Chapter 1. Main policy lessons from selected country reviews

This chapter offers an overview of main policy lessons from country reviews and related work on ways to improve the long-term productivity and sustainability performance of the food and agriculture system. Following a brief presentation of the framework used as a basis for the country reviews and a summary of the main productivity and sustainability challenges faced by the twelve reviewed countries, the chapter outlines the key policy recommendations in the different policy areas covered in the reviews. Finally, knowledge gaps are identified and ways to improve the relevance of the reviews are discussed.

Strengthening the long-term performance of food and agriculture

Developing policies to underpin competitive, sustainable, productive and resilient farm and food businesses is a high priority for OECD and G20 governments.[1] In 2016, Ministers of agriculture of OECD countries recognised "…the need for integrated policy approaches that will better enable farmers and the food sector to simultaneously improve productivity, increase competitiveness and profitability, improve resilience, access markets at home and abroad, manage natural resources more sustainably, contribute to global food security, and deal with extreme market volatility, while avoiding trade distortions." (OECD, 2016a). They invited the OECD to pay urgent attention to analysing the policy environment for food and agriculture in this context.

Since the mid-1980s, agricultural policy reforms in OECD and key emerging economies have reduced distortions to markets and trade: support levels have generally decreased and there has been a shift towards measures having less impact on producer decisions and, in some cases, target policy objectives more precisely (OECD, 2018a). However, progress has been unequal across countries. A large part of support to agriculture continues to support farm income, irrespective of actual levels and without setting specific targets. Many countries use commodity-specific measures, which are not efficient at transferring income or meeting other productivity-sustainability objectives. Thus, current policies are generally not well-aligned with policy objectives.

A more efficient approach would be to focus agricultural policy on measures that strengthen the long-term productivity[2] and sustainability[3] performance of the sector (OECD, 2018a). These include investments that improve innovation[4] and infrastructure capacity, and farmer access to input and output markets. Strengthening the long-term performance of food and agriculture would also require adopting integrated policy approaches that encompass the wider enabling policy environment.

A framework to review policies affecting the food and agriculture sector

A wide range of policies affect food and agriculture performance. Thanks to the increasing number of policy evaluation requirements that are imposed in many countries, significant progress has been made to date in understanding the impact of agriculture-specific policies. However, the impact of general policies on the economic and environmental performance of the agricultural sector has received less attention. Yet, establishing synergies between policy areas, as well as avoiding overlaps and contradictory policy signals, are clearly important for achieving the twin goals of a more productive and a more environmentally sustainable food and agriculture sector.

The OECD has developed the "Food and Agriculture Productivity-Sustainability Framework" to help countries adopt a more enabling policy environment for food and agriculture (Box 1.1). This framework identifies innovation, structural change, natural resource use, and climate change as the drivers of productivity and sustainability and considers the main channels through which policy incentive areas affect these drivers.

Box 1.1. The Food and Agriculture Productivity-Sustainability Framework

This framework considers the full range of policy incentives and disincentives to innovation, structural change, natural resource use, and climate change, all of which have been identified as drivers of productivity growth and the sustainable use of resources (Figure 1.1).

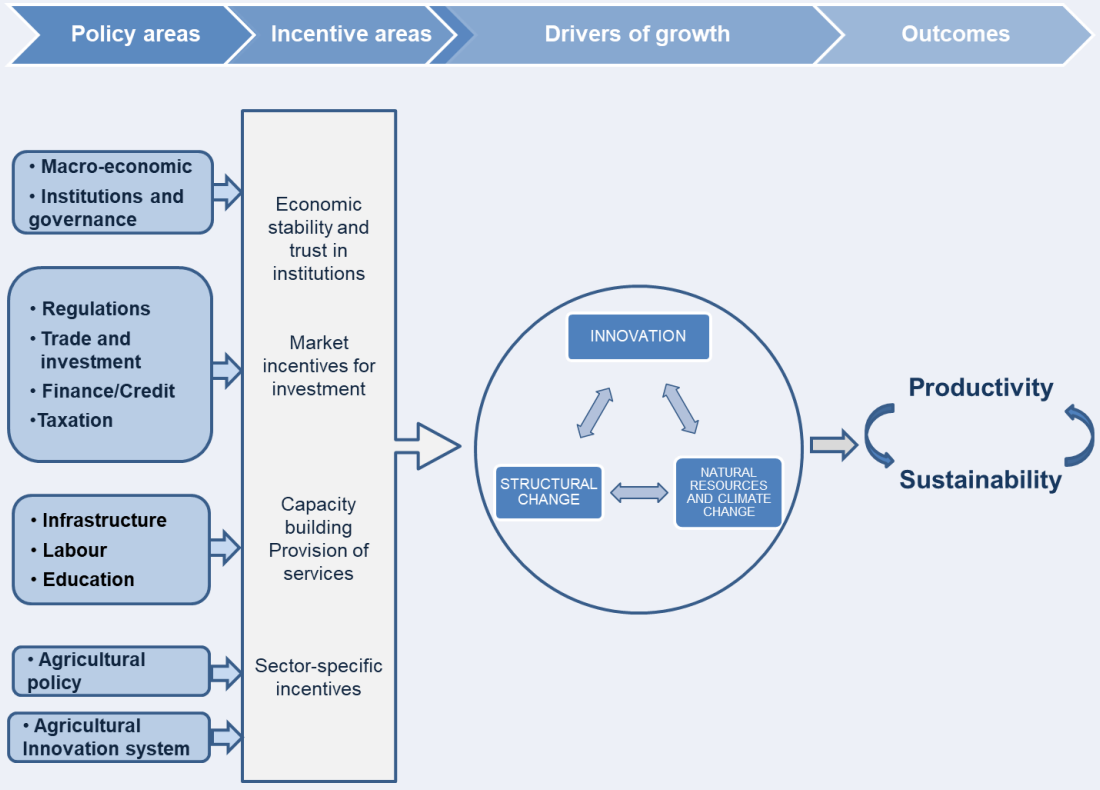
The main channels, or incentive areas, are the following:

- Economic stability and trust in institutions (macro-economic policy, justice, security, property rights), which are essential to attract long-term investment in the economy.
- Private investment, which in turn requires a transparent and predictable environment that balances the interests of investors and of society. The regulatory environment for businesses, natural resource use, and farm inputs and food products and policies related to trade and investment, finance and credit, and taxation have a direct impact on investment in agricultural and food companies.
- Physical and human capacity building enables the provision of essential public services and the development of skills needed in food and agriculture. Capacity building is influenced and affected by infrastructure, rural development, labour, and education policies.
- Agriculture-specific policies, which provide direct incentives and disincentives to innovation, structural change and natural resource use in agriculture. They include market price support measures, input subsidies, direct payments to producers, and various services to producers and the sector. Within policies that provide services, the agricultural innovation system receives special attention. It provides continuous innovation in technologies, practices, and organisation that facilitate the development of a more productive and environmentally sustainable food and agriculture sector.

Drivers interact with each other: some innovations (e.g. labour saving ones) facilitate structural adjustment, and structural adjustment facilitates the adoption of scale-dependent innovations. Natural resource constraints foster the adoption of innovation (e.g. drought-resistant seeds), which help improve sustainable resource use and adaptation to climate change.

The role of innovation and structural change in productivity growth is well-established in the theoretical and evidence-based literature. At the firm level, productivity growth has three components: 1) technological progress reflects early adoption of innovation by best performers; 2) technical efficiency change represents wider diffusion of innovation; and 3) economies of scale represent a movement along the efficiency frontier due to a change in firm size (OECD, 2011a; Latruffe, 2010). Structural change also affects the capacity to adopt scale-dependent innovations. Many if not most agricultural innovations result from formal public and private investments in agricultural research and development (R&D); in turn, many studies find a long-term positive impact of agricultural R&D on productivity growth. Moreover, productivity growth is often used as an indicator of research or innovation impact.

Figure 1.1. Policy drivers of innovation, productivity and sustainability in food and agriculture



Source: OECD (2015a), "Analysing Policies to improve agricultural productivity growth, sustainably: Revised framework", www.oecd.org/agriculture/topics/agricultural-productivity-and-innovation/documents/analysing-policies-growth-2015-draft-framework.pdf.

Since 2015, the OECD has undertaken 12 in-depth country reviews using this framework.[5] Parts of the framework have also been used in reviews of agricultural policies in Argentina, Colombia and Switzerland. The countries reviewed differ in their economic and environmental conditions, policy frameworks, and performance of their food and agriculture sector. The reviews identify the extent to which countries' policy settings have been addressing productivity and sustainability challenges, if and how they have realised developments towards achieving both, or where they have put more implicit or explicit weight on one of the two objectives. These reviews reflect positively on the relevance of the framework to analyse the policy environment for food and agriculture in a wide range of countries.

Various OECD studies provided analytical support to the reviews, notably those on agricultural innovation systems, drivers of productivity growth, and green growth in the food and agriculture sectors. In addition, analyses were conducted in parallel in order to shed light on specific issues, such as taxation policy in food and agriculture, drivers of farm-level performance, the impact of agricultural policy on farm productivity and sustainability, digital opportunities for agriculture, strengthening agricultural resilience in the face of multiple risks, and on how to meet labour and skills demands, particularly in rural areas.

The reviews reveal gradual, but significant improvements in the policy environment for food and agriculture, although progress has been unequal among reviewed countries and among policy areas. In many countries, the existing policy environment continues to impede innovation, adjustment, the sustainable use of resources, as well as better adaptation to climate change. Diverse types of policy incoherencies slow down efforts towards a more productive and sustainable agriculture.

The reviews, however, highlight common solutions to developing and implementing policies that improve productivity and sustainability in food and agriculture. The comparison of reviews further suggests that countries would gain from learning from each other's experiences, both positive and negative.

Further productivity and sustainability improvements are needed in food and agriculture

All countries reviewed face challenges with respect to the productivity and sustainability in food and agriculture, and they will need to address these challenges jointly in order to respond to changing demands, to generate adequate income for farming families, and to contribute to the rural economy (Table 1.1).

The productivity performance of primary agriculture is contrasted across reviewed countries. Total factor productivity (TFP) growth, as estimated by the United States Department of Agriculture (USDA), ranged from 1% to over 3% per year on average over the period 2001-14 (Table 1.2). In countries with an annual TFP growth below 2% on average, performance has declined compared to that of the previous decade. In contrast, significant improvements have occurred since the period of 1991-2000 in countries which registered a TFP growth over 2% over 2001-14. There are also large differences in productivity growth by commodity sector (e.g. between soybeans and other products in Argentina), farm size and regions. In Estonia and Korea, several of the larger farms drive national productivity growth. Sustainability challenges, including the availability and quality of land and water, already constrain productivity growth in some countries.

Improving productivity growth further remains a challenge both in highly performing countries, where easy adjustments have already occurred, and in less performing ones where changes in incentives and disincentives are needed. In many countries, the lack of competitiveness and capacity in food processing industries is an issue for at least some part of the sector, limiting the expansion of agriculture, innovation and export capacity in the food system. Improvements are thus needed along the value chain.

At the farm level and along the value chain, improving the measurement of productivity would help to better understand the potential issues and to identify appropriate actions. Yet the measurement of TFP remains a challenge, given the different methods used and data limitations. These difficulties increase when attempting to incorporate environmental performance in TFP, as the quality and availability of the information also remain a limitation.[6]

Table 1.1. Summary of main challenges for food and agriculture

	Structural challenge	Productivity challenge	Sustainability challenge	Climate change challenges and opportunities
Argentina	Investment in rural and transport infrastructure	Regional and product differences in productivity growth	Deforestation, increased use of inputs affecting water and air quality	Increasing frequency of extreme weather events, melting of glaciers
Australia	Increasing differences between small and large farms. Remoteness of some farms	Availability of new technology. Drought and water shortages constrain productivity growth	Water and soil constraints, Greenhouse Gas (GHG) emissions	More severe water constraints
Brazil	Dualistic structure	Large productivity gap between subsistence and commercial farms	Land management, GHG emissions	Not included in the review
Canada	Production quotas, weak food industry, and small domestic market	Mainly in the dairy sector	Land management affecting biodiversity, regional water quality issues from excess nutrients	Better growing conditions in some regions, increased frequency of extreme weather events (floods, droughts), potential increase in pest and disease
China	Small farms dominate Income gap between rural and urban households	Water resource constraints, small farms	Water resources constraints, pollution of soils and water, and expansion of intensive livestock production	Rising temperatures, more frequent extreme weather events, spread of pests and disease
Colombia	Small, subsistence farms	Large differences by commodity sector. Low productivity in dairy farms due to small scale, high input prices, poor transport infrastructure and inefficient value chain	Land management affecting biodiversity, GHG emissions, and intensive use of inputs	Rising and more erratic precipitations causing soil degradation. Rising temperatures requiring moving production in higher altitudes (Coffee). Melting of glaciers and disappearance of moorland
Estonia	Dualistic structure	Productivity driven by a small number of larger farms, high growth rates reflecting catch up	Local water pollution by nutrients	Better growing conditions despite potential increase in pests and diseases, and rainfall variability
Japan	Increasing differences between small and large farms	Labour shortages and ageing	High nutrient surplus driven by intensive use of fertiliser, GHG emissions	Increased frequency of extreme weather events (typhoons)
Korea	Small farms dominate Income gap between rural and urban households	Productivity gap with manufacturing sector, small farms	High nutrient surplus. Expansion of intensive livestock production, increasing nutrient surplus and GHG emissions	More typhoons; more erratic monsoons; warming in the South
Latvia	Dualistic structure	Productivity driven by a small number of larger farms, high growth rates reflecting catch up	Local water pollution by nutrients	Better growing conditions, increase in pest and disease, and rainfall variability
Netherlands	High land prices	Sustain growth with higher constraints	Water pollution by nutrients; GHG emissions and biodiversity	Increased frequency of extreme weather events, Water management
Sweden	Areas with natural handicaps (northern latitudes)	Low and declining growth rate for some sectors	Eutrophication, biodiversity and GHG emissions	Better growing conditions, prolonged cultivation period, climate favourable to other crops
Switzerland	Areas with natural handicaps (mountains)	Low and declining growth rate	Nitrogen surplus does not meet country targets	--
Turkey	Large number of small farms	Productivity gap between small and larger farms	Water scarcity, water quality and soil erosion	Increased water stress and temperature increase affecting agriculture
United States	Labour shortage	Declining growth rate	Water scarcity, pollution and soil erosion, particularly in certain regions	Higher frequency of extreme weather events, higher water constraints in some regions

Source: OECD country reviews.

In most reviewed countries, structural challenges remain, as smaller and less productive farms continue to co-exist with larger operations. In some, small farms account for a large part of land use and production, while in others, they co-exist with very large farms, which dominate production in a dualistic structure, with increasing differences in performance between small and large farms. Structural challenges also include labour shortage and weaknesses in infrastructure, particularly in remote areas, as well as areas with natural handicaps (mountains or northern latitudes).

Table 1.2. Total Factor Productivity growth

Annual percentage growth, 1991-2000 and 2001-14

	2001-14	Increase compared to 1991-2000	Decrease compared to 1991-2000
<1.0%			
1.0-1.5%	Australia, Colombia, Sweden, Switzerland		Australia, Colombia, Sweden, Switzerland
1.5-2.0%	Canada, Korea, United States, EU28, OECD	EU28, OECD	Canada, Korea, United States
2.5%	Turkey	Turkey	
2.5-3.0%	Japan, Netherlands, Brazil, Latvia	Japan, Netherlands, Brazil, Latvia	
>3.0%	China, Estonia	China	

Notes: 1. EU28 and OECD averages. 2. 1991-2000 data are not available for Estonia and Latvia.
Source: USDA (2018), Economic Research Service, International Agricultural Productivity, www.ers.usda.gov/data-products/international-agricultural-productivity.aspx (accessed October 2018).

Despite a wide diversity of situations, environmental pressures are increasingly decoupled from agriculture productivity trends (Table 1.3), i.e. while agricultural productivity grows, environmental damages decrease or increase at a slower rate in many countries. Sustainability issues affect most countries but differ in terms of nature and extent between and within countries. In some countries, water scarcity is the main problem, while in others it is pollution from nutrients. Progress has been observed at least in some dimensions of agriculture sustainability in all reviewed countries, even if environmental pressures remain high. In most countries, the percentage change in agriculture's negative impacts on the environment have not exceeded the percentage change in productivity gains (thereby experiencing relative environment decoupling), with some countries even reducing negative impacts while increasing productivity (absolute environment decoupling).

Table 1.3. Decoupling agriculture productivity from resource and environmental pressure: Observed trends

Based on average annual change between 1998-2000 and 2010-12[1]

	Resource	Environment
Absolute decoupling	Water use: Australia, Estonia, Korea, Netherlands Land use: Korea, Netherlands	Nitrogen and Phosphorous balance: Estonia, Sweden, Turkey, United States Ammonia: Netherlands, Sweden, United States Greenhouse gas (GHG) emissions: Netherlands, Turkey Pesticide sales: Netherlands, Korea, United States; Pesticide risk: Sweden
Relative decoupling	Water use: China, Turkey, United States Energy use: Estonia, United States	GHG emissions: Estonia, United States
Deterioration	Energy use: Turkey	Pesticide sales: Turkey GHG emissions: Korea

Notes: 1. Time periods are not identical for each country, more recent date on agri-environmental indicators might alter this assessment. 2. Absolute decoupling refers to a situation in which resource impacts decline in absolute terms. 3. Relative decoupling refers to a decline in the ecological intensity per unit of economic output.
Source: Adapted from country reviews.

Climate change will modify the natural conditions for agriculture and increase uncertainties everywhere. Northern countries will enjoy better growing conditions that increase productivity, but higher temperatures may also result in an increase in pest and diseases. More extreme weather is expected, and water management will become more challenging in most countries. This will affect the range of climate-adapted products, and thus productivity, and the type and degree of stress from water, heat, pests and disease, so adaptation is crucial. Efforts to mitigate climate changes through reductions in greenhouse gas (GHG) emissions from agriculture will also constrain production.

Removing policy distortions and regulatory impediments along the value chain

First and foremost, existing policies that deter agricultural productivity and sustainability should be removed. This will prevent inconsistent policy signals and the creation of further complexities into policy making. The main areas for policy improvement include agricultural markets, land markets, water management, and enforcement of property rights. Access to competitive inputs and services also need to be improved in many countries.

Remove support that most distorts agricultural commodity markets

The most distorting forms of support from agricultural policies should be eliminated, as they encourage the sub-optimal and unsustainable use of resources and production choices. These include border measures and domestic policies that raise prices and receipts received by producers above world levels, and measures that reduce the cost of variable farm inputs without imposing environmental constraints. Reducing support levels and differences in support level across commodities would also enhance the reallocation of resources towards more efficient uses based on market demand. In particular, the provision of coupled payments that enhance commodity production and distort allocation of resources across commodities should be limited to well-targeted measures.

Australia provides an example of a country where agricultural policy distortions are minimal: support to agricultural producers is one of the lowest amongst the reviewed countries; domestic prices are fully aligned with international prices and producer support measures mainly focus on facilitating risk management and adaptation. Moreover, about half of Australian support to the agricultural sector funds general services, in particular agricultural innovation systems and rural infrastructure which foster long-term improvements in productivity and sustainability. Successive droughts and water shortages have, however, limited productivity growth since 2000.

Since the mid-1990s, there have been significant reductions in distortions in EU Member States, Switzerland, and the United States, resulting from lower support levels and the introduction of payments to producers that are not based on production criteria or do not require production to replace former coupled support. While these decoupled payments are much less distorting than coupled support, they allow maintaining land in non-productive uses and slow structural adjustment, thus affecting productivity growth.

Other impediments to innovation, structural change, and sustainable resource use should be removed. For example, support that provides higher benefits (or impose lower tax rates) to smaller farms or firms can slow adjustment towards more productive production scales, and thus may discourage them to develop their activities for fear of losing these benefits.

In some countries, support to farmers is conditional on the adoption of environmentally-friendly production systems. This has had positive impacts on sustainability, but requirements should not discourage innovation and adaptation to local conditions.

Improve the functioning of input markets

Impediments or disincentives to structural adjustment and the realisation of scale economies may exist in the land and labour markets. In Asian countries, land scarcity and restrictions on land use and markets have hindered the adjustment needed to improve productivity and sustainability. Efforts are being made, however, to improve the functioning of land markets, in part to respond to the shortage of labour in the sector. For example, the People's Republic of China (hereafter "China") implemented measures to facilitate land consolidation. While promoting flexible formats for consolidated farm operations, the government supports the development of co-operatives as a new type of farm management unit, using preferential tax treatment.

Ensuring that the supply of labour meets the demand of the food and agriculture sector is a widespread issue, as is adapting skills to changing needs. In response to seasonal labour needs, most of the countries reviewed with the exceptions of Argentina and Brazil have less protective regulations on temporary forms of employment than on regular employment. The reviewed countries have implemented specific provisions for seasonal immigration, which makes up a significant part of seasonal labour. These provisions include temporary immigration schemes that allow employers to hire foreign nationals when qualified citizens are not available (Canada, Korea, and the United States), schemes that provide sponsorship of employers for foreign workers, including skills training components (Australia), regional programmes to attract newcomers to regions with shortages, and the removal of impediments regarding labour costs for employing foreign workers (Estonia). In Sweden, in addition to incentives that promote employment in the green industries (e.g. forest) for newly arrived individuals, the 2017 Food Strategy emphasises the need to accelerate labour adjustment for both the agriculture and food sector.

To reduce labour shortages, it is also important to ensure that taxation is not so high that it discourages participation in labour markets, in particular for low-cost jobs in food and agriculture, and to ensure legislation and tax provisions do not impede farm transmission.

Several of the reviewed countries have recently introduced promising programmes or regulations to improve their management of water resources, with a particular emphasis on agriculture. For example, Brazil has initiated steps to bolster the use of water charges for hydropower facilities and agriculture users. These water charges aim to help improve water allocation while helping to recover regulatory agency recover charges.

A well-functioning financial market facilitates access to finance for farmers and agri-food firms. Many countries provide investment support to farms and food processing firms, but it would be more efficient to address the causes for the lack of access to credit at market conditions (e.g. by addressing market failures, facilitating collaterals, or improving risk management).

Finally, an effective competition policy, including low barriers to entry and exit, facilitates access to a diversity of affordable inputs for farmers and to food for consumers. Competitive conditions also encourage innovation and productivity growth, including through their impact on structural change along the value chain. Business regulations have generally become more supportive of innovation over time. In particular, starting a business has become easier in many countries, thus improving competition.

Reduce barriers to trade

Trade can facilitate the flow of goods, capital, technology, knowledge, and people needed to innovate. In OECD countries, trade policy does not generally restrict access to modern

technologies and farm inputs. Tariffs on capital and intermediate goods are particularly low in Australia, Canada, Japan, and the United States. In emerging economies like Brazil and China, however, these tariffs are higher than in most OECD countries. This increases the cost of capital, inputs and machinery equipment that are needed to innovate, and thus affects the competitiveness of the agri-food sector. In the reviewed countries, some farm sectors are also protected from foreign competition.

Country reviews and accumulated evidence suggests that governments should reduce tariff protection to facilitate trade and investment, as well as to ensure that non–tariff measures do not lead to excessive trade costs, either because regulations are different between countries while aiming at the same regulatory issue or because implementation and conformity assessment are overly burdensome.

Trade facilitation procedures have improved in most of the reviewed countries since 2012, but countries should explore the scope for further trade facilitation, e.g. by using digital technologies. There are few restrictions to foreign direct investment in the reviewed countries, with the exception of agricultural land in a few of them.

Making the agriculture research and innovation system more responsive to needs

Continuous innovation in technologies, practices and organisation facilitate the development of a more productive and environmentally sustainable food and agriculture sector. Research and innovation play a dominant role in driving productivity growth in the short and long term in all the countries reviewed. The theoretical pathways between innovation and productivity are backed by empirical evidence from both sector-level and farm-level estimates. Innovation can also improve sustainability if incentives to that effect are in place. Improving the responsiveness of agricultural innovation systems to needs, and the acceptance of innovation by consumers and society, is thus crucial.

Agricultural innovation systems are diverse

The agricultural innovation system (AIS) is the main vehicle to develop agronomic and technological solutions to improve the productivity and sustainability of food and agricultural production. Encompassing the adoption of these solutions, the system involves a wide range of actors including policy makers, teachers, researchers, advisors and brokers of innovation, farmers, agri-food companies, co-operatives, non-profit organisations (NGOs), and consumers.

AISs in the reviewed countries are very diverse in terms of ambitions, institutional set-up, and funding mechanisms. For example, country reviews cover the two countries that contribute the most to world public investment in agricultural research — China and the United States — as well as small economies with greater reliance on imported knowledge. The contribution of public research organisations under agriculture-related ministries to agricultural research is particularly important in Argentina, Brazil, Colombia, Korea, Japan, and the United States, while that of specialised universities dominate in other countries. Public and private research intensity — expenditure on food and agriculture research as a percentage of the sector's gross-value added — varies significantly across countries as do funding mechanisms, notably the share of project funding in total government expenditure on agricultural research.

Governments traditionally play an important role in agricultural innovation systems

Governments provide strategic guidance, financial support to researchers and advisors in public and private organisations, and research infrastructure such as databases, laboratories and information and communication technologies (ICT). In many countries the public sector dominates agricultural research. Governments also encourage private investment in research and innovation through investment support, tax policy, intellectual property rights (IPR) protection, and more generally policies that enable investment. Governments have traditionally played an important role in organising and financing training and advisory systems, thus facilitating innovation at the farm level, and public systems continue to dominate in some countries.

Agricultural innovation systems are in transition

Changes are in response to the recognition in many of the reviewed countries that new challenges require a different approach to innovation. The main trend in innovation policy is to improve the impact of public expenditure and make the system more collaborative and demand-driven to increase adoption. Despite progress, however, top-down approaches continue to dominate in most countries, although mechanisms are in place to improve responsiveness to needs, as outlined below.

Various trends in public funding for agricultural research are found across countries, depending on the indicator. Government budget allocated to agricultural R&D has decreased in the last 15 years in several major exporting countries like Canada, the Netherlands and the United States, both as a percentage of gross value added and in constant value, but has increased in other reviewed countries (Table 1.4). Gross domestic expenditure on R&D for agricultural and veterinary sciences in government and higher education organisations increased in constant value in all reviewed countries for which data are available.

Public funding mechanisms for agricultural research has also changed, as the share of competitive projects in total funding increases. Efforts to foster public-private collaboration have been made in most of the reviewed countries, using funding and institutional mechanisms. The importance of international co-operation is acknowledged in all the countries as it helps to reduce costs and to pool resources and exploit synergies on regional or global challenges.

Renewed policy attention is being given to improving the adoption of innovation in farms and firms through improvements in the enabling environment and specific investment support. Farm advisory systems are in transition to adapt to new needs and to provide a wider range of advice requiring re-training and flexibility. New intermediary actors have emerged to meet these needs.

Based on the experience in the countries reviewed, the common principles noted below would make the AIS more efficient and responsive to needs.

Table 1.4. Trends in public research expenditure

Level in 2017*, and change between 2000 and 2017

	GBARD[1]	Public GERD on agricultural science[2]	Agriculture BERD[3,4]	Food and beverages BERD[3,5]
Research intensity in 2017*				
<0.1%			Estonia, Latvia, Japan, Turkey	
0.1% - 0.5%	Turkey	Turkey	Canada, Korea	Latvia, Turkey, Switzerland
0.5% - 1.0%	China, Colombia, Netherlands, Sweden	Argentina	Australia	Canada, Estonia,
1.0% - 1.5%	Argentina, Australia, Estonia, Latvia, United States	Estonia	Netherlands	Sweden
1.5% - 2.0%	Brazil, Canada, Japan	Latvia		Japan
2.0% - 2.5%				
2.5% - 3.5%	Korea, Switzerland	Australia, Korea		Korea, Netherland, United States
>3.5%		Japan, Netherlands, Sweden		
Research intensity change between 2000 and 2017*				
Increase	Australia, China, Estonia, Japan, Korea, Sweden	Estonia, Korea, Latvia, Turkey	Australia, Estonia, Korea, Netherlands, Turkey	Estonia, Korea, Netherlands, United States
Stable	Brazil, Colombia	Japan		
Decrease	Argentina, Canada, Netherlands, United States	Argentina, Australia	Canada, Japan	Canada, Japan, Sweden, Switzerland
Research expenditure change between 2000 and 2017* (in 2010 Dollars; Constant prices and PPPs)				
Increase	Australia, China, Colombia, Estonia, Japan, Korea, Sweden, Switzerland	Argentina, Australia, Estonia, Japan, Korea, Latvia, Netherlands, Sweden, Switzerland, Turkey	Australia, Canada, China, Estonia, Japan, Korea, Netherlands	China, Estonia, Korea, Latvia, Netherlands, Turkey
Decrease	Canada, Netherlands, United States			

Note: * or nearest available year.

1. Government budget allocation for R&D (GBARD) is a funder-based approach for reporting R&D, which involves identifying all the budget items that may support R&D activities and measuring or estimating their R&D content. It enables linking these budget lines to policy considerations through classification by socioeconomic objectives. However, it provides only a partial indicator of investment in public agricultural research, since it refers to research funding instruments dedicated specifically to agriculture.

2. Gross domestic expenditure on R&D for agricultural and veterinary sciences (GERD), by government and higher education organisations. Data are not available for Brazil, Canada, China, Colombia, and the United States.

3. Business Expenditure on R&D (BERD) is the measure of intramural R&D expenditures within the business enterprise sector (regardless the sources of R&D funds).

4. BERD agriculture data are not available for Brazil, China, Colombia, Sweden, Switzerland, and the United States.

5. BERD food and beverages data are not available for Australia, Brazil, China, and Colombia.

Source: OECD (2017a), "Research and Development", OECD Statistics (database), https://stats.oecd.org/; and for Brazil, China and Colombia: ASTI (2017), Agricultural Science and Technology Indicators (database), www.asti.cgiar.org/data (accessed March 2018).

Improve the governance of agricultural innovation systems

Government priorities for agricultural research and innovation need to be co-ordinated and communicated clearly. They should be part of a longer-term strategy for agricultural innovation, which takes into account long-term challenges such as climate change, and consumer and societal demands. They should also be integrated into wider growth policy

strategies. A common finding from the country reviews is the need to better involve stakeholders in the definition of objectives, starting at an early stage of the definition process. For example in Canada, an objective of Value Chain Round Tables (VCRTs), which bring together key industry leaders from across the value chain with federal and provincial government policy makers, is to share information about challenges and opportunities, identify research, policy, regulatory and technical requirements, and to create co-operative long-term strategies.

Co-ordination between the various public and private research organisations at the national and sub-national levels needs to be improved. A good practice is to give a co-ordinating role to a specific national institution and to clarify the mandates of organisations. In Sweden, efforts to strengthen the general innovation system have focused on improving governance and linkages, including the grouping of public research institutes into a single holding entity. Financial and institutional mechanisms – such as consortia, networks, co-operative research agreements, funding of collaborative R&D partnerships and platforms for discussion and sharing information – help to improve co-ordination and knowledge on the respective activities of diverse actors.[7]

Research and innovation investments and outcomes need to be monitored and policy impacts evaluated against objectives. This should enable continuous improvement, but also help identify where more profound changes are needed to meet objectives. Comprehensive, coherent and regular evaluation procedures should be developed. Ideally, these should include independent evaluations and cover a wide range of indicators of efforts, outputs and impacts that go beyond research excellence and financial considerations. In Australia and the United States, research evaluation procedures are in place that include impact assessment.

Simplify research programming to improve effectiveness and transparency

In some of the countries reviewed, government funding of research and innovation goes through multiple channels, making access of funds and evaluation of programmes quite complex. Simplified programming of public R&D and innovation funding, and provision of clear information, preferably on a single platform, as done in the Netherlands, should improve access. The efficiency of research funding mechanisms should also be reviewed on a regular basis to ensure higher impact.

At the same time, a challenge is to explore innovative ways to generate new (breaking through) ideas to overcome current constraints, for example through demand-driven funding mechanisms.

Improve complementarity of public funding of agricultural R&D with private investment by focusing on areas with characteristics of public goods

Improving the complementarity between public research funding at the national, sub-national and international levels with private efforts would help better leverage public money. However, linkages between public and private research are not well understood. Estimating the impact of public expenditure on agricultural research on private research as part of evaluation procedures should help target public policy and improve complementarity. The United States offers a good example of complementarity between public and private agricultural research, facilitated by the strong investment of some multinational companies in agricultural research, and regular assessment of public research investments.

Knowledge infrastructure is a public good that facilitates public and private research activities and enables innovation. It is particularly important to support the development of ICT infrastructure and general purpose technologies, as well as specific knowledge infrastructure such as databases and institutions, which require long-term stable funding as done in Brazil. Since they joined the European Union in 2004, Estonia and Latvia have upgraded research infrastructure using EU structural funds. In some countries, however, the decline in public funding for agricultural research and the high reliance on project funding were identified as potential issues for the long-term performance of the AIS.

Governments should dedicate public funds to long-term riskier large-scope research projects and projects that aim to improve long-term sustainability in food and agriculture. They should also dedicate specific funds for policy-relevant research, i.e. research that generates information needed to improve policies.

Government should facilitate Public-Private Partnerships (PPPs) for research and innovation, when they bring additional benefits by providing guidelines, governance, and enabling R&D funding mechanisms (Moreddu, 2016). A first step is to remove institutional constraints to public research organisations to engage in co-operation activities with the private sector. Many of the general innovation policies of the reviewed countries include funding mechanisms that support PPPs. For instance, Canada offers PPP support as part of its agricultural policy.

In the reviewed countries where agricultural research is organised by commodity sector, research is often focused on improving profitability. Public co-funding thus needs to ensure broader sustainability issues are covered. An option is to create cross-sector thematic areas and projects, including environmental issues, or to broaden the scope and membership of existing commodity research systems. For example, some Research and Development Corporations (RDCs) in Australia address broader challenges at the supply-chain level.

Strengthen private contribution to R&D and innovation for food and agriculture

Agri-food industries are important actors in the innovation process. With the exception of Korea, the Netherlands and the United States, where business expenditure on food R&D as a percentage of gross value added is over 2.5% (Table 1.4), national processing companies in most of the reviewed countries have limited capacity to engage in research. Strengthening the capacity of smaller domestic companies to engage in research and innovation, possibly using incentives targeted to their needs, is important for the performance of the whole sector.

Business investments in R&D for food and agriculture have increased in constant value terms in all countries for which data are available since the 2000s (Table 1.4). Investments are normally driven by market demand, but governments also provide different kinds of incentives. They include direct investment support, tax incentives, and Intellectual Property Right (IPR) protection. Few mechanisms supporting innovation in private companies are sector-specific, but some programmes target innovation in small- and medium-size enterprises (SMEs) (e.g. the Small Business Innovation Research (SBIR) programmes in the Netherlands and the United States). The extent to which they benefit agri-food companies in the countries reviewed is not clear. The evaluation of programmes that support research and innovation in private companies should be strengthened to ensure they are efficient and reach their intended beneficiaries.

The increase in IPR protection in recent decades has prompted higher investment in food and agriculture research and innovation by enabling firms to recover their investment. In some of the reviewed countries, however, enforcement of IPR protection needs to be improved. The challenge for IPR regulations is to provide incentives for private investment in innovation without compromising the sharing of knowledge and further use for research purposes (OECD, 2013). To facilitate the innovation process, Australia grants innovation patents with a shorter protection of eight years. The Plant Breeders' Right, as provided by the International Union for the Protection of New Varieties of Plants (UPOV), offers commercial protection to the "breeder" of a plant variety, without compromising further breeding research and re-use from farmers' planting.

Governments should facilitate the development of alternative sources of funding for research and innovation, through appropriate legislation. They include farmers' contributions from levies; revenues from royalties or Intellectual Property, venture capital and Foreign Direct Investment (FDI). In Australia, Canada, Colombia, Sweden, and the United States, producer levies can fund agricultural R&D. This funding remains within the value chain, except in Sweden. The most comprehensive system is the Australian Rural Research and Development Corporation (RDC) model of co-financing of rural R&D activities and places interactions between public R&D and agricultural industries at the heart of the rural innovation system. In the Netherlands, revenues from patents fund research (Innovation Box).

Strengthen linkages within the agricultural innovation system and across sectors

Research and innovation in food and agriculture increasingly benefit from advances in other sectors and general-purpose research, such as genetics and digital technologies. It is thus crucial to promote and enable research co-operation across sectors. The integration of the agricultural system in the general innovation system should ensure better use of public funds, increased efficiency of innovation systems through the pooling of complementary expertise and resources, and higher spill-over across sectors. As they focus on local needs, regional innovation systems are well-placed to identify synergies across sectors and actors that can benefit rural development.

Stronger linkages between AIS actors (researchers, educators, extension services, farmers, industry, NGOs, consumers and others) also contribute to improving the efficiency and relevance of the system. This does not necessarily require institutional reforms, but rather mechanisms to facilitate connections and co-ordination. To foster balanced partnerships, governments need to strengthen and harness the capacity of private companies and farmer organisations to participate in research partnerships via project funding and support to networking and training activities, as done by the EU innovation and agricultural policy or the Canadian Value Chain Round Tables. The link between research and technical assistance, in particular, requires strengthening in many of the countries reviewed. This can be done by adding a technology transfer component to research projects, or by valuing and encouraging networking between researchers, advisors and producers.

It is important to facilitate the sharing of knowledge in order to strengthen innovation by improving public understanding of the importance of innovation in food and agriculture, in the sector and in society, and building trust in science through increased transparency and education. For example, Japan established a platform for open innovation in agriculture that includes all agricultural innovation actors, private companies, universities, and research institutions in non-agricultural sectors.

Facilitate international R&D co-operation

The countries reviewed recognise the benefits of international co-operation for national systems from national specialisation, international spill-overs, and improved capacity to respond to global challenges. There are many opportunities for public research to engage in bilateral, regional and multilateral co-operation in R&D and technology transfer that need to be explored. To facilitate international co-operation, governments can, for example, remove institutional constraints to public research organisations that impede the hiring of foreign researchers or trainees, or to engage in activities that are not directly of national interest. Governments can also support the integration of research data and sharing of experience at the international level, student and staff exchanges, and the sharing of equipment and laboratories. For example, Embrapa in Brazil created Labex (Virtual Laboratories Programme) to promote opportunities for institutional co-operation in agricultural research and to monitor scientific advances, trends, and activities of interest to agribusiness in partner countries. EU Member States illustrate the benefits from the EU-wide innovation policy, which supports collaborative, multi-country projects and provides complementary funding to national research and innovation organisations.

Strengthen farm advisory systems to facilitate adoption

The potential benefits of innovations are only realised if they are effectively implemented. Farm advisory systems need to be flexible in order to respond to changing demands at the farm level. A role for the government is to encourage a varied supply of relevant advice from diverse public and private suppliers, while ensuring needs are met. In the Netherlands, for example, a diversity of private companies provide a wide range of advisory services since the privatisation of the public service. In Estonia, the government provides guidance but delivery is made by independent organisations.

In such a pluralistic and competitive system, public resources should focus on services that the private sector typically under-provides, including advice to small, semi-subsistence farmers to broaden their opportunities, targeted advice on sustainable technologies and practices, and use experience to better understand issues and needs. In the United States, for example, support to technical assistance and research projects is provided for within agri-environmental policies. A role for the government is also to facilitate the sharing of experiences through networking, and the development of open databases, and to ensure advisors have up-to date knowledge – possibly through certification – and to facilitate continuous life-long training.

Address skills need in food and agriculture

Matching labour and skills demand from food and agriculture is a growing issue in many countries. Agriculture-related education in particular can contribute by becoming more attractive to students, anticipating new skills demand and adapting courses accordingly, offering long-life training to all workers in the sector. Governments should ensure training and re-training programmes respond to needs, including for digital, environmental and management skills, and cover all workers, including immigrants, women and seasonal workers. This requires discussion with education actors and the private sector to identify long-term needs. In the Netherlands, the Green Table was created in 2014 to continue collaboration among educational institutions on common interest regarding discussion and negotiation with the government; relationships between education and the labour market; and maintenance of a good knowledge infrastructure. The Netherlands also succeeded in making agriculture-related education more attractive and responsive to changing skills

needs in the labour market, and students' choices, by emphasising job opportunities and societal values. To meet future needs, it is important to change traditional public perception and to be more proactive in reaching non-traditional agricultural students.

Ensuring a stable and enabling policy and regulatory environment to facilitate investment

A broader role for the government is to ensure that the general policy and regulatory environment is conducive to investment that leads to productivity and sustainability improvements. Two areas for improvement are outlined in this section: regulations and sustainability incentives.

Modernise regulations

The regulatory environment for entrepreneurship affects food and agricultural companies. Following OECD Good Regulatory Practices (OECD, 2012a), the countries reviewed are encouraged to simplify their regulatory system where necessary, and to make regulations clearer, more transparent, more easily accessible, and more coherent across jurisdictions. Regulatory collaboration between and within countries should also be enhanced to reduce regulatory heterogeneity. For food and agriculture in particular, regulations should become more flexible and responsive to industry and consumer needs, and anticipatory of science and technology developments and changes in public perception. Modernisation of regulations in Canada involves rationalising the government's role, adopting incorporation by reference to update regulations, increasing the use of outcome-based regulations, increasing regulatory alignment with the United States (as part of regulatory co-operation), and reducing unnecessary administrative burdens. Regulatory co-operation between the United States and Canada provides an opportunity to revisit differences between federal and provincial regulations. While some regulations may be perceived as slowing innovation, others stimulate the development of innovative solutions that enable the industry to meet requirements. This is the case, in particular, with environmental regulation.

Align policies and regulations towards sustainability improvements

Regulations on natural resources are central to ensuring the long term sustainable use of natural resources. In large part, they determine access to and use of land, water and biodiversity resources, and impose limits on the impact of industrial and agricultural activities on natural resource (e.g. water pollution, soil degradation, greenhouse gas emissions). Several countries have set regulations to restrict agricultural land expansion to forested areas (e.g. Brazil and Colombia), to discourage farmland fragmentation (Turkey), or to prevent agricultural land conversion to urban uses (Japan and Korea). While qualitative comparison can be made based on country reviews, the evaluation of environmental regulatory stringency for agriculture and the role of regulations and their effectiveness require further investigation.

Evidence from the country reviews suggests that policy incentives towards environment and resource sustainability need to be realigned by removing environmental harmful subsidies, such as fuel tax rebates, and using taxation or market mechanisms to meet environmental objectives. Sweden was one of the first countries to introduce taxes on pesticides in 1984. Combined with other policy measures, the tax contributed to reducing pesticide sales by more than 50% nationally, and a large decrease in pesticide risks for human health and to the environment. The Netherlands introduced in 2013 a charge to fund the production of sustainable energy in addition to the standard tax on energy. Several

countries have undertaken promising initiatives to improve water management in agriculture, such as the introduction of water charges in Brazil, a new groundwater regulation in the US state of California, and the Canada-Ontario Lake Erie action plan to address phosphorus pollution.

There is also much scope to improve the governance and management of natural resources by strengthening environmental laws and regulations that define responsibilities and rights, and by identifying and tackling local conflicts. In particular, compliance could be improved by using modern technology and by providing to agencies in charge of monitoring compliance the necessary financial and skills capacity.

Using agricultural policy to strengthen the sector's long-term performance

In a policy and regulatory environment more conducive to sustainable and productive investments, agricultural policies can be used to address specific issues that are prone to market failures, while contributing to the long-term performance of the sector. A mix of approaches and instruments, including taxes, regulations or direct support, are available to address well-identified problems. For example, to increase public goods provision and to address negative environmental externalities, agricultural policies should directly encourage the reduction of pollution and promote the sustainable use of natural resources.

In this context, agricultural policies should focus more specifically on strengthening the drivers of productivity and sustainability, which are innovation, structural change, sustainable resource use, and climate change adaptation. For example, where markets fail, agricultural policy measures can be used to:

- Facilitate innovation directly by supporting investments in the modernisation and restructuring of farm and agri-food firms; the diversification of activities; the uptake of new technologies and digital-based opportunities such as the use of big data, precision farming and clean energy; collaborative activities and participation of farmers or farmers' representatives in knowledge networks. For example, agricultural policy in Canada includes programmes that target innovation directly. EU agricultural policy measures support farmers' participation in innovation networks and improvements in advisory services
- Facilitate structural adjustment using time-bound, non-distortive investment support, where needed, or "retirement package" payments as the voluntary restructuring scheme offered in 2006-08 to EU farmers and processors in the sugar industry to facilitate adjustment to the 2006 sugar policy reform.
- Strengthen incentives to sustainable use of natural resources and reduction of pollution. Governments can improve the design of agri-environmental programmes, using best available scientific and economic evidence basis to better target and tailor to actual needs. Increasing evidence supports the use of performance-based policies, which require an evaluation of policies and implementation of measurable performance indicators, as is done in Switzerland. Environmental impact assessment should apply to more agricultural activities. Sweden, for example, requires an environmental impact assessment for a wide range of agricultural activities, the cost of which is borne by farmers. Governments could also revisit the balance between regulation and economic incentives in view of fostering environmentally-friendly innovation; they could consider market-based approaches to further reduce environmental pressure and the development of environmental service markets, such as carbon offsets and water quality credit

markets. At the same time, efforts to provide targeted and tailored advice to farmers on sustainable and productive technologies and practices should be strengthened.

- Explore options for reducing GHG emissions from agriculture, in particular grazing livestock, facilitate farmers' adaptation to climate change, and initiate relevant research. For example, Australia has introduced an Emission Reduction Fund, which attributes funding to the most effective bidders to reduce GHG emissions.
- Support technical assistance to improve compliance as part of agricultural support programmes, as in US conservation programmes.

Farmers need effective risk management tools in order to innovate and adapt to climate change. The government's role should focus on preparedness, the availability of information systems, and catastrophic risks. Existing risk management policies, such as subsidised agricultural insurance schemes, should be reviewed and evaluated with regard to their long-term financial and actuarial soundness and in view of climate change risk. Business-as-usual risk management in the face of climate change means that more risk and responsibility is shifted to governments and taxpayers. Government action should move towards a more forward-looking resilience approach to enhance the capacity to absorb, adapt and transform in the face of external shocks. This includes funding R&D activities aimed at developing practices and technologies that enable farmers to manage risks more effectively (e.g. drought resistant seeds, water management technologies), and providing information on risk exposure and risk management methods to farmers, as done in Australia and the Netherlands.

Improving policy coherence

Develop comprehensive strategic plans, including the whole value chain

The whole policy package affects food and agriculture and it needs to provide consistent signals. An important step to improving policy coherence is to develop comprehensive strategic plans that ensure co-ordination between policy areas, clarify policy objectives and responsibilities across levels of government, and that take into consideration trade-offs among specific policy objectives and interactions between policy areas. Improving consultation and communication about policy action, transparency and accountability is also essential to building trust and increasing efficiency.

Comprehensive food and agricultural strategies should develop a vision to improving the long-term productivity and sustainability performance of the whole value-chain and its capacity to respond to future challenges and opportunities. For example, climate change adaptation and mitigation should be integrated as a cross-cutting aspect of agricultural and agri-environmental policies, as is done in the Netherlands and Sweden. Any plan should include clear operational objectives with measurable targets for evaluation. This requires flexible data and information systems for evaluation, and comprehensive evaluation procedures that ensure lessons learned are considered when developing new policies.

Policy strategies should cover the whole food chain. Productivity and sustainability do not only concern farms and farmers. The entire value chain is at play, and the policy framework needs to consider the performance of each segment, as well as the relationships between them. Retailers have a closer interface to consumers than farmers, and agro-food industries are the main buyers of farm products. Each stage of the value chain is implicated in lifting productivity and improving the sustainability of production. Indeed, in many countries the success in tapping into higher value opportunities for the farm sector hinges on

improvements along the food chain. The role of the government in improving the functioning of the value chain requires further attention.

Minimise policy incoherencies

Policy incoherence can slow or prevent progress towards improved productivity and sustainability in the sector. Policy incoherencies were observed among policy goals, across policy domains, within agriculture or innovation policies, or between policy approaches in all the countries reviewed. More work is needed, however, to identify inconsistencies, to require better measurement, and to develop strategies that build on synergies and are able to deal with trade-offs.

Different types of policy incoherence are reported in the reviewed countries. The following sequence of actions could help reduce incoherencies:

- Identify the main policy incoherencies, and address them, by separating and reducing the signals misaligned with a productive and sustainable agriculture from other parts of policies.
- Ensure that no new incoherencies are introduced. In the case of innovation, agriculture or environmental policies, introduce a rapid *ex ante* assessment, with deeper analysis only if needed, ensure that policy evaluations focus on results rather than just the level of implementation, and incorporate the objective of assessing coherence in future agriculture policy evaluations. In the case of other policies, encourage lawmakers to open their views on the indirect effects of related policies on agriculture.
- Encourage synergistic policy plans, build policy bridges, and support win-win policy solutions. Cohesion starts in high-level policy plans, which should consider reaching out to non-agriculture objectives. In so far as possible, solutions that can contribute to both productivity and sustainability objectives should be developed and promoted.

Target interventions to the issue at stake

As a general principle, policy interventions are most effective and efficient if they target a specific problem at hand. Agricultural policies, in particular, often suffer from imprecise definitions on the scope of intervention. The best type of policy action will depend on the specificity of the issue (general, rural, or sectoral), and the targeted population (farmers, landowners, or rural dwellers). If the problem is not specific to the agricultural sector, it is more efficient to start using a general or regional policy. For example, wider income or growth objectives require a non-sectoral policy, such as a territorial, bottom-up approach to rural development. The general social security system in OECD countries can be adapted to provide an income safety net for farm households. The specific needs of small, semi-subsistence farmers require using a wider range of policy approaches than agricultural policy.

Fostering the relevance and impact of country reviews

Country reviews are conducted in collaboration with experts in governments. They draw on internationally comparable data and analysis in the OECD and other international organisations, as well national information and expertise. This collaboration is essential to ensuring their accuracy and relevance, and increasing their policy impact.

Impact can include policy changes following policy recommendations, as well as improvements in policy-relevant data and analysis to address the information gaps identified. For example, following the Canadian review (OECD, 2015d), Canada adopted the 1991 Act of the International Convention for the Protection of New Varieties of Plants (UPOV 91) in 2015 and launched a review of Agriculture and Agri-Food Canada public funding for agricultural innovation in 2018. An important recommendation in the review for the Netherlands was to define long-term objectives for R&D and innovation (OECD, 2015e). The Netherlands responded by developing a strategic knowledge and innovation agenda. Social issues are central to this agenda and are implemented through multi-year mission-driven innovation programmes. Together with stakeholders, concrete goals are defined for a wide range of policy instruments. At present, the agenda is still under preparation but nearing completion.

Experience with country reviews and analytical studies underpinning the framework should help strengthen the framework in the future. Moreover, discussion of policy issues identified in the reviews have continued at government and research levels in some countries, and evidence on drivers of productivity performance and the link between innovation and productivity is increasing. As discussed earlier, there is a need for improved evidence in many areas.

The framework used to collect information and analyse policies in reviewed countries was used flexibly in each country. It is important to retain this flexibility while ensuring that important issues are covered. Areas for improvement were nevertheless identified, notably on considerations of policy coherence and trade-offs; the need to better account for food systems, in particular on the consumer side; and to the need to include other aspects of the food and agriculture system such as the bioeconomy, fisheries, and circularity in the system.

A number of information gaps were identified. There is a limited understanding of the determinants of productivity growth and the nature of sustainability challenges in specific contexts. This requires better indicators of productivity and sustainability, including at the disaggregated level (particularly for sustainability indicators), as well as improving and diversifying the analytical tools and approaches. More forward-looking approaches are needed to deal with fundamental uncertainties to anticipate future challenges. In all areas, primary agriculture receives more attention than the food industry, both in the literature and in actual policies. Greater efforts should also be focussed on exploring the potential of digital technologies to create, improve and maintain information systems. The country reviews indicated the need to improve information systems not only to guide research and innovation policies, but also to facilitate knowledge sharing. The development of indicators and tools is required to evaluate the performance of the agricultural innovation systems and innovation policy on a regular basis, taking longer-term effects into account. Limited information is available on the extent to which cross-cutting policies affect food and agriculture. The country reviews have started to contribute to filling this gap, but the evidence remains limited, and it remains difficult to understand the interactions between a general policy, such as improved access to credit for SMEs, and agriculture-specific measures, such as farm investment support.

Notes

1 See for example the G20 Agriculture Ministers' Declaration 2017 — "Towards food and water security: Fostering sustainability, advancing innovation", 22 January 2017, Berlin (G20, 2017); the Interagency Report to the Mexican G20 Presidency (G20, 2012); and the joint declaration of Agriculture Ministers at the meeting of the Committee for Agriculture at ministerial level at OECD on 7-8 April 2016 (OECD, 2016a).

2 The most comprehensive productivity indicator is the Total Factor Productivity (TFP), which reflects the efficiency with which firms combine inputs to produce outputs.

3 In this report, sustainability refers to the preservation of natural capital, i.e. environmental sustainability. This encompasses managing agriculture's use of natural resources to ensure their long-term viability and reducing the negative environmental impacts of agriculture production which can damage the natural assets. Sustainable agriculture production systems also need to adapt to the projected impacts of climate change and to mitigate greenhouse gas (GHG) emissions.

4 As defined by the Oslo Manual (OECD/Eurostat, 2018), innovation is a broad concept. It is more than research and development (R&D) and encompasses both the creation and adoption of innovation, which can be "new to the firm, new to the market or new to the world".

5 Australia, Brazil, Canada, the People's Republic of China (hereafter "China"), Estonia, Japan, Korea, Latvia, the Netherlands, Sweden, Turkey and the United States.

6 Efforts to improve TFP measurement are taking place within the OECD Network on Agricultural Total Factor Productivity and the Environment. Following the 2014 Meeting of Agricultural Chief Scientists (MACS) in Australia, where the issue of performance measures for sustainable agricultural intensification was discussed, the MACS formed a working group to review the status and availability of TFP, and assess whether it, or some other measure or combination of measures, would be sufficient to assess progress towards sustainable agricultural intensification. The Working Group prepared a White Paper on Metrics of Sustainable Agricultural Productivity, presented at the 2016 G20 MACS in China (G20 MACS, 2016).

7 Fuglie and Toole (2014) contains a detailed analysis of this issue and estimations of the impact of public expenditure on agricultural research in the United States on private agricultural research.

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