 2 billion inhabitants that will be added to the global population over the next 30 years, and that will have to be fed, will not be born in the rich countries. The developed countries, whether the United States or those in Europe, seem to place greater emphasis on building border protections than on reaching agreement to help strengthen agriculture in the South and develop markets that meet the needs of the poor. It is always simpler to build a wall than an alliance.

Research for development will not by itself eliminate rural poverty. That said, rural areas will not emerge from poverty without strong and targeted research for development. The Green Revolution demonstrated that it was possible to intensify agricultural production in the countries of the South. Unfortunately, this was not without perverse environmental and social effects. It was ultimately learned that this type of intensification could not be applied everywhere and by everyone. It did nevertheless make it possible to satisfy the food requirements of global urban populations. This stands as a major success of international agricultural research.

Forecasts are unanimous in confirming today that the population growth anticipated in the decades ahead will require a considerable increase in agricultural output. Some say it will be necessary to produce twice as much, while others say as much as three times more will be needed. This should come as a surprise to no one. Because this increase in production will not be possible through a proportional increase in the land areas under cultivation, a way will have to be found to increase the productivity of the land already in use. None of this will occur in the absence of major investments in international agricultural research. But where should such investment be made? How? And for whom?

Is it reasonable to envisage that a "doubly green revolution," as referred to by Griffon (see *The future and prospects for agricultural research* on page 151 of this volume), on farms that are already producing over 4 tons of grain per hectare, might enable the doubling of agricultural output that will be needed by the tropical world? Or, at the other extreme, should the emphasis be placed on a careful intensification of activity on poorly performing family farms? Here again, the answer seems to go without saying. Even urbanization continuing apace, 70% of the planet's poor still live in rural areas and remain dependent on agriculture and related activities. However, many live on land deemed marginal for agriculture, where the resource constraints are severe, and are unable to use this land to advantage. It will not be possible to feed 2 billion more mouths without improving the performance of these small-scale farmers. And there is no country in the South, even in the emerging economies, that is now or will in the future be able to afford the luxury of moving these small farmers into cities on the pretext of land redistribution and intensification.

As I. Serageldin wrote: "It is essential to correct the policy and investment bias in favor of cities, on pain of finding that scientific excellence, the finest programs and the best approaches go for naught."

While case studies such as those in India and China conducted by the International Food Policy Research Institute (Meinzen-Dick et al. 2004) show clearly that agricultural research has played a major role in the evolution of poverty in these two large countries in recent decades (Table 1), they also show that the bulk of the gains stem from research conducted prior to 1990. Since that time, investment in rice research has slowed, and the increases in yields observed each year are slowing as well. An urgent need exists both to revitalize research and to propose new solutions, and this is particularly true as regards improving production in the marginal areas where the poorest are concentrated.

In the early 1960s, two-thirds of India's population lived below the conventional poverty line of "a greenback a day." By the end of the 1980s, the proportion of the poor had dropped to one-third. According to official statistics in China, the proportion of poor fell from a third in 1970 to a tenth in 1984. The relative importance of the various types of investment listed in Table 1 have changed over time. Investment in irrigation, for example, yields much less today than it did in the 1970s. The investments with the greatest impact on poverty reduction today are clearly those in the marginal areas that depend on rainfed crops.

Table 1. Impact of various types of investment on yields and rural poverty in India (from Meinzen-Deck et al. 2004)

	Impact on yields		Impact on poverty	
	Percentage	Rank	In rupees (millions)[a]	Rank
Research and Development	6.0	1	84.5	2
Roads	2.4	2	123.8	1
Education	0.6	3	41.0	3
Irrigation	0.6	4	9.7	7
Electricity	0.1	8	3.8	8
Soil and water	0.4	6	22.6	5
Rural development	0.5	5	25.5	4
Health	0.4	7	17.8	6

[a] *1 million rupees = approximately €18,000.*

Analysts have calculated that the benefits associated with national and international rice research exceeded the amounts invested in that research by a factor of 10. Studies in India make it possible to estimate that 4.6 million individuals emerged from poverty each year between 1991 and 1999 as a consequence of research on rice varieties. There is room for discussion of the definition used for poverty, in particular in terms of access to other basic rights beyond food, namely education, health, freedom of expression, etc. In particular, the investments made in the past appear to have rather little impact on the poorest rural families, except indirectly; when they now go to sell their surplus rice, maize or wheat on the market, they derive only an extremely meager income because the prices of these basic agricultural commodities, which are controlled from afar, are extremely low and expected to remain low.

Research can have an extremely great impact on poverty in these areas if it is specifically targeted on the small farming operations there. The upstream research of the Green Revolution aimed only to increase agricultural production globally. It had the anticipated impact. In France, the dominant subject of discussion currently is generic agricultural research, with many maintaining that there is no agricultural research for development distinct from agricultural research. Many think that the two should be merged because they both use the same principles and the same technologies, which is largely true. In support of this argument, some go so far as to repeat that it is particularly necessary to avoid making research for development a new ghetto. Of course this is so. But everywhere that this great principle of genericity has been applied, targeted research, and particularly research that could have an impact on small family farming for the poorest rural residents, has simply disappeared. Who is currently raising serious arguments before the French supervisory ministries in favor of targeted research — research to combat poverty that is not carried out in isolation from leading-edge generic research? Why would such research constitute a ghetto? It requires quality generic research, including the most advanced forms of it.

Operations like the Generation Challenge Program of the CGIAR, which targets drought, and HarvestPlus, which targets nutrition, show clearly that the two kinds of research are not incompatible. Any reform poses the danger of moving on to restructuring before giving serious thought to strategic directions. French research for development is an original and unique component of the broad range of research for the South. It should re-examine its mission, more than its structure, to become a research system that combats poverty and thereby contributes — with its unique strengths, and with the other major national and international stakeholders in the sector — to achieving the Millennium Development Goals to which France is committed.

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Reference

Meinzen-Dick R, Adato M, Haddad L, Hazell P. 2004. Science and poverty: An interdisciplinary assessment of the impact of agricultural research. Food Policy Report No. 16. International Food Policy Research Institute; Washington, DC.

Abbreviations

ACTA	Association de coordination technique agricole (Association for Agricultural Technical Coordination), France
ACTIA	Association de coordination technique pour l'industrie agoalimentaire (Association for the Coordination of the Agroalimentary Industry), France
ADAR	Agence de développement agricole et rurale (Agricultural and Rural Development Agency), France
ADB	Asian Development Bank, Philippines
AEGIS	A European Genebank Integration System
AFSSA	Agence française pour la sécurité sanitaire des aliments (French Agency for Food Health Security), France
AIT	Asian Institute of Technology, Thailand
ANR	Agence nationale de la recherche (National Research Agency), France
APFORGEN	Asia Pacific Forest Genetic Resources Program
ARD	agricultural research for development
ARI	advanced research institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BC	backcross
BFP	basin focal project of CPWF
BRG	Bureau des ressources génétiques (Genetic Resources Bureau), France
BSE	bovine spongiform encephalopathy (mad cow disease)
BUROTROP	Bureau pour le développement de la recherche sur les oléagineux tropicaux (Bureau for the Development of Research on Tropical Perennial Oil Crops), France
CARBAP	Centre africain de recherches sur bananiers et plantains (African Centre for Research on Banana and Plantain), Cameroon
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agriculture Research and Training Center), Costa Rica
CBD	Convention on Biological Diversity
CCDE	Comité consultatif de déontologie et d'éthique (Consultative Committee on Professional and General Ethics) de l'IRD, France
CD-ROM	read-only memory compact disk
CEMAGREF	Centre national du machinisme agricole, du génie rural, des eaux et forêts (National Agricultural Machinery Center for Rural Engineering, Water, and Forests), France
CENICAFÉ	Centro Nacional de Investigaciones de Café (Colombian National Coffee Research Center), Colombia
CERAAS	Centre régional d'étude pour l'amélioration de l'adaptation à la sécheresse (Regional Centre for Studies on the Improvement of Plant Adaptation to Drought), Senegal
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical International (International Center for Tropical Agriculture), Colombia
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center), Mexico
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (French Agricultural Research Center for International Development), France

CIRAD-FLHOR	Centre de coopération internationale en recherche agronomique pour le développement, Département des productions fruitières et horticoles (Fruit and Horticultural Crops Department of CIRAD), France
CNER	Comité national d'évaluation de la recherche (National Committee for Research Evaluation), France
CNRS	Centre national de la recherche scientifique (National Center for Scientific Research), France
COLCIENCIAS	Instituto Colombiano para el Desarrollo de la Ciencia y Tecnología (Colombian Institute for the Development of Science and Technology), Colombia
ComMod	companion modeling
CONARROZ	Corporación Arrocera Nacional (Costa Rican Rice Corporation), Costa Rica
COP	Conference of the Parties to the Convention on Biological Diversity
CORAF/WECARD	Conseil ouest et centre africain pour la recherche et le développement agricole/West and Central African Council for Agricultural Research and Development
CNEARC	Centre national d'études agronomiques des régions chaudes (French Institute for Teaching and Training in Tropical and Subtropical Agricultural Studies), France
CNPAF-EMBRAPA	Centro Nacional de Pesquisa do Arroz e Feijão (National Rice and Beans Research Center) of EMBRAPA
CPWF	Challenge Program on Water and Food of the CGIAR
CRAI	Commission de la recherche agricole internationale (International Agricultural Research Commission), France
CRYMCEPT	Establishing cryopreservation methods for conserving European plant germplasm collections (EU-funded project)
DNA	deoxyribonucleic acid (cDNA = capture DNA, tDNA = target DNA)
EAN	Estaçao Agronomica Nacional (National Agricultural Station), Portugal
ECART	European Consortium for Agricultural Research for the Tropics
ECG	European Coordination Group
Echel-Eau	Water Resources Integrated Management Tools: Applications for the Limpopo, Mekong and Niger Basins (CPWF project funded by the French Ministry of Foreign Affairs)
ECP/GR	European Cooperative Program for Crop Genetic Resources
EEIG	European Economic Interest Grouping
EFARD	European Forum on Agricultural Research for Development
EHESS	Ecole des hautes études en sciences sociales (School for Advanced Studies in the Social Sciences), France
EIARD	European Initiative for Agricultural Research for Development, Belgium
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation), Brazil
ENGREF	Ecole nationale du génie rural des eaux et des forêts (French Institute of Forestry, Agricultural and Environmental Engineering), France
ERA	European Research Area
ERA-ARD	Agricultural Research for Development dimension of the European Research Area
ETFRN	European Tropical Forest Research Network
EU	European Union
EUFORGEN	European Forest Genetic Resources Program
EURISCO	European Internet Search Catalogue of the ECP/GR
ExCo	Executive Council of the CGIAR
FAO	Food and Agriculture Organization of the United Nations

FAnGR	farm animal genetic resources
FARA	Forum for Agricultural Research in Africa
FEDEARROZ	Federación Nacional de Arroceros (National Federation of Rice Producers), Colombia
FHIA	Fundación Hondureña de Investigación Agrícola (Honduran Agricultural Research Foundation), Honduras
FONTAGRO	Fondo Regional de Tecnología Agropecuaria (Regional Fund for Agricultural Technology), Latin America
G×E	genotype-by-environment (interaction)
GCDT	Global Crop Diversity Trust, Italy
GDP	gross domestic product
G-EAU	Gestion de l'eau, acteurs et usages (joint research unit), France
GFAR	Global Forum on Agricultural Research, Italy
GGP	Groundnut Germplasm Project, West and Central Africa
GIP	French public interest group
GIS	French scientific interest group
GIS	geographic information system
GMO	genetically modified organisms
GRUMEGA	Grupo de Mejoramiento Genético Avanzado de Arroz (Working Group on Advanced Rice Breeding), LAC
GSP	Groundnut Seed Project, Africa
GTZ	Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation), Germany
ha	hectare
IAR4D	integrated agricultural research for development
IARC	international agricultural research center
ICARDA	International Center for Agricultural Research in the Dry Areas, Syria
ICGN	International Coffee Genomics Network
Ecor (I) Asia	Ecoregional Initiative for the Humid and Subhumid Tropics of Asia
ICRA	International Centre for development oriented Research in Agriculture, France and Netherlands
ICRISAT	International Crops Research Institute for Semi-Arid Tropics, India
IDRC	International Development Research Centre, Canada
IFAD	International Fund for Agricultural Development, Italy
IFPRI	International Food Policy Research Institute, USA
IFREMER	Institut français de recherche pour l'exploitation de la mer (French Research Institute for Exploitation of the Sea), France
IICT	Instituto de Investigação Científica Tropical (International Institute of Tropical Agriculture), Portugal
IITA	International Institute of Tropical Agriculture, Nigeria
ILRI	International Livestock Research Institute, Ethiopia and Kenya
ILRAD	International Laboratory for Research on Animal Diseases (ILRAD, now ILRI)
IMF	International Monetary Fund, USA
IMTP	International Musa Testing Program
INCO	Specific International Cooperation Activities program of the European Union

INIBAP	International Network for the Improvement of Banana and Plantain, France and Belgium
INRA	Institut national de la recherche agronomique (National Institute for Agricultural Research), France
INRM	integrated natural resource management
INSERM	Institut national de la santé et de la recherche médicale (National Health and Medical Research Institute), France
IPGRI	International Plant Genetic Resources Institute, Italy
IPM	integrated pest management
IPTRID	International Programme for Technology and Research in Irrigation and Drainage of FAO, Italy
IR64	popular modern rice variety
IRAD	Institut de recherche pour le développement (Institute of Agricultural Research for Development), Cameroon
IRD	Institut de recherche pour le développement (Development Research Institute), France
IRRI	International Rice Research Institute, Philippines
ISNAR	International Service for National Agricultural Research, Netherlands (now subsumed by IFPRI)
ISRA	Institut sénégalais de recherches agricoles (Senegalese Agricultural Research Institute), Senegal
ITFF	Institut technique français des fromages (French Technical Institute for Cheese), France
IWMI	International Water Management Institute, Sri Lanka
IWRM	integrated water resource management
km2	square kilometer
kPa	kilopascal (measure of soil hydric potential)
LAC	Latin America and the Caribbean
MDG	Millennium Development Goals
MGIS	Musa Germplasm Information System
MNHN	Muséum national d'histoire naturelle (National Museum of Natural History), France
mm	millimeter
mm3	cubic meter
M-POWER	Mekong Program on Water, Environment and Resilience of the CPWF
MSEC	Management of Soil Erosion Consortium
NARES	national agricultural research and extension system
NARS	national agricultural research system
NATURA	Network of European Agricultural (Tropically and Subtropically Oriented) Universities and Scientific Complexes Related with Agricultural Development
NERICA	new rices for Africa
NGO	nongovernmental organization
OECD	Organisation for Economic Co-operation and Development
ORSTOM	Office de la recherche scientifique et technique outre-mer (Institute for Scientific and Technical Research Overseas, now IRD), France
PCSI	Programme commun sur les systèmes irrigués (Common Program on Irrigated Systems), France
PLS	pilot learning site of the SSA-CP

R&D	research and development
REDARFIT	Red Andina de Recursos Fitogenéticos (Andean Plant Genetic Resources Network), South America
RYMV	rice yellow mottle virus
S&T	science and technology
SAFORGEN	Sub-Saharan African Forest Genetic Resources Program
SAM	Systèmes agraires de montagnes (Mountain Agrarian Systems) Program, Vietnam
SSA-CP	Sub-Saharan Africa Challenge Program of the CGIAR
UMR	unité mixte de recherche (joint research unit)
WARDA	West African Rice Development Association now the Africa Rice Center, Côte d'Ivoire
WFP	World Food Programme of the United Nations, Italy
WTO	World Trade Organization, Switzerland