2. Agricultural investment: patterns and trends

Using data newly compiled and analysed for this report, this chapter reviews trends in private and public investment globally, regionally and by income group and assesses the extent to which progress is being made in agricultural capital formation within these areas.

Basic concepts: investment versus expenditures and public versus private goods

Broadly speaking, investment involves giving up something today in order to accumulate assets that generate increased income or other benefits in the future. Farmers invest in their farms by acquiring farm equipment and machinery, purchasing animals or raising them to productive age, planting permanent crops, improving their land, constructing farm buildings, etc. Governments may invest in, *inter alia*, building and maintaining rural roads and large-scale irrigation infrastructure, assets that generate returns in terms of increased productivity over a long period of time. Governments also invest in other, less tangible, assets such as the legal and market institutions that form part of the enabling environment for private investment. Determining whether an expenditure, public or private, constitutes an investment can thus be difficult both conceptually and empirically, and in some cases it is not clear-cut. Investment is generally defined as activities that result in the accumulation of capital (Box 1) that yields a stream of returns over time.

In agriculture, a distinction is usually made between investment and spending on inputs, based rather arbitrarily on the length of time required to generate a return. Thus, planting trees is typically considered an investment because it takes more than a year to generate a return, but applying fertilizer to a maize crop is not considered an investment because it generates a return during the current crop cycle. More important from a conceptual

BOX 1
What is capital?

Farmers and governments invest to build assets that promote agricultural productivity and growth. Capital is composed of both tangible and intangible assets and is often considered in terms of the following categories, all of which are important for agricultural productivity:

- Physical capital, such as animals, machinery, equipment, farm buildings, off-farm infrastructure;
- Human capital acquired through education, training and extension services;
- Intellectual capital acquired through research and development of agricultural technologies and management practices;
- Natural capital, such as land and other natural resources required for agricultural production;
- Social capital, such as the institutions and networks that build trust and reduce risk; and
- Financial capital, such as private savings.

Financial capital is primarily a means for acquiring other types of capital. However, many investments by farmers are not made primarily or exclusively through financial outlays but through time spent, for example in clearing or improving land or in constructing farm buildings or irrigation channels.

point of view, trees are a capital asset that yields a stream of returns over many years. Even in this seemingly simple case, the distinction may not be clear. If fertilizer use helps maintain and build soil fertility in the long run, it may also be considered an investment. Similarly, in public expenditures, a distinction is generally made between investment and current expenditures, but again this is not always clear-cut, not least because current expenditures are required to maintain the value of capital assets such as roads and other physical infrastructure.

Perspective also matters for what is perceived as investment. From a farmer's point of view, the purchase of land may represent an important investment in his or her productive capacity; from the perspective of society it simply involves a change in ownership of an asset rather than a net increase in capital stock, as occurs for instance when land improvements are undertaken.

Farmers and governments invest to build capital that allows the agriculture sector to become more productive in the future. Some of the most important types of capital for agriculture are not necessarily tangible. Governments invest extensively in agricultural research and development (R&D), which generates intellectual capital – a crucial input for raising the long-run productivity of agriculture. Both governments and individuals invest in education, which raises the productivity of the beneficiaries and generates long-term returns through human capacity development. Farmers spend time and resources developing producer associations, a form of social capital that can reduce risk and enhance productivity. All these activities are forms of investments because they build capital, even though the value of the capital may be difficult to measure.

Many of the investments made by governments are called "public goods" because they generate benefits for society that cannot be captured by a private investor. Once a public good has been created, people cannot be excluded from taking advantage of it, and use by one person does not diminish the ability of others to use it. In technical terms they are "non-exclusive" and "non-rival". Private investors have little or no incentive to provide public goods because they cannot charge enough to recover the cost of the investment. Examples of important public goods for agriculture include many types of R&D and rural roads and other infrastructure. Other types of public investment, such as building institutions and human capacity, provide less tangible but perhaps even more important public goods for agriculture. What constitutes a public good will depend to some extent on country characteristics and local context, and mixed public/private goods are common in agriculture.

Public investment helps create an appropriate enabling environment that influences farmers' incentives to invest. It also directly creates other forms of capital that support the development of a thriving agriculture sector. Some types of government investment are specific to agriculture and aimed specifically at enhancing primary production in the crop, livestock, aquaculture and forest sectors as well as in upstream and downstream activities. These can be referred to as investments *in* agriculture. Government investment in other sectors can also have a positive impact on agricultural production and productivity and on farm incomes. For example, investments in transport and communications infrastructure, energy, general education, health and nutrition, ecosystem services, market institutions and broader legal and social institutions all support agriculture and can be considered as investments *for* agriculture.

This report focuses on the accumulation of capital by farmers in agriculture and the investments made by governments to facilitate this accumulation. It does not cover the full range of investment in upstream and downstream private enterprises. Investment by input suppliers and agro-processors, for example, is crucial to supporting on-farm investment and agricultural development because it influences the opportunities and incentives perceived by farmers. Unfortunately, comprehensive data are not available for these sectors and they are outside the scope of the analysis, beyond noting their role in catalysing on-farm investment.

From concepts to measurement: making sense of the data

Moving from a conceptual understanding of agricultural investment to an empirical analysis poses a number of challenges because the available data provide only rough proxies for the components we want to measure. Despite some limitations, the data compiled and analysed for this report provide the most comprehensive and comparable estimates of investment in agriculture in low- and middle-income countries that have been prepared to date (Lowder, Carisma and Skoet, 2012).

Four key categories of investment and five internationally comparable data sets are analysed in this report (Figure 4). As noted in Chapter 1, the four categories of investment are domestic private, domestic public, foreign private and foreign public. Domestic private investment comes primarily from farmers, and the most comprehensive data available to measure this are estimates of on-farm agricultural capital stock calculated by FAO. Domestic public investment by governments is measured by two datasets: public expenditures on agricultural R&D from the Agricultural Science and Technology Indicators (ASTI) database (IFPRI, 2012a) and government expenditures in and for agriculture from the SPEED database (IFPRI, 2010 and IFPRI, 2012b), both maintained by the International Food Policy Research Institute (IFPRI). Both datasets measure aspects of public investment in agriculture. The best available measure of private foreign investment in agriculture and related sectors comes from data on foreign direct investment (FDI) compiled by the United Nations Conference on Trade and Development (UNCTAD). Foreign public investment is measured by data on official development assistance (ODA) to agriculture collected by the Organisation for Economic Co-operation and Development (OECD). None of these datasets captures the full range of asset accumulation in and for agriculture, but they are the most complete available.

The data clearly show that farmers are by far the largest investors in agriculture (Figure 5). On-farm investment is more than three times as large as all other sources of investment combined. Annual investment in on-farm agricultural capital stock exceeds government investment by more than 4 to 1 and other resource flows by a much larger margin. Agricultural capital stock measures only the most tangible forms of investment by farmers (i.e. land development, livestock, machinery and equipment, plantation crops [trees, vines and shrubs yielding repeated products] and structures for livestock). Because it excludes other forms of investment (e.g. education, training and participation in social networks), it probably represents a lower bound estimate of farmers' investment. Government investment is that portion of public expenditures that can be considered as investment (Box 5). In contrast, the R&D, ODA and FDI figures reported here do not distinguish between investment and current expenditures and thus represent an upper-bound estimate of these sources of investment.

Agricultural capital stock

Trends in total on-farm agricultural capital stock

The total accumulated investment by farmers worldwide, as measured by the value of agricultural capital stock, has increased about 20 percent since 1975 and now exceeds US$5 trillion (Annex table A2). At the global level, trends in total agricultural capital stock have been influenced by major political and economic events as well as international commodity prices (Figure 6). Sharply declining commodity prices throughout most of the 1980s and 1990s and unsupportive government policies provided fewer incentives for agricultural investment during this period.

The build-up of commodity stocks in the 1980s and early 1990s depressed investment in the high-income countries of Europe and North America. The collapse of the Union of Soviet Socialist Republics and economic reforms in the transition countries of Central and Eastern Europe led to sharp declines in agricultural capital stock in those countries during the 1990s. High rates of taxation of the agriculture sector further depressed investment in many low- and middle-income countries (see Chapter 3 for a more complete discussion). Progressive trade liberalization since the mid-1990s, following the completion of the Uruguay Round of multilateral trade negotiations, and higher commodity prices have improved the economic incentives to invest in agriculture through the mid-2000s. Continued high international commodity prices may have further stimulated investment in recent years, although comprehensive data to confirm this are not yet available.

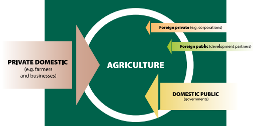
FIGURE 4
Key international datasets on financial flows to agriculture

INVESTMENT

	DOMESTIC		
	PRIVATE	PUBLIC	
	On farm agricultural capital stock	**Government expenditures**	**Public spending on agricultural research and development**
Source	FAO	IFPRI-SPEED	IFPRI-ASTI
Sectors included	Crops and livestock	Crops and livestock	Crops and livestock, forestry, fisheries, natural resources, and on-farm food-processing
Definition	• Land development • Livestock • Machinery and equipment • Plantation crops (trees, vines and shrubs yielding repeated products) • Structures for livestock	• Administration supervision and regulation • Agrarian reform, agricultural land settlement, development and expansion • Flood control and irrigation • Farm price and income stabilization programmes • Extension, veterinary, pest control, crop inspection and crop grading services • Production and dissemination of general and technical information on agriculture • Compensation, grants, loans or subsidies to farmers	• Research on crops, livestock, forestry, fisheries, natural resources and socio-economic aspects of primary agricultural production • Research on on-farm postharvest activities and food-processing
Country coverage	204 countries and former sovereign states	Complete coverage for 51 countries, partial coverage for an additional 28 countries	140 countries in 2000, fewer in more recent years
Time span	1979–2007	1980–2007	1980– 2002 or 2009 (varies by country)
Unit of measure	Constant 2005 US$	Constant 2005 PPP dollars	Constant 2005 PPP dollars

FOREIGN

PRIVATE	PUBLIC
Foreign direct investment inflows	**Official development assistance**
UNCTAD	OECD-CRS
Crops and livestock, forestry, fisheries and hunting	Crops and livestock, forestry and fisheries
• Crops, market gardening and horticulture • Livestock • Mixed crops and livestock • Agricultural and animal husbandry services, excluding veterinary activities • Hunting, trapping and game propagation • Forestry and logging • Fishing, fish hatcheries and fish farms	• Agrarian reform, agricultural policy, administrative management, crop production, land and water resources, inputs, education, research, extension, training, plant and postharvest protection and pest control, financial services, farmers' organizations and cooperatives • Livestock production and veterinary services • Forestry policy and administrative management, development, production of fuelwood and charcoal, education and training, research and services • Fishing policy and administrative management, fisheries development, education and training, research and services
Varies by year (44 countries in most recent years)	153 countries
1990–2008	1973–2010
Current US$	Constant US$



AGRICULTURE

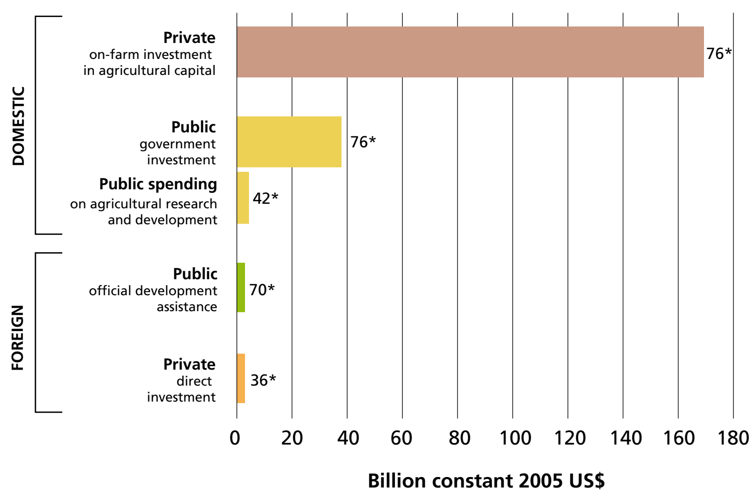
BOX 2
Better data on agricultural investment for policy analysis

Empirical analysis of investments in agriculture is rendered difficult by the very limited availability of data. This report provides the most comprehensive overview to date of trends in agricultural investment and of the magnitude of different sources of investment. All the datasets reviewed shed light on important dimensions of agricultural investment, but they are far from providing a complete picture.

Improved data would significantly enhance the analysis of agricultural investment. Improvements could cover different dimensions: comparability and consistency of data, country and year coverage, more up-to-date information and inclusion of areas not yet covered by data or estimates. Better coordination and collaboration among different institutions collecting data in similar or related areas could help. Specific areas for improvement include the following.

- **Agricultural capital stock.** Existing data have broad country coverage; however, the set of assets covered is significant but not complete and the methodology applied cannot account for improvements in quality of assets. Alternative estimates based on national accounts are currently only possible for a limited number of countries (Box 4).
- **Government expenditure.** Data compiled by IFPRI provide the most comprehensive information on government expenditures in low- and middle-income countries, but country coverage is not complete. There is also discrepancy between these data and data from other sources for specific countries. Harmonization and improvement of data on public expenditures could lead to better and more comprehensive data for analytical purposes. Also, a better breakdown of agricultural expenditures and more information on how much

FIGURE 5
Investment in agriculture in selected low- and middle-income countries, by source



Explanatory note:

Data are averages for 2005–07 or for the most recent year available. Gross annual on-farm investment in agricultural capital stock (FAO, 2012a) is calculated using a 5 percent annual depreciation rate for the annual change in existing capital stock. Government investment is estimated using an assumption that 50 percent of government expenditures constitute investment. This assumption is based on a survey of agricultural public expenditure reviews, which give a mean of 42 percent for observations from a set of 12 countries (see Box 5). Official development assistance (ODA) is estimated using data from OECD (2012a); public spending on agricultural R&D is from IFPRI (2012a); and foreign direct investment (FDI) data are from UNCTAD (2011). No assumption is made regarding the share of R&D, ODA and FDI that constitute investment.

* Number of countries.

Source: Lowder, Carisma and Skoet, 2012.

they contribute to capital formation would improve the basis for analysis. Similarly, a breakdown of expenditure between rural and urban areas for types of non-agricultural investment that are strongly supportive of agriculture would also be important for analysis.

- **Research and development.** Data compiled by IFPRI's ASTI programme provide estimates of public expenditures – including government, higher-education, and non-profit – on agricultural R&D, but country coverage is limited and data are not updated with the necessary frequency to allow trends to be assessed over time. Funding for enhanced data collection would seem to be a priority. Also, private agricultural R&D appears to be a growing phenomenon in a number of low-and middle-income countries, but very limited information is available.
- **Foreign direct investment.** Data on FDI flows to agriculture are particularly weak. Available data are limited, inconsistent over time and far from comprehensive. One notable gap is the lack of coverage of investment by large institutional investors such as mutual funds, equity funds and pension funds, which appear to be growing.
- **Natural capital.** Natural resources are crucial for agricultural production and constitute some of the most important assets of developing countries. In spite of this, data assessing the value of natural resources for agricultural production are extremely limited.
- Finally, no internationally comparable data exist for **investment in value chains** beyond primary agriculture.

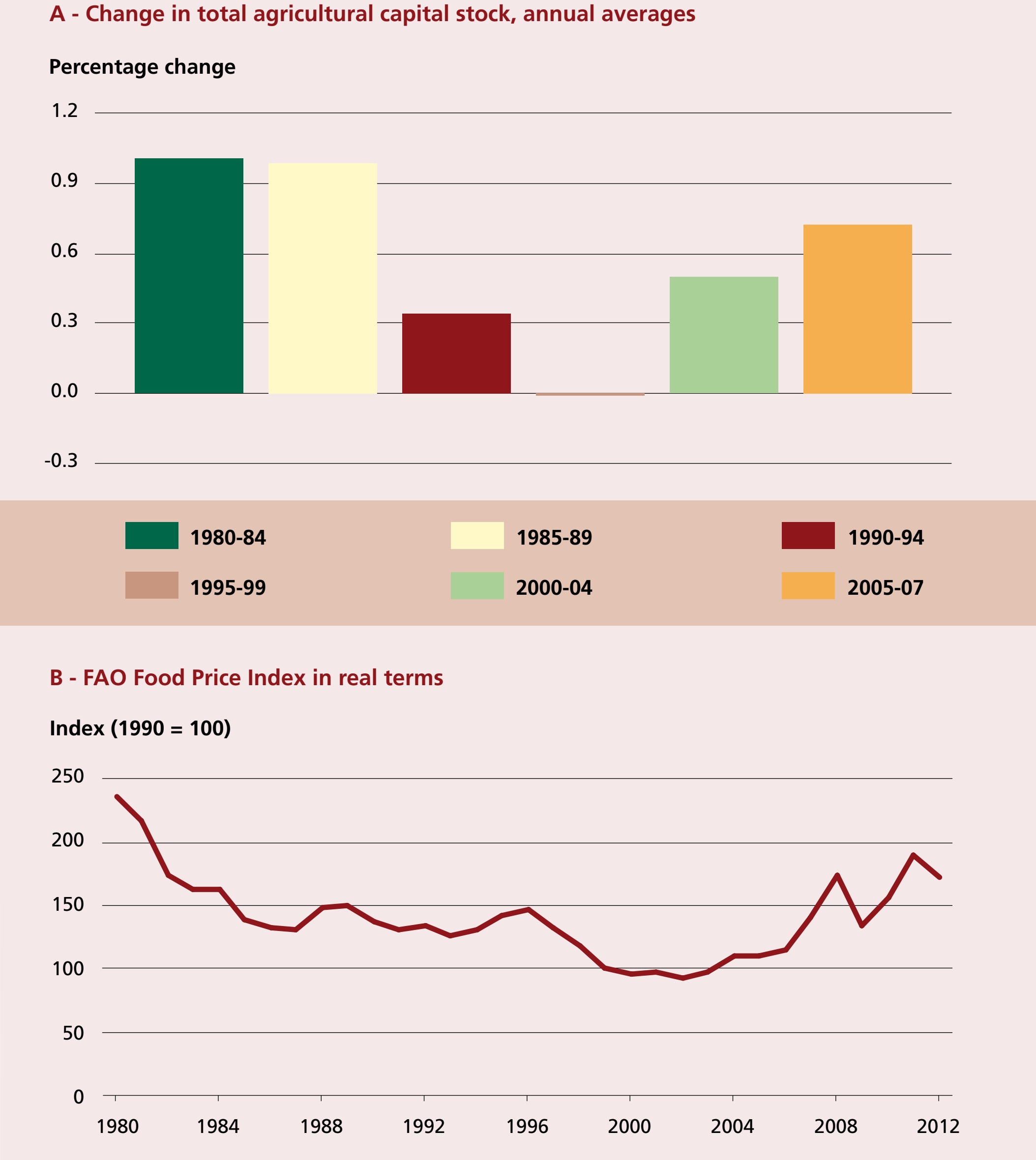
Agricultural capital stock per worker and labour productivity

More significant than the total level of agricultural capital stock is the amount per worker in agriculture,[3] because this is a major determinant of labour productivity and farm incomes (see Annex table A1 for data on the economically active population in agriculture). Figure 7 shows the correlation between agricultural capital stock per worker and labour productivity (measured by agricultural GDP per worker) for a large number of countries. Although the graphic cannot establish the direction of causality, the two are clearly highly correlated and rise markedly with overall per capita income levels. Broadly speaking, low-income countries have low levels of agricultural capital per worker and correspondingly low levels of agricultural output per worker. Low agricultural labour productivity may be considered a defining characteristic of low-income countries.

For agricultural labour productivity to grow, the amount of capital available for each worker (the capital–labour ratio) must grow. This requires agricultural capital stock to increase at a faster rate than the agricultural labour force. How quickly this occurs will affect the pace of farm income growth. In many instances, the gaps between high-income and low-income countries are widening as a result of low investment rates and/or growing labour forces in countries with low levels of agricultural capital per worker (Table 1). High rates of growth in the agricultural labour force have contributed both to declining capital per worker and declining farm size in the countries with the lowest levels of labour productivity (Box 3). Over the past decades, the capital–labour ratio has continued to increase rapidly in the high-income countries, primarily because

[3] Agricultural workers represent the economically active population in agriculture, including own-account farmers and formal or informal workers providing paid or unpaid labour.

FIGURE 6
Investment in agriculture and international commodity prices



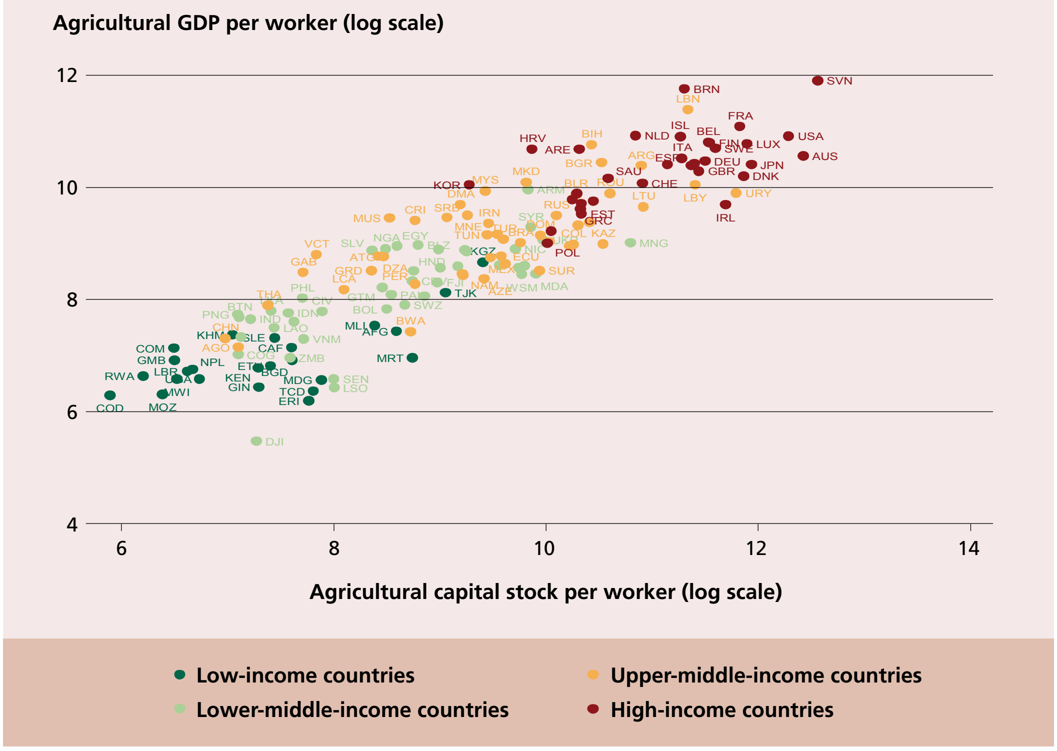
Note: The FAO Food Price Index is calculated using the international prices for cereals, oilseeds, meats and dairy products. FAO calculates it from 1990 to the present on a regular basis; in this figure it has been extended back to 1980 using proxy price information. The FPI for 2012 is calculated using data through May 2012. The index measures movements in international prices and not necessarily domestic prices. The United States GDP deflator is used to express the Food Price Index in real rather than nominal terms.
Sources: FAO Food Price Index: FAO, 2011b; change in total agricultural capital stock: authors' calculations using FAO, 2012a.

of falling numbers of workers in the sector, while it has declined in the low-income country group.

Regional trends in capital–labour ratios, are striking (Figure 8, page 19). Two regions in particular, with already low levels of capital per worker, saw stagnant or declining capital–labour ratios over three decades.

In sub-Saharan Africa, where rapid growth in the agricultural labour force outpaced growth in total agricultural capital stock, the ratio fell at an average annual rate of 0.6 percent. In South Asia, the capital–labour ratio stagnated as total agricultural capital stock and the agricultural labour force grew at about the same rate.

FIGURE 7
Agricultural capital stock and agricultural GDP per worker, by country



Notes: Both indicators are measured for the year 2007 using constant 2005 US dollars.

Sources: Authors' calculations using agricultural GDP data from the World Bank, 2012 and agricultural capital stock data from FAO, 2012a. See Annex table A2.

TABLE 1
Level and change in agricultural capital stock per worker, by region

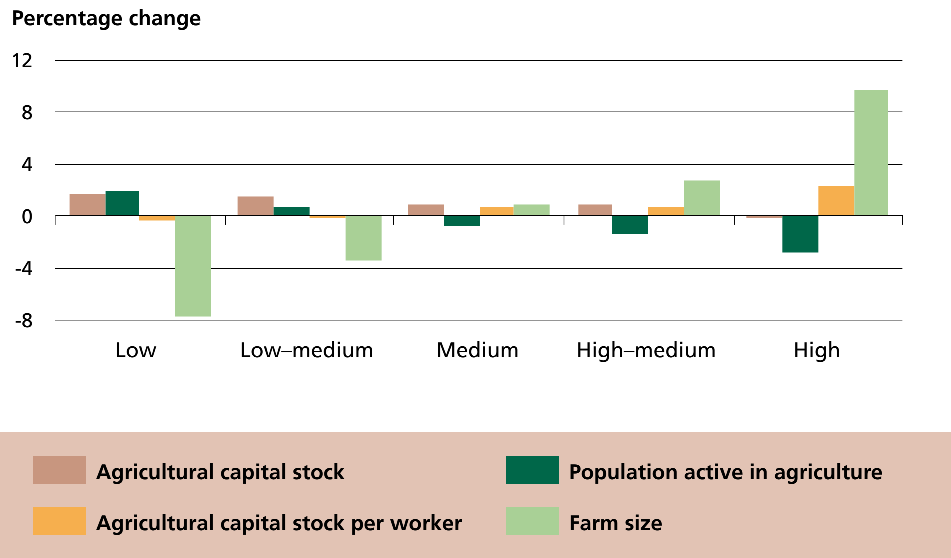
INCOME GROUP/REGION	AVERAGE AGRICULTURAL CAPITAL STOCK PER WORKER, 2005–07	AVERAGE ANNUAL CHANGE (1980–2007) IN:		
		Agricultural capital stock	Number of agricultural workers	Agricultural capital stock per worker
	(Constant 2005 US$)		*(Percentage)*	
High-income countries	**89 800**	**0.2**	**-2.9**	**3.0**
Low- and middle-income countries	**2 600**	**0.9**	**1.2**	**-0.3**
East Asia and the Pacific	1 300	1.8	1.1	0.7
East Asia and the Pacific, excluding China	2 000	2.1	1.4	0.7
Europe and Central Asia	19 000	-1.0	-1.7	0.7
Latin America and the Caribbean	16 500	0.7	0.0	0.7
Middle East and North Africa	10 000	1.8	0.9	0.9
South Asia	1 700	1.4	1.4	0.0
South Asia, excluding India	3 000	1.4	1.6	-0.1
Sub-Saharan Africa	2 200	1.5	2.1	-0.6
WORLD	**4 000**	**0.6**	**1.1**	**-0.5**

Source: Authors' calculations using FAO, 2012a and World Bank, 2012. See Annex table A2.

BOX 3
The productivity gap

Are less productive countries catching up with the most productive countries? Analysis of about 100 countries between 1980 and 2005 suggests that they are not; on the contrary, most are falling further behind (Rapsomanikis and Vezzani, 2012). Countries with an initially low level of agricultural labour productivity exhibit lower rates of growth in agricultural capital stock per worker and declining average farm size (see Figure). These countries cannot catch up with more highly productive countries because small farm size and low investment rates hinder the introduction of more productive technologies. Unless policies provide the enabling environment and facilitate investment by smallholders on their farms, through good governance, infrastructure improvements, well-developed land markets and smallholder-conducive technology, the probability of countries escaping the "slow productivity growth trap" will continue to be low.

Determinants of productivity according to level of labour productivity

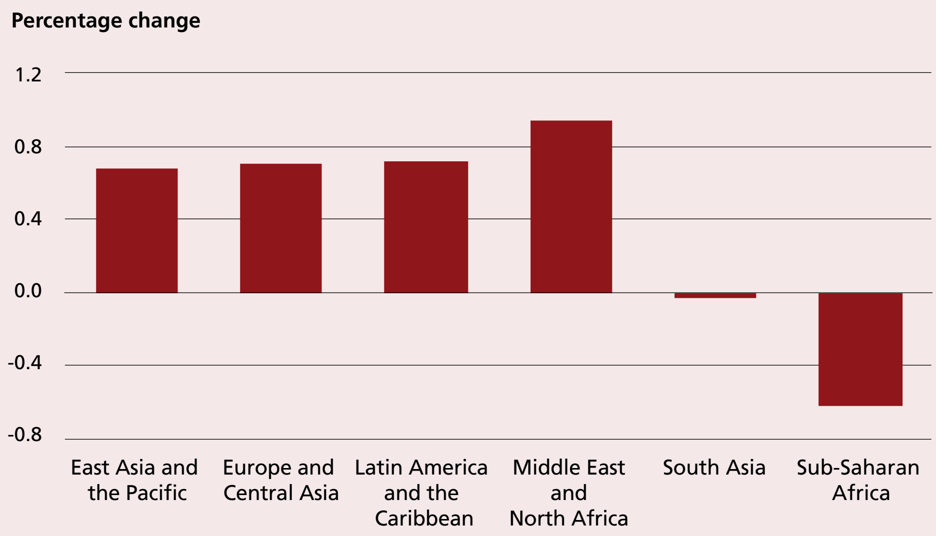


Note: Median annual growth rate, 1980–2005. Country groups are defined by quintiles in terms of labour productivity expressed as agricultural GDP per economically active worker in the sector. Each group represents 20 percent of the sample.
Source: Authors' calculations using FAO, 2012a.

The composition of agricultural capital stock

The composition of agricultural capital stock has implications for agricultural labour productivity and environmental sustainability. Natural resources (a major component of natural capital) constitute some of the most important assets of developing countries and they form the biophysical foundation for agriculture. The World Bank (2006a) estimated that natural capital represented about 26 percent of the total wealth of low-income countries (excluding oil states) in 2000 – a greater share than produced capital (infrastructure, buildings, machinery and equipment) at 16 percent. Cropland constituted by far the largest share (59 percent) of natural capital, with subsoil assets (17 percent) and pastureland (10 percent) accounting for the next largest shares. The relative share of natural capital is lower for countries with higher income levels, amounting to 13 percent in the middle-income countries and 2 percent in the high-income countries.

FIGURE 8
Average annual change in agricultural capital stock per worker in low- and middle-income countries, 1980–2007



Notes: For countries in Europe and Central Asia, average annual changes are calculated for the period 1992 to 2007.
Source: Authors' calculations using FAO, 2012a and World Bank, 2012.

Despite the importance of natural capital, data on many aspects of natural capital – such as those relating to the quality of soils, water and genetic resources – are limited. Available measures of agricultural capital stock (such as FAO's) thus rely on measures such as machinery, livestock, structures and land development.

As agriculture becomes technologically more advanced, the composition of agricultural capital changes. There are major differences in the composition of agricultural capital stock in the high-income countries and in the low- and middle-income countries, especially concerning the share of machinery and equipment (Figure 9, page 21). Machinery and equipment account for more than 40 percent of total agricultural capital stock in the high-income countries, in stark contrast with less than 3 percent in the low-income countries. For the low- and middle-income countries, the dominant forms of on-farm capital are those embodied in livestock and land improvements.

Sustained productivity gains over time depend on changes in capital, including those aspects of natural capital for which data are scarce. Sustainable production systems are also knowledge-intensive, so the transition to sustainable, climate-smart agriculture will imply a greater reliance on types of capital that embody intellectual and human capital in order to economize on increasingly scarce natural resources. Available measures of agricultural capital stock only partially capture knowledge-related capital (machinery and equipment are one proxy, but very crude and incomplete). A key conclusion is that investment is needed in precisely the kinds of assets that are becoming most relevant to decision-making about sustainable productivity growth, namely the quality of natural and human capital – as well as in the activities, such as agricultural R&D, that can help improve them.

Implications of trends in agricultural capital stock

The trends in agricultural capital stock, agricultural capital stock per worker and the composition of agricultural capital stock all suggest that investment is seriously lagging in the low- and lower-middle-income countries, and particularly in sub-Saharan Africa and South Asia. The close correlation between capital–labour ratios and agricultural labour productivity suggest that significant increases in on-farm investment will be required in these regions in order

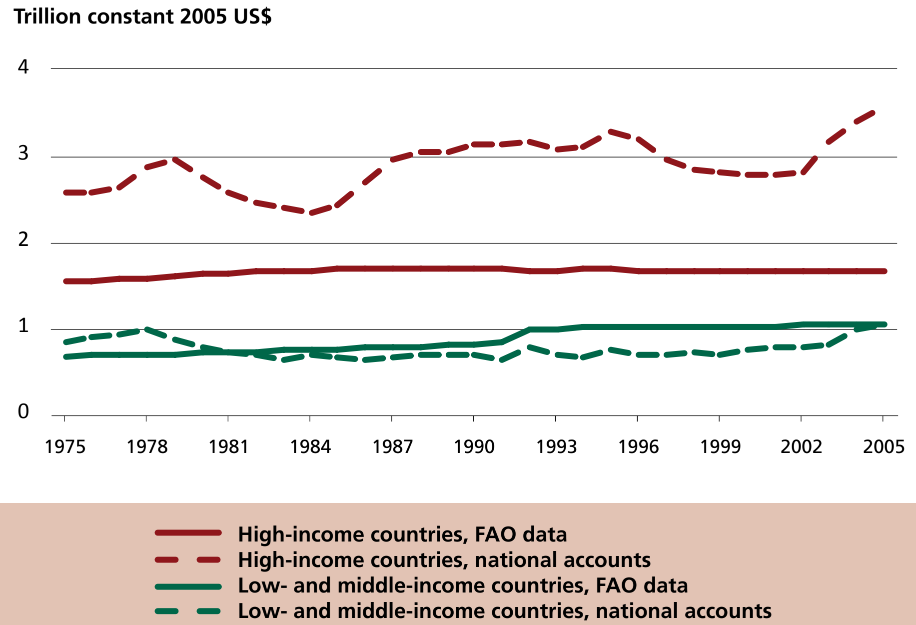
BOX 4
Alternative estimates of agricultural capital stock

Estimates of agricultural capital stock presented in this report are derived by FAO from data on inventories of capital assets that include land development, livestock, machinery and equipment, plantation crops and buildings for livestock. This inventories-based approach provides comparable estimates of agricultural capital stock for a large number of countries over several decades, but has various limitations; in particular, it does not cover all relevant assets, and it cannot account for differences in the quality of assets across countries or for improvements in their quality over time. As a result, the FAO approach is likely to underestimate agricultural capital stock.

An alternative approach attempts to overcome these problems by deriving estimates of agricultural capital stock from investment data reported in national accounts (Crego *et al.*, 1997; Larson *et al.*, 2000; Daidone and Anríquez, 2011). However, this approach can only be applied to countries that have good national accounts data. Such data are available for most high-income countries but for only some middle-income countries and very few low-income countries.

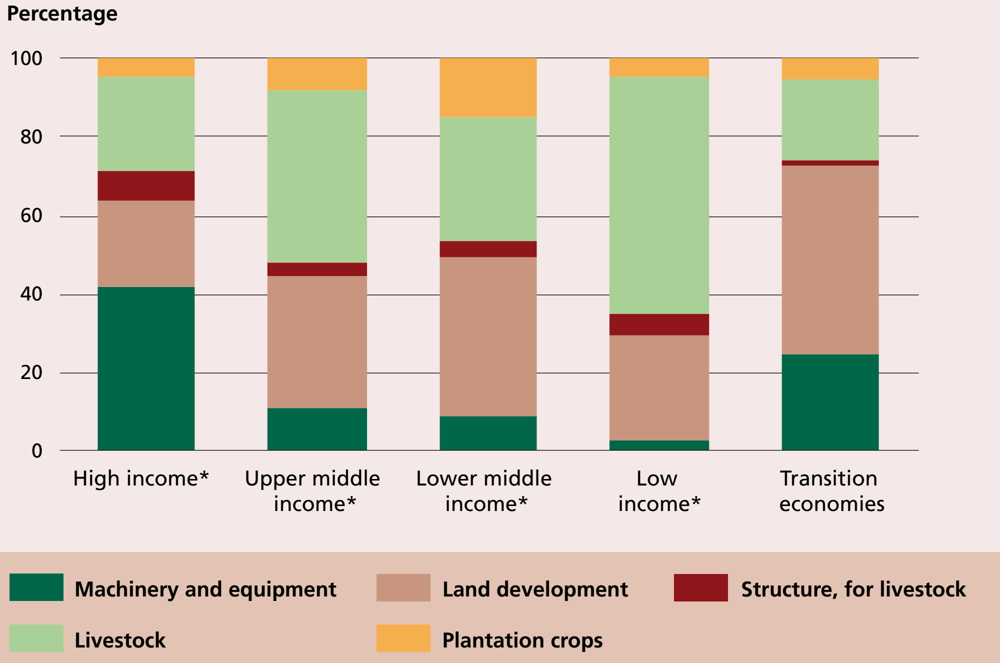
The figure below compares the FAO data on agricultural capital stock with estimates based on the national accounts approach prepared by Daidone and Anríquez. For the low- and middle-income countries, the two estimates are very similar, suggesting that the FAO data are reasonably accurate. For high-income countries, the national accounts approach produces much higher and more variable estimates than the FAO approach. This implies that the gap in capital–labour ratios between high-income countries and low- and middle-income countries may be even wider than indicated by the FAO data.

Comparison of inventories-based and national accounts-based estimates of agricultural capital stock by income group



Note: The comparison includes 22 high-income and 22 low- and middle-income countries for which observations are available from both datasets.
Source: Authors' calculations using FAO, 2012a and Daidone and Anríquez, 2011.

FIGURE 9
Composition of agricultural capital stock by income group, 2005–07



Note: *The income group classification uses the World Bank atlas method for all countries except the transition economies, which are presented as a separate group.
Source: Authors' calculations using FAO, 2012a.

to make progress against poverty, hunger and resource degradation. Broader changes in the agricultural economy, including a transition of labour out of the sector as has occurred in other regions as a result of economic growth, will also be necessary.

Foreign direct investment in agriculture

Much recent attention has been given to FDI, which appears to be a growing source of investment in agriculture in low- and middle-income countries. Data limitations make it difficult to draw solid conclusions about the magnitude of such investment globally, or the long-term trends, but the best available data show that agricultural FDI remains very small compared with domestic agricultural investment (See Annex table A3 for data by country). In addition, it is unclear how much it contributes to capital formation as opposed to a mere transfer of ownership.

For 2007 and 2008, comparable data on total FDI to all sectors are only available for 27 countries. For these countries, average annual inward FDI flows in the two years were estimated at US$922.4 billion (UNCTAD, 2011). Of this total, FDI to agriculture (including hunting, forestry and fisheries) represented only 0.4 percent. A larger share, 5.6 percent, went to the food, beverages and tobacco sectors, primarily in high-income countries.

Trends over time in FDI are difficult to monitor because the number of countries for which data are available varies from year to year. Looking at agriculture alone, recent comparable data are available for 44 countries; FDI to these countries more than doubled between 2005–06 and 2007–08 (Table 2). However, the majority of these flows went to upper-middle and high-income countries (Lowder and Carisma, 2011).

These figures underestimate actual flows of foreign investment in agriculture, because data are missing for so many countries and only direct investment by private companies is included. Investments made by large institutional investors, such as mutual funds, banks, pension funds,

TABLE 2
Average annual foreign direct investment in agriculture, by income group

INCOME GROUP	2005–06	2007–08
	(Current US$, billions)	
Transition economies (13)	0.3	0.8
High-income countries* (7)	0.1	0.5
Upper-middle-income countries* (13)	1.4	3.7
Lower-middle-income countries* (7)	0.2	0.3
Low-income countries* (4)	0.1	0.2
Total (44)	**2.1**	**5.4**

* Income groups are the same as those used by the World Bank, but not including transition economies, which are shown separately.
Note: The number of countries included in each calculation is shown in parentheses.
Source: Authors' calculations using data supplied by UNCTAD, 2011. See Annex table A3.

hedge funds and private equity funds are not included in estimates of FDI. A broad, though not comprehensive, recent survey of agricultural investment funds in several developing regions (excluding East Asia and the Pacific) found that such funds have increased in number and value (Miller *et al.*, 2010).

However, given the relatively small size of FDI flows to primary agriculture reported in the international dataset, especially in low-income countries, it is unlikely that FDI can contribute significantly to raising capital stock in agriculture. Nevertheless, it can still have significant impacts at the local level. FDI in agriculture may offer opportunities for developing countries in terms of employment and technology transfer, but potentially negative social and environmental impacts of such investments (especially those that involve direct control of agricultural land) remain a reason for concern. The issue of foreign investment and land acquisition in developing countries will be examined more closely in Chapter 4.

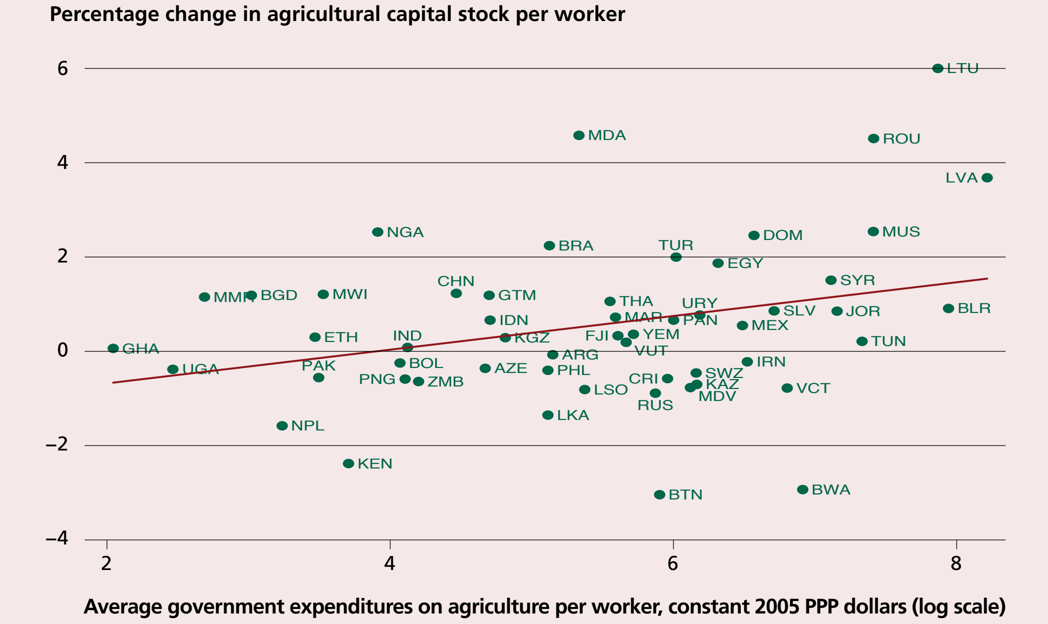
Government expenditures on agriculture

After farmers' investment in on-farm capital stock, the second-largest source of investment in agriculture is government expenditures. Public expenditures constitute an essential component of creating an enabling environment for farm investment and are positively correlated with the formation of on-farm capital stock per worker (Figure 10). However, the large variation of observations around the fitted trend line in Figure 10 indicates that other factors are relevant, such as the composition and quality of expenditure on agriculture. This suggests that some government expenditures are more effective than others in promoting agricultural investment and growth.

Government expenditures have been growing in real terms over the last three decades in the 51 low- and middle-income countries covered by a database released by IFPRI (2010), but trends differ by region and income group (Figure 11; see also Annex table A4 for information by country). Agricultural expenditures grew more slowly than other expenditure categories, and the share of agriculture in overall government expenditures has consequently declined. The long-term decline in the share is common to all regions (Figure 12). Only South Asia seems to have seen a renewed increase in the share of agricultural expenditures in the most recent years. Not all government expenditure on agriculture constitutes investment and assessing how much of it contributes to capital formation is not straightforward (Box 5).

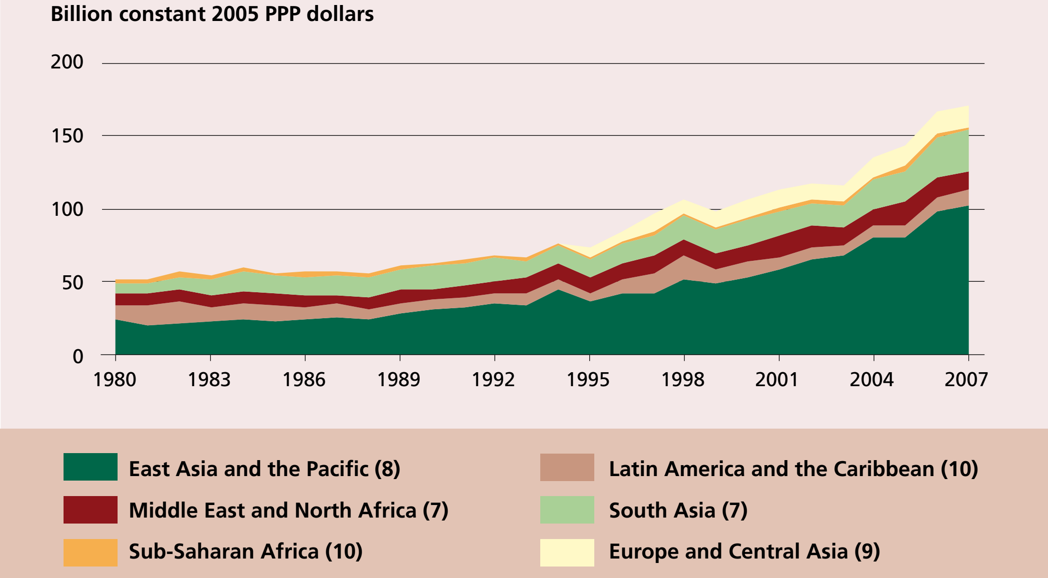
More important than overall levels of agricultural expenditure or their share in total government expenditure are measures that assess these trends relative to the role of agriculture in the economy. One such measure is government expenditures on agriculture per worker in the sector (Table 3; see Annex table A5 for data by country).

FIGURE 10
Government expenditure on agriculture and percentage change in agricultural capital stock per worker in selected low- and middle-income countries



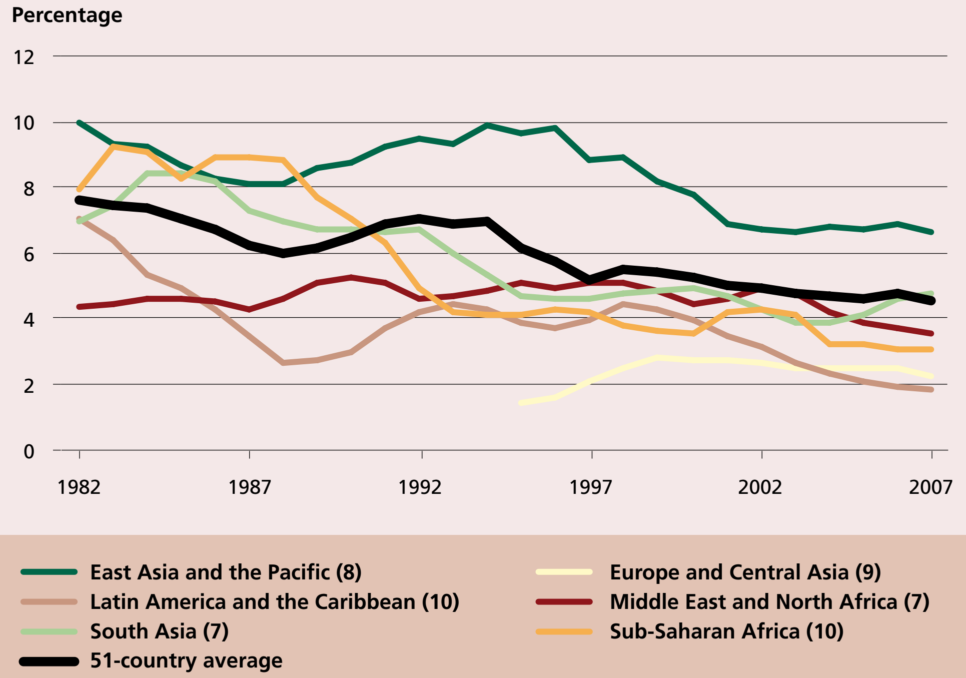
Note: Change in agricultural capital stock and government expenditures are annual averages from 1990 to 2007 for all countries except those located in Europe and Central Asia, for which averages are from 1995 to 2007.
Source: Authors' calculations using IFPRI, 2012b and FAO, 2012a.

FIGURE 11
Government expenditure on agriculture, by region



Note: Calculations include 51 low- and middle-income countries. The number of countries included in each group is shown in parentheses. For countries in Europe and Central Asia estimates are from 1995 to 2007.
Source: Authors' calculations using IFPRI, 2010. See Annex table A4.

FIGURE 12
Agricultural share of public expenditure, by region, three-year moving averages



Note: Calculations include 51 low- and middle-income countries. The number of countries included in each group is shown in parentheses. For countries in Europe and Central Asia estimates are from 1995 to 2007. Ethiopia has been excluded from the calculation of the regional average for sub-Saharan Africa for this and other graphics and tables on government expenditure. According to the SPEED database, the share of agriculture in public expenditures in Ethiopia increased from 4–7 percent in 2001–04 to 14–17 percent in 2005–07.
Source: Authors' calculations using IFPRI, 2010. See Annex table A4.

TABLE 3
Public spending on agriculture per worker in low- and middle-income countries, by region

REGION	1980–89	1990–99	2000–04	2005–07
	(Constant 2005 PPP dollars)			
East Asia and the Pacific (8)	48	69	108	156
Europe and Central Asia (9)		413	559	719
Latin America and the Caribbean (10)	337	316	309	341
Middle East and North Africa (7)	458	534	640	677
South Asia (7)	46	50	53	79
Sub-Saharan Africa (10)	152	50	51	45
Total (51 countries)	**68**	**82**	**114**	**152**

Notes: Calculations include 51 low- and middle-income countries. The number of countries included in each group is shown in parentheses. For countries in Europe and Central Asia estimates are from 1995 to 2007.
Source: Authors' calculations using IFPRI, 2010 and FAO, 2012a. See Annex table A5.

From the 1980s to the late 2000s, all regions but one increased or maintained their levels of agricultural expenditures per worker. The conspicuous exception is sub-Saharan Africa, where spending per worker declined by more than two-thirds between the 1980s and the early 2000s. Countries in sub-Saharan Africa and South Asia spend significantly less per agricultural worker than those in any other region.

BOX 5

How much of public expenditure on agriculture is investment? Evidence from public expenditure reviews

It is not always easy to determine which government expenditures should be considered investment and which should not. Public expenditure reviews (PERs) are an important tool for assessing and analysing public expenditures and can provide a useful benchmark against which to evaluate the effectiveness of government expenditures. The content and format of such reviews vary, due to differences in purpose, approach and sectoral coverage, thus they may not allow the kind of cross-country comparability that would be needed in a international score card system. Some PERs for the agriculture sector available in the public domain provide information on the breakdown of agricultural expenditures, including by capital and current expenditures (see Table).[1] The share of capital expenditures in total expenditures is highly variable, ranging from as little as 9 percent in the United Republic of Tanzania to 84 percent in Lao People's Democratic Republic and Mozambique. In some cases, a clear difference is also recorded between budgeted and actual expenditures.

[1] The terms " current (or recurrent) expenditures" and "capital expenditures" are frequently found in the economics literature analysing public expenditures, including public expenditure reviews, but are not used in the formal manuals and guides on government statistics. The International Monetary Fund's *Government Finance Statistics Manual* (IMF, 2001) distinguishes between expenses and expenditures on (non-financial) assets and public capital formation. The two sets of concepts are close, but not identical.

Share of capital expenditures in overall agricultural expenditures from selected public expenditure reviews

COUNTRY	CAPITAL SHARE OF AGRICULTURAL EXPENDITURES *(Percentage)*	NOTES	PERIOD
Ghana (1)	17	Development, total (a)	2005
	24	MoFA, actual	
	46	MoFA, budgeted	
Honduras (2)	66		2006
Kenya (3)	30		2004/05
Lao People's Democratic Republic (4)	84		2004/05
Mozambique (5)	84	Total (b)	2007
	9	MINAG	
Nigeria (6)	58	Budgeted	2001-05
	44	Actual	
Nepal (7)	46	(c)	1999-2003
Philippines (8)	26	(d)	2005
Uganda (9)	24		2005/06–2008/09
United Republic of Tanzania (10)	9		2011
Viet Nam (11)	77		2002
Zambia (11)	24		2000

Notes: (a) Development as opposed to recurrent expenditures. Covers all government expenditure, as opposed to only those made by MoFA (Ministry of Food and Agriculture), the latter accounts for about 25 percent of total government expenditure in this sector. (b) 84 percent refers to total government expenditure; 9 percent is for MINAG (Ministry of Agriculture [Ministério da Agricultural]) only. (c) Includes irrigation and agriculture expenditures. (d) Consolidated Department of Agriculture expenditure figures.

Sources: (1) Kolavalli *et al.*, 2010; (2) Anson and Zegarra, 2008; (3) Akroyd and Smith, 2007; (4) Cammack, Fowler and Phomdouangsy, 2008; (5) World Bank, 2011a; (6) World Bank, 2008; (7) Dillon, Sharma and Zhang, 2008; (8) World Bank, 2007b; (9) World Bank, 2010a; (10) World Bank, 2011a; (11) Akroyd and Smith, 2007.

The Agricultural Orientation Index (AOI) provides a way to assess whether government expenditures on agriculture reflect the economic importance of the sector (Table 4, page 28; see Annex table A5 for data by country). This index is calculated as the share of agriculture in total government expenditure divided by the share of agriculture in total GDP. It is an indicator of the degree to which the share of agriculture in public expenditure is commensurate with the weight of the sector in GDP.[4] Time trends in the index vary across regions, but the most striking is that of sub-Saharan Africa, where the AOI is well below half the level it was in the 1980s.

Composition of public expenditures

As seen above, the decline in the share of agriculture in public expenditure is not generally the result of declining levels of expenditure on agriculture, but of larger increases in other areas that have been given higher priority over time. For a complete picture of the dynamics of public expenditures on agriculture, they must be seen in the context of the dynamics of overall government expenditure patterns (Table 5, page 28).

On average, governments in all regions currently spend more on defence than on agriculture. The share of education in public expenditure has also increased significantly since 1980 in all regions except the Middle East and North Africa, while all regions have seen an increase in the share spent either on health or social protection, if not both. All of these are expenditure categories with a significant potential development impact, and in many cases they are also likely to have a positive impact on agricultural and rural development. They may include significant levels of expenditures *for* agriculture. However, at the same time, the share of another expenditure category with a possible positive impact on agriculture – transport and communication – has declined over time in most regions.

Given fiscal constraints, increased public expenditures on agriculture would have to

[4] The AOI is useful for comparisons across countries and over time, but it is not prescriptive. Many essential government expenditures – such as education, health, infrastructure and social transfers – do not reflect the economic contribution of the relevant sector.

BOX 6

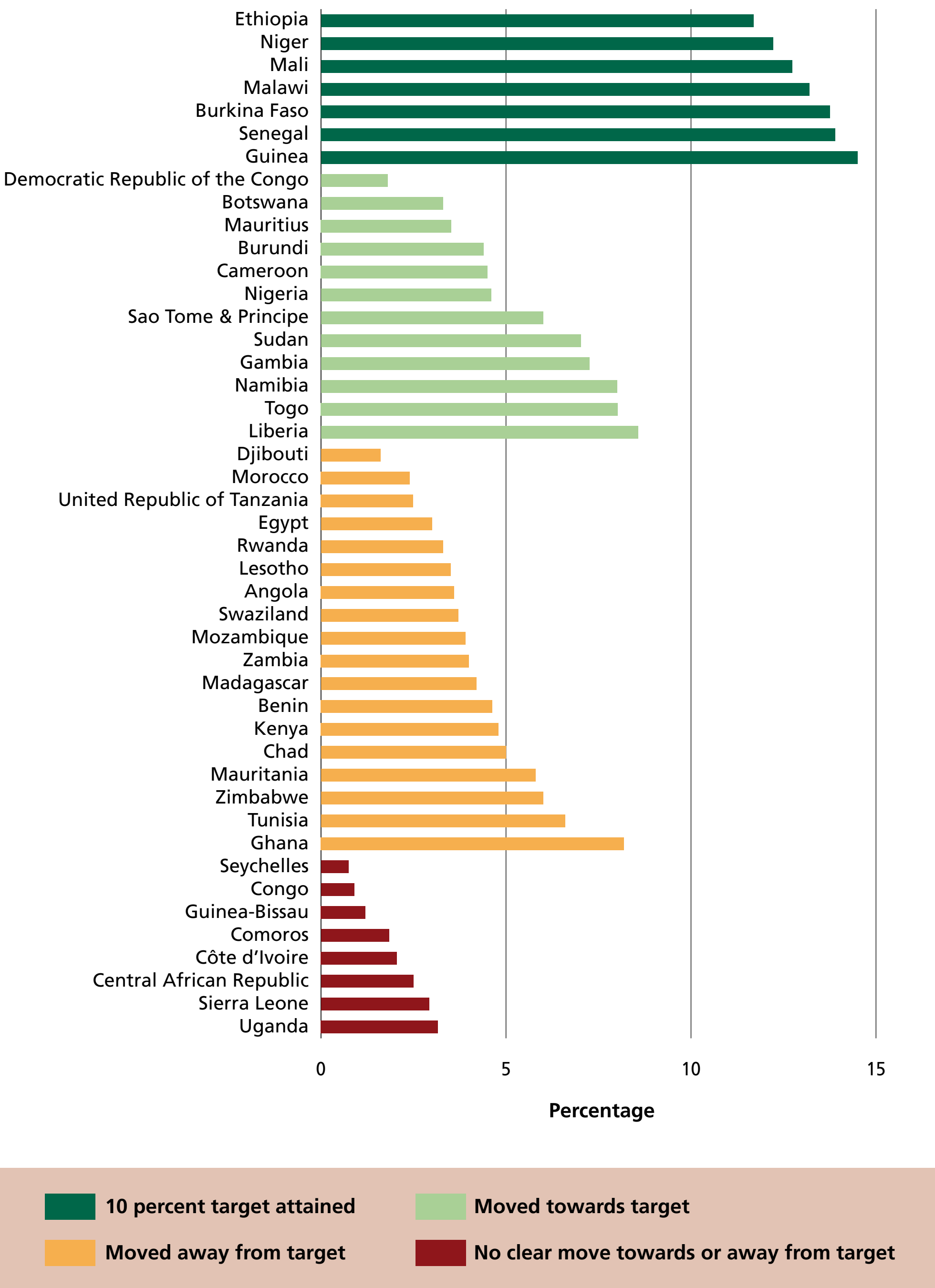
The 2003 Maputo declaration and the share of agriculture in government spending in African countries

At the Assembly of the African Union in July 2003 in Maputo, African Heads of State and Government endorsed the "Maputo Declaration on Agriculture and Food Security in Africa", which established the Comprehensive Africa Agriculture Development Programme (CAADP, see Box 23 on page 87). Two significant targets were to increase agricultural productivity by 6 percent annually through 2015 and to allocate at least 10 percent of national budgetary resources to agriculture and rural development within five years.

Notwithstanding whether 10 percent is necessarily the appropriate budgetary allocation to agriculture, such a target can provide a useful benchmark against which to evaluate a country's commitment to agriculture. The Regional Strategic Analysis and Knowledge Support System (ReSAKSS) – an Africa-wide network – was established to provide analytical tools to support policy-making and to evaluate progress towards the CAADP goals. The system compiles data on the share of government spending going to agriculture in African countries. As shown in the Figure, only seven countries covered by the data had attained the 10 percent target in the most recent year for which information is available.[1]

[1] There are discrepancies between the data from ReSAKSS and the SPEED database arising from differences in definitions, coverage and data sources. The variations from year to year can be significant, even for countries that have reached the target or progressed.

Agricultural share of government expenditures in African countries



Note: Share shown is for most recent year available (2007 or 2008 in most cases). The move towards or away from the target is based on changes in the last three available years.
Source: Authors' calculations using ReSAKSS, 2011.

TABLE 4

Agricultural Orientation Index (AOI) for public spending in low- and middle-income countries, by region

REGION	1980–89	1990–99	2000–04	2005–07
		(Ratio)		
East Asia and the Pacific (7)	0.31	0.48	0.49	0.59
Europe and Central Asia (9)		0.29	0.35	0.36
Latin America and the Caribbean (6)	0.96	0.86	0.56	0.38
Middle East and North Africa (5)	0.34	0.37	0.37	0.30
South Asia (5)	0.24	0.21	0.21	0.27
Sub-Saharan Africa (9)	0.30	0.17	0.14	0.12
Total (41 countries)	**0.35**	**0.38**	**0.38**	**0.41**

Notes: The AOI for public spending equals the agricultural share of government spending divided by the agricultural share of GDP. Calculations include 41 low- and middle-income countries. The number of countries included in each group is shown in parentheses. For countries in Europe and Central Asia estimates are from 1995 to 2007.
Source: Authors' calculations using IFPRI, 2010 and World Bank, 2012. See Annex table A5.

TABLE 5

Composition of government expenditures, by sector and region in low- and middle-income countries

REGION	YEAR	AGRICULTURE	DEFENCE	EDUCATION	HEALTH	SOCIAL PROTECTION	TRANSPORT AND COMMUNICATION	OTHERS
					(Percentage share of total)			
East Asia and the Pacific (8)	1980	11.1	15.8	10.5	5.6	1.4	7.9	47.6
	1990	9.2	9.8	14.5	7.0	1.6	4.1	53.6
	2000	6.9	6.9	16.4	6.2	8.5	2.1	53.1
	2007	6.5	7.2	13.8	4.2	10.2	1.2	57.1
Europe and Central Asia (9)	1980							
	1995	1.4	3.7	2.0	7.0	2.2	8.8	74.9
	2000	2.8	15.3	6.7	4.1	11.2	3.0	56.8
	2007	2.1	9.9	6.4	7.4	8.6	3.4	62.3
Latin America and the Caribbean (10)	1980	6.9	3.6	17.9	4.4	14.4	5.8	47.1
	1990	3.8	5.8	16.3	4.1	3.4	4.4	62.2
	2000	3.9	5.2	23.7	7.8	7.3	3.9	48.0
	2007	1.9	3.3	25.9	19.1	5.8	2.2	41.8
Middle East and North Africa (7)	1980	4.5	17.5	15.6	4.5	8.6	5.1	44.2
	1990	4.9	13.3	18.7	9.0	8.4	4.8	40.9
	2000	4.4	15.1	14.8	10.5	12.7	8.8	33.6
	2007	3.1	10.5	11.8	7.7	24.4	3.5	39.0
South Asia (7)	1980	6.6	19.2	2.9	2.0	4.2	4.3	60.8
	1990	6.9	18.1	3.1	1.8	1.9	3.1	65.0
	2000	4.8	15.3	3.4	1.8	1.8	2.2	70.7
	2007	4.9	12.9	4.6	2.3	1.6	3.2	70.5
Sub-Saharan Africa (10)	1980	6.0	6.1	11.9	3.4	7.8	13.9	50.9
	1990	6.0	8.4	13.9	4.5	3.0	6.0	58.1
	2000	3.6	6.1	15.5	4.7	3.1	3.8	63.3
	2007	2.7	5.4	16.5	7.3	3.5	3.6	61.1

Notes: Calculations include 51 low- and middle-income countries. The number of countries included in each group is shown in parentheses. For countries in Europe and Central Asia estimates are for the years 1995 to 2007. The category "Others" refers to total government spending on all sectors other than the remaining six sectors identified above. Public expenditures on agricultural research and development are included in the "Others" category.
Source: Authors' calculations using IFPRI, 2010.

TABLE 6
Public expenditures on agricultural research and development in 2000, by region

COUNTRY CATEGORY	SPENDING	SHARE
	(Million constant 2005 PPP dollars)	*(Percentage)*
Low- and middle-income countries (131)	**11 441**	**46**
East Asia and Pacific, excluding China (19)	1 192	5
China (1)	1 745	7
Eastern Europe and Former Soviet States (23)	1 177	5
South Asia, excluding India (5)	358	1
India (1)	1 487	6
Latin America and the Caribbean (25)	2 755	11
Sub-Saharan Africa (45)	1 315	5
West Asia and North Africa (12)	1 412	6
High-income countries (40)	**13 456**	**54**
Total (171 countries)	**24 897**	**100**

Note: The number of countries included in each group is shown in parentheses.
Source: IFPRI, 2012a. See Annex table A6.

come at the cost of either increased taxation or a decline in other expenditures, some of which may be socially desirable in their own right and have a significant development impact, including on agricultural productivity and development. It is therefore particularly important to enhance the effectiveness and impact of public expenditures on agriculture, even within existing budget constraints. The allocation of expenditures within agricultural budgets may be more important than overall agricultural expenditure levels (see Chapter 5).

Public expenditures on agricultural research and development

Levels of public expenditure on agricultural research and development

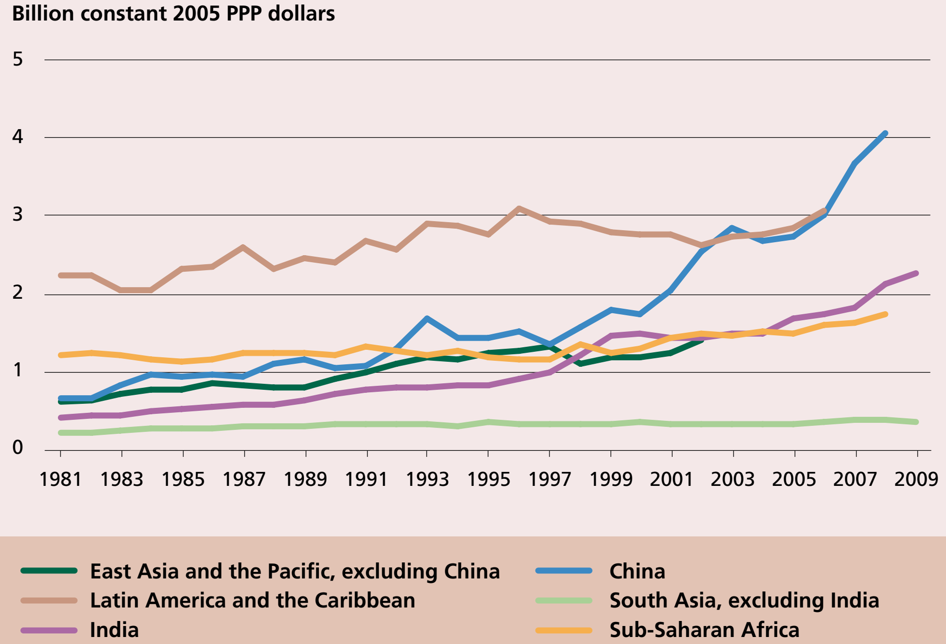
Agricultural research and development (R&D) is a key component of public expenditures on agriculture and is one of the most crucial contributors to agricultural productivity growth. The data on agricultural R&D are reported separately from other agricultural government expenditures. The data do not clearly distinguish between investment and current expenditures, but the literature on returns on spending on agricultural R&D almost universally shows very high returns in terms of agricultural productivity growth and poverty alleviation (see Chapter 5).

According to data compiled by the ASTI initiative managed by IFPRI (2012a), total public expenditures[5] on agricultural R&D worldwide amounted to US$24.9 billion in 2000, the most recent year with complete information (Table 6).[6] Of this, 46 percent was spent by low-and middle-income countries. The 49 low-income countries only accounted for US$2.6 billion, or 10.4 percent.

Public expenditure on agricultural R&D in low- and middle-income countries has increased since 1980 in all regions (Figure 13). The same does not necessarily apply to all countries within the regions (see Annex table A6 for more recent data by country). Indeed, several countries have well-managed and funded systems, producing world-class research; others, some of which are highly dependent on agriculture, have experienced significant reductions in their R&D spending and capacity levels.

[5] Public expenditures include expenditures by governments, institutions of higher education and non-profit organizations.
[6] Data are updated to different years for different regions, but, at the time of writing, 2000 is the most recent year for which complete information is available for all regions. Preliminary results from a global update through 2008 indicate major growth in public spending on agricultural R&D, driven mainly by increases in spending by China and India as well as a number of other large, often more advanced economies.

FIGURE 13
Public expenditures on agricultural research and development, by region



Source: IFPRI, 2012a. See Annex table A6.

In high-income countries, levels of private agricultural R&D are significant, but in the developing world R&D by the private sector remains small (Beintema and Stads, 2008a; Pray, Fuglie and Johnson, 2007; Echeverría and Beintema, 2009). Agricultural R&D in low- and middle-income countries thus depends critically on adequate public funding for these activities.

Most public expenditure on agricultural R&D in the low- and middle-income countries is highly concentrated in a few large countries. China accounted for about two-thirds of total public agricultural R&D spending in East Asia and the Pacific in 2002 (the latest year with available data for the entire region). China's agricultural research spending has continued to expand rapidly ever since. Other countries such as Malaysia and Viet Nam have also realized impressive growth since the early 1990s. In Latin America and the Caribbean, Argentina, Brazil, and Mexico account for the bulk of regional spending, with Brazil alone representing 42 percent of the region's total in 2006. In South Asia, India accounted for 86 percent of the total spending in 2009 (the latest year with available data for the subregion).

In sub-Saharan Africa, after a decade of stagnation in the 1990s, investment in agricultural research in the region rose by more than 20 percent between 2001 and 2008. However, most of this growth occurred in only a few countries. Agricultural research spending in most of the remaining countries in the region, especially in francophone West Africa, has stagnated or fallen since the turn of the millennium.

It is important to assess the magnitude of agricultural R&D efforts relative to the economic significance of the sector. High-income countries spent, on average, 2.4 percent of their agricultural GDP on public agricultural R&D in 2000 (Table 7), while low- and middle-income countries spent significantly less in relative terms (0.5 percent). A target of 1 percent has been recommended by the recent literature as an adequate share for developing countries (Beintema and Elliott, 2011).[7] Considering the significance of private R&D expenditures in high-income countries compared with

[7] As with all indicators, this has several limitations and needs to be considered within the appropriate context (Beintema and Stads, [2008b]).

their limited role in developing countries, the difference between shares in the two groups would be even sharper if private R&D expenditures were included in the comparison.

The lowest regional average is found in South Asia (0.3 percent in 2009) and the highest in Latin America and the Caribbean – the only low- and middle-income region with an average above 1 percent. However, even in this region the ratio is only half that of the high-income countries. Furthermore, large variations at country-level exist within regions (see Annex table A6). Most regions have seen an upward trend in the share of R&D in agricultural GDP. The main exception is sub-Saharan Africa, where the share declined significantly between 1981 and 2000. The downward trend in the region has since been reversed, but the share in the region remains below that of 1981.

Official development assistance to agriculture

Official development assistance (ODA) can contribute to public investment in agriculture, although it is not always clear what share of ODA should be considered investment rather than current expenditure. ODA has been receiving renewed international attention following the food price crisis of 2008. Although overall levels of ODA to agriculture are relatively small compared with government expenditures on agriculture, they may be more significant for individual countries that are major recipients of ODA.

Data from the OECD's creditor reporting system on ODA (Figure 14) indicate that commitments to agriculture peaked in the 1980s – after having grown significantly in the years following the international food crisis of 1973–74 (see Annex able A7 for data by country). During the 1990s, ODA commitments to agriculture decreased continuously, both in absolute terms (measured in constant prices) and as a share of total ODA. Since the mid-2000s, renewed international attention to agricultural development and concerns about rising international food prices have led to partial recovery in the level of ODA to agriculture and its share in total ODA, but both (especially the share) remain well below earlier levels.

New data compiled by FAO with a more comprehensive coverage of donors (FAO, 2012a) show that annual commitments to

TABLE 7
Public expenditures on agricultural research and development as a share of agricultural GDP, by region

COUNTRY CATEGORY	1981	1991	2000	LATEST YEAR
		(Percentage)		
Low- and middle-income countries (108)	**0.55**	**0.54**	**0.54**	..
Sub-Saharan Africa (45)	0.75	0.61	0.55	0.61 (2008)
East Asia and the Pacific, excluding China (19)	0.41	0.51	0.51	0.57 (2002)
China (1)	0.38	0.34	0.38	0.50 (2008)
South Asia, excluding India (5)	0.37	0.39	0.31	0.25 (2009)
India (1)	0.22	0.29	0.39	0.40 (2009)
Latin America and the Caribbean (25)	0.90	1.08	1.21	1.18 (2006)
West Asia and North Africa (12)	0.60	0.59	0.74	..
High-income countries (32)	**1.53**	**2.11**	**2.37**	..
Total (140)	**0.91**	**0.98**	**0.97**	..

Notes: Table excludes 31 countries in Eastern Europe and the former Union of Soviet Socialist Republics, because of data unavailability.
.. = data not available.
Sources: Data on public expenditures on agricultural research and development are from IFPRI (2012a). Data on agricultural GDP are from the World Bank's *World Development Indicators* (2012). See Annex table A6.

BOX 7
Sources of productivity growth in agriculture

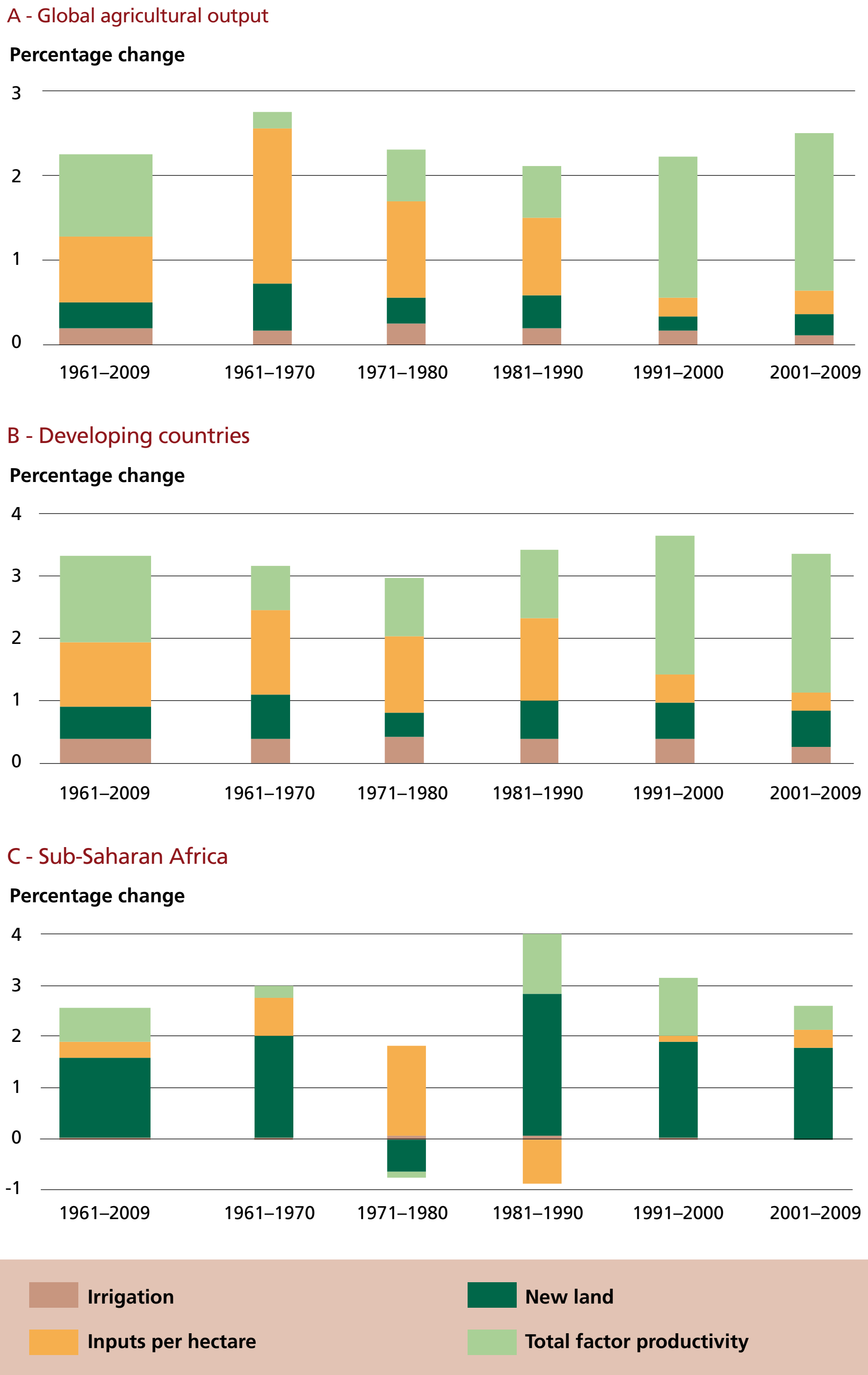
There is strong evidence that gains in agricultural productivity have contributed significantly to rising farm incomes and reductions in rural and urban poverty.[1] Above, we discussed the importance of agricultural capital for labour productivity, as measured by agricultural GDP per worker. Such partial productivity indicators are important but do not account for all the factors that contribute to productivity growth. Total factor productivity (TFP) attempts to account for all sources of productivity growth in agriculture. It is an index of measured outputs divided by an aggregate index of measured inputs and physical capital such as land, labour, machinery, livestock, chemical fertilizers and pesticides. Growth in TFP thus represents that part of production growth that is not explained by increased use of these factors but by other things such as technological progress, human capital development, improvements in physical infrastructure and government policies, as well as unmeasured factors such as improvements in input quality or depletion of natural resources (Fischer, Byerlee and Edmeades, 2009).

Fuglie (2010) finds that TFP growth has accounted for an increasing share of agricultural output growth. Figure A shows a breakdown of factors contributing to global agricultural output growth over the past five decades. Machinery, livestock, material inputs (especially fertilizer) and land were key drivers of agricultural growth in the 1960s, 1970s and still in the 1980s. As the contributions of increased use of inputs, physical capital and land declined over time, TFP growth became increasingly prominent and by the 1990s and 2000s was by far the most important factor underlying agricultural growth in a global context. This pattern is also evident in developing regions (Figure B). The only region where this pattern does not hold is sub-Saharan Africa (Figure C). Here new land has been the dominant driver of agricultural growth in the period 1981–2009. TFP became the second most important factor in the 1980s, but its contribution has declined over the years, in contrast with that of developing countries as a whole. For sub-Saharan Africa, the transition to sustainable agricultural intensification will require a change from a strategy based on area expansion to one based on investment in activities that enhance TFP growth.

Earlier work by Evenson and Fuglie (2009) examined the relationship between long-run TFP growth and national investment in technology capital for 87 developing countries. They considered both an indicator of the capacity to *develop or adapt* new technology and an indicator of the capacity to *extend and adopt* agricultural technology. They found that rising TFP growth rates were positively correlated with increases in either indicator provided that a minimum capacity existed in the other. Both research and extension were thus found to be important drivers of TFP growth. However, the results pointed to the need to place more emphasis on research relative to extension. Improvements to research capacity were often associated with increased productivity growth even in the absence of improved extension capacity, while the reverse was not true. The results were confirmed in subsequent analysis by Fuglie (2012).

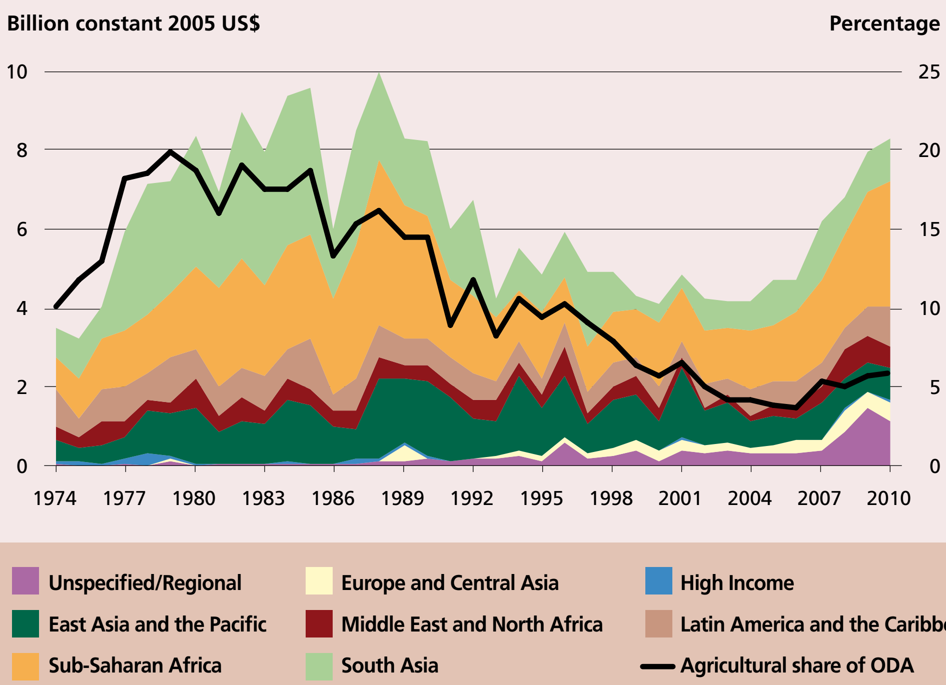
[1] For a sample of the numerous studies on the contribution of agricultural productivity to growth and poverty reduction see Thorbecke and Jung (1996); Datt and Ravallion (1998); Foster and Rosenzweig (2004); Mundlak, Larson and Butzer (2004); Ravallion and Chen (2004); Christiaensen and Demery (2007); Bezemer and Headey (2008); Otsuka, Estudillo and Sawada (2009); and Suryahadi, Suryadarma and Sumarto (2009).

Growth in global agricultural output, by source of growth and time period



Source: Fuglie, 2012.

FIGURE 14
Level and share of official development assistance committed to agriculture, by region



Source: Authors' calculations using data from OECD, 2012a. See Annex table A7.

agriculture in recent years exceeded those reported by the OECD's creditor reporting system by 1–2 billion US$, but confirm the general pattern revealed by the OECD data.

Increasing investment in agriculture

The evidence presented in this chapter suggests that many low- and middle-income countries need to invest more in agriculture. However, assessing exactly how much and what type of additional investment is needed and by whom these investments should be made is more difficult. Several efforts have been made over time – by FAO and others – to estimate overall investment needs in agriculture. These differ, depending on factors such as the specified objective, the time horizon, the sectoral coverage (only primary agriculture or also upstream and downstream sectors), the geographical coverage, whether both private and public investment are considered, whether they consider incremental or total investment, and whether they represent gross or net investment.

As noted in Chapter 1, the first edition of *The State of Food and Agriculture* in 1947 called for increased investment in agriculture to transform less-populated regions in Latin America and Africa into "granaries" for the rest of the world. In 1949, the third edition of *The State of Food and Agriculture* indicated that the low-income countries needed additional foreign capital for investment in support of agriculture of US$4 billion per year to supplement the US$13 billion that they would need to raise themselves (FAO, 1949). The two most recent key global estimates prepared by FAO, based on different objectives and assumptions, are presented in the following.

Meeting demand for food in 2050

In 2009, FAO estimated that average annual investment flows amounting to US$209 billion were needed to meet projected demand for agricultural products in 2050 in 93 developing countries (Schmidhuber, Bruinsma and Bödeker, 2009). These projections embodied a broad range of capital items in primary crop and livestock

BOX 8
The L'Aquila Food Security Initiative

Since the food price crisis of 2008, issues of food security have moved to the forefront of the international agenda. The G8 meeting in L'Aquila, Italy, in July 2009 resulted in a Joint Statement on Global Food Security, which recognized consistent underinvestment in agriculture combined with economic instability as partial reasons for the persistence of food insecurity. It noted the decreasing levels of ODA to agriculture and the need to reverse the trend. The G8 member nations reaffirmed their commitment to improve food security and pledged US$20 billion in assistance to agriculture and food security in developing countries over the following three years (G8, 2009). At a meeting of the G20 in Pittsburgh in September 2009, the amount was increased to US$22 billion and the Global Agriculture and Food Security Program (GAFSP) was established to assist in delivery on the pledges.

The GAFSP is housed at the World Bank and is governed by a Steering Committee with wide representation by major donor and recipient countries and international organizations, including the multilateral development banks, IFAD, FAO, WFP, the International Finance Corporation (IFC) and the UN Secretariat. It aims to increase both the level and predictability of ODA to agriculture, by reviewing proposals by donors and by monitoring and evaluating project implementation. From its inception through February 2012 the GAFSP had approved proposals for projects totalling 1.1 billion US$ to be implemented in Cambodia, Ethiopia, Haiti, Liberia, Mongolia, Nepal, the Niger, Rwanda, Sierra Leone, Tajikistan and Togo.

The L'Aquila initiative has been criticized for failing to specify whether the pledged funds were additional to existing levels of ODA or to provide clear definitions of what was meant by aid, agriculture and food security. While there is no official monitoring of delivery on the L'Aquila pledges, FAO, in response to recommendations by the renewed Committee on World Food Security (CFS), has developed the Mapping Actions for Food Security and Nutrition web-based platform, which allows countries to track and map their investment in support of food security and nutrition. (FAO, 2011c). Despite the L'Aquila pledges, ODA commitments to agriculture increased only about one-third of a billion US$ from 2009 to 2010 (OECD, 2012a).

production as well as downstream support services,[8] and they were made under specific assumptions regarding key parameters such as population growth and urbanization. Of the total, US$83 billion represent net investment, with the residual corresponding to the cost of replacing depreciating capital. A breakdown of the average annual investment needs from 2005–07 to 2050 by region and aggregate type of investment is shown in Figure 15.

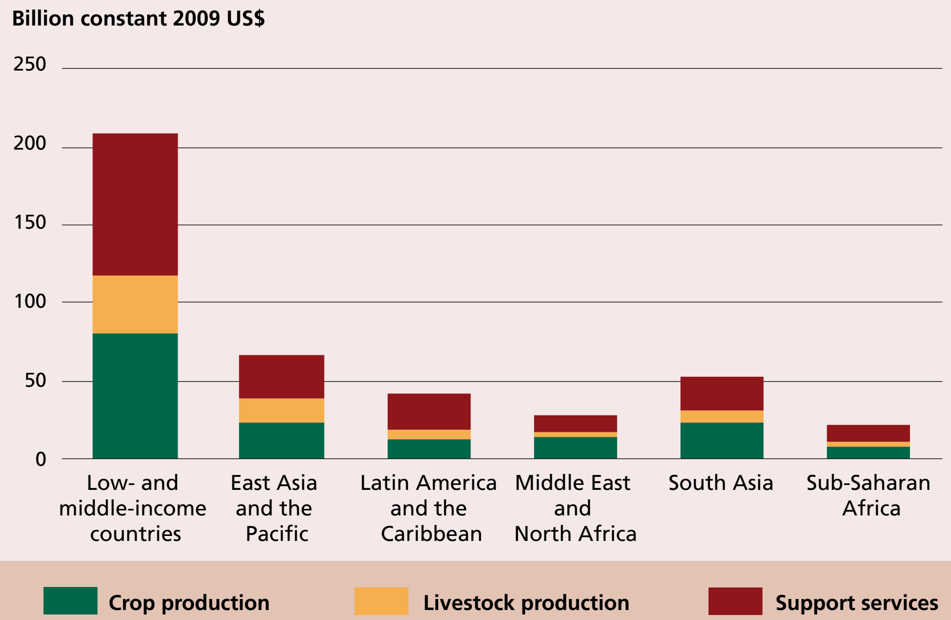
These estimates represent the level of investment required to meet growing demand for food in 2050 – not to eliminate hunger, although they do imply some reduction in poverty and hunger. Specifically targeting poverty or undernourishment implies assessing how much more investment is needed in addition to these projections or to some other "business as usual" scenario.

Targeting poverty and hunger

In a separate analysis, Schmidhuber and Bruinsma (2011) provide estimates of incremental public expenditures on agriculture and safety nets needed to reach a world free of hunger by 2025. Over this period, incremental annual public expenditures of US$50.2 billion

[8] Main categories included are as follows. For crop production: land development, soil conservation and flood control, expansion and improvement of irrigation, permanent crop establishment, mechanization, other power sources and equipment, working capital. For livestock production: herd increases, meat and milk production. For downstream support services: cold and dry storage, rural and wholesale market facilities, first-stage processing. No distinction is made regarding whether investments will be financed from private or public sources.

FIGURE 15
Average annual investment needs in low- and middle-income countries, by region



Note: The figure presents average annual needs over the period 2005–07 to 2050.
Source: Schmidhuber, Bruinsma and Bödeker, 2009.

TABLE 8
Incremental annual public investment needed to eradicate hunger by 2025

PRIORITY AREA FOR INVESTMENT	INVESTMENT NEEDED
	(Billion constant 2009 US$)
1. Expand rural infrastructure and market access	18.5
2. Develop and conserve natural resources	9.4
3. Research, development and extension	6.3
4. Rural institutions	5.6
5. Expenditures for safety nets	10.4
Total investment costs	**50.2**

Source: Schmidhuber and Bruinsma, 2011.

are estimated to be required (in addition to existing levels of spending) to support investment in rural infrastructure, natural resource conservation, research, development and extension, and rural institutions, but also to provide safety nets aimed at those suffering from hunger (Table 8).

Making the transition to sustainability

Meeting future demand growth sustainably, while accelerating the reduction of poverty and hunger, will require even higher levels of investment by farmers and the public sector. Analysis of sustainable production systems often shows them to be beneficial in terms of both increasing returns to producers and improving the environment (Pretty *et al.*, 2006). Yet the relatively low adoption rate of such systems seems to indicate they are not attractive to producers.

Moving to sustainable production systems involves significant immediate costs, not only in the form of investment and operating expenses, but also opportunity costs – for example the income producers forego during the transition to a new system. It can be several years before positive returns to sustainable agricultural systems are realized, particularly where they involve restoration of degraded ecosystems (McCarthy, Lipper and Branca, 2011). Few producers can finance such a long period of lost income – even if they stand to make major gains in the future (see also Box 14). Transaction costs can also be an obstacle to adopting sustainable practices. Sustainable production systems require more coordination, for example in managing common-property natural resources, or in coordinating post-harvest, processing, storage and marketing activities. This implies significant investments in social capital. Transitioning to sustainable consumption systems incurs a similar set of costs. Reducing waste involves not only investment and operating costs, but also the transaction costs of coordination among production, processing, storage and marketing phases.

Several governments in low- and middle-income countries have begun supporting farmers in the transition to more sustainable production practices. For example, the Government of Zambia adopted conservation agriculture as a policy priority in late 1999 in order to improve agricultural productivity and sustainability. It created the Conservation Farming Unit, which now provides extension services to 170 000 farmers in 17 districts to support the adoption of conservation agriculture. The technology has been most successful in semi-arid regions because it reduces the effects of drought on agricultural productivity without sacrificing yields. Even in these regions, however, many farmers have abandoned the practice, suggesting that more needs to be known about the institutional, agro-ecological and economic factors that influence the successful adoption of more sustainable agricultural practices (Arslan *et al.,* 2012). Similarly, the Government of Malawi supported the establishment of a National Task Force on conservation agriculture in 2002 and reports that 18 471 hectares, 110 percent of the target, are cultivated using conservation agriculture (Malawi Ministry of Agriculture, Irrigation and Water Development, 2012). The Government of Viet Nam has also embraced sustainable development of agricultural production, especially sustainable rice intensification, which has significant potential in improving food security and decreasing greenhouse gas emissions, while improving farmers' capacities to adapt to the effects of climate change.

Appropriate institutions and policies can reduce the costs individual investors face in moving to sustainable systems. For example, social safety nets and programmes to reduce risk and strengthen resilience *ex-ante* can strengthen incentives for investments in sustainable systems (FAO, 2010a). Publicly provided agricultural research, development and extension systems, combined with capacity building, reduce transaction costs and increase incentives for investments in sustainable practices. The reallocation of existing public and private investment resources – moving from investments that have low "sustainability" returns to higher ones – is key to moving towards sustainable production systems. Ensuring that environmental goods and services are incorporated into investment incentives is a crucial policy challenge (see Chapter 3). Similarly, agricultural research and development is essential for underpinning sustainable approaches in agriculture.

Potential new and additional sources of financing that could channel more private-sector finance towards sustainable development include payments for the provision of environmental public goods (such as biodiversity conservation, climate change mitigation or protection of water bodies). Linking climate change finance to sustainable agricultural investment plans could also provide additional finance (both are discussed further in Chapter 3).

The challenge of fostering investments in agriculture

The relative magnitude of investment flows from public and private sources clearly shows that private investment is the key to meeting future demand growth, achieving food security and making the transition to sustainable agriculture. But governments can only facilitate private investment by farmers and other investors. The question facing policy-makers therefore is "What is required to ensure that adequate agricultural investments occur and that they meet the objectives of food security, poverty alleviation and environmental sustainability?" This question will be addressed in the following chapters.

Key messages

- Private investment by farmers themselves is the largest source of investment in agriculture in low- and middle-income countries, far exceeding the annual flows to agriculture from governments, donors and foreign investors. The roles of public and private investors are complementary and generally cannot be substituted for each other, but the central role of farmers must be recognized in any strategy that seeks to promote agricultural investment.
- Systematic and comprehensive data on agricultural investment are very limited. A few internationally comparable datasets shed some light on different aspects of investments in agriculture, but improved data are necessary to clarify the levels and trends in agricultural investment and to enable more robust analysis of the impacts of different types of investment.
- Agricultural capital stock – especially agricultural capital stock per worker – is an important determinant of agricultural labour productivity. There are large gaps in agricultural capital–labour ratios between the high-income countries and the middle- and low-income countries. The gap between high-income and low-income countries has widened over recent decades as agricultural capital stock in the low-income countries has been outpaced by growth in the labour force. In particular sub-Saharan Africa and South Asia has seen declining and stagnant capital–labour ratios during this period.
- FDI in agriculture has increased in recent years but it represents a very small portion of total FDI flows and of total resource flows to agriculture in low-and middle-income countries. FDI is unlikely to make a significant contribution at the global level to increasing agricultural capital stock per worker, but it is a major factor for some individual countries.
- Public investment in agriculture is necessary to promote private investment in the sector, but governments in low- and middle-income countries have devoted a declining share of public expenditures to agriculture. The regions with the highest incidence of undernourishment – sub-Saharan Africa and South Asia – are also the ones that devote the smallest share of expenditure to agriculture relative to agriculture's share in GDP.
- Overall, low- and middle-income countries spend significantly less on R&D as a share of agricultural GDP than the high-income countries, and most of these expenditures are concentrated in relatively few countries. Given the positive role of R&D in promoting agricultural growth and poverty reduction, there is an urgent need to increase R&D funding for agriculture in the low- and middle-income countries.
- Globally, flows of ODA comprise a relatively minor share of agricultural investment but can be significant for some countries. After years of continuous decline, in recent years ODA to agriculture has increased both absolutely and as a share of total ODA, while still remaining below the levels of the 1980s.
- The relative importance of private investment means that the investment climate in which farmers make decisions is critical. It is the responsibility of governments to create the conditions to foster investment in agriculture.