MODULE 6

Creating an Enabling Environment for Agricultural Innovation

OVERVIEW

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EXECUTIVE SUMMARY

The "enabling environment" for agricultural innovation encompasses factors that influence agricultural innovation positively but are controlled by policy domains other than agricultural innovation policy. An agricultural innovation policy seeks coordination with these other domains to ensure that together they enable agricultural innovation. Cross-cutting policy issues affecting agricultural innovation include policies to reduce poverty and sustain the environment, to foster collaboration between the public and private sectors, and to build social capital more generally.

Three clusters of enabling factors for agricultural innovation appear to require attention and investment in most developing countries: (1) *innovation policy* and corresponding governance structures to strengthen the broader framework for agricultural innovation policies; (2) *regulatory frameworks* that stimulate innovation directly (such as IPRs) or indirectly (standards that stimulate trade) or steer innovation towards certain preferred outcomes (safer food); and (3) *accompanying agricultural investments* in rural credit, infrastructure, and markets.

Innovation policy is a new area, and in most countries the governance structure for innovation is only starting to emerge. A particular challenge is where to assign responsibility for innovation policy within the government structure. Some countries delegate this task to the ministry in charge of science and technology, while others establish a higher-level entity that brings relevant ministries together to coordinate national innovation policy. In most countries, the overall objective of the national innovation policy is to facilitate the transition toward a *knowledge economy*, resulting in increased competitiveness and sustainable economic growth. A national innovation policy defines the roles and functions of actors and stakeholders within the national innovation system (NIS), provides an overall framework for innovation policies specific to particular sectors, and sets priorities across sectors and technologies. It creates positive conditions for innovation by investing in public goods essential for an innovative knowledge economy.

Regulatory frameworks important for agricultural innovation include those for IP; biosafety; and standards and technical regulations related to agricultural health and food safety and quality aspects. Countries will need assistance to develop legislation, assess the options from which they can choose, develop their regulatory agencies, and invest in standards-related infrastructure.

Better coordination of agricultural innovation investments with accompanying rural investments should lead to greater synergy and impact. Investments in rural financing systems will adopt a more holistic approach to financial services, including credit, savings, money transfers, leasing, and insurance. Investments in roads and market institutions and

infrastructure help to improve agricultural productivity, reduce marketing costs, increase profit margins, and open up new opportunities for innovation.

These policies, investments, and regulatory reforms will trigger significant changes, such as improving the access of agricultural products to foreign markets, increasing private investment in agricultural R&D, and fostering the use of more sustainable agricultural practices. Policy measures will be needed to ensure that people are not left behind and make the transition to more promising economic activities.

RATIONALE FOR INVESTMENT

A key characteristic of the innovation systems approach is its holistic perspective on innovation as a multifaceted, iterative process that is very much shaped by the context within which it takes place. For that reason, national innovation policies are usually formulated as overarching policies trying to coordinate a wide spectrum of policy domains—science and technology policy, education policy, economic policy, industrial policy, infrastructure policy, taxation policy, and justice policy, among others—in such a way that together they create an environment that enables and stimulates innovation in the most positive way. Such overarching coordination is only possible with strong, high-level political support, often in the person of the prime minister or president chairing the council in charge of national innovation policy.

Sector-specific innovation policies (such as the policy for agricultural innovation) more or less replicate the national innovation policy's overarching and coordinating nature, but they will often have considerably less political clout to influence policies outside their domains. For example, a sector-specific innovation policy will have little influence over the adoption of a tax regime for R&D. Such a matter is more often dealt with at the national level.

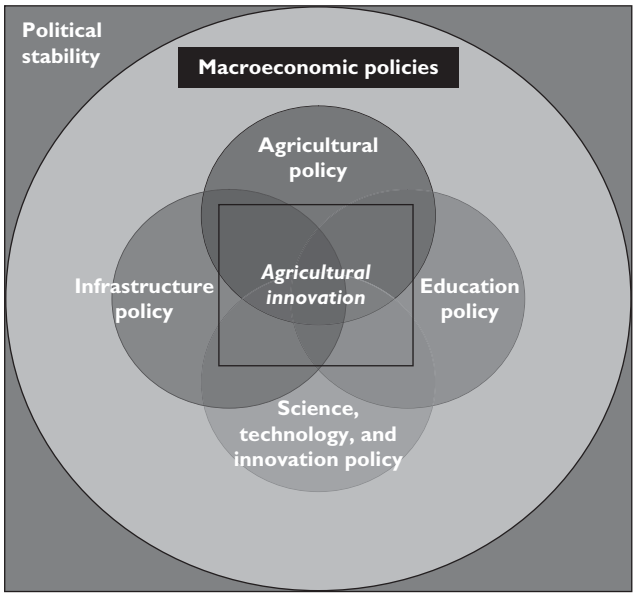
One problem with the holism of the innovation system approach is that it tends to incorporate its enabling environment. Because innovation systems (or for that matter any soft system) do not exist "out there" as objective entities or realities but rather exist only "in the minds of those who define them" (Daane 2010), there is no natural delineation between what is core to an innovation system and what should be considered its enabling environment. An artificial but potentially practical solution to this problem is to define the "enabling environment" as those factors that influence agricultural innovation positively but that are controlled by policy domains other than the domain of agricultural innovation policy per se. An agricultural innovation policy will have to interact and seek coordination with these other policy domains to ensure that together they enable agricultural innovation in the most positive way. This interaction may possibly lead to collaboration in the form of joint projects or programs, although not necessarily.

The agricultural innovation policy landscape

Figure 6.1 sketches the most relevant policy domains shaping agricultural innovation. At the most aggregate level, *political stability* is by far the most critical, overarching factor for any innovation system. Without such stability, investments in innovation activities (particularly those with long time horizons, such as plant breeding) are too risky to be attractive. Moreover, war and civil unrest often affect the knowledge infrastructure (research stations are destroyed, libraries plundered, and so on) and, by uprooting people, lead to a loss of knowledge and experience of agricultural practices and trade relations.

At the same time, it is important to realize that innovation in itself can be very destabilizing, because it comes with what Schumpeter labeled "creative destruction." New products and new production methods take over from old ones and in that process destroy old jobs, vested interests, and sometimes whole industries. As a result, innovations may encounter much opposition and catalyze social unrest. Creating new opportunities for those who lose their jobs

Figure 6.1 Policy Spheres Shaping the Environment for Agricultural Innovation



Source: Author.

(for example, by offering training to acquire new skills) is one of those measures that should accompany innovation to help reduce friction.

At the next level, *macroeconomic policies* dealing with taxation, exchange rate, market, and trade policies and similar matters can have an important impact on the relative competitiveness of agriculture in regional and global markets. In developing countries, many of these policies work against agriculture. They result in a net taxation of agriculture that hampers agricultural growth and innovation. Economic reform programs for the past twenty-five years have addressed this macroeconomic imbalance with some success (World Bank 2007b), but it remains a cause for concern and policy attention, especially considering that developed countries heavily subsidize agriculture to the detriment of developing countries. Consensus is growing (amid concern over rising food prices) that agriculture has been relatively neglected in developing countries by both donors and governments and that agricultural budgets have to be raised. The economic reform agenda focused initially only on improving the productivity and competitiveness of the agricultural sector. Over the years, however, poverty reduction and environmental sustainability have become equally important objectives. This expanded policy agenda also affects public investment decisions related to agricultural innovation. The big challenge for policy makers is to decide how to handle trade-offs between the different objectives.

At the meso level, four policy domains have the most direct influence on agricultural innovation: (1) agriculture; (2) science, technology, and innovation (STI); (3) education; and (4) infrastructure. These domains overlap considerably, and it is not always clear which domain should lead when it comes to investments. For example, agricultural research can be paid out of the agricultural budget or the science and technology budget. The scope of these different policy domains is also usually broader than agricultural innovation per se. An important task for an agricultural innovation policy is to influence and coordinate these policy domains (including investment decisions in those domains) so that they create the best environment for agricultural innovation to prosper. Each policy domain is described in detail in the sections that follow.

Agricultural policy. An agricultural policy usually comprises a wide range of topics, including agricultural health, research and extension, input supply, rural credit, land reform and improvement, rural infrastructure, market regulation and development, trade promotion, and sector organizations (farmer organizations, cooperatives, commodity boards, and the like). Some of these topics fall fully within the agricultural innovation policy orbit—agricultural research and extension, for example—whereas others partially overlap. Coordination between these various topics is important, because many of them complement each other. For example, the lack of rural credit often restrains the exploitation of market opportunities and new technologies.

A crucial element in agricultural transformation is farmers' integration into markets. With farmers' increasing integration into markets, market institutions (commodity chain organizations are one example) and regulations (such as product and health standards) become more important and require attention and investment. While agriculture-based economies depend on self-sufficiency for food security, urban economies depend on markets (including international markets) for food security.

Education policy. Agricultural education and training are core components of an AIS (see module 2), but they are also part of a broader national education policy that plays an enabling role. There is a strong positive correlation between primary education enrollment rates and agricultural productivity. The effectiveness of agricultural extension and training programs depends strongly on the basic skills that farmers acquire through primary education. At the same time, basic educational skills are important for those who seek employment outside agriculture.

In many developing countries, *vocational education* at the secondary level is virtually nonexistent (UNESCO education statistics),[1] and job specialization starts only after secondary school. Elsewhere a long tradition of vocational education at the secondary level equips the next generation of farmers with skills and knowledge. Despite the considerable debate about the disadvantages of forcing young people to make career choices early in life, the problem with waiting too long is that most students never reach the tertiary level. Tertiary education usually targets the more specialized jobs in agriculture, which may not necessarily be the best preparation for an all-round farmer (module 2). Promoting the introduction or expansion of vocational training in agriculture at the secondary level should advance agricultural innovation, but it will require many countries to rethink their national education policies.

Science, technology, and innovation policy. In recent years, many developing countries—especially middle-income countries—have started to recognize the crucial role of innovation in economic growth and are aiming to

make the transition toward a knowledge economy. As a consequence, STI policy is rapidly gaining importance in these countries.

This new emphasis on STI significantly affects the public agricultural research and extension services that pre-date STI initiatives by several decades. After many decades of relative isolation within ministries of agriculture, these agencies must now interact with new STI agencies that have a far wider scope that requires agricultural research and extension to compete with nonagricultural topics for resources.

Infrastructure policy. Innovation opportunities often depend strongly on infrastructure such as roads, railways, utilities, and irrigation systems. High transportation costs are notorious for cutting heavily into the prices farmers and agribusinesses receive for their products and raising the costs of the agricultural inputs they purchase. When farmers and agribusinesses find it unprofitable to produce for the market, agricultural production often remains below its potential. It is affordable access to markets that makes it worthwhile and feasible to adopt new technologies, specialize, and raise production. The economic impact of lower transportation costs and improved market access can be quite dramatic (see box 6.2 later in this overview). As illustrated in IAP 1 for Zambia, investments in improved feeder roads can be an essential component of efforts targeted at enhancing agricultural innovation, value addition, and competitiveness.

Key enabling factors

The agricultural innovation policy landscape depicted in figure 6.1 comprises a wide range of enabling factors that are critical to agricultural innovation. It is impossible to cover them all, but the more important ones can be clustered as follows:

- Investments in innovation policy and corresponding governance structures that strengthen the broader framework for an agricultural innovation policy.
- Investments in regulatory frameworks affecting agricultural innovation, such as IPRs, sanitary and phytosanitary (SPS) measures, and biosafety regulations, aim to stimulate private actors to invest in innovation, improve the quality and safety of their products, and/or facilitate trade.
- Accompanying rural investments such as investments in rural credit, rural infrastructure (irrigation, roads, and utilities), and agricultural markets.

PAST EXPERIENCE

Experiences with investments in enabling factors have been quite mixed. Some types of investment have been around for decades (if not centuries—witness rural infrastructure), whereas others have emerged only very recently (biosafety regulations). Hence these interventions have quite different track records, as discussed next.

Innovation policy and governance structures

Investment in a national innovation policy and corresponding governance structures strengthens coordination across policy domains on innovation issues, addresses issues relevant across sectors (such as IPRs or tax deductions for innovation), provides a framework for more sector-specific innovation policies (including an agricultural innovation policy), and, not unimportantly, prioritizes public innovation investments across sectors. In many instances, national innovation policy has generated a substantial influx of new ideas and instruments into the agricultural innovation domain, including such concepts as business incubators and risk capital (see module 5). Embedding agricultural innovation policy in the national innovation policy may provoke inevitable complications and frictions, but at the end of the day it should result in a stronger AIS.

Innovation policies were first implemented in developed countries in the 1990s and have been emerging in developing countries only in the decade since then. In most countries, innovation policies and their accompanying governance structures are still very much in flux; in fact, the large majority of developing countries, particularly the smaller ones, still lack an innovation policy. In this sense, the historical record of innovation policy is still very short, both in developing and developed countries.

Regulatory frameworks

Except for environmental standards, the other three regulatory frameworks (IPRs, SPS standards, and product standards) have been around for decades, if not centuries. The international standardization and mutual recognition of these frameworks have been on the political agenda for quite some time. The Paris Convention for the Protection of Industrial Property, launched in 1883, was one of the first international treaties on IPRs. It has been revised many times and gained numerous signatories since then. Globalization and intensified trade have put increased pressure on countries to adopt these frameworks; the international

community supports them strongly, and several international initiatives provide technical assistance and build capacity to implement them.[2]

One type of IPR that is quite specific to agriculture is plant variety rights (PVRs). In developed countries in particular, PVRs have been instrumental in developing a private seed industry and enabling public plant breeding to be funded through royalties. Only 68 countries are currently members of the International Union for the Protection of New Varieties of Plants (UPOV)[3], indicating an absence of PVR legislation consistent with UPOV standards. Membership is especially weak in Africa and Asia.

Considerable debate surrounds the introduction of PVR legislation in developing countries, many of which are under pressure to introduce legislation to meet the deadline (originally 2005, now 2016) set by the TRIPS[4] agreement. The debate focuses particularly on two issues. The first issue is farmers' rights in relation to breeders' rights: To what extent can farmers re-use, exchange, or sell PVR-protected seed? The second issue is the role of farm communities as custodians of genetic diversity: Should seed companies compensate communities for their services? With respect to the second issue, UPOV takes the position that farmers' customary role as curators of genetic resources is best regulated separately from PVR legislation. On the issue of farmers' rights, UPOV has moved over time toward a more restrictive standard favoring plant breeders. The criticism of developing countries is that UPOV is pushing for the adoption of developed country standards that are not necessarily adequate for developing countries (box 6.1).

Box 6.1 Plant Variety Rights Legislation in Africa

In 1998, the Heads of State of the African Union (AU) adopted the "African Model Law for the Protection of the Rights of Local Communities, Farmers, and Breeders, and for the Regulation of Access to Biological Resources." This watershed document addresses two issues—plant variety protection and access to biological resources—based on the premise that both issues are closely linked. The AU model law strongly favors farmers' rights over breeders' rights: PVRs can be withheld or nullified for reasons such as food security, health, biological diversity, and any other requirement of the farming community for propagation material of a particular variety. The model law also emphasizes the protection of Africa's biological resources and traditional knowledge.

The model law was criticized heavily by UPOV and WIPO.[a] Discussions between the AU, UPOV, and WIPO in 2001 did not reconcile their differences. Yet the AU member states did not hold a unified position on the issues. Some members (Egypt, Kenya, South Africa, and Tunisia) belonged to UPOV many years before the AU developed its model law. In 2002 the African intellectual property organization OAPI,[b] comprising some 16 Francophone African countries, approved a plant variety protection (PVP) chapter largely in line with UPOV standards as part of the 1999 Bangui Agreement. This decision was taken despite major opposition by international nongovernmental organizations.

In more recent years, the discussion in Africa regarding PVP has moved from the AU to the subregional economic communities, such as ECOWAS, SADC, and EAC.[c] Their strategy is to harmonize the (emerging) seed regulatory frameworks within their communities to facilitate trade and to join forces where possible to reduce regulatory costs. For example, ECOWAS and SADC each recently adopted the idea of setting up a common variety release system in their respective communities. Both communities have initiatives to work toward an integrated, regional PVP system. SADC, for example, developed a draft protocol for national PVP legislation. In other developing regions, regional economic communities are keen promoters of standardizing PVP systems. Most African countries seem to be moving toward adopting a PVP system that is compatible with the international UPOV standard—but only after much heated debate.

Source: Author.

a. UPOV is the International Union for the Protection of New Varieties of Plants and WIPO is the World Intellectual Property Organization. b. OAPI (Organisation Africaine de la Propriété Intellectuelle) was created in the early 1960s to replace the French institute in charge of IPRs prior to independence. It manages a single IPR system across 16 countries. c. Economic Community of West African States, Southern African Development Community, and East African Community.

Accompanying rural investments

Most countries have a long history of addressing enabling factors such as rural credit, rural infrastructure, and agricultural markets. In many instances, government interventions in these factors in the form of direct investment or facilitating private or mixed investment have been far from adequate and often rather fragmented, lacking attention to coherence among interventions. To cite a recent World Bank evaluation report on agricultural investments in sub-Saharan Africa):

> ...the lending support provided by the Bank has not reflected the interconnected nature of agriculture activities. Rather, the lending has been "sprinkled" across an array of activities in rural space, including research, extension, marketing reform, drought relief, seed development, and transport, but with little recognition of the relationships among them and the need for all of these areas to be developed at the same time, or at least in an optimal sequence, to effectively contribute to agricultural development. While the Bank's broader rural focus from the mid-1980s was justified, an unintended result was that it led to less focused attention on the need for various activities that are critical for agricultural development in rural space to come together at the same time or to take place in some optimal sequence. (World Bank 2007a, xxv)

Rural credit. The lack of working capital and access to affordable credit often prevents farmers and agribusinesses from buying modern inputs and equipment and fully benefiting from proven technological opportunities. Despite many attempts to address this issue, lack of affordable rural credit remains a major bottleneck in many countries. The formal banking sector is still largely absent from rural areas, because it perceives the risks and transaction costs to be too high to make business attractive. Popular rural credit schemes run by governments from the 1950s to the 1980s did little to attract commercial banks and proved unsustainable because of poor management and high default rates. The microfinance movement that emerged in the late 1990s tried to bridge the rural finance gap through self-help groups, which absorb the high costs inherent in small transactions and use social control to reduce risks (IAP 4). This approach has its limitations, and the model has not succeeded everywhere.

What is needed is a more active involvement of commercial banks in agriculture. Previous approaches tended to isolate financing for agriculture from the development of the wider financial system and overemphasized credit as opposed to savings and other financial services. Within a financial systems approach, however, financing for agriculture is viewed as part of the wider rural finance market. Underpinning this approach is the fact that institutions adhering to commercial principles are more likely to achieve outreach and sustainability. The public sector's role is to concentrate on ensuring that the environment is conducive to the emergence and growth of such institutions (World Bank 2006).

For example, the Innovative Finance Initiative of the Alliance for a Green Revolution in Africa tries to mobilize commercial banks to provide more credit to the agricultural sector through a loan guarantee scheme. By absorbing some of the risks that commercial banks run when lending to agriculture, the initiative has managed to leverage some US$4 billion from commercial banks in the form of affordable loans for farmers and agribusinesses (www.agra-alliance.org).

Another practice that has fallen out of favor is to use subsidized credit to introduce new technologies. Such schemes have often undermined farmers' repayment discipline because farmers considered the subsidies to be gifts rather than loans. Jump-starting the introduction of a new technology is best done through a direct subsidy (starter packets at reduced costs, for example).

Rural infrastructure. Early research on economic growth illustrated the importance of infrastructure, provided that: (1) a good balance was maintained with other investments and (2) infrastructure and related services were run efficiently. More recent econometric research suggests that infrastructure investment and improvement may have received too little attention in the lowest-income countries. There are also signs that rapidly growing middle-income countries have underinvested in infrastructure, leading in some cases to geographic patterns of development that hamper economic growth (Willoughby 2002). Other recent studies of infrastructure investments conclude that:

- ***Institutional reforms are needed*** to strengthen the capacity of local and regional governments to formulate and implement an infrastructure policy and to strengthen the capacity of infrastructure organizations to provide customer-responsive services.
- ***Institutional reforms in the more advanced countries led to greater involvement of the private sector*** in investing and managing infrastructure, which requires improved capacity at the government level to run transparent tender procedures and maintain open competition.
- ***Decisions to invest in infrastructure should focus*** on regions that lag in economic development.

Box 6.2 Economic Impact of Rural Roads in Bangladesh

A detailed econometric study of the impact of investments in rural roads in Bangladesh found substantial savings in household transport expenses, averaging about 36 percent in villages participating in the Rural Development Project (RDP) and 38 percent in villages participating in the Rural Roads and Market Improvement and Maintenance Project (RRMIMP). Road improvement also significantly affected men's agricultural wages (which rose by 27 percent in RDP villages), fertilizer prices (which fell by about 5 percent in RDP and RRMIMP areas), and aggregate crop indices (prices increased by about 4 percent in both project samples, whereas production increased by about 38 percent in RDP and 30 percent in RRMIMP villages). The road effects are substantial for adult labor supply in RDP villages and schooling of both boys and girls. The overall effect of road improvement on per capita consumption was estimated at 11 percent in both project areas.

This study clearly shows that investment in rural roads unleashes the agricultural production potential of rural areas. The supply response to what looks like modest input and output price changes is quite dramatic in the study areas. Much of this additional production found its way to the market.

Source: Khandker, Bakht, and Koolwal 2006.

Despite broad agreement about the importance of rural roads for linking farmers with markets, surprisingly little statistical evidence exists on the size and nature of the benefits of rural roads or their distributional impacts. Isolating the impact of investments in rural roads on agricultural productivity from other enabling factors is not only challenging (Walle and Cratty 2004), but many other benefits must be considered—higher wages, better access to schooling and health services, and so forth (see box 6.2).

Another rural infrastructure investment, irrigation, is considered an innovation in its own right as well as an important enabler of agricultural innovation more generally. A key reason cited for the limited impact of Green Revolution technology (improved varieties in combination with modern inputs) in sub-Saharan Africa is the very limited area under irrigation in comparison to other regions, particularly Asia. The underlying problem is that investment costs per irrigation unit are many times higher in sub-Saharan Africa than in Asia. Irrigation investment projects also tend to fail more often in sub-Saharan Africa. The World Bank's Operations Evaluation Department identified specific weaknesses in irrigation investment projects, including irrigation system design, operation and maintenance, cost recovery, and user groups. For example, cost-recovery schemes did not improve operation and maintenance because revenues went into the general treasury. Despite these weaknesses, World Bank irrigation projects report good returns on average, but these projects require above-average preparation and oversight because of their complexity.

Market institutions and infrastructure. Investment in market institutions and infrastructure was greatly affected by the market liberalization ideology that dominated the economic policy debate during the 1980s and 1990s. During the 1960s and 1970s, many governments played an active, direct role in agricultural markets, and donors provided significant direct investment in state-owned companies, government-controlled cooperatives, and public marketing agencies. When these government-dominated systems fell into disgrace because of their poor performance, donor support for them evaporated. Difficult, lengthy, and sometimes disruptive processes of privatization and market liberalization marked the ensuing transition to private market-based systems. It took some time to realize that well-functioning markets would not inevitably emerge (and foster agricultural innovation); some form of government assistance is often needed. Attention has recently focused on strengthening a new architecture for agricultural market institutions and incentives, promoting private commercial activity, and reorienting state activity to providing enabling regulatory and physical infrastructure; as a result, donor investments in market institutions have begun to increase again (World Bank 2006).

KEY POLICY ISSUES

Aside from the more thematic policies that shape agricultural innovation, discussed previously, several cross-cutting policy issues affect agricultural innovation. They include

policies to reduce poverty and sustain the environment, to foster collaboration between the public and private sectors, and to build social capital more generally.

Poverty reduction and environmental sustainability

The impact of investments in agricultural innovation has been measured mainly in terms of improvements in agricultural productivity (see the numerous rate-of-return studies). Over the years, however, environmental sustainability and poverty reduction have assumed equal importance as outcomes of agricultural innovation. This changed perspective affects not only the orientation of investments in agricultural innovation but investments in enabling factors. An environmental sustainability assessment is standard procedure for major investment projects in most countries. The poverty alleviation impact of new technologies is often difficult to assess ex ante, however. In this sense, innovation in itself is a rather crude poverty alleviation instrument, in contrast to enabling factors such as investments in rural infrastructure or rural credit, which can be targeted far more specifically to the poor.

Public-private collaboration

With widespread adoption of the market-economy model, many governments are minimizing direct intervention in the economy and, where possible, leaving things to the private sector. When government intervention is unavoidable, governments are delegating or contracting implementation to the private sector as much as possible. For example, in closing the rural finance gap, the preferred approach now is to involve commercial banks (often by subsidizing them to take on less profitable rural loans) or microfinance schemes rather than to establish government-owned rural banks. The construction of rural infrastructure is contracted out to the private sector, which is increasingly contracted to handle infrastructure operations and maintenance as well.

A primary objective of many national innovation policies is to create the right incentives for private investment in innovation. Governments can use five important instruments to stimulate private investment in innovation: (1) IPR legislation; (2) tax deductions and subsidies for R&D; (3) antitrust legislation (because a competitive environment stimulates innovation); (4) subsidized risk capital (either directly or through tax deduction facilities) and business incubators; and (5) restraining bureaucratic procedures for introducing new products and technologies.

Social capital

When it comes to strengthening the various enabling factors that stimulate agricultural innovation, social capital (the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions) often stands out as critical to success. Examples of social capital's important role include the management of irrigation schemes, self-help groups in microfinance initiatives, communal road maintenance, the establishment of value chains, and similar efforts.

NEW DIRECTIONS, PRIORITIES, AND REQUIREMENTS FOR INVESTMENT

The previous section described the policies that shape the enabling environment for agricultural innovation, which can range from the very generic to the very specific. This section explores concrete investments that will stimulate agricultural innovation by creating a more positive enabling environment.

Investments in innovation policy and governance structures

A national innovation policy should:

- ***Provide guidance to actors and stakeholders*** within the NIS regarding their roles and functions in the system, and give a sense of direction (in other words, describe what they want to achieve together).
- ***Provide an overall framework*** within which innovation policies specific to particular sectors—agriculture, health, energy, and so on—and particular technologies—ICT, biotechnology, nanotechnology, and so on—should fit. The national policy sets priorities across sectors and technologies (and the public resources allocated to them), whereas the more specific policies set priorities within a particular sector or technology field.
- ***Create the best possible conditions for innovation*** by investing in a range of public goods essential for an innovative knowledge economy. A functional analysis of the NIS is a good starting point to identify which functions of the system are particularly weak and require additional attention and investment. Aside from the more traditional investments in the generation and exchange of scientific knowledge, investments are needed to support the application of scientific and industrial knowledge throughout the economy. Although this responsibility primarily belongs to the private sector,

government can stimulate innovative behavior in the business sector by providing incentives for private innovation (subsidies, tax breaks, and recognition, for example) and by stimulating the startup of new, knowledge-intensive companies using business incubators, venture capital, and similar measures (module 5).

Since innovation policy is such a new area, in most countries the governance structure for innovation has only very recently started to emerge. "Governance" concerns the systems and practices that governments use within their NISs to set priorities and agendas, design and implement policies, and obtain knowledge about their impacts (OECD 2005).

A particular challenge is where to assign responsibility for innovation policy within the government structure. A considerable number of countries have delegated this task to the ministry in charge of science and technology, while others have opted to establish a higher-level entity that brings relevant ministries together to coordinate national innovation policy. TNs 1 and 2 discuss investments in innovation policy and innovation governance structures in greater detail.

Investments in policy and regulatory frameworks that affect agricultural innovation

The most important regulatory reforms underway at present that affect agricultural innovation include:

- ***IPRs.*** Like PVRs and patents, trademarks, certification marks, and geographic indications are IPR instruments that, applied correctly, support private investments in product quality and distinctiveness that go beyond minimum standards. The TRIPS agreement places considerable pressure on countries to comply. These issues are discussed in TN 3 and IAP 3.
- ***Biosafety.*** Frameworks (including instruments and activities) that analyze and manage risks in the sectors on food safety, animal life and health, and plant life and health, including associated environmental risks (which came together under the so-called biosecurity framework). For example, the establishment of proper legislation and enforcement capacity regarding genetically modified organisms (GMOs) is a prerequisite for regulating their adoption (or prohibition). Signatories to the Cartagena Protocol on Biosafety assume the obligation to put the necessary legislation and enforcement capacity in place.[5] A large number of countries in Africa and Asia have yet to adopt biosafety legislation and enforcement regimes. Investments are needed to put regulations in place, establish oversight structures, and train personnel. TN 4 discusses the ins and outs of biosafety regulation.
- ***Technical regulations and standards.*** TN 5 explores the introduction and upgrading of technical regulations and standards related to food safety, animal life and health, plant life and health, and quality-related attributes. The past several decades have seen a tremendous expansion of the number of technical regulations and standards emerging in these areas. This momentum reflects the intensification of regional and global trade and heightened concerns over accompanying threats to food safety and animal and plant health, as well as consumer concerns on the environmental impacts of agriculture production. It also reflects a wider set of innovations in science and technology that permit very sensitive detection and analytical methods, as well as improved knowledge of the quality and associated health hazards of agrifood products. But these emerging technical regulation and standards are also defining the focus of agricultural innovation. For example, plant breeding can be steered toward developing products that attain a preferred quality attribute (size, color, taste, and so on), while the prohibition of certain pesticides (due to stricter regulations) will induce research on alternatives for the control of pests and diseases.

For some time, countries may need assistance to develop the necessary legislation and assess the options from which they can choose. They will also need support to build and strengthen the related regulatory agencies and invest in standards-related infrastructure.

The regulatory reforms currently being implemented are expected to trigger all kinds of changes, such as improving the access of agricultural products to foreign markets (because they will meet higher SPS standards), increasing private investment in agricultural R&D (because IP is protected), fostering the adoption of more sustainable agricultural practices (because of the introduction and enforcement of environmental standards), and increasing the adoption of GM crops (because biosafety legislation and enforcement are in place).

Accompanying rural investments

Systems-thinking increasingly permeates approaches to economic development, including agricultural development. Criticism of earlier agricultural investments has focused on their tendency to operate as relatively isolated interventions that fail to develop any synergies. The current trend within the World Bank is to formulate bigger and more holistic agricultural development projects with longer time horizons. This module describes examples of the three types of

rural investment that have strong synergies with agricultural innovation investments:

- ***Rural financing systems.*** To eliminate the lack of affordable credit as a constraint on the adoption of agricultural innovations, it is better not to look at credit in isolation, but to take a more holistic approach to financial services, including credit, savings, money transfers, leasing, and insurance. Microfinance initiatives can be an important intermediate step toward a more mature rural financial system. IAP 4 provides an innovative example of microfinance in Andhra Pradesh.
- ***Rural infrastructure.*** IAP 1 provides an example from Zambia of how investment in improved feeder roads enhances agricultural innovation, value added, and competitiveness.
- ***Market institutions and infrastructure.*** There is a strong synergy between market development and agricultural innovation, as both tend to take a value chain approach and emphasize the importance of markets and market institutions. Investment opportunities in market development include market infrastructure (such as distribution and collection points, storage facilities, and market and auction facilities), market institutions (such as supply chain organizations and information systems), and the capacity to explore and develop new markets.

MONITORING AND EVALUATING AN ENABLING ENVIRONMENT FOR AGRICULTURAL INNOVATION

How can a country's progress in creating an enabling environment for agricultural innovation be monitored and evaluated? This section identifies indicators corresponding to the various enabling factors discussed in this module (table 6.1). The indicators can monitor progress through time and, by benchmarking with other countries, give an idea of a country's relative position in establishing an enabling environment. The list of indicators is just an illustration, but a pretty good one to make a start. Other factors and indicators can be added later, and some may not be feasible in all instances because reliable statistical information may be lacking.

Table 6.1 Enabling Environment Factors and Indicators

Cluster	Enabling factor	Indicator(s)
Macroeconomic policies	Political and socioeconomic stability	• Political instability index (the *Economist*) or consult www.countryrisk.com for various stability indices
	Favorable macroeconomic policies	• Net taxation of agriculture • Difference between the official and the market exchange rate • Impact of trade agreements on the agricultural sector
	Increased public investment in agriculture	• Agricultural expenditure as a percentage of total government expenditure • Share of public goods in agricultural expenditure
Education	General education	• Literacy rate (urban/rural) • Enrollment in primary education (urban/rural) • Enrollment in secondary education (urban/rural) • Enrollment in higher education (urban/rural) • Programme for International Student Assessment (PISA) scores
	Agricultural education	• Enrollment in agricultural schools at secondary level • Enrollment in on-the-job agricultural training schemes (such as farmer schools, extension courses)
	Agricultural higher education	• Number of agricultural graduates
Innovation policy and governance	A comprehensive national innovation policy in place	• Presence of an innovation policy • Presence and use of innovation policy instruments
	Innovation governance structure in place	• Existence of a governing body at the governmental (highest political) level for STI • Involvement of key stakeholders of the STI system in the governing body (composition of the governing body) • Existence of a national strategy (priorities) for STI • Main activities for the implementation of the national strategy • Intensity of interaction in the STI system vertically and horizontally • Participation and commitment of the private sector in policy preparation and implementation
	General "innovativeness" of a country	• Composite innovation indices such as the World Bank Knowledge Economy Index, the UNCTAD Innovation Capability Index, or the UNDP Technology Achievement Index[a]

(Table continues on the following page)

Table 6.1 Enabling Environment Factors and Indicators (continued)

Cluster	Enabling factor	Indicator(s)
Regulatory reforms	IPR legislation and regulatory regime in place and operating effectively	• Status of IPR legislation (patents, PVRs, trademarks, certification marks, geographic indications) • Capability of the IPR registration system (e.g., average time to complete a registration) • Capability of the legal system to handle IPR disputes • Patent statistics (number of newly registered patents, broken down by local and foreign) • PVR statistics (number of newly registered varieties, broken down by local and foreign) • Use of certification marks and geographic indications
	Biosafety legislation and regulatory regime in place and operating effectively	• Biosafety legislation in place • Biosafety regulatory system in operation • GMO research trials allowed • Introduction of genetically modified crops
	Policy and regulatory frameworks and capacity for managing agricultural health, food safety and associated environmental risks in place and operating effectively	• Legislative and regulatory frameworks upgraded • Institutions operating under clear mandates • Effective mechanisms in place for coordination and collaboration among the entities performing SPS and quality-related functions (including private actors) • Prioritization of investments and short-, medium-, and long-term plans in place to ensure that identified capacity needs (for example, in terms of skills, physical infrastructure, institutional structures, and procedures) are met • Incentives in place to support private sector compliance • Set of sustainable agricultural practices developed and promoted
Accompanying rural investments	Well-functioning rural financial system	• Domestic credit provided by banking sector as percentage of GDP • Agricultural credit as a percentage of total domestic credit
	Good rural infrastructure	• Road density per square kilometer • Percentage of agricultural land under irrigation
	Well-functioning agricultural markets	• Percentage of agricultural production sold in the market • Share of exports in total agricultural production • Presence and strength of supply chain organizations

Source: Author.
(a) UNCTAD = United Nations Conference on Trade and Development; UNDP = United Nations Development Programme.