OECD Food and Agricultural Reviews

Innovation, Agricultural Productivity and Sustainability in Japan

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Foreword

Innovation, Agricultural Productivity and Sustainability in Japan is a part of the OECD Food and Agricultural Reviews series. It examines the conditions in which farms and businesses in Japan undertake innovation in the food and agriculture sector to become more productive and environmentally sustainable. The review starts with an overview of the food and agriculture sector and outlines development challenges and opportunities (Chapter 2). It then considers a broad spectrum of policies according to the main channels or incentive areas through which they affect productivity growth and the sustainable use of resources (Chapter 3); the agricultural policy environment (Chapter 4); the agricultural innovation system (Chapter 5); and human capital development in agriculture (Chapter 6). Chapter 1 summarises the findings of this review and provides policy recommendations.

Policies in Japan are analysed following the analytical framework developed by the OECD, in the context of work with the G20, to evaluate the extent to which existing policies facilitate productivity growth and sustainability in food and agriculture. To date, this framework has been applied to Australia, Brazil, Canada, the People's Republic of China, Estonia, Korea, Latvia, the Netherlands, Sweden, Turkey, and the United States.

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The inputs to this review included several background reports by national experts: on agricultural policy by Fumihiro Kabuta of the National Graduate Institute for Policy Studies (currently Nakamura Gakuen University); on agricultural R&D system by Masayasu Asai of the Policy Research Institute of Ministry of Agriculture, Forestry and Fisheries; and on skills and human resource development policy by Tomohiro Uchiyama of the Tokyo University of Agriculture.

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This review was declassified by the Working Party on Agricultural Policies and Markets in March 2019.

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Acronyms

ABIC	Agri-Food Business Innovation Center
AEI	Agro-Environmental Indicators
AEM	Agro-Environmental Monitoring
AFFRC	Agriculture, Forestry and Fisheries Research Council
A-FIVE	Agriculture, Forestry and Fisheries Fund Corporation for Innovation Value-Chain and Expansion Japan
AI	Artificial Intelligence
AIS	Agricultural Innovation System
ALA	Agricultural Land Act
AMA	Anti-Monopoly Act
APC	Agricultural Production Corporation
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
ASTI	Agricultural Science and Technology Indicators
BERD	Business Expenditures on R&D
BoJ	Bank of Japan
BRAIN	Bio-Oriented Technology Research Advancement Institution
CAP	Common Agricultural Policy
CGIAR	Consultative Group on International Agricultural Research
CH4	Methane
CIAT	International Center for Tropical Agriculture
CO2	Carbon Dioxide
CPI	Consumer Price Index
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CSTI	Council for Science, Technology and Innovation
EAPVP Forum	East Asia Plant Variety Protection Forum
EPA	Economic Partnership Agreement
ESA	Endangered Species Act
ESI	Essential Science Indicators
EU	European Union
EU15	15 European Union countries prior to 1 May 2004
EUR	Euro
FDI	Foreign Direct Investment
FKII	Field for Knowledge Integration and Innovation
FAO	Food and Agriculture Organization
FAS	Farm Advisory System
GAEC	Good Agricultural and Environmental Condition
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
GHG	Greenhouse Gas
GI	Geographical Indication
GIO	Greenhouse Gas Inventory Office of Japan
GSSE	General Services Support Estimate
GVC	Global Value Chain
ICT	Information and Communication Technology

IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Right
IPSS	National Institute of Population and Social Security Research
IRRI	International Rice Research Institute
IT	Information Technology
IITA	International Institute of Tropical Agriculture
JA	Japan Agricultural Co-operative
JAS	Japanese Agricultural Standards
JFC	Japan Financial Corporation
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
JISNAS	Japan Intellectual Support Network in Agricultural Sciences
JMA	Japan Meteorological Agency
JPY	Japanese Yen
JSPS	Japan Society for the Promotion of Science
JST	Japan Science & Technology Agency
LID	Land Improvement District
LRF	Federation of Swedish Farmers
MACS	Meeting of Agricultural Chief Scientists
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEXT	Ministry of Education, Culture, Sports, Science and Technology
METI	Ministry of Economy, Trade and Industry
MFN	Most Favoured Nation
MHLW	Ministry of Health, Labour and Welfare
MIC	Ministry of Internal Affairs and Communications
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOE	Ministry of Environment
MOF	Ministry of Finance
MoU	Memorandum of Understanding
MPS	Market Price Support
MRL	Maximum Residue Limit
N2	Nitrogen
N2O	Nitrate Oxide
NARO	National Agriculture and Food Research Organization
NH3	Ammonia
NO	Nitric Oxide
OECD	Organisation for Economic Co-operation and Development
OMA	Ordinary Minimum Access
PPP	Public-Private Partnership
PRIMAFF	Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries
PSE	Producer Support Estimate
RCA	Revealed Comparative Advantage
RCEP	Regional Comprehensive Economic Partnership
R&D	Research and Development
RDC	Australian Research and Development Corporation
RIETI	Research Institute of Economy, Trade and Industry
SBS	Simultaneous Buy and Sell
S&T	Science and Technology
SCT	Single Commodity Transfers
SEK	Swedish krona
SIP	Strategic Innovation Promotion Program
SME	Small and Medium Sized Enterprise
SNG	Subnational government

STI	Science, Technologies and Innovation
TFP	Total Factor Productivity
TPP	Trans-Pacific Partnership
TSE	Total Support Estimate
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UPOV	International Union for the Protection of New Varieties of Plants
URAA	Uruguay Round Agreement on Agriculture
US EPA	United States Environmental Protection Agency
USD	United States Dollar
USDA	United States Department of Agriculture
WAGRI	Agricultural Data Collaboration Platform Council
WEF	World Economic Forum
WGI	Worldwide Governance Indicators
WTO	World Trade Organization

Executive Summary

Until recently, Japanese agriculture experienced a long period of contraction. Since 1990, the value of Japan's agricultural production has decreased by more than 25% and the number of commercial farm households and agricultural workers by more than 50%. The agricultural sector continues to be under pressure to raise its productivity, primarily to improve international competitiveness and thereby contribute to economic growth, in particular in rural areas. At the same time, intensive agricultural production contributes to a high level of environmental pressure.

Historically characterised by small-scale rice production, the structural transformation of Japanese agriculture towards more productive, profitable, and larger-scale farms has been a major policy goal. Today, rice represents less than 20% of the total value of agricultural production and a smaller number of large, often corporate farms are emerging. In 2015, the largest 3% of farms in Japan produced more than half of total agricultural output.

A smaller domestic market and declining labour force have important implications for Japan's economy, including in the food and agriculture sector. The country's working age population is expected to decrease by 41% by 2055, and the share of the population over 65 years is expected to increase to almost 40% over the same period. The aging population is most advanced in the agricultural sector, with 56% of farm managers over the age of 65.

Rapid economic growth in East Asia, however, is opening up market opportunities for Japanese agro-food products, and Japan's agro-food exports doubled between 2012 and 2018 (albeit from a small base). As agriculture becomes more technology and data intensive, Japan is well-positioned to develop a more technologically intensive agriculture domestically and, potentially, to expand its production networks for high value agro-food products, regionally and globally.

Innovation in agriculture increasingly depends on technologies that are developed outside agriculture. As this process of innovation becomes highly interactive among a growing and diverse network of stakeholders, the further integration of agriculture with other parts of the economy could enable Japan's agricultural sector to benefit from competitive technology and skills that prevail in other sectors. In Japan, agriculture has long been treated differently from other parts of the economy, based on the implicit policy assumption that government needs to support small-scale, resource poor family farms that would otherwise disappear. The evolution of the agricultural structure in Japan and the global trend towards more integrated domestic, regional and global value chains requires a shift in this policy paradigm towards measures that would promote innovation, entrepreneurship, and sustainable resource use.

To promote the integration of agriculture with other sectors, the role of private input and service suppliers will need to grow. At present, commercial banks play a relatively small role in agricultural finance. Agricultural co-operatives (known as JAs) provide integrated services for their members, including banking, insurance, farm input supply, and marketing. As such, JAs maintain a dominant position in certain input markets.

Competition between JAs and other players, however, could facilitate the development of alternative farm input and service providers that could better meet the specialised needs of professional farmers.

Improving the environmental performance of agriculture, and increasing its preparedness for more frequent natural disasters due to climate change, is key to ensuring the sustainable growth of Japanese agriculture. However, progress in reducing the environmental pressure from agriculture has been limited thus far. Japan should develop an integrated agri-environmental policy framework in which all producers commit to improving their environmental performance. Agricultural policy programmes should provide consistent incentives to adopt sustainable production practices and, where appropriate, impose penalties for non-performance. Subnational governments should play a greater role in implementing agri-environmental policy at the regional level, with the national government ensuring that all policies are coherent with national targets and agricultural policy programmes.

The types of policy support required by professional farms has also evolved. Although Japan has increased the role of non-commodity specific payments, most support to producers continues to be in the form of market price support that requires the production of certain commodities. Agricultural policy should shift away from directive policies that keep farmers in uncompetitive and low-income activities, and towards allowing them the freedom to make their own farm business decisions. Government policy should target producers' management constraints and business opportunities. For example, access to education and skills upgrading, specialised advisory services, and risk management instruments could be prioritised. In particular, farm managers need entrepreneurial and digital skills to develop integrated business plans and to develop links with value chains, making use of internal and external skills and resources. Making agricultural education and training more attractive and relevant is critical to attracting talent and to avoiding potential mismatches of skills in the agricultural sector.

Professional farms today have a greater capacity to engage proactively in agricultural research and development (R&D) and human capital development. Greater engagement of stakeholders in these areas would also make Japan's agricultural innovation system more demand oriented. Moreover, a further integration of agricultural R&D systems with general innovation systems, as well as removing the impediments to cross-sectoral and international collaboration would allow Japanese agriculture to benefit from technologies of other domestic sectors and foreign countries.

Key policy recommendations
Develop policy and market environments that are more conducive to innovation and entrepreneurship in agriculture
• Develop a more demand-oriented approach to exploit the diverse demand for Japanese agro-food products in overseas markets, including the international expansion of local production networks.
• Reduce the role of government credit support and increase the role of commercial banks.
• Ensure a level playing field between JA groups, and other agricultural input and service providers by enforcing the Antimonopoly Act and limiting cross-subsidies between financial and agricultural businesses in local JAs.
• Increase the linkage between farm management policy and wider policies focused on small and medium-sized enterprises (SMEs) to address the entrepreneurial needs of farms beyond agricultural production.
• Develop soft infrastructure to facilitate the digitalisation of agriculture and redesign the hard infrastructure to facilitate the adoption of new digital technology.
• Give farmers more freedom to make production decisions by phasing out commodity-specific support and progressively opening up to international markets.
• Enhance the role of farmers in managing normal business risk by lowering the threshold of revenue loss covered by policy programmes and consider introducing voluntary risk-management programmes.
Fully integrate environmental policy objectives in the agricultural policy framework
• Define agri-environmental policy targets at the national and regional levels based on a systemic assessment of the environmental performance of agriculture with the participation of a wide range of stakeholders.
• Expand the scope of environmental reference levels defined in the current environmental principle to a wider set of environmental issues, including climate change mitigation and biodiversity, and establish environmental targets and reference levels adapted to local ecological conditions.
• Increase cross-compliance conditions on producer support programmes with locally adapted reference levels of environmental quality and design an integrated agri-environmental policy at the subnational level.
• Better reflect the actual water use in paddy field on water use fees to improve the water use efficiency and include the long-term rehabilitation costs of irrigation system in order to balance the costs and benefits of the investment between current and future water users, and to maintain irrigation infrastructure sustainably.
Establish a more collaborative agricultural innovation system
• Focus public agricultural R&D on pre-competitive research areas with a medium- to long-term perspective and on areas that are not specifically tied to commercial production.
• Introduce co-funding schemes for agricultural R&D with producer organisations to reflect demand in R&D activities and to increase overall spending capacity for agricultural R&D investment.
• Increase funding for collaboration, and co-funding with the private sector, foreign researchers and institutions beyond the presently limited number of competitive research grant projects.
• Further integrate agricultural R&D systems with general innovation systems to promote cross-sectoral innovation.
• Clarify the role of national and prefectural agricultural research organisations and consolidate efforts in regional R&D at a broader regional level.
Enhance the capacity of farmers to innovate
• Strengthen the partnership between agricultural education and the agro-food industry, including more participation of professional farms in teaching activities and funding.
• Reorient the curriculum of vocational education in agriculture to develop the skills required of farm managers, provide more structured opportunities for learning, and develop training programmes that combine lectures with work experiences.
• Consolidate prefectural agricultural colleges at a broader regional level to pool resources and develop a unique and specialised agricultural education that is adapted to regional conditions. This should be accomplished in partnership with the private sector.
• Focus the role of prefectural extension services in areas of public interest, such as promoting sustainable production practices and giving advice on compliance with regulations and government policy programmes; expand the role of private advisory services.

Chapter 1. Assessment and recommendations

This chapter presents the framework used in the report to analyse the extent to which policies in Japan are supportive of innovation and structural change, and the extent to which they affect access to, and use of, natural resources for productivity growth and sustainability. It also gives an overview of the review's findings on a wide range of policies and develops specific recommendations for related policy areas.

1.1. Enhancing innovation, productivity and sustainability is a key challenge in the food and agriculture sector globally and in Japan

Agriculture productivity growth must be improved in order to address the global challenge of growing demand for food, feed, fuel and fibre. Furthermore, this must be done sustainably through more efficient use of natural and human resources, and reduced pollution. A wide range of economy-wide policies affect the performance of the food and agriculture sector, and must be considered alongside agriculture-specific policies. This report focuses on the performance of agricultural innovation systems in Japan, recognising the importance of innovation in improving productivity growth sustainably along the whole agro-food chain.

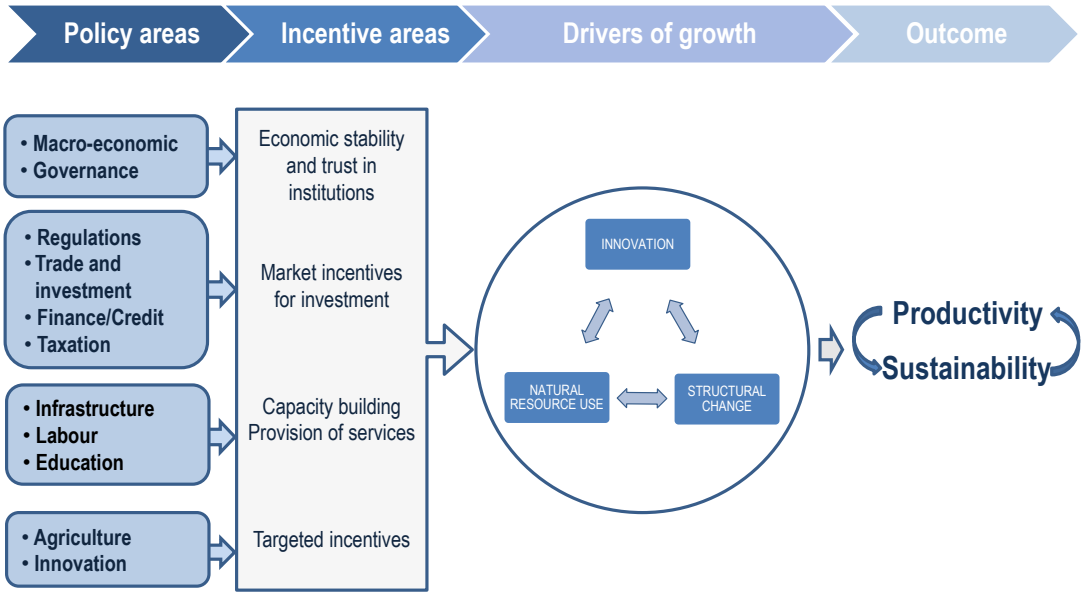
The framework of this report considers policy incentives and disincentives to key drivers of sustainable productivity growth: innovation, structural change, and the environmental sustainability of agriculture (Figure 1.1).

This report begins with an overview of the characteristics and performance of the food and agriculture sector, and the challenges it will face in the future (Chapter 2). It then considers a broad spectrum of policies according to the main channels or incentive areas through which they affect productivity growth and sustainable use of resources:

- the general policy environment for food and agriculture (Chapter 3)
- the agricultural policy environment (Chapter 4)
- the agricultural innovation system (Chapter 5)
- human capital development in agriculture (Chapter 6).

The report draws on background information provided by experts, and on recent OECD agricultural, economic, rural, environmental, and innovation policy reviews. Throughout, it discusses the likely impacts of each policy area on innovation, productivity growth and sustainability, and draws recommendations from a range of policy areas.

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



Source: (OECD, 2015[1]), "Analysing policies to improve agricultural productivity growth, sustainably: Draft framework", www.oecd.org/agriculture/policies/innovation.

1.2. Japan's agriculture is at a turning point

After three decades of contraction, Japan's agriculture show some signs of growth

Since 1990, the value of agricultural production has declined by more than 25%, and commercial farm households and agricultural workers by more than 50%. In 2017, the share of agriculture in the Japanese economy was 1.1% of Gross Domestic Product (GDP) and 3.4% of employment.

Japan is the second largest net importer of agro-food products after the People's Republic of China (hereafter "China"). Despite policy efforts to maintain food self-sufficiency, more than 60% of calorie intake in Japan depends on imports. Trade flows show that the country does not have a comparative advantage in agriculture and food products. However, rapid economic growth in East Asia has boosted demand for Japanese agro-food products, with exports doubling between 2012 and 2018 (albeit from a small base), opening new market opportunities. The value of agricultural production increased three consecutive years after 2015 and the number of young new entrants to agriculture is increasing.

Structural change has driven agricultural productivity growth in Japan

The higher share of agriculture in employment than in GDP indicates that labour productivity in agriculture is lower than in the rest of the economy. The food and agriculture sector continued to be under pressure to raise its productivity in order to keep up with the highly competitive manufacturing sector, as well as improve its international competitiveness and its contribution to the economy, including in rural areas.

A reallocation of resources to more profitable sectors and to more productive large-scale farms has been a major driver of productivity growth in Japan's agriculture. The value share

of rice in agricultural production declined from 43% in 1965 to 17% in 2015, while that of livestock and vegetables increased to 35% and 27% in 2015 from 23% and 12% in 1965, respectively. Westernisation of the Japanese diet reduced rice consumption by more than half from its peak, and increased meat and dairy consumption.

The concentration of land into large, professional farms has accelerated in the last two decades as older farmers have retired and policies that support land rental have been reinforced. As a result, agricultural production is structurally polarised with a small number of large, commercial farms accounting for the bulk of production, while many small farms remain, notably in the rice sector. Management of farms has also shifted from the traditional family farm to corporate farms that hire regular employees. The number of corporate farms doubled between 2005 and 2015, accounting for more than a quarter of agricultural production. In 2015, 3% of farms produced more than JPY 30 million (USD 278 000), accounting for more than half of total production. The economic-size distribution of farms indicates that the farm structure in Japan has evolved in a way similar to that of European Union countries prior to 1 May 2004 (EU15).

Sustainability performance of agriculture has significant room for improvement

Despite the declining share of primary agriculture in the economy, it is important to minimise the environmental impact of agriculture on natural resources as the sector comprises 36% of the country's total habitable land area and 68% of total water withdrawal. Given the limited availability of land, Japan's agricultural production sites and residential areas tend to be closely located. Improving the environmental performance of agriculture should be considered a local issue affecting the lives of local residents.

There is significant room to improve the environmental performance of Japanese agriculture. Japan has one of the highest nutrient surpluses among OECD countries, indicating the potentially high risk of environmental pressure on soil, water, and air. While many OECD countries have reduced agricultural nutrient surpluses, Japan's progress in this area has been much slower. For example, the nitrogen balance in Japan decreased by only 0.3% between 1993-95 and 2013-15, while it fell by 35% in the EU15 and by 24% in the OECD area – in both cases from lower initial levels.

Future growth in agriculture in Japan can no longer depend on the intensive use of inputs and natural resources. More frequent extreme weather events combined with natural disasters will likely pose a major risk to future agricultural production. Promoting the sustainable use of land and water, and increasing the country's preparedness for climate change are critical to ensuring long-term growth. Promoting environmentally-friendly farming can also add higher value to agro-food products that are in strong demand by consumers in Japan and abroad.

Demographic trends pose one of the biggest challenges

The contraction of the Japanese population and labour force is a major challenge for the economy, and one which increasingly affects food and agriculture. Total population peaked in 2008 and is expected to decline by 31% by 2065. The working age population started to decline in 1995 and is expected to decline by a further 41% over the next four decades. The ageing population is of particular concern. The share of the population more than 65 years old will rise from around 27% in 2016 to almost 40% in 2055, the highest in the OECD area.

A smaller domestic market and a declining labour force will have significant implications for Japan's economy. A shortage of labour in agriculture has already severely constrained many agricultural operations. Moreover, a declining and ageing population will reduce the size of the domestic food market in the medium- to long-term. The future growth of the agriculture and food sector thus depends on increasing productivity by using less human and natural resources, and producing high-value-added products for the domestic and overseas markets.

Policymakers face new policy challenges

Past policy efforts have focused on structural change, in particular on the concentration of land use. The productivity of the sector improved mainly through resource reallocation to more productive, large-scale farms. However, future productivity growth and environmental performance will depend more on the capacity of professional farms to develop and take up innovation and sustainable production practice.

The evolution of Japan's agricultural structure requires a change in the implicit policy assumption that the government needs to support small-scale, resource-poor family farms that would otherwise disappear. In Japan, the income disparity between farm and non-farm households has disappeared as agricultural production resources became concentrated on a small number of professional farms and off-farm income for small-scale side-business farms were increased. Moreover, with the rapidly changing technological conditions in agro-food value chains, innovation in agriculture increasingly depends on technologies that are developed outside agriculture. Further integration of agriculture with other parts of the economy would enable Japanese agriculture to benefit more from the competitive technology and skills that are prevalent in other sectors. In this context, developing a favourable policy environment for entrepreneurial farms to enable innovation, entrepreneurship, and sustainable resource use has become more relevant.

The types of support required by large, professional farms are different from those of traditional small family farms. For example, developing risk management tools has become more important as agricultural businesses become more vulnerable to market and production risks, especially as weather-related disasters increase due to climate change. Access to a diverse set of skills is also important as farm operations become more technology- and data-intensive, and have the capacity to engage proactively in agricultural R&D and education systems.

1.3. Developing policy and market environments more conducive to innovation and entrepreneurship in agriculture

A more demand-oriented approach would expand overseas markets for Japanese agro-food products

Japan set an ambitious target to double the export of its agro-food, fisheries and forestry products to JPY 1 trillion (USD 9 billion) from 2012 to 2019. This effort concentrates largely on overseas marketing and promotion activities, and harmonisation of quality and sanitary standards with international standards. However, the current export promotion strategy largely focuses on the supply side of export. A more demand-driven strategy would fully capture the growing demand for Japanese food products in world markets. Domestic production could concentrate more on producing high-value-added products with higher service content, while expanding the production network overseas, for example through outward foreign direct investment (FDI), to meet the diverse demand for Japanese agro-

food products. Such a strategy would increase interlinkages between domestic and global value chains and create new opportunities that make the sector attractive for human capital, investment and innovation.

Commercial banks should play a greater role in agricultural finance

Agriculture is treated differently from other parts of the economy, reflecting the unique structure of the sector, once dominated by small, family farms. For example, while Japan has a well-developed banking sector and financial market, commercial banks play a relatively small role in agricultural finance. Instead, government financial institutions and agricultural co-operatives channel the generous government credit programme to producers. High levels of guaranteed credit are also likely to reduce incentives for commercial banks to develop credit evaluation systems and risk management skills for agricultural financing, or to monitor borrowers. However, Japan's agricultural structure evolved so that large, business-oriented farms now account for the majority of production. Agriculture also became more technology- and data-intensive, incorporating services into value generation. A higher degree of interconnection with sectors through value chains facilitates innovation in agriculture as knowledge and experiences in other fields become available. In particular, regional commercial banks could play a greater role in connecting agriculture and other local industries.

Farm management policy should have a greater link with small and medium-sized enterprise policy

Fostering entrepreneurship in agriculture is a particularly important policy agenda, as entrepreneurs bring innovative ideas, products and processes to market, and attract more skilled labour to the sector. Regulations revised to expand the eligibility of non-farmers to own and rent farmland lowered the barriers to entrepreneurship in agriculture. Japan should remove the remaining obstacles to the integration of agriculture and other parts of the economy to bring competitive technology and skills from outside agriculture and enhance innovation and entrepreneurship in agriculture.

With an increase in corporate farms, farm managers face similar management issues as small- and medium-sized enterprises (SMEs) in other sectors, such as human capital development, business succession and business matching. Greater links between farm management policy and SME policy would help farm managers address their management issues and enhance networks between agriculture and other industries.

More competitive input and output markets strengthen the sector

Developing competitive input and output markets is crucial for meeting the diversified needs of professional farms. In Japan, agricultural co-operatives (JA groups; also simply referred to as JA) provide integrated services for members, including banking, insurance, farm input supply, marketing, technical advice, and welfare services. The JA profit structure shows that profits from banking and insurance cover losses in other business activities. JA also benefits from a reduction in corporate tax rates and exemption from certain regulations such as the Antimonopoly Act. Given its advantageous market position, JA maintains large shares of certain input and output markets. The dominant position of JA limits development of alternative farm service providers.

Recognising that high costs in Japan's agricultural input markets constrain competitiveness, Japan recently implemented a number of reforms, including of JA groups, to facilitate more competition in domestic input industries and wholesale markets. JA faces

a challenge in meeting the specialised and diversified needs of large, professional farms, especially as the majority of JA members continue to be side-business rice farms. A more competitive market environment between JA and other players would improve the function of farm input and output markets, and facilitate the emergence of alternative farm service providers, which are likely to introduce technology and skills from outside agriculture.

More fundamentally, domestic output price support policies result in higher input prices. In particular, under limited competition in input markets, suppliers have an incentive to raise input prices in order to capture the benefit of high output prices. Policy reform to reduce domestic market price support would eventually lead to lower input prices and improve the competitiveness of agriculture.

More diverse formats of land consolidation would contribute to productivity growth in land-intensive farming

The consolidation of fragmented farmland has been a major policy issue in Japan for the last five decades. Policies to activate land rental transactions contributed to concentration of land among large-scale producers. The farmland bank system established in 2014 enhanced the financial and regulatory incentives for land transactions. However, financial incentives attached to transactions through farmland banks may have discouraged more diverse formats of land consolidation adapted to local conditions such as contracting out farming operations, collective use of farm machinery and formation of community farm organisations.

Infrastructure development policy should adapt to the emerging technology environment

Japan has a well-developed hard digital infrastructure with the highest rate of mobile broadband subscriptions per 100 inhabitants among OECD countries. However, intensive use of data in agriculture also requires the development of a soft digital infrastructure. The recent government initiative to establish a guideline on agricultural data-related contracts and a platform to co-ordinate, share and supply agriculture-related data shows efforts in this direction. The design of physical and institutional infrastructures has to be reconsidered in order to facilitate use of digital technologies in agriculture, including radio regulation, design of farm road and road safety regulations.

Agricultural support policy can be more targeted to innovation, productivity growth and sustainability

Japan provides one of the highest levels of support to agricultural producers among OECD countries. Although policy reforms over the last decade increased the role of non-commodity specific support, such as the Farm Income Stabilisation Programme, most support to producers comes in the form of market price support. Support linked to single-commodity production interferes with producers' decisions about what to produce based on market demand, and keeps resources in uncompetitive sectors that would otherwise be reallocated to more productive uses. It also encourages more intensive production, which is incoherent with sustainability policy objectives.

Providing general services and public goods to the sector is more efficient than support to individual producers for enhancing long-term productivity growth and sustainability in the food and agriculture sector. More than 80% of Japan's support to general services in the sector is infrastructure investment, in particular for irrigation facilities. On the other hand,

Japan's share of support to innovation and knowledge systems is particularly low among OECD countries. Japan could further rebalance the portfolio of agricultural support to be more coherent with the long-term policy objectives of boosting productivity growth and improving sustainability performance in agriculture.

Despite progress, policies to support rice prices continue to be a major part of agricultural policy

Despite a declining share of rice in the value of production, rice policy continues to be a central aspect of agricultural policy, with rice-related policies accounting for close to 40% of Japan's producer support estimate (PSE). The government's control of rice production and marketing impedes the optimum distribution of rice production across regions and reduces incentives for innovation in the rice sector. And although Japan has gradually reduced its direct control of the rice market over the last 25 years – ending the administrative allocation of rice production quotas and the abolishment of rice income support payments in 2018 was a milestone in this reform process – the government still maintains policy incentives to limit table rice production via payments that divert table rice production to other crops, which would support the price of rice.

Policy programmes cover a large part of the risk

The role of risk management programmes is expected to increase as large commercial farms have more exposure to market and production risks. The introduction of a revenue insurance programme in 2019 increased the choice of risk management tools for producers. However, various overlapping payment and insurance programmes make the role of each policy less clear. Moreover, most of the programmes tend to trigger payment or indemnity for relatively small reductions in farm revenue, which would usually be considered normal business risks.

Healthy risk-taking behaviour by producers is one driver of innovation and entrepreneurship at the farm level. Current risk management programmes leave relatively little room for producers to take the risks associated with new opportunities. Policy coverage to normal business risk could crowd out market-based solutions and own-farm risk management strategies, and incentivise farmers to take more risk through less diversification.

Recommendations for developing policy and market environments more conducive to innovation and entrepreneurship in agriculture

- Establish a more demand-oriented approach to exploit the diverse demand for Japanese agro-food products in overseas markets, combining the domestic production of high-value-added products with higher service content and the international expansion of the production network.
- Reduce the role of government credit support and increase the role of market-based finance in agriculture.
- Ensure a level playing field between JA groups and other players in agricultural input and service providers by enforcing the Antimonopoly Act to end unfair practices, and by limiting cross-subsidisation between financial and agricultural businesses at local JAs.

- Increase the linkage between farm management policy and general SME policy to address the need to support farm management beyond agricultural production.
- Reduce financial incentives to transact through the Farmland Bank so as to diversify forms of farm consolidation, while the Farmland Bank continues to play an intermediary role between land owners and farm operators.
- Develop a soft infrastructure to facilitate the digitalisation of agriculture and redesign the hard infrastructure to facilitate the adoption of new digital technology.
- Provide farmers more freedom to make production decisions by phasing out commodity-specific support and progressively opening to international markets.
- Simplify the overlapping risk management programmes according to risk layers and convert commodity-specific risk management programmes to a farm-based programme.
- Enhance the role of farmers in managing normal business risks by lowering the threshold of revenue loss covered by policy programmes, and consider introducing voluntary co-financed risk-management programmes such as mutual funds, or a programme that allows farmers to place savings in a special account which is excluded from income declaration and possibly matched by a government subsidy.

1.4. Sustainability policy objectives should be integrated in agricultural policy framework

Japan should develop an integrated framework of agri-environmental policy

Japan's environmental policy is generally more stringent than the OECD average. In agriculture, water quality and offensive odour regulations control point source pollution from the livestock sector, although nonpoint source pollution from the crop sector is not directly regulated by the general environmental regulation. Although improving the environmental performance of agriculture is an objective of agricultural policy, no quantitative policy target has been defined at the national and regional levels, nor are systemic assessments of the environmental performance of agriculture to define policy targets, and to monitor and evaluate its progress, in place.

Agri-environmental payments cover only 2% of Japan's cultivated area. Policy makers need to ensure that the vast majority of farmers who do not participate in the agri-environmental payment programme improve their environmental performance. Indeed an integrated agri-environmental policy framework is needed in which all producers commit to improving their environmental performance. Agricultural policy programmes should provide consistent incentives for producers to adopt sustainable production practices and, where appropriate, impose penalties for non-performance.

Designing such a comprehensive framework for agri-environmental policies requires defined environmental targets and reference levels. In Japan, the Principles of Agricultural Production Practice Harmonised with the Environment define the reference level of environmental performance quality that farmers are required to provide at their own expense. However, the reference level is set only at the national level and its scope does not include a wider set of environmental practices such as climate change mitigation and biodiversity. The number of payments that are conditional on compliance with this environmental reference level have increased, including a major direct payment programme. Japan also strengthened the support for producers implementing the Good

Agricultural Practice, which include a wider set of environmental practices, and increased the types of agricultural policy programmes which provide preference to these producers. Nevertheless the payments conditional on adopting specific production practice account for only 30% of total budgetary support to producers. This contrast with the majority of payments in the European Union and the United States which impose such a conditionality. However, experience in OECD countries shows that such conditionality is not be effective unless it is adapted to the diversity of local farming practices and conditions.

In Japan, the national government has a predominant role in agricultural policy design and its implementation. However, public goods such as water quality and biodiversity are closely linked to the local environment (OECD, 2015[2]). Subnational or local approaches, in both decision making and financing, to the provision of local public goods are superior to national approach (van Tongeren, 2008[3]), and should play a bigger role in the design and implementation of agri-environmental policy, including in the setting of locally adapted environmental targets and reference levels. To achieve regional policy goals, subnational governments could establish an integrated agri-environmental policy that combines different policy instruments, including stricter regulatory measures, agri-environmental payments and voluntary certification system. The role of the national government should be to ensure that regional plans and policy implementation are consistent with the targets set at the national level.

Sustainable use of water resource requires more effective management of irrigation infrastructure

Agriculture uses nearly 70% of water withdrawal in Japan. With the exception of a few large-scale irrigation systems, the Land Improvement Districts (LIDs) operate and maintain most of the irrigation infrastructures. LIDs allocate operation and maintenance costs to members according to land area, often without consideration for the types of crops planted or even whether the land is fallow, based on the assumption that rice could be cultivated in the future or as a second crop. The current system provides little incentive for producers to economise on water use and constrains the structural change of agriculture away from rice production. Land consolidation into a smaller number of large operations and the development of sensor technology increased the feasibility of imposing a fee based on on-farm water use.

Japan has invested heavily in its irrigation infrastructure over the last 50 years, but more than 20% of the core irrigation facilities have exceeded its expected lifespan. While members of the LIDs cover the operational and maintenance costs of irrigation facilities, the governments share the cost of rehabilitating irrigation facilities with LIDs. At present, the development, renewal or rehabilitation costs are paid by LID members on an individual project basis, which can create imbalances of costs and benefits between current and future irrigation water users. The sustainable operation and maintenance of irrigation facilities requires current and future users to equally cover the cost of renewal or rehabilitation of irrigation systems.

Recommendations for integrating sustainability policy objectives in the agricultural policy framework

- Define agri-environmental policy targets at national and regional levels based on a systemic assessment of the environmental performance of agriculture with the participation of a wide range of stakeholders.
- Expand the scope of environmental reference levels defined in the environmental principle to a wider set of environmental issues, including climate change mitigation and biodiversity. Environmental targets and reference levels should be adapted to local ecological conditions.
- Increase the cross-compliance condition of producer support programmes with a reference level of environmental quality that is adapted to local conditions.
- Design an integrated agri-environmental policy at the subnational level to achieve regional policy targets, combining regulation, agri-environmental payments and voluntary certification schemes.
- Better reflect the actual water use in paddy fields on water use fees to improve water use efficiency and facilitate structural changes in agriculture away from rice production.
- Include the long-term renewal or rehabilitation costs of irrigation systems in water use fees to balance the costs and benefits of the investment between current and future water users, and to maintain irrigation infrastructures sustainably.

1.5. More collaboration between public and private actors, and across sectors would strengthen Japan's agricultural innovation system

Innovation in agriculture needs a more systemic approach beyond R&D

The predominant model for innovation has been mostly supply-driven: scientists in the public sector create new technologies which are then disseminated by extension officers to farmers who are asked to adopt them. Agricultural Innovation Systems (AIS) worldwide are in transition to better reflect user demand and generate solutions more effectively. Although research and development (R&D) remains an important component of innovation, overall innovation policy is moving beyond supply-side policies focused on R&D and specific technologies to a more systemic approach that takes into account various factors and actors, and to better reflect user demand so as to generate innovative solutions more effectively.

In Japan, public R&D institutions play a major role at every stage of agricultural R&D, while the private sector has a limited role except for certain farm inputs such as machines and chemicals. In principle, public agricultural R&D should concentrate more on areas in which the private sector underinvests, for example pre-competitive research areas with a medium- to long-term perspective, or in areas that are not specifically tied to commercial production.

More engagement of producers, agro-food and other industries in agricultural R&D is key to enhancing demand-driven and open innovation

The experience of OECD countries shows that establishing more demand-driven agricultural innovation system requires a strong partnership with stakeholders. While Japan has strengthened the engagement of producers and other stakeholders in the planning, implementation, and evaluation of public agricultural R&D, more proactive engagement with stakeholders, including financing, would make the country's AIS more demand oriented. In particular, co-financing schemes for agricultural R&D investment can be useful for producers to strengthen partnerships with research organisations and to play a leading role in the governance of agricultural R&D. This would also allow the government to channel more public funds to the medium- and long-term research agenda while boosting overall spending capacity for agricultural R&D.

However, individual producers have little incentive to finance R&D projects as most benefits of R&D accrue to the whole sector. Establishing co-funding schemes with producers requires legal and fiscal systems that encourage producers to form industry groups to collectively fund R&D projects.

The collaboration in agricultural R&D among AIS actors could be further strengthened

Recently, Japan established a platform for open innovation in agriculture and introduced a new competitive research grant to give preference to research proposed by the research consortium created by this platform. It also enhanced tax incentives for collaborative R&D between SMEs and universities. These are useful initiatives, but more integration of agricultural R&D systems with general innovation systems and removing the impediments to cross-sectoral collaboration would facilitate open innovation in agriculture.

Governance of public research institutions can be improved

OECD governments increasingly use project-based competitive funding to allocate resources to priority areas. Japan has increased project-based funding to agricultural R&D, but the share of institutional funding in public agricultural R&D budgets remains particularly high. The National Agriculture and Food Research Organization (NARO) finances around 90% of its budget from institutional funding from the Ministry of Agriculture, Forestry and Fisheries (MAFF). More use of project-based competitive funding in public agricultural R&D would facilitate the engagement of various AIS actors in agricultural R&D.

Japan has developed a comprehensive planning and evaluation system for public R&D, including the preparation of annual project plans and annual evaluations by the relevant ministries and a third-party council. While strict research management is necessary to assess the progress of R&D projects, the annual evaluation process may impede the long-term research agenda and discourage other AIS actors from collaborating with public research institutions.

Public R&D institutions are increasingly required to meet a diversity of demand by producers and to conduct practical research. As NARO's regional research centres are increasingly oriented towards more demand-side research collaboration with regional producer groups, the gap between national and prefectural agricultural research mandates has narrowed. There is room to consolidate efforts in regional R&D through improving

co-ordination between national and regional research organisations and by clarifying the role of each organisation.

More international collaboration in agricultural research would allow Japan's AIS to benefit from cross-border technology spill-overs

International research collaboration in agriculture strengthens Japan's own innovation system as it allows specialisation and gains from international spill-overs. It is also particularly important in relation to global challenges such as climate change and transboundary issues. However, the degree of international co-authorship in agro-food R&D outputs in Japan is lower than the OECD average.

Recommendations for establishing a more collaborative agricultural innovation system among public and private actors, and across sectors

- Focus public agricultural R&D on pre-competitive research areas with a medium- to long-term perspective and on areas that are not specifically tied to commercial production. Planning and evaluation systems of public agricultural R&D should be focused more on long-term perspectives.
- Further integrate agricultural R&D systems with general innovation systems to promote cross-sectoral innovation. For example, policy linkages should be increased between core policy principles as expressed in the Basic Plan for Agriculture, Forestry and Fisheries Research, and the Science and Technology Basic Plan and Integrated Innovation Strategy.
- Promote more demand-oriented agricultural innovation systems, where producers and other stakeholders proactively participate in innovation. This would include the introduction of co-funding schemes for agricultural R&D with producer organisations to reflect their demands in R&D activities and increase overall spending capacity for agricultural R&D.
- Increase funding for collaboration, and co-funding with the private sector and foreign researchers and institutions beyond a limited number of competitive research grant projects. Such conditionality should be attached to funding for public agricultural R&D institutions such as NARO.
- Clarify the role of national and prefectural agricultural research organisations and consolidate efforts in R&D at a broader regional level.
- Simplify the administrative process for public agricultural R&D funding to increase the efficiency of research funding mechanisms and reduce transaction costs for the private sector to collaborate with public agricultural R&D institutions.

1.6. Enhancing farmers' skills to innovate is a fundamental part of innovation policy in agriculture

Innovation in agriculture needs wider skills to adapt emerging technologies

The skills and qualifications required of farm managers in Japan has evolved with the rapidly changing technological conditions in agro-food value chains, and with the structural

move towards business-oriented corporate farms. Farm managers increasingly need entrepreneurial and digital skills to develop integrated business plans beyond agricultural production, making use of both internal and external human capital and knowledge resources. In addition to fostering the skills of farmers, bringing knowledge, experiences and skills from other fields and sectors also increases the supply of skills in the agricultural innovation process. Attracting skilled labour to agriculture requires making agricultural industries more appealing and conducive to innovation and entrepreneurial opportunities. Skilled labour from different educational backgrounds can also enrich the innovation process in this sector.

Professional education in agriculture should correspond better to needed skills

The mismatch between the supply and demand of skills limits the capacity of the agricultural sector to develop and uptake innovation. Making agricultural education and training more appealing and relevant can play a critical role in attracting talent and resolving potential mismatches of skills in the labour market. In particular, responding to the evolving need for skilled labour in this sector requires retraining and the regular adjustment of educational programmes to reflect industry demand. Lifelong learning is required to prepare for agro-food jobs using new technologies. However, the engagement of agro-food industries, including producers, in agricultural education and training is much less active in Japan than in other OECD countries. A more iterative co-creation and co-development process involving multiple stakeholders is necessary to improve agricultural education in Japan.

At present, prefectural agricultural colleges, which are part of the prefectural extension system, are the main provider of vocational education in Japan. However, these colleges do not necessarily attract the most enthusiastic students who wish to be future farm managers. They also face difficulties in adjusting their educational and training programmes to the more diversified and specialised skill requirements in today's agricultural sector.

The government has scaled-up support to young farmers entering the sector. It provides income support payments to young famers for up to seven years before and after entry. Providing more structured learning opportunities and training that combines lectures and internships in professional farming operations is likely to be more important than transitory income support for acquiring the necessary skills to become a viable farmer.

Public agricultural extension systems should evolve to increase the role of private technical service providers

Prefectural governments are responsible for providing public agricultural extension services with partial financial support from the national government. In addition, the local JAs provide technical services to its members. These services are free of charge, in contrast to other OECD countries where farmers increasingly pay for individual advice from public extension systems. However, the extension advisors working in prefectural extension services and JAs face constraints in updating their skills and knowledge as quickly as current technology and industry develop. Alternative commercial technical advisory services that could meet the needs of professional farmers for specialised and tailored advice are relatively underdeveloped in Japan, except in the livestock sector.

Many OECD countries face similar challenges to convert agricultural extension systems to more demand-driven, pluralistic and decentralised advisory services that mix public and private providers. In such systems, private technical advisory services play a major role in

providing specialised technical services to commercial farmers, while public extension services still play an important role in areas of public interest, such as promoting sustainable production practices and supporting disadvantaged producers. Public extension systems often facilitate compliance with regulations or policy requirements in the field.

Recommendations to enhance farmer's skills to innovate

- Strengthen the partnership between agricultural education and agro-food industry to reflect industry demand. This would include greater participation of professional farms in teaching activities and funding.
- Reorient the curriculum of vocational education in agriculture from acquiring agricultural production techniques to developing the broader skills required for future farm managers in areas such as entrepreneurship and digital technologies, provide more structured opportunities for learning, and develop training programmes that combine lectures with work experiences. One way to achieve this would be to convert existing agricultural colleges to professional and vocational universities.
- Consolidate prefectural agricultural colleges at the broader regional level to pool their resources and develop a unique and specialised agricultural education that is adapted to regional conditions. This should be done in partnership with the private sector.
- Concentrate prefectural extension services on areas of public interest, such as promoting sustainable production practices and supporting disadvantaged producers, as well as giving advice on compliance with regulations and government policy programmes.
- Promote the development of private technical advisory services, including making JA's advisory service more competitive through paid services.

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Chapter 2. Overview of the food and agriculture situation in Japan

This chapter describes the overall economic, social and environmental context in which Japan's food and agriculture sector operates, and the natural resource base upon which it relies. It provides an overview of the general geographical and economic characteristics of Japan; identifies the main structural characteristics of the food and agriculture sector; provides an overview of the main food and agriculture outputs and markets; and analyses the main trends in agricultural productivity, competitiveness and sustainability. It finally raises a number of challenges the agro-food complex is likely to face in the future.

2.1. General economic context

Agriculture in the Japanese economy

Japan is the world's third largest economy, after the United States and the People's Republic of China (hereafter "China"), with a relatively small land area and high population density (Table 2.1). The share of agriculture in GDP has declined to 1.1%, while the share in employment is 3.4%, both of which are lower than the OECD average (Table 2.2). The higher share of agriculture in employment than GDP indicates that labour productivity in agriculture is lower than in the rest of the economy. The majority of those employed in agriculture are part-time farmers.

The food and agricultural sector, including food manufacturing industries, accounts for 3.4% of GDP and 5.3% of employment. In rural areas, the service industry generates the majority of employment. Even in the mountainous agricultural region, the employment share of primary industry is only 12%. Hokkaido, the northernmost prefecture, has a higher economic share of the food and agricultural sector, where these industries generate 7% of GDP and 10% of employment in the prefecture. The food manufacturing sector generates nearly half of employment in the manufacturing sector in Hokkaido.

Despite small shares of agriculture in the economy, agriculture is a major user of natural resources. Agriculture is the largest user of land and water, accounting for 12% of the total land area (36% of the total inhabitable area) and 68% of total water withdrawals. Japan is a mountainous country and forests account for about two-thirds of total land. The agricultural area decreased by more than 10% over the past two decades due to farmland abandonment and conversion to non-farm uses (e.g. residential or commercial uses). About half of farmland is irrigated paddy field used for rice production, while the rest is upland (dryland) for non-rice production such as wheat and soybeans.

Table 2.1. Contextual indicators, 2017*

	GDP USD billion in PPP** (2017)	GDP per capita USD in PPP** (2017)	Population million (2017)	Total land area thousand km2 (2015)	Agricultural land thousand ha (2015)	Arable land per capita hectares (2015)	Freshwater resources billion m3 (2014)	Freshwater resources per capita m3 (2014)
Japan	**5 487**	**43 299**	**127**	**365**	**4 496**	**0.03**	**430**	**3 378**
Australia	1 260	50 588	25	7 682	365 913	1.93	492	20 932
China	23 301	16 807	1 386	9 425	528 635	0.09	2 813	2 062
Korea	1 973	38 350	51	97	1 736	0.03	65	1 278
France	2 876	42 858	67	548	28 727	0.28	200	3 016
Germany	4 188	50 649	83	349	16 731	0.15	107	1 321
Netherlands	904	52 799	17	34	1 837	0.06	11	652
United Kingdom	2 861	43 314	66	242	17 138	0.09	145	2 244
EU28	21 086	41 119	512	4 238	184 534	0.21	1 505	2 968
United States	19 391	59 535	326	9 147	405 863	0.47	2 818	8 844
OECD	56 473	43 624	1 295	34 466	1 181 729	0.30	10 499	8 251

Note: * or latest available year, ** PPP: Purchasing Power Parity.
Sources: Eurostat (2017[1]), *[demo_pjan]*, http://ec.europa.eu/eurostat/data/database; FAO (2017[2]), *FAOSTAT* (database), http://www.fao.org/faostat/en/; OECD (2018[3]), *National Accounts* (database), https://stats.oecd.org/; UN (2018[4]), *World Population Prospects: The 2017 Revision*, https://esa.un.org/unpd/wpp/; World Bank (2018[5]), *World Development Indicators* (database), http://data.worldbank.org/indicator.

Table 2.2. Share of agriculture in the economy and in natural resources, 2017*

	Gross value added (2017)	Employment (2017)	Exports (2016)	Imports (2016)	Total land area (2015)	Total water withdrawals (2014)
	Per cent					
Japan	**1.1**	**3.4**	**0.7**	**8.8**	**12.3**	**67.6**
Australia	3.0	2.6	16.7	6.7	47.6	23.7
China	8.9	27.0	2.5	6.6	56.2	NA
EU28	1.3	4.2	7.3	6.6	43.5	24.6
France	1.6	2.6	13.0	9.4	52.5	10.0
Germany	0.6	1.3	5.8	8.1	48.0	1.1
Korea	2.2	4.8	1.2	5.9	17.8	60.6
Netherlands	1.8	2.0	19.8	14.7	54.5	0.9
United States	1.1	1.6	11.3	5.6	44.4	35.8
OECD	1.5	4.6	8.9	8.1	34.3	42.1

Note: * or latest available year. 1. Value added in agriculture, hunting, forestry and fishing as a share of total value added. 2. Share of employed persons aged 15 years and over, in agriculture, hunting, forestry and fishing in total NACE activities. 3. Agro-food definition does not include fish and fish products. 4. For EU28, imports and exports include only extra-EU trade. 5. For OECD, imports and exports include both intra- and extra-OECD trade. 6. For EU28, share of total water withdrawals does not include Austria, Bulgaria, Croatia, Cyprus**, Ireland, Italy, Malta, Portugal and Romania. 7. For OECD, share of total water withdrawals does not include Chile.

** 1. Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue". 2. Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

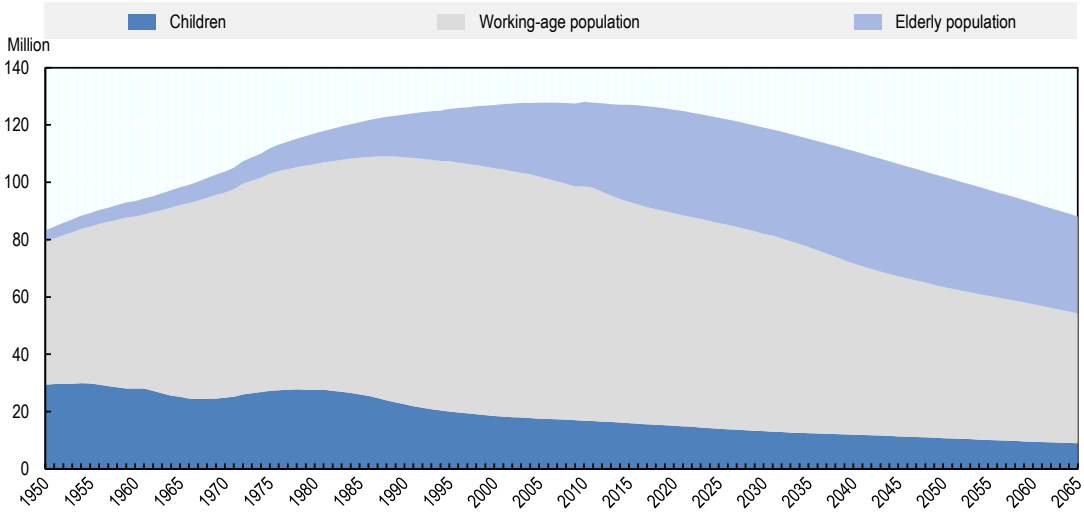
Sources: Eurostat (2018[6]), *[nama10_a10], [lfsa_egan2]*, http://ec.europa.eu/eurostat/data/database; OECD (2018[7]), *System of National Accounts, Annual Labour Force Statistics*, http://data.oecd.org/; UN (2018[8]), *COMTRADE United Nations Commodity Trade Statistics* (database), https://comtrade.un.org/; OECD (2018[9]), Agri-environmental indicators (database), http://www.oecd.org/tad/sustainableagriculture/agri-environmentalindicators.htm.World Bank (2018[5]), *World Development Indicators* (database) http://data.worldbank.org/indicator.

Demographic change

The contraction of the Japanese population and labour force is a major challenge which increasingly affects the food and agriculture sector. Japan's total population peaked in 2008 and is expected to decline by 31% by 2065 (Figure 2.1). Its working age population first began to decline in 1995 and it is expected to decline by 41% over the next four decades. The country's fertility rate (1.44 in 2016) is lower than the OECD average (1.73) and one of the lowest among OECD countries (World Bank, 2018[5]). Labour shortages are a reality with a ratio of more than one job opening per applicant since 2011, and the share of firms reporting shortages of labour has increased markedly (OECD, 2017[10]).

The ageing population is particularly significant for the economy. The share of the population aged 65 years or more will rise from around 27% in 2016 to almost 40% in 2055, the highest in the OECD area. The elderly population is projected to reach 73% of the working age population (15-64) by 2050. Half of the children born in 2007 are expected to live until the age of 107. This elderly dependency ratio in rural and urban areas is again the highest among OECD countries (OECD, 2013[11]). The ageing issue is more severe in rural areas, where both depopulation and ageing are more advanced and growing faster than in other areas of the country, largely due to the migration of young people to cities (OECD, 2016[12]).

Figure 2.1. Japan's demographic structure, 1950 to 2065



Note: Children refers to the population under 14 years, working-age population refers to those aged between 15 and 64, and elderly population refers to those aged 65 years and over.
Source: MIC (2017[13]) *2015 Population Census*, http://www.stat.go.jp/english/data/kokusei/index.html, IPSS (2017[14]), *Population Projections for Japan: 2016 to 2065*, http://www.ipss.go.jp/pp-zenkoku/e/zenkoku_e2017/pp_zenkoku2017e.asp.

StatLink http://dx.doi.org/10.1787/888933957211

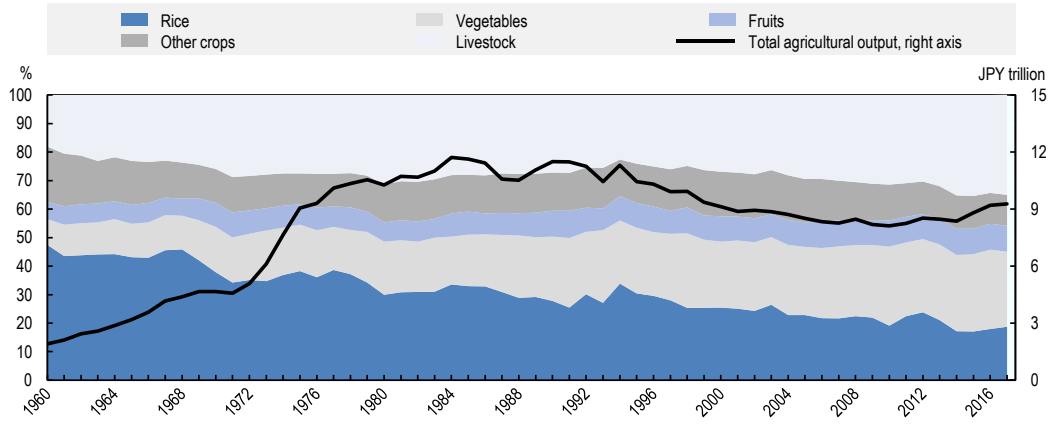
2.2. Characteristics of the agricultural and agro-food sectors in Japan

Production

The total value of agricultural production peaked in 1984 and up to 2010 declined on average by 1.4% annually. Increasing imports of food and agricultural products and declining domestic food consumption are the main drivers of this decline. However, between 2010 and 2017, the value of agricultural production increased on average by 1.9% annually. As a result, the value of agricultural production in 2017 recovered its highest level since 2000.

The structure of agricultural production has evolved over time. The share of rice in the value of agricultural production declined from 43% to 17% between 1965 and 2015 (Figure 2.2). Over this same period, the share of livestock and vegetable production increased from 23% and 12% to 35% and 27%, respectively. Livestock, vegetable and fruits now account for more than 70% of the total value of agricultural production.

Figure 2.2. Composition of agricultural production value in Japan, 1960 to 2017



Source: MAFF (2018[15]), *Statistics on Agricultural Income 2017* (database), http://www.maff.go.jp/j/tokei/kouhyou/nougyou_sansyutu/index.html.

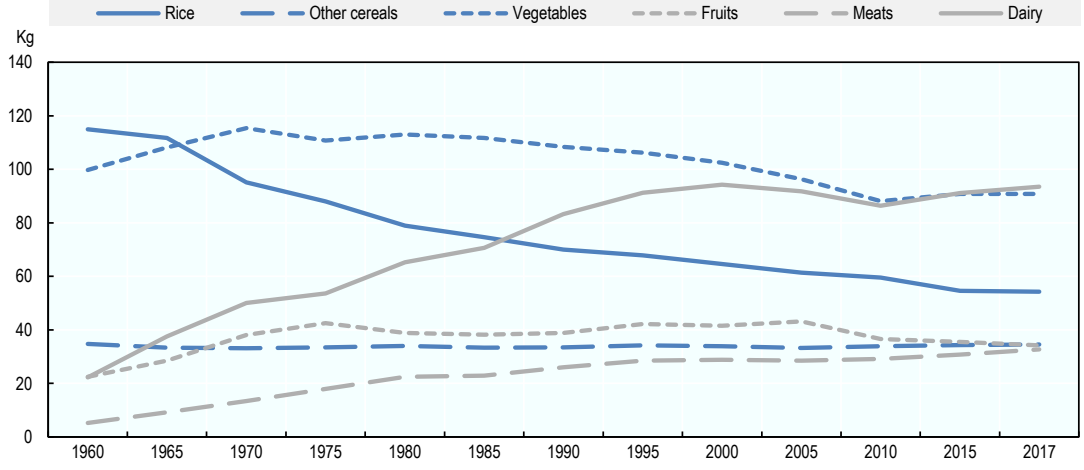
StatLink http://dx.doi.org/10.1787/888933957230

Consumption

In 2016-18, on average, 26% of household expenditure went to food, of which 19% was consumed outside the home (MIC, 2019[16]). Similar to the change in the agricultural production structure, annual consumption per capita of rice declined continuously between 1962 and 2017, from 118 kg to 54 kg (Figure 2.3). The "westernisation" of the Japanese diet increased consumption per capita of meat and dairy by 6.3 and 4.2 times between 1960 and 2017.

Due mainly to the ageing Japanese population, calorie supply per capita started to decrease in 1996 and is projected to decline by 11% to 26% between 1995 and 2050 depending on the alternative assumptions (PRIMAFF, 2014[17]). As the Japanese population continues to age and to contract, domestic food demand is expected to decline.

Figure 2.3. Per capita supply of food in Japan, 1960 to 2017



Source: MAFF (2018[18]), *Food Balance Sheet 2017* (database), http://www.maff.go.jp/j/zyukyu/fbs/.

StatLink http://dx.doi.org/10.1787/888933957249

Trade

Japan is the world's fourth largest importer of agro-food products, after the United States, China, and Germany (UN Comtrade, 2018[8]), and the second largest net importer of agro-food products after China (MAFF, 2017[19]). In 2015-17, the value of its agro-food imports was 13.4 times larger than that of its exports.

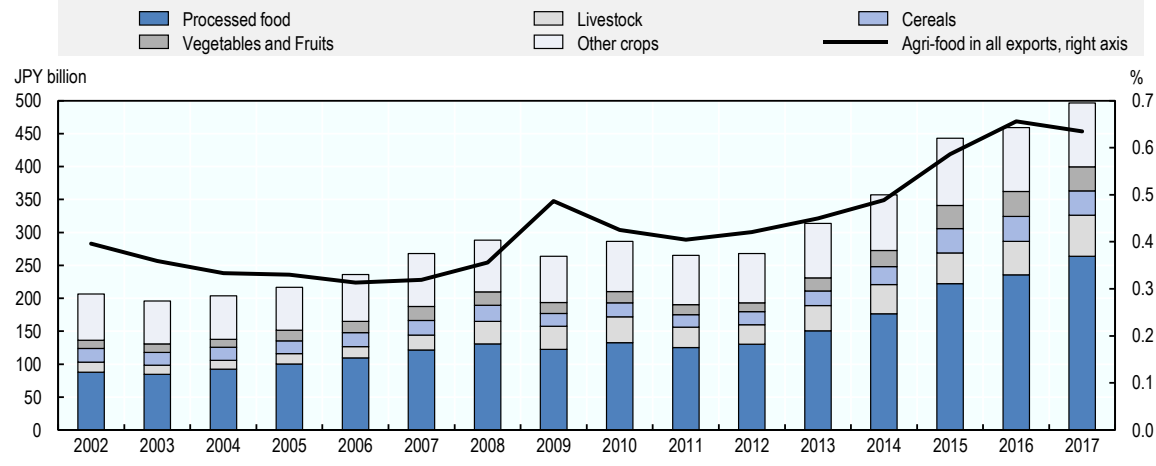
While Japan maintains near self-sufficiency in rice, the food self-sufficiency ratio in calorie supply declined from 79% in 1960 to 38% in 2017, meaning that more than 60% of calorie intake depends on imports. Wheat and soybean depend largely on imports. On a value basis, the self-sufficiency ratio was 65% in 2017, reflecting a recent proportional increase in domestic vegetables, fruits and livestock products, which have a relatively higher unit price and added value per calorie.

Japan's agro-food exports are rapidly growing (Figure 2.4). In particular, agro-food exports nearly doubled from 2011 to 2017, reaching JPY 497 billion (USD 4.4 billion). In 2016, the government set a target to increase exports of agro-food, fisheries and forestry products to JPY 1 trillion (USD 9 billion) by 2019.[1] The share of agro-food exports in total exports increased from 0.4% to 0.6% over the same period.

Most Japanese agricultural exports are directed at final consumers rather than to an intermediate industry use. Processed food products such as alcohol, green tea, snacks, sauces and seasonings account for the majority of Japan's agro-food exports. Among the unprocessed products, apples and beef are the most exported products. Approximately half of Japan's agricultural imports are primary and processed products for consumption, while the rest is for further processing by domestic industries. These products include pork, maize, poultry, and poultry products.

The United States is Japan's largest trading partner for agro-food imports, followed by China, Australia, Thailand, Canada and Brazil (Table 2.3). The majority of Japan's agro-food exports goes to Asian countries; Hong Kong and Chinese Taipei are the largest importers of Japanese agro-food products.

Figure 2.4. Japan's agro-food exports, 2002 to 2017



Source: MAFF (2018[20]), *Overview of Foreign Trade of Agricultural, Forestry, and Fishery Products*, http://www.maff.go.jp/j/tokei/kouhyou/kokusai/houkoku_gaikyou.html.

StatLink http://dx.doi.org/10.1787/888933957268

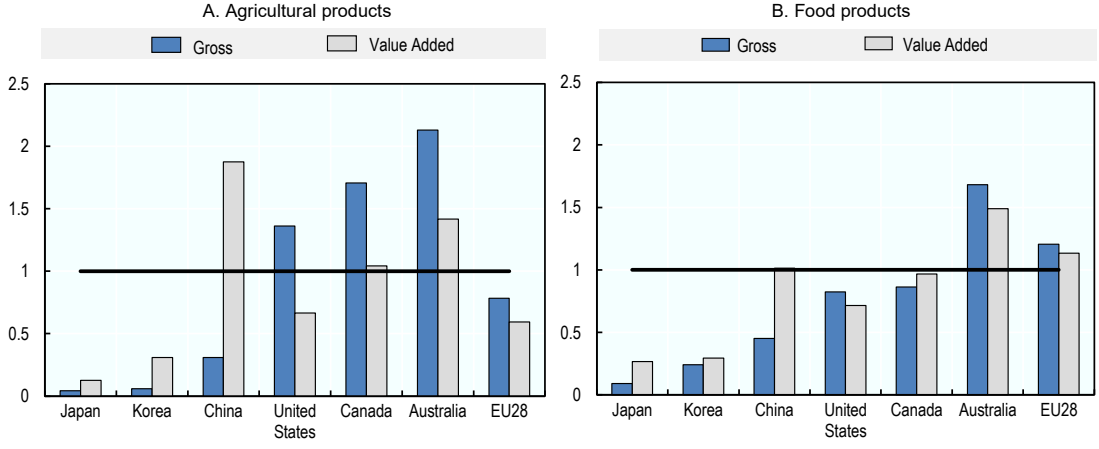
Table 2.3. Major agro-food trade partners of Japan, 2015-17

Imports	%	Exports	%
United States	23.5	Hong Kong, China	21.7
China	11.9	Chinese Taipei	15.2
Australia	7.0	United States	14.9
Thailand	6.8	China	8.7
Canada	6.1	Korea	7.4
Brazil	4.9	Singapore	4.1
France	3.2	Thailand	4.1
Italy	3.0	Viet Nam	3.4
Korea	2.5	Australia	2.4
New Zealand	2.4	Netherlands	1.8
Other	28.7	Other	16.3
EU28	15.4	EU28	7.3

Source: MAFF (2018[20]), *Overview of Foreign Trade of Agricultural, Forestry, and Fishery Products*, http://www.maff.go.jp/j/tokei/kouhyou/kokusai/houkoku_gaikyou.html.

International trade flows suggest that Japan does not have a comparative advantage in the agriculture and food sectors, either in gross or value-added terms. The Revealed Comparative Advantage (RCA) indicator compares the country's share in world agro-food exports with its share in world exports of all goods – a ratio above parity indicates comparative advantage and vice versa.[2] Japan's RCA in gross trade flow is estimated at 0.04 for agricultural goods and 0.09 for food products (2005-14) suggesting that Japan is not competitive both in agricultural and food products (Figure 2.5). However, the RCAs estimated in value-added trade flow terms are higher than those estimated by gross trade flow, indicating Japan's relatively high value-added positioning in agro-food trade.

Figure 2.5. Revealed comparative advantage of agricultural and food products, 2005-14



Note: The value-added RCA is defined as the share of value-added originating from a given sector in a country's exports divided by the share of value-added originating from this sector in world exports.
Source: OECD (2017[21]), *Statistics on Trade in Value-Added* (database), https://doi.org/10.1787/tiva-data-en.

StatLink http://dx.doi.org/10.1787/888933957287

Increasing trade in agro-food sectors within global value chains have the potential to offer new opportunities to add value to agricultural production. The degree of a country's participation in global value chains can also reveal the role of its trade in enhancing competitiveness and innovation, and thus its exposure to globally competitive production and processes. Participation in Global Value Chains (GVCs) can be analysed through the import content of exports (backward participation) and the extent to which domestic value added from an industry in a given country form part of the value of another country's exports (forward participation) (Greenville, Kawasaki and Beaujeu, 2017[22]).

Japan's overall participation in GVCs is close to average compared with other OECD and non-OECD countries (OECD, 2017[21]). It's agricultural products have a relatively higher degree of backward integration in foreign value chains, in which 13% of the value added that consumers paid for agricultural products originated abroad (compared to 8% for the world). Reflecting the low level of agricultural exports, the forward integration of Japan's agriculture into the value chain outside the country is very low; only 2% of the agricultural value added is exported (compared to 11% for the world).

However, the value-added flows between Japan's agriculture sector and other domestic and foreign sectors is larger than what GVC indicators seem to reveal. For instance, 31% of agricultural value added comes from other domestic sectors (26% for the world), which represents a significant backward linkage to domestic manufacture and service industries (Table 2.4). In particular, the share of value added from domestic manufacturing sector is relatively large. Domestic service sector is playing an important role in the presence of stronger competition, helping differentiate, customise and improve product quality, bundling them with products and services, and helping develop closer, more longstanding relationships with customers.

The degree of forward linkage between Japan's agriculture and domestic value chains is particularly high. Overall, 57% of agricultural value-added ends in the production of other sectors in the country (43% for the world), indicating a strong forward linkage of Japan's agriculture with domestic industries, in particular food processing.

Table 2.4. Agriculture backward and forward linkage with value chains, 2014

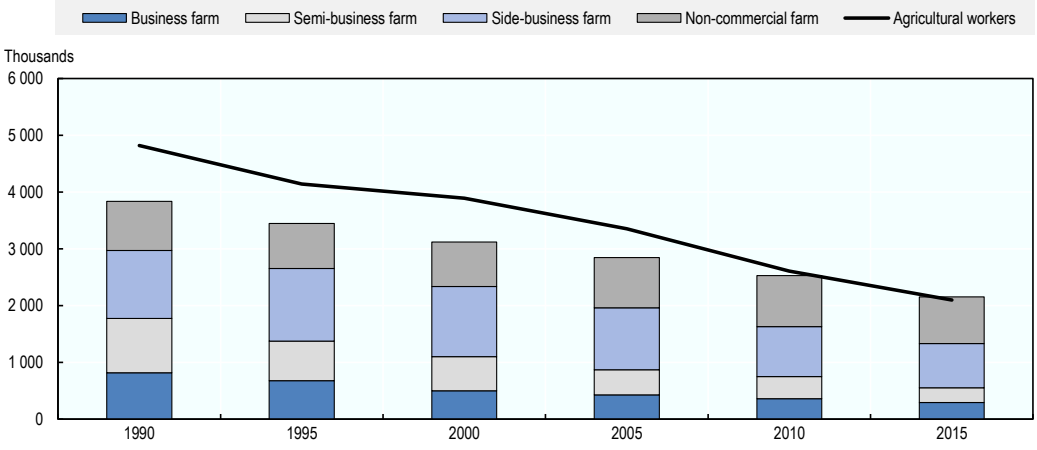
	World	Japan	China	Korea	United States	Australia	France	Germany	United Kingdom
Sources of value added used for the production of agriculture									
Sector shares of value added in %:									
Agriculture	61	51	78	57	52	55	60	53	45
Industry	9	14	9	13	12	8	7	6	9
Service	17	17	8	10	27	26	14	26	19
Foreign countries	13	17	5	21	8	11	19	15	17
Destination of agricultural value added by domestic and foreign demand									
Shares of domestic and foreign demand, direct and indirect (through other sectors), in total value added of agriculture,%:									
Direct domestic	36	30	26	28	18	11	13	16	31
Indirect domestic	43	57	57	47	51	39	39	27	37
Direct exports	10	1	2	2	21	29	24	14	9
Indirect exports	11	11	16	24	10	21	25	43	23

Source: Author's calculation from 2014 ICIO GTAP database (Greenville, Kawasaki and Beaujeu, 2017[23]).

Farm structure

Japan has experienced a significant transformation in its agriculture in the last few decades. The number of agricultural workers declined from 4.8 million in 1990 to 2.1 million in 2015, with an accelerated pace of decline in the last decade (Figure 2.6). Similarly, the number of commercial farm households declined from 3 million in 1990 to 1.3 million in 2015.[3] The number of business and semi-business farms declined faster than side-business farms. As a result, the share of side-business farms in commercial farm households increased from 40% to 59% between 1990 and 2015.

Figure 2.6. Evolution of farm households and agricultural workers in Japan, 1990 to 2015



Source: MAFF (2016[24]) *Census of Agriculture and Forestry*, http://www.maff.go.jp/j/tokei/census/afc/.

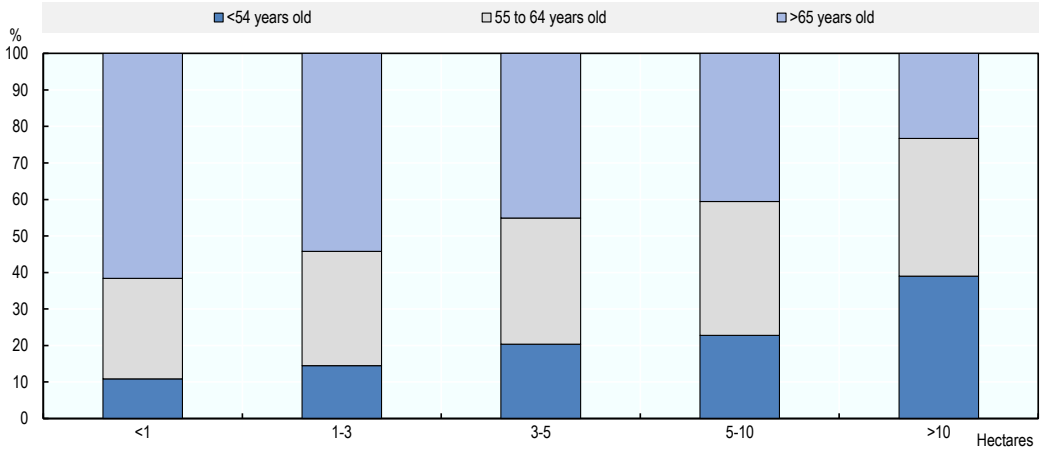
StatLink http://dx.doi.org/10.1787/888933957306

The average age of agricultural workers increased from 59.1 to 66.4 years between 1995 and 2015. In 2015, 63% of agricultural workers were more than 65 years old. This contrasts with many OECD countries; for example, only 32% of farm managers in the European Union were aged more than 65 years old. Moreover, in Japan, aged farmers are concentrated in small farms. Larger, business farms tend to be operated by younger farm managers. Farm managers under 54 years old account for 39% of farms of more than 10 hectares, but only 11% of farms less than 1 hectare (Figure 2.7).

Because of the increasing dominance of side-business and non-commercial farms in the number of farm households, production and resource use are increasingly concentrated on a small number of large-scale business farms. These farms often convert their legal status to that of a corporation to strengthen farm management capacity and hire non-family workers. The number of farm corporations more than doubled between 2005 and 2015 (Table 2.5).

Figure 2.7. Age distribution of farm managers by farm size in Japan, 2015

Share of each age group of farm managers for each farm-size class



Source: MAFF (2016[24]), *Census of Agriculture and Forestry*, http://www.maff.go.jp/j/tokei/census/afc/.

StatLink http://dx.doi.org/10.1787/888933957325

Table 2.5. Number of corporate farms in Japan, 2005, 2010 and 2015

	2005	2010	2015
Farm co-operatives	1 663	3 077	5 163
Corporation	6 016	8 395	12 115
Other co-operative organisations	643	652	810
Other forms	378	387	769
Total	8 700	12 511	18 857

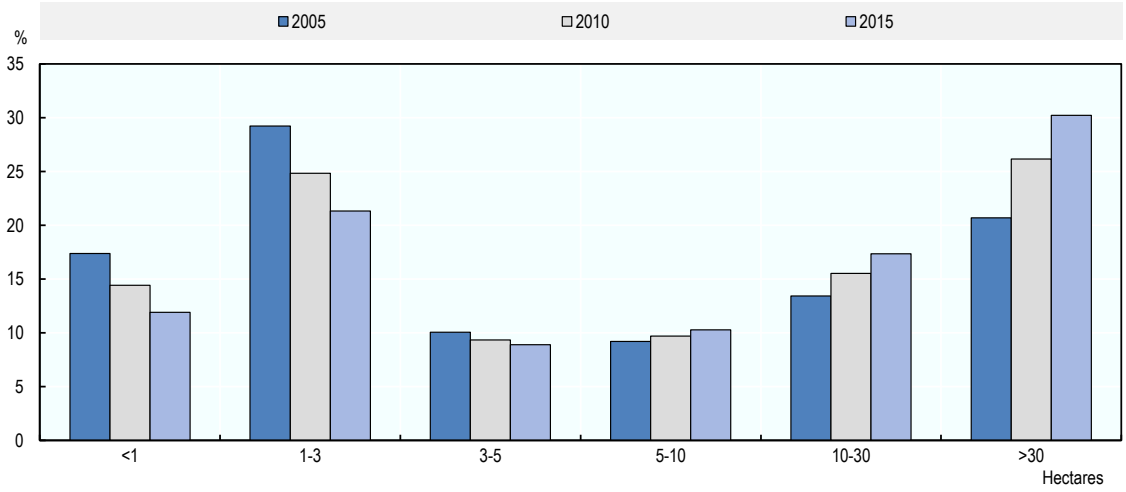
Note: "Farm co-operatives" refers to farms engaged in commercial activities and excludes farm households. It does not include co-operatives consisting of one household. "Corporation" refers to joint stock co-operation, unlimited and limited partnership, limited liability companies based on the Companies Act, and mutual companies based on the Insurance Business Act. "Other co-operative organisations" refers to agricultural co-operatives, agricultural mutual insurance organisations, agricultural related associations or forestry co-operatives etc.
Source: MAFF (2016[24]), *Census of Agriculture and Forestry*, http://www.maff.go.jp/j/tokei/census/afc/.

The average farm size increased from 1.4 hectares to 2.2 hectares between 1990 and 2015. Despite the slow increase in average farm size, concentration of land use to large farms accelerated in the last decade. For example, the share of farms operating more than 10 hectares of land increased from 34% to 48% between 2005 and 2015 (Figure 2.8). In Japan, farm structure is polarised so that the largest 3% of commercial farms cultivate nearly half of total farmland, although a large number of small-scale operations remains in the sector. This polarisation of agricultural structure is widely observed among OECD countries. In the European Union, the 7% of farms that were of 50 hectares or more in size account for a little over two-thirds (68%) of the European Union's utilised agricultural area in 2013 (Eurostat, 2017[25]).

It is estimated that this 3% of large farms, with more than JPY 30 million (USD 278 000) of sales, accounted for 53% of total output in 2015 (Figure 2.9). This is similar to the EU15, where 3% of all holdings with more than a standard output of EUR 250 000 (USD 311 000) were responsible for 55% of total agricultural economic output in 2013.

Figure 2.8. Distribution of farm size in Japan, 2005, 2010 and 2015

Share of the area cultivated by each farm-size class in the total cultivated land area



Source: MAFF (2016[24]), *Census of Agriculture and Forestry*, http://www.maff.go.jp/j/tokei/census/afc/.

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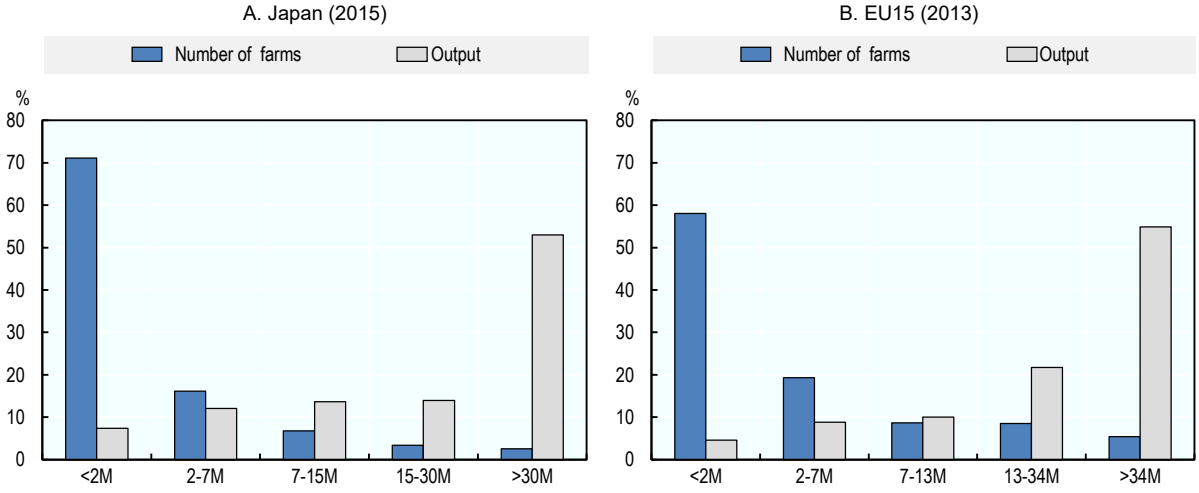
Figure 2.9. Distribution of output in Japan and EU15

Share of output by each farm-size class (in sales) in the total value of outputs



Note: Farm-size class is expressed in JPY. The output value of each farm-size class in Japan is calculated by multiplying the number of farms by the median value of each class. For the classes of JPY 500 million (USD 4.1 million) or more, which is the highest class of the original statics, JPY 1 billion (USD 8.3 million) is used as the median output.

Source: MAFF (2016[24]) *Census of Agriculture and Forestry*, http://www.maff.go.jp/j/tokei/census/afc/; Eurostat (2017[25]), *Farm Structure Survey 2013* (database), https://ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics.

StatLink http://dx.doi.org/10.1787/888933957363

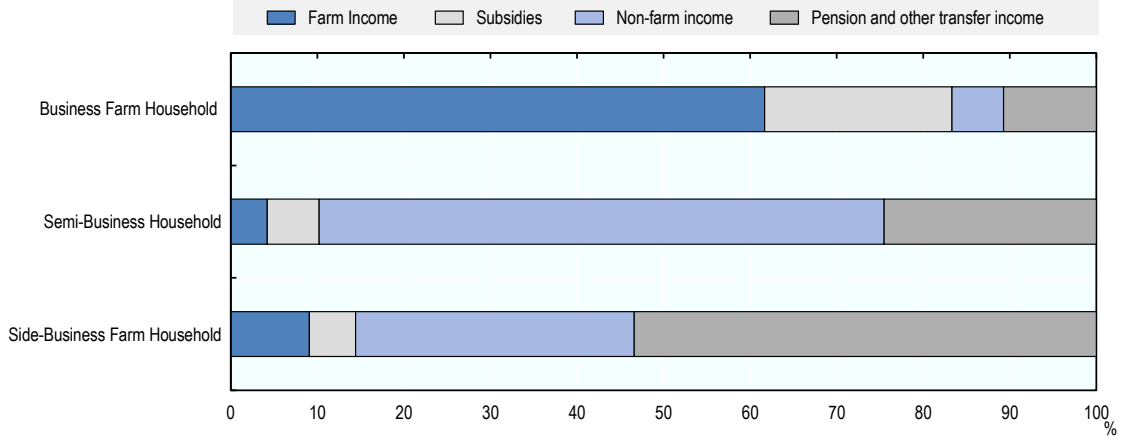
Farm income

In Japan, the income gap between farm and non-farm households became negligible. The agriculture, forestry and fisheries household earned 98% of average household income and owned 29% more financial assets in 2014 (MIC, 2015[26]). Inter-regional inequalities in income in Japan are exceptionally low by OECD standards: in 2010, Japan had the second-lowest level of inequality among regions in GDP per capita. Moreover, inequality across Japanese regions has fallen over time, while it has increased in most other OECD countries (OECD, 2016[12]).

The income equality between farm and non-farm households is largely due to increasing non-farm income opportunities in rural areas. In 2015, two-thirds of rural communities are within a 30-minute drive of an urban centre, while over 90% are within an hour's drive (MAFF, 2016[24]). This implies that the vast majority of hamlets are effectively within the commuter belts of reasonably large cities.

The share of farm income including subsidies among semi-business and side-business farm households was only 10% and 14% in 2017, respectively (Figure 2.10). The majority of income of side-business farm households are pension and other transfer income. In contrast, business farm households earn the majority of household income from farming. However, they are more dependent on subsidies, which accounted for 22% of the income of business farm households in 2017.

Figure 2.10. Composition of farm household income in Japan, 2017



Source: MAFF (2018[27]), *Survey on Farm Management Statistics on Type of Management (individual management)*, http://www.maff.go.jp/j/tokei/kouhyou/noukei/einou_syusi/index.html.

StatLink http://dx.doi.org/10.1787/888933957382

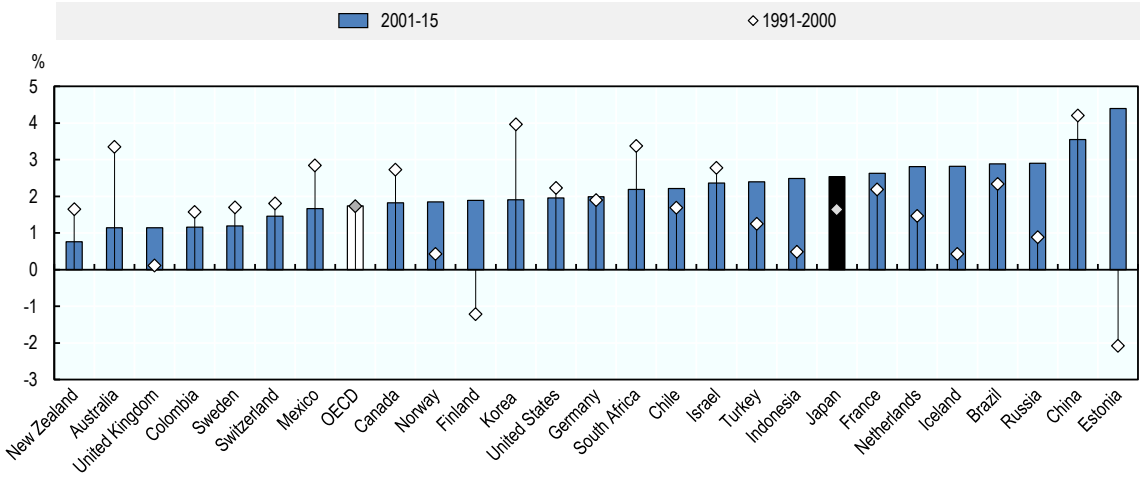
2.3. Productivity performance of agriculture in Japan

Total factor productivity (TFP) – the ratio of total output quantity to the total input quantity in a given sector – is a standard measure of productivity. According to the United States Department of Agriculture (USDA), Japan's TFP growth in primary agriculture in 2001-15 averaged 2.5% a year, which is 0.8 percentage points above the OECD average (Figure 2.11). Productivity growth after the 2000s accelerated in comparison to the 1990s.

Decomposing TFP growth into total output and input growth in different time periods shows the dynamics of productivity growth. Recent TFP growth in Japan's primary agriculture is mainly driven by the faster decline in inputs than outputs (Figure 2.12). In particular, labour input declined on average by 6.6% in 2001-15. Output growth has slowed since the 1990s and has been negative over the last two decades.

Figure 2.11. Agricultural total factor productivity growth, 1991-2000 and 2001-15

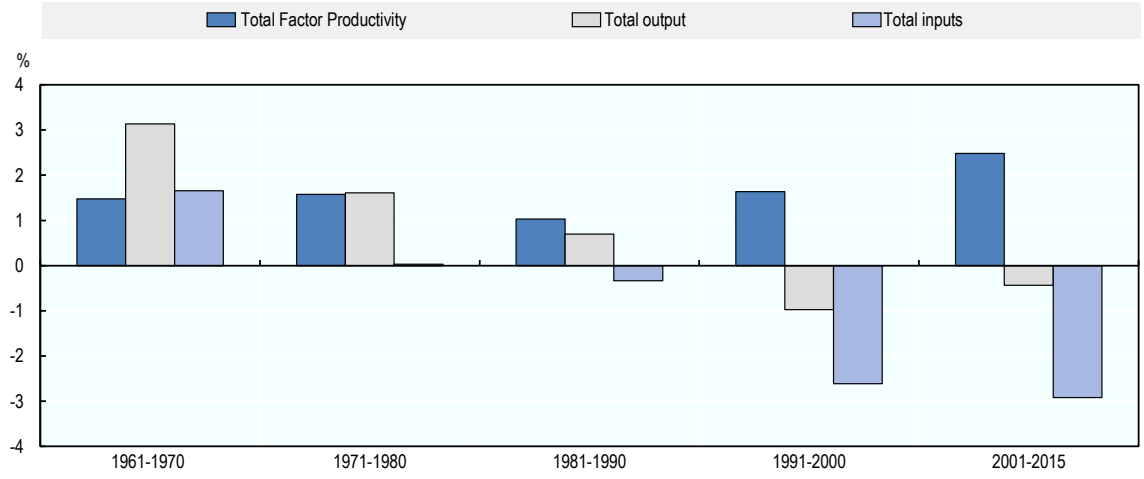
Annual growth rates



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: USDA, Economic Research Service (2018[28]), *International Agricultural Productivity* (database), https://www.ers.usda.gov/data-products/international-agricultural-productivity.

StatLink http://dx.doi.org/10.1787/888933957401

Figure 2.12. Decomposition of total factor productivity growth in Japan, 1961 to 2015



Source: USDA, Economic Research Service (2018[28]), *International Agricultural Productivity* (database), https://www.ers.usda.gov/data-products/international-agricultural-productivity.

StatLink http://dx.doi.org/10.1787/888933957420

The Japan Industrial Productivity Database, however, shows that the productivity growth of the agricultural sector has been lower than the manufacturing sector (RIETI, 2015[29]). The productivity gap between the agriculture and manufacturing sectors has widened since 1970. There has been a sustained lower productivity growth for agriculture since the 1990s. Within the manufacturing sector, electronics, transportation and precision machinery achieved high productivity growth, but productivity growth in the food manufacturing industry remains consistently lower than other manufacturing industries.

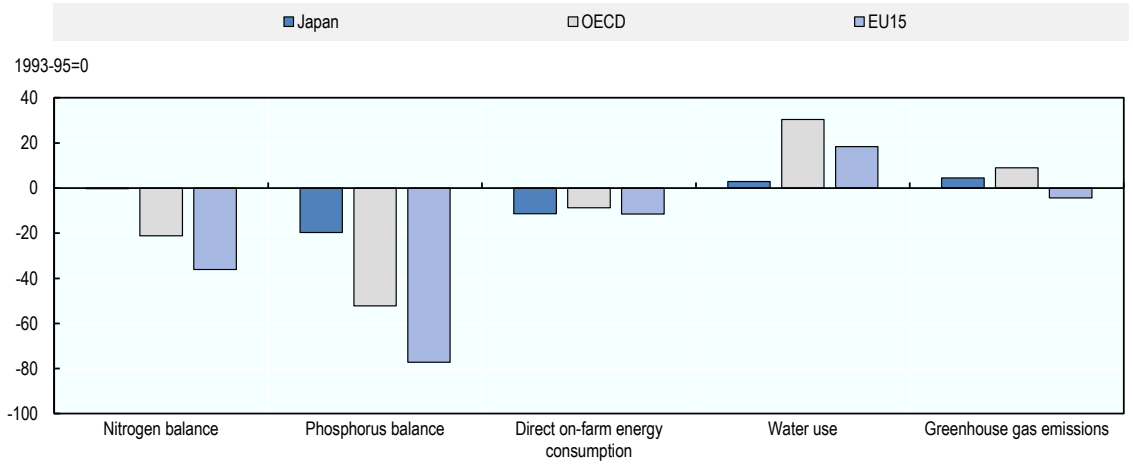
2.4. Sustainability performance of agriculture in Japan

Agriculture is often considered as a part of a "managed nature" or so called *Satoyama* that is indispensable for conserving the country's natural environment (Cabinet Office, 2014[30]).[4] However, agricultural production can negatively impact the environment, including through soil and water pollution (OECD, 2015[31]). The agricultural sector plays a key role in natural resource management as it accounts for 36% of its total inhabitable land and 68% of total water withdrawal.

The total amount of inputs and emissions – including fertilisers, pesticides, water and energy consumption, as well as greenhouse gas (GHG) emissions – has decreased in Japanese agriculture, but this does not necessarily mean the environmental performance of the sector has improved. The nitrogen balance per hectare in Japan decreased by 0.3% between 1993-95 and 2013-15, while it fell by 35% in the EU15 and by 24% in the OECD area. Similarly, phosphorus balance per hectare decreased on average by 58.5% between 1993-95 and 2013-15 in the OECD area, whereas the decrease of Japan's phosphorus balance remained at 24.5% (Figure 2.13). The nitrogen and phosphorus balance of Japan remains one of the highest among OECD countries.

Rice production plays an important role in Japan's agricultural environmental performance as it accounts for more than half of total farmland use and 94% of agricultural water withdrawal in Japan (MLIT, 2018[32]). The rice sector is also the largest source of methane (CH_4) emissions, accounting for 45% of the national CH_4 emissions in 2016 (MOE, GIO, 2018[33]). At the same time, rice paddy fields provide non-commodity outputs such as conserving biodiversity and natural habitat. In particular, the usage of paddy fields – shallow water is retained during the growing period of rice while fields are drained before harvest – creates habitats for diverse organisms (Maeda, 2001[34]). Rice paddy fields also recharge about 20% of groundwater by percolating through soil (Mitsubishi Research Institute, 2001[35]). They retain water and slow the passage of water, which contributes to flood prevention. The irrigation canals of paddy fields can also prevent landslides (OECD, 2015[31]).

Figure 2.13. Japan's agri-environmental performance compared to the OECD and EU15 averages, 1993-95 to 2013-15



Notes: All indicators are calculated per unit of agricultural land. For water use, the 2013-15 average was replaced by 2012-14. Greenhouse gas emissions excludes LULUCF emissions.
Source: OECD (2018[9]), *Agri-environmental indicators* (database), http://www.oecd.org/tad/sustainableagriculture/agri-environmentalindicators.htm.

StatLink http://dx.doi.org/10.1787/888933957439

Nutrient balance

Fertiliser use and manure application are the main nutrient inputs of today's agriculture to nature. Nitrogen is a key nutrient for crop growth and 40-60% of applied nitrogen is estimated to be absorbed by crops, but during and after fertiliser and manure application, some of these nutrients volatilise in the form of ammonia (NH_3) and nitric oxide (NO) (Mosier et al., 1998[36]; Sebilo et al., 2013[37]). Excessive nitrogen leads to eutrophication of surface water which can cause biodiversity loss and pose risks to human health if concentrated in ground water. Moreover, rice paddy farming can lead to loss of soil nitrogen to gaseous nitrogen (N_2) or nitrous oxide (N_2O) through denitrification.[5] N_2, a major product of denitrification, is neutral from an environmental perspective, but N_2O is a GHG and acidifies soil and water (Goulding, 2016[38]; OECD/Eurostat, 2007[39]).

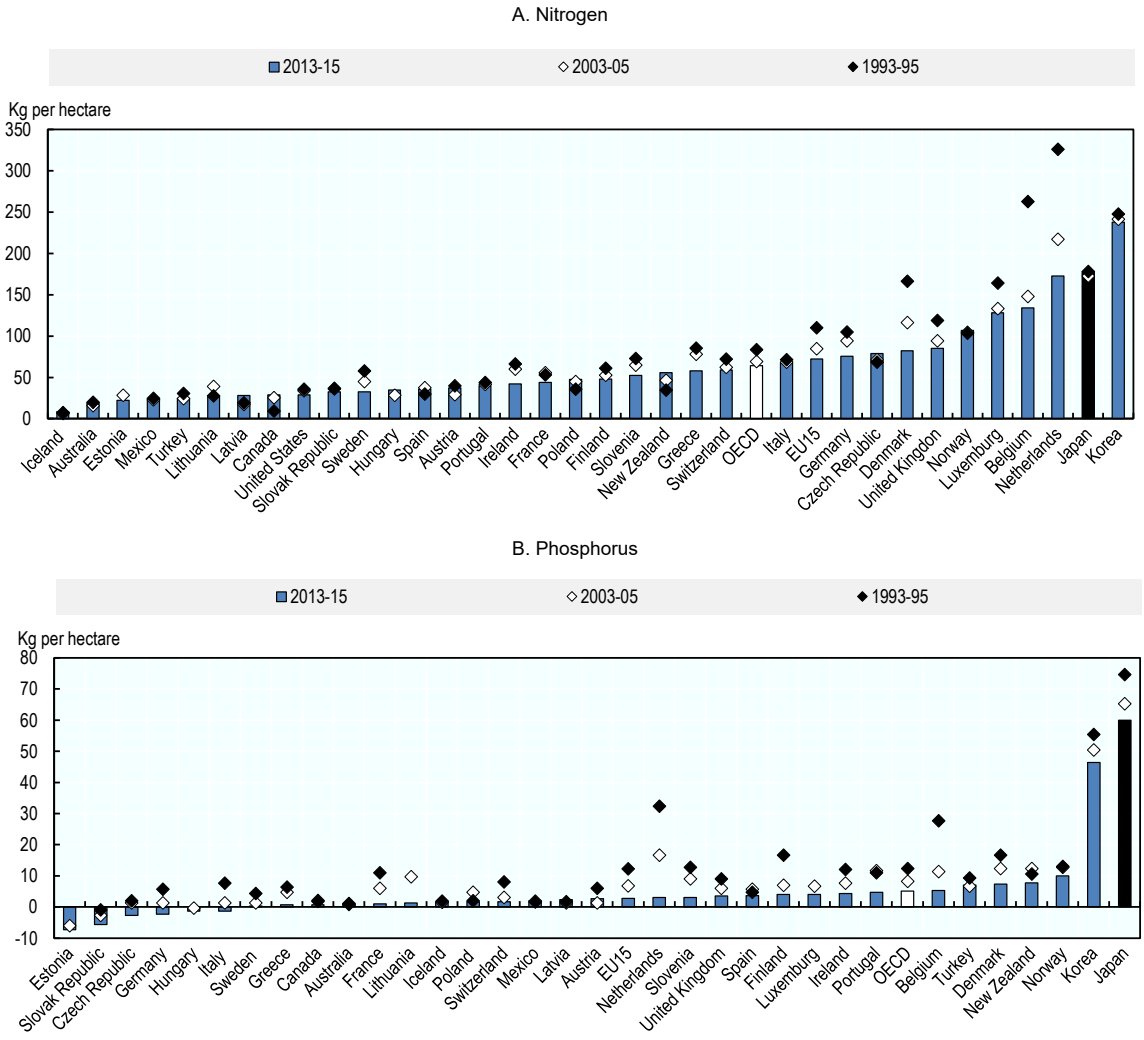
Japan's nitrogen balance in 2013-15 was 177.7 kg per hectare, the second highest among OECD countries and 2.8 times higher than the OECD average (Figure 2.14 Panel A). Manure has been the largest source of nitrogen input in Japan, 1.5 times higher than that from inorganic fertilisers. However, the intensity of inorganic nitrogen input was also above the OECD average (89.1 kg/hectare versus 60.8 kg/hectare) in 2015, although this represented a decrease from 104.7kg/hectare in 1995 (OECD, 2018[9]). A high degree of fertiliser use and livestock production, combined with a low share of pastureland, contribute to the high intensity of nutrient inputs in Japan (Shindo, 2012[40]).

A survey conducted by the Ministry of Environment (MOE) (2018[41]) found that more than half of underground water contamination in Japan was due to excess nitrogen originating from agriculture. The share of monitoring sites in agricultural areas that exceeded recommended drinking water limits, however, was low (Figure 2.15). For surface water, only two out of 3 156 river sites were found to be contaminated by an excess of nitrogen, and no excess levels were found in lakes and oceans (MOE, 2018[42]). Nitrogen leaching in groundwater is much lower from paddy fields due to denitrification (OECD/Eurostat,

2007[39]). Indeed, the largest source of N_2O emissions in 2016 was agriculture – agricultural soils and manure management accounted for 26% and 19% of N_2O emissions, respectively (MOE, GIO, 2018[33]).

Figure 2.14. Nitrogen and phosphorus balance in OECD countries, 1993-95, 2003-05 and 2013-15

Balance (surplus or deficit) expressed as kg nitrogen or phosphorus per hectare of total agricultural land



1. Countries are ranked according to the average amount of nitrogen or phosphorus balance in 2013-15. Chile and Israel are excluded due to data availability.
2. Data for 1993-95 nitrogen average refer to 1995 for Portugal and the United Kingdom while for Estonia, Hungary, Lithuania, and Luxemburg data are not available.
3. Data for 1993-95 phosphorus average refer to 1995 for Portugal and the United Kingdom while for Estonia and Hungary are not available.
4. Data for 2003-05 nitrogen and phosphorus average refer to 2004-05 average for Estonia.
5. For Switzerland, total agricultural area includes summer grazing.
Source: OECD (2018[9]), *Agri-environmental indicators* (database), http://www.oecd.org/tad/sustainableagriculture/agri-environmentalindicators.htm.

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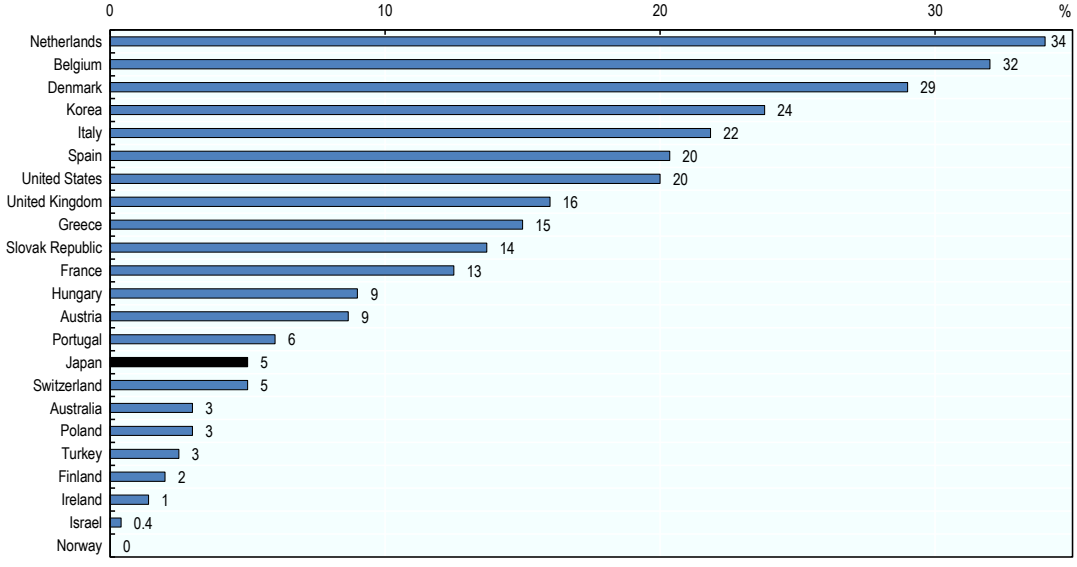
Unlike nitrogen, phosphorus, another important nutrient, is scarce in nature and exploited from mineral resources. Phosphorus uptake rates by crops are estimated to be 10%-15% (Roberts and Johnston, 2015[43]). The runoff of excess phosphorus in water increases toxic substances produced by cyanobacteria and produces algae, which restricts oxygen in the water and causes biodiversity loss (Chorus and Bartram, 1999[44]; Hitzfeld, Hoger and Dietrich, 2000[45]). In view of past applications and the accumulation of phosphorus in the soils, phosphorus application rates have declined in many OECD countries (OECD, 2013[46]).

However, the phosphorus balance in Japan was 59.9 kg per hectare in 2013-15, the highest of all OECD countries and 11.7 times higher than the OECD average (Figure 2.14 Panel B). Inorganic fertilisers account for 48% of phosphorus input and the intensity of inorganic phosphorus fertilisers in 2015 was substantially higher than the OECD average (36.2 kg/hectare versus 6.9 kg/hectare). The type of soil in Japan, Andosols, which has strong phosphate fixation (i.e. low phosphorus availability) caused by aluminum and iron, requires more intensive phosphorus input (FAO, 2015[47]).

The amount of phosphorus runoff from farmland is estimated to be less than 2% for most cases, mainly because phosphorus is easily fixed by soil and little flows out (Mishima et al., 2003[48]). However, phosphorus runoff increases when accumulated phosphorus reaches a certain level (Heckrath et al., 1995[49]). In the case of Japan, accumulated phosphorus increases the risk of eutrophication by overflow from paddy fields and surface runoff from upland farm fields in the rainy and the typhoon seasons (Mishima et al., 2003[48]).

Figure 2.15. Agricultural areas exceeding recommended drinking water limits for nitrates in groundwater, OECD countries, 2000-10

Share of monitoring sites in agricultural areas exceeding nitrates limits



Note: The figures refer to: 2000 for Japan, Korea, Turkey and United States; 2001 for Greece; 2002 for Australia, Finland, Hungary and Norway; 2003 for Denmark, Italy and Spain; 2005 for Belgium (Flanders), Portugal and Slovak Republic; 2008 for France and Poland; 2009 for Switzerland; and 2010 for Austria, Ireland, Israel, Netherlands and United Kingdom.

Source: Adapted from OECD (2013[46]), *OECD Compendium of Agri-environmental Indicators*, http://dx.doi.org/10.1787/9789264181151-en.

StatLink http://dx.doi.org/10.1787/888933957477

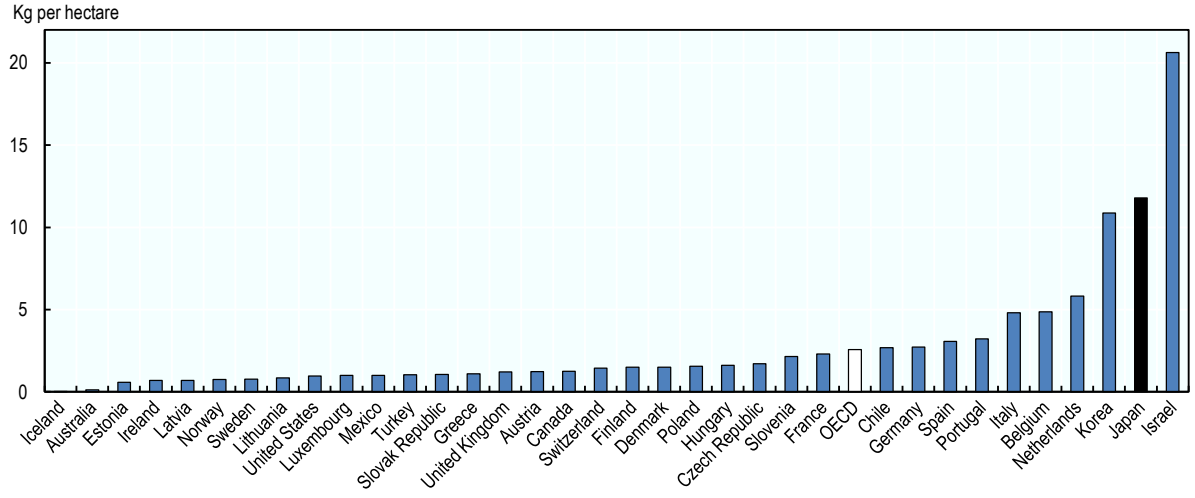
Pesticides

Annual sales of chemical pesticides declined in quantity by 38% between 1994-96 and 2014-16. In 2014-16, 42% of pesticides sales were fungicides, followed by insecticides (33%) and herbicides (24%) (OECD, 2018[9]). The chemical pesticides sales also declined from 17 kg/ha in 1994-1996 to 11.8 kg/ha in 2014-16, although in 2011-15 it was the second highest among OECD countries (Figure 2.16). The intensive use of pesticides in Japan is due in part to its topography and humid temperate climate, which increases the occurrence of insects and mould.

Rice paddy fields are one of the most important non-point sources of pesticide water contamination in Japan. Since rice paddy fields are linked with the circulation of basins, pesticide discharge to water bodies sourced from paddy fields can be lethal to the aquatic environment. Moreover, extensive use of pesticides may adversely affect beneficial microorganisms in the soil and other species (Hussain et al., 2009[50]; Parsons, Mineau and Renfrew, 2010[51]).

Pesticide residue in food poses potentially serious detrimental health effects if it exceeds maximum residue limit (MRL). Globally, an average of 200 000 deaths per year from toxic exposure to pesticides is reported (UN, 2017[52]). In the case of Japan, however, the level of domestically-produced agro-food products that exceeded the MRL was only 0.003% in FY 2015 (MHLW, 2015[53]). Pesticides were handled in accordance with the regulations by all farmers surveyed in FY 2015 and FY 2016 (MAFF, 2018[54]).

Figure 2.16. Pesticides sales per agricultural land in OECD countries, 2011-15



Notes: Figure excludes New Zealand due to data availability. Data for 2011-13 are not available for Norway; data for 2013-15 are not available for Chile; data for 2014 and 2015 are not available for Israel, and data for 2015 are not available for Switzerland.
Source: OECD (2018[9]), *Agri-environmental indicators* (database), http://stats.oecd.org/.

StatLink http://dx.doi.org/10.1787/888933957496

Water

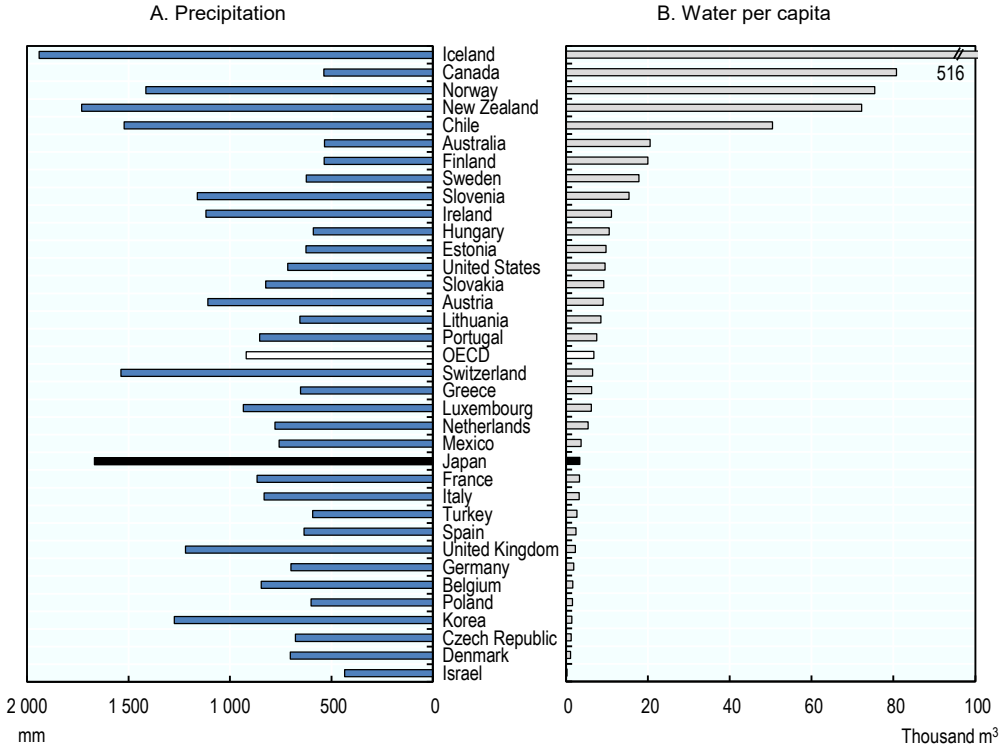
Japan is located in the easternmost part of the Monsoon Asia, one of the world's heaviest rainfall regions. Average annual precipitation reaches 1 668 mm, 1.8 times more than the OECD average. However, the country's annual available quantity of water resources per

person is 3 397 m^3, which is less than one-eighth of the OECD average (Figure 2.17). The amount of precipitation varies by season and region due to the country's mountainous topography.

Japan's steep topography requires good water management to preserve water resources as well as prevent water-related disasters such as floods, landslides and drought. Rice paddy fields are effective in retaining rainfall and flood reduction (Sujono, 2010[55]; OECD, 2015[31]). Paddy fields store water, lower the peak flow of rivers, and increase groundwater recharge, and most of the water that flows down to rivers and groundwater is reused downstream for agriculture and other purposes (Matsuno et al., 2006[56]; MLIT, 2018[32]). The decline of rice paddy fields is a concern in Japan from a water management perspective.

In 2015, 68% of Japan's total water abstraction was used for agriculture, of which 94% was directed to paddy field irrigation (MLIT, 2018[32]). As freshwater withdrawal accounts for 95% of water use in agriculture, the reliance of groundwater in agriculture sector is the second lowest among OECD countries in 2013 (OECD, 2018[9]). Overall, agricultural water use has been stable since 2005, due largely to the offset of the decrease in paddy fields and the increase of other use (Cabinet Office, 2018[57]).

Figure 2.17. Annual precipitation and per capita water availability in OECD countries, 2014



Note: Countries are ranked according to the average amount of water per capita.
Source: FAO (2018[58]), *AQUASTAT* (database), http://www.fao.org/nr/water/aquastat/main/index.stm.

StatLink http://dx.doi.org/10.1787/888933957515

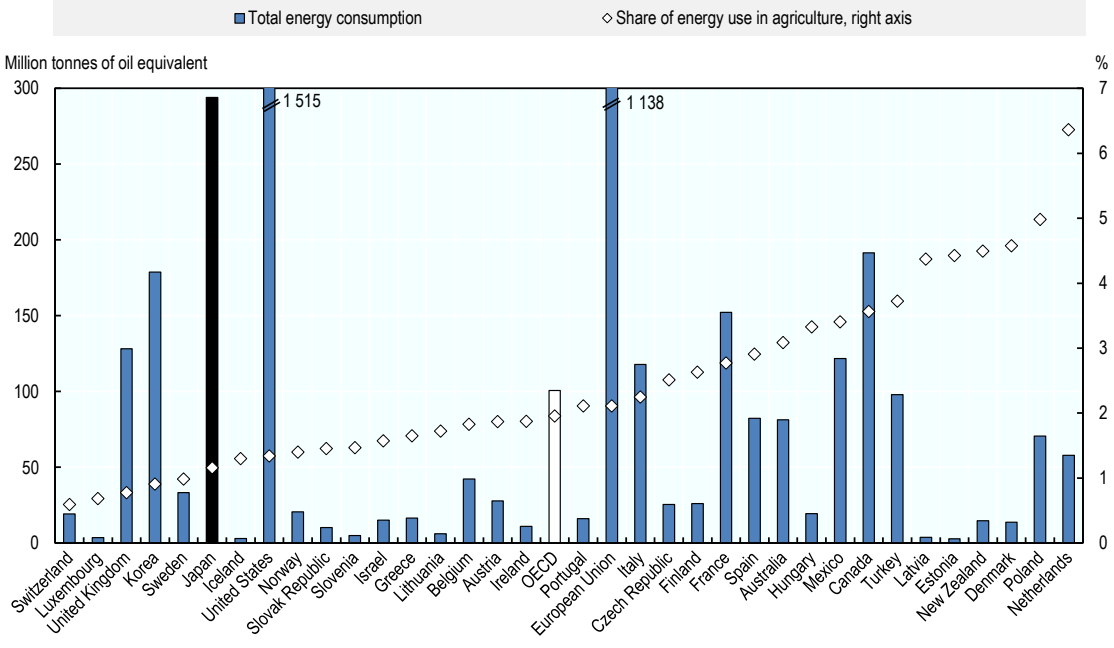
Energy use and GHG emissions

Reflecting the low economic share of agriculture, the share of agricultural energy consumption in Japan's total final energy consumption was 1.2% in 2016 (Figure 2.18). However, on-farm energy consumption in 2016 was 3.4 million tonnes of oil equivalent, about twice the OECD average (OECD, 2018[9]).

Japan introduced the feed-in tariff scheme for renewable energy in 2012 to expand renewable energy production. This scheme requires electric utility companies to purchase electricity generated from renewable energy sources with a fixed price set by the government for a fixed period. The cost of purchasing electricity from renewable energy sources is transferred to consumers as a surcharge that is proportional to their use of electricity. Due mainly to this scheme, the share of renewable energy in the total primary energy supply increased from 2.1% to 5.5% between 1990 and 2017 (OECD, 2018[59]). This scheme also accelerated the production of renewable energy in the agricultural sector utilising agricultural dam and water channels, as well as photovoltaic solar panels built above the farmland (Farming Photovoltaics) (MAFF, 2018[60]).

Bioethanol production decreased from 52 tonnes in 2000 to 39 tonnes in 2018. Biodiesel production increased from 6 tonnes in 2008 to 11 tonnes in 2018, but the quantity remains marginal. Renewable energy derived from biomass source is mainly waste-based in Japan.[6] The use of agriculture waste such as the non-edible parts of crops and thinning or scrap woods, is low as costs of transportation and conversion into fuel are high. The crop-based biofuel production has not reached the stage of wide practical use mainly because of competition with food production and the high cost of production.

Figure 2.18. Energy use in OECD countries, agriculture and total, 2016



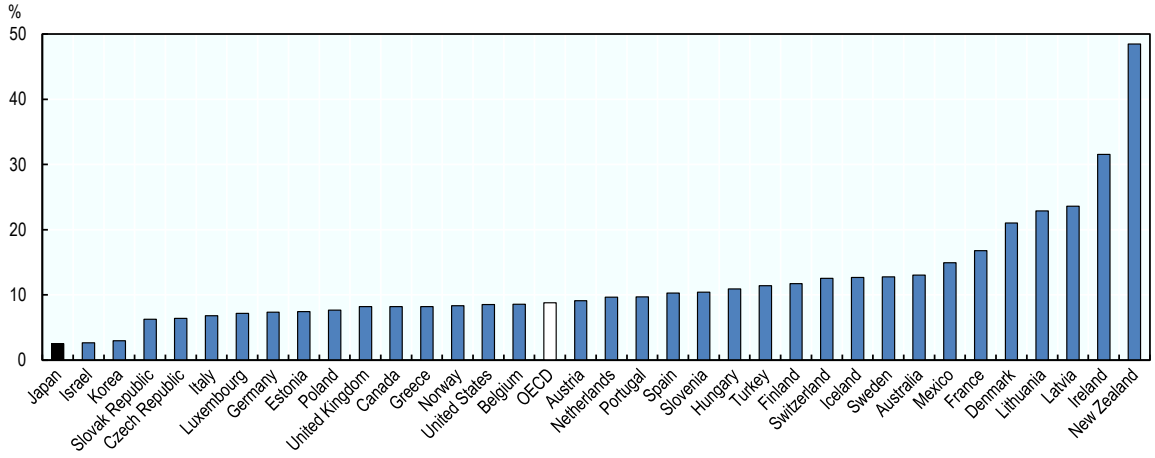
Note: Figure excludes Chile and Germany due to data availability.
Source: OECD (2018[9]), *Agri-environmental indicators* (database), http://stats.oecd.org/.

StatLink http://dx.doi.org/10.1787/888933957534

Japan's total GHG emissions was 1.3 million tonnes of carbon dioxide (CO_2) equivalent in 2016, 7.3% lower than the level in the peak year of 2013. The reduction of GHG emissions was mainly driven by lower emissions from the energy sector — precisely the increase of renewable energy use and the re-operation of nuclear power plants after the Great East Japan Earthquake and the Fukushima accident of 2011 (MOE, 2018[61]). However, emissions are still 3% higher than the 1990 level.

Globally, the agricultural sector is one of the largest contributors of GHG emissions, accounting for approximately 20% of total emissions (FAO, 2018[62]). However, the agricultural sector in Japan represented only 2.6% of total national GHG emissions in 2015, the lowest share in OECD countries (Figure 2.19). GHG emissions from the agricultural sector decreased by 10.9% between 1990 and 2016. Agricultural GHG emissions in Japan are mainly CH_4 originating from rice cultivation (42%), followed by CH_4 from livestock enteric fermentation (22%) and N_2O by fertiliser application (16%) (MOE, GIO, 2018[33]). CH_4 emission from agriculture accounts for 76.9% of the country's total CH_4 emission. GHG emissions from rice cultivation increased by 4.2 % between 2003-05 and 2013-15 (OECD, 2018[9]). The increase of CH_4 emission from rice production highlights that policies seeking to minimise CH_4 emissions from rice paddy fields is particularly effective in reducing GHG emissions originating from the Japanese agricultural sector.

Figure 2.19. Share of GHG emissions from agriculture in OECD countries, 2015



Note: Chile is not included due to data availability.
Source: OECD (2018[9]), *Agri-environmental indicators* (database),
http://www.oecd.org/tad/sustainableagriculture/agri-environmentalindicators.htm.

StatLink http://dx.doi.org/10.1787/888933957553

Climate change

Japan's average annual temperature increased at a rate of 1.19°C per century, which is higher than the global average of 0.85°C (IPCC, 2013[63]). The prevalence of extreme high temperatures has increased in Japan since around 1990 and the number of days with a minimum temperature below 0°C has decreased. The mean sea surface temperature around Japan increased by 1.11°C per century, which is also higher than the global average of 0.54°C. The average temperature in Japan is projected to rise by 4.5°C by the end of the 21st century (2076-2095) from the late 20th century (1980-1999), with more frequent extreme weather events (JMA, 2018[64]).

The impact of climate change on agricultural productivity are evident in the quality of rice (e.g. occurrence of white immature grain, cracked grain, and chalky rice kernels), which is projected to decline nationwide due to an increase in temperature during the ripening period (MAFF, 2018[65]). Although the Intergovernmental Panel on Climate Change (IPCC) (2014[66]) projects a reduction of rice yields in western Japan, overall rice yields are expected to increase up to the mid-21st century (Government of Japan, 2018[67]; MAFF, 2018[65]). More vulnerable to climate change, perennial crops are similarly affected by the change in weather patterns, including a decline in quality and alterations in the type of disease and pests (MAFF, 2018[65]; IPCC, 2014[66]). Nonetheless, the net impact on the national agricultural production remains uncertain. As temperatures rise, primary agricultural production sites on certain commodities may experience economic loss, but the country's northern region may be able to increase agricultural production as the temperature becomes similar to that of current major agricultural production areas.

Japan is relatively susceptible to water related disasters, but the frequency of strong typhoons reaching Japan is projected to increase (MAFF, 2018[65]). In addition to typhoons, IPCC (2014[66]) warns that the frequent occurrence of long-term heatwaves increases extreme rainfalls and droughts in Japan. Japan Meteorological Agency (JMA) (2018[68]) estimates that climate change is one factor of the recent heavy rains and heatwaves. More frequent extreme weather events combined with natural disasters will likely be a major risk to future agricultural production in Japan.

2.5. Summary

Agriculture in Japan showed a long period of contraction until recently. Since 1990, the value of Japan's agricultural production declined more than 25%, and the number of commercial farm households and agricultural workers decreased by more than 50%. The food and agriculture sector continues to be under pressure to raise productivity in order to keep up with the highly competitive manufacturing sector and to increase its exposure to international competition. Although TFP growth in agriculture is higher than the OECD average, the sector's productivity growth remains lower than that of the manufacturing sector.

The working-age population started to decline in 1995 and is expected to contract further by 41% over the next four decades. The declining working-age population and the ageing population have significant implications for Japan's agriculture from both production and consumption sides. The shortage of labour in agriculture is already causing severe constraints in many agricultural operations. Declining population and ageing will reduce the size of the domestic food market in the medium to long term. The future growth of the agriculture and food sector thus depends on the production of high-value-added products for the domestic and overseas markets.

Japan is the second largest net importer of agro-food products after China. Despite policy efforts to maintain food self-sufficiency, more than 60% of calorie intake depends on imports. Trade flows show that Japan does not have a comparative advantage in agriculture and food products. However, rapid economic growth in East Asia boosted demand for Japanese agro-food products and the country's agro-food exports more than doubled between 2012 and 2018, opening new market opportunities for the future.

Resource reallocation to more profitable sectors and more productive large-scale farms drive productivity growth of Japan's agriculture. The value share of rice in agricultural production declined from 43% in 1965 to 17% in 2015, while that of livestock and

vegetables increased to 35% and 27% in 2015 from 23% and 12% in 1965, respectively. Westernisation of the Japanese diet has reduced rice consumption by more than half from its peak, and increased the consumption of meat and dairy products.

Structural changes in agriculture has accelerated over the past two decades. As a result, the structure of agricultural production is polarised with a small number of large, commercial farms dominates the sector. At present, the top 3% of large farms producing more than JPY 30 million (USD 278 000) accounts for more than half of total production. The farm structure in Japan is now similar to that of the EU15, and the future performance of the sector will depend more on improving productivity and sustainability performance at the farm level than on concentration of land to large-scale farms.

Income disparity problems between farm and non-farm households has gradually disappeared due to increasing off-farm employment opportunities in rural areas. In contrast, large farms depend on farm income and are thus more vulnerable to income risk associated with agricultural production and markets. They are typically incorporated farms and hire regular employees, separating agricultural production operations from overall business management. The number of corporate farms doubled between 2005 and 2015.

The evolution of Japan's agricultural structure and the global trend towards more integrated value chains require a change in the implicit policy assumption that the government needs to support small-scale family farms that are disadvantaged in the economy. Developing a favourable policy environment for entrepreneurial farms to enable innovation, entrepreneurship, and sustainable resource use has become more relevant.

Despite the declining share of primary agriculture in the economy, controlling the impact of agriculture on natural resources is important as the sector uses 36% of the country's total inhabitable land area and accounts for 67% of total water withdrawal. The evolution of Japan's agricultural structure requires producers to take more responsibility of their environmental performance.

There is significant room to improve the environmental performance of Japanese agriculture. Japan has one of the highest nutrient surpluses among OECD countries, indicating the potentially high risk of environmental pressure on soil, water and air. While many OECD countries have reduced their agricultural nutrient surpluses, Japan's progress has been much slower. For example, the nitrogen balance in Japan decreased by only 0.3% between 1993-95 and 2013-15, while it fell by 35% in the EU15 and by 24% in the OECD area – in both cases from lower initial levels. Future growth in Japanese agriculture can no longer depend on the intensive use of inputs and natural resources.

The impact of climate change on agriculture is already evident. The prevalence of extreme high temperatures has increased in Japan since around 1990 and days with minimum temperatures below 0°C have decreased. More frequent extreme weather events combined with natural disasters will likely be a major risk to future agricultural production. Increasing preparedness for climate change is critical to ensuring the sustainability of agriculture production in Japan.

Notes

[1] The value of exported agro-food, fisheries and forestry products was JPY 907 billion (USD 8.2 billion) in 2018, of which agro-food products amounted to JPY 566 billion (USD 5.1 billion).

[2] In general, RCA values greater than 1 indicate a comparative advantage and that a country specialises in exports for that sector, meaning that the sector is competitive within the economic system of the country with respect to other sectors. Values less than 1 indicate that a country has not specialised in that sector and that it has no comparative advantage.

[3] A farm household in Japan's agricultural statistics is a household that cultivates more than 0.1 hectare of land or has more than JPY 150 000 (USD 1 379) in annual sales of agricultural products. Farm households are divided into commercial farm households and self-sufficient farm households. Agricultural workers are defined as farm household members of 15 years or older who mainly engage in farming. Commercial households are farm households that cultivate more than 0.3 hectare of land or sell more than JPY 500 000 (USD 4 596) of farm products and are further sub-categorised as follows according to the extent of non-farm employment: 1) Business farm household: a farm household whose farm income is more than half of the total household income and which has at least one family member (less than 65 years-old) engaged in farming more than 60 days per year; 2) Semi-business farm household: a farm household whose farm income is less than half of the total household income and which has at least one family member (less than 65 years-old) engaged in farming more than 60 days per year; 3) Side-business farm household: a farm household in which no member either engages in farming more than 60 days or is less than 65 years-old.

[4] *Satoyama* is located between villages (sato) and the mountains (yama) in which rich biodiversity have been fostered for centuries thanks to continued human management of the land. MOE selected 500 *Satoyamas* as important biodiversity sites in an attempt to conserve the lands but the selection does not legally bind the use of land or farming methods.

[5] Denitrification is a reduction of nitrates or nitrite by heterotrophic bacteria in soil that results in the escape of N_2 or N_2O into the air. Denitrification is common in anaerobic soils and is encouraged by high soil temperatures. It occurs during and after flood irrigation and/or heavy rainfall. Denitrification process is important for soil bacteria because it supplies them with oxygen but it can also result in N_2O emissions.

[6] The government set rates for biomass plants that burn liquidified biomass from thinning or scrap woods at JPY 32 (USD 0.3) per kilowatt-hour and agricultural waste (methane fermentation) at JPY 39 (USD 0.4) per kilowatt-hour through the feed-in tariff scheme.

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Chapter 3. General policy environment for food and agriculture in Japan

In Japan, agriculture has been treated differently from the rest of the economy based on the implicit assumption that small-scale family farms needed government support as they were disadvantaged within the economy as a whole. The evolution of the agricultural structure has shifted this policy paradigm towards developing policy and market environments that are more conducive to innovation and entrepreneurship. This chapter reviews how the general policy environment could be yet more conducive to innovation and entrepreneurship in agriculture, and more coherent with sustainability policy objectives.

3.1. Macroeconomic policy environment

In 2013, Japan launched "Abenomics". This was characterised by its three pillars designed to overcome two decades of sluggish growth: a bold monetary policy, flexible fiscal policy, and a growth strategy. The growth strategy included agricultural policy reform as a major topic. Real output growth nearly doubled to an annual pace of 1.1% during the 2012-16 period in comparison to 1997-2002 period, thanks in part to Abenomics. On a per capita basis, real output growth nearly matched the OECD average (OECD, 2017[1]). Abenomics has also brought improvements to the labour market. Japan's unemployment rate today is the lowest in the OECD area and net household financial wealth is among the highest. A shortage of labour has become a major constraint in many industries, including agriculture.

Gross general government debt increased from 68% of GDP in 1992 to 224% in 2017, the highest ever recorded in the OECD area (Table 3.1). Core consumer price index (CPI) inflation has been above zero since 2014, the longest period since 1995-98. However, OECD (2017[1]) questions the fiscal sustainability due to the risk of rising government bond yields and with the large amount of government debt, as well as an expected rise in social security spending.

Table 3.1. Key indicators of Japan's economic performance, 1990 to 2019

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018e	2019e
Real GDP growth, %	5.6	2.7	2.8	1.7	4.2	-0.1	1.5	2.0	0.4	1.4	1.0	1.7	1.2	1.2
General government financial balance[1]	2.2	-4.3	-7.4	-4.4	-9.1	-9.1	-8.3	-7.6	-5.4	-3.6	-3.4	-3.5	-3.0	-2.5
General government gross debt[2]	66.1	89.8	130.9	159.1	187.0	202.3	209.9	212.9	218.3	216.6	222.4	224.1	225.5	225.2
Current account balance[1]	1.6	2.2	2.7	3.6	3.9	2.1	1.0	0.9	0.8	3.1	3.8	4.0	3.7	4.1
Exchange rate (Yen per USD)[3]	144.8	94.1	107.8	110.1	87.8	79.7	79.8	97.6	105.8	121.0	108.8	112.2	108.9	109.3
Inflation, annual %, CPI all items	2.8	-0.1	-0.5	-0.6	-0.6	-0.3	0.0	0.3	2.8	0.8	-0.1	0.5	1.2	1.5
Unemployment rate, %[4]	2.1	3.1	4.7	4.4	5.0	4.6	4.3	4.0	3.6	3.4	3.1	2.8	2.5	2.5

Note: e = OECD Economic Outlook estimate
1. As a percentage of GDP
2. As a percentage of GDP at market value
3. Period average
4. End year, as a percentage of total labour force
Source: OECD (2018[2]), *OECD Economic Outlook* (database), https://doi.org/10.1787/494f29a4-en.

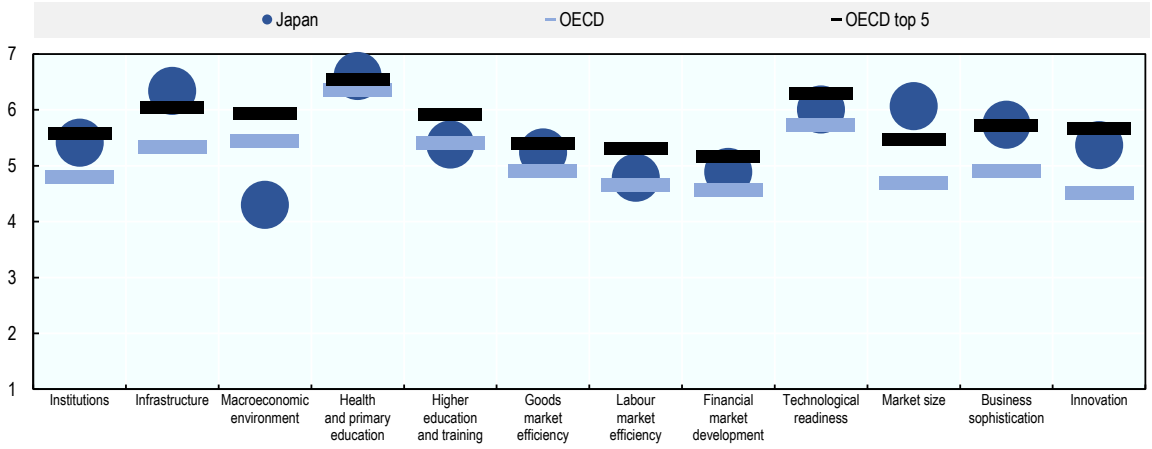
The World Economic Forum Global Competitiveness Index for 2017-18 ranks Japan ninth out of 137 countries. Japan scored particularly high on the quality of physical and digital infrastructure as well as health and primary education (Figure 3.1). However, it ranked only 23 for higher education and training. A high level of government debt and unbalanced government budgets make the macroeconomic environment Japan's lowest performing area, ranking 93. Public institutions are considered relatively competitive and are ranked 17. In the area of public institutions, protection of property rights ranks in the top 10, but the burden of government regulation is particularly high and Japan is thus ranked 59.

The innovation system is one of Japan's most highly scored areas (ranked 8). In terms of number of patent applications, it ranks first in the world. Private R&D expenditure and the

availability of scientists and engineers are also among the top 10. However, it is ranked at only 23 for university-industry collaboration in R&D.

Figure 3.1. Global Competitiveness Index: All components, 2017-18

Scale from lowest (1) to highest (7) performance



Note: Indices for OECD are the simple average of member-country indices. OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries for the overall index (Switzerland, United States, Netherlands, Germany and Sweden).
Source: WEF (2017[3]), *The Global Competitiveness Report 2017-2018: Full Data Edition*, http://reports.weforum.org/global-competitiveness-index-2017-2018/.

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3.2. Public governance

Japan's quality of governance is considered to be very good according to the World Bank's Worldwide Governance Indicators (WGI). The WGI measures six broad aspects of governance: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. Japan scores higher than the OECD average in all areas except for voice and accountability, which indicates citizen participation in selecting their government, freedom of expression and association, and a free media (Table 3.2).

The highest percentile rank is in government effectiveness, indicating that the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies are perceived as very high.

Table 3.2. Governance indicators for Japan, 2016

Percentile rank: Lowest (0) to highest (100)

	Japan	High income (OECD) countries
Voice and accountability	78	87
Political stability	86	73
Government effectiveness	96	88
Regulatory quality	90	88
Rule of law	88	88
Control of corruption	91	85

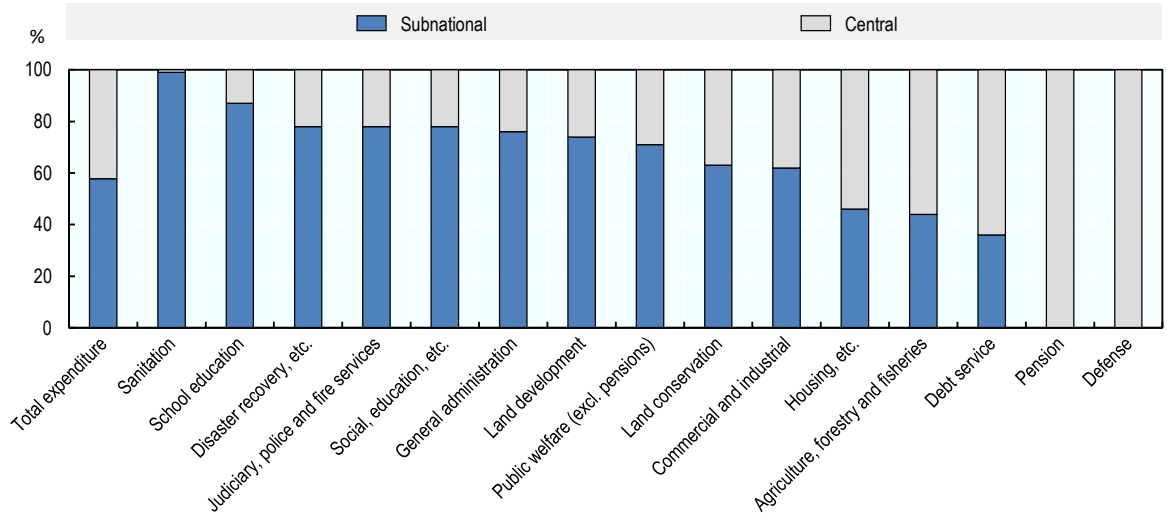
Source: World Bank (2018[4]), *Worldwide Governance Indicators* (database), http://info.worldbank.org/governance/wgi/.

In Japan, subnational governments (SNGs) play an important role, including the implementation of agricultural policies.[1] Japanese SNG revenue and spending as a share of GDP are both close to the average of OECD countries. Japanese SNGs were responsible for 74% of general government spending (excluding social security), one of the highest shares in the OECD area. However, the central government tends to delegate administrative functions to SNGs while retaining authority over finance and programme design (OECD, 2016[5]). The prefectures are in charge of most public infrastructure, education and welfare, livelihood support in towns and villages, child welfare policy, and employment training. The municipalities have extensive responsibilities for urban planning, municipal roadways, some harbours, some public housing, and sewers.

Decentralisation of government fiscal and regulatory authorities has been pursued in the last decades to increase flexibility of policy implementation at the local level. However, SNGs still depend on grants and subsidies from the central government for 43% of their revenue, which is higher than the OECD average of 37% in 2016. In agriculture, forestry and fisheries, the grants and subsidies from the central government account for 56% of the expenditure, which is one of the highest among the policy areas (Figure 3.2). This indicates that local governments have a lower degree of autonomy in implementing agricultural policy.

While the promotion of agriculture and food security are both considered to be the responsibility of the national government, more flexible design and implementation of agricultural policy at the local level would contribute to more diverse agricultural production based on local characteristics.

Figure 3.2. Allocation of spending responsibility by function in Japan, 2016



Source: MIC (2018[6]), *White Paper on Local Public Finance 2018*, http://www.soumu.go.jp/iken/zaisei/30data/2018data/30010000.html.

StatLink http://dx.doi.org/10.1787/888933957591

3.3. Trade and investment policy

Trade policy

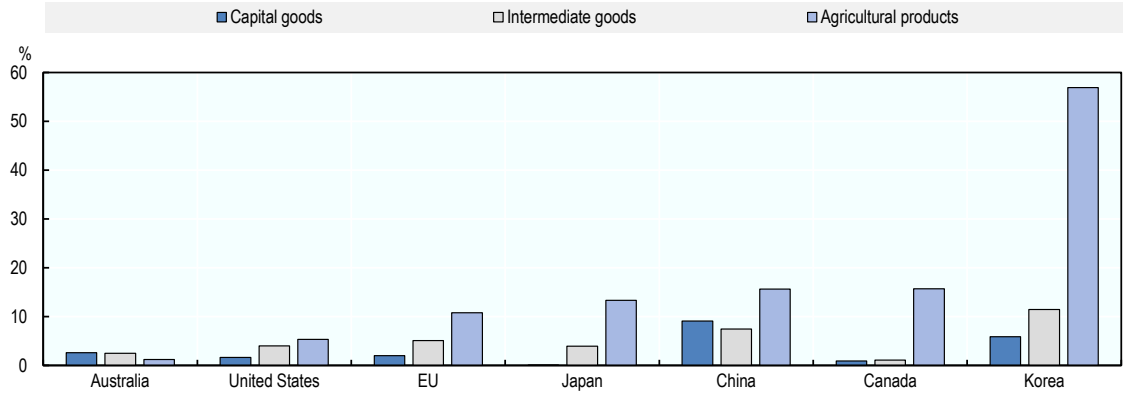
Japan ranks fourth worldwide in terms of the value of exports and imports, which accounted for about 16% of GDP in 2016. The share of trade in Japan's GDP is about half the OECD average, reflecting the large size of the Japanese economy. In 2015, the United States was the largest export market, with a share of 20.2%, followed by the People's Republic of China (hereafter "China") with 17.5%. Asian countries (China, Association of Southeast Asian Nations (ASEAN) countries and the Newly Industrialised Economies) account for about half of both Japanese exports and imports.

Japan continues to promote the multilateral trading system, as well as bilateral and regional trade agreements, considering that these are complementary to and not substitutes for the multilateral trading system (WTO, 2017[7]). The country's overall simple-average applied Most Favoured Nation (MFN) tariff rate is about 6%. Of the 101 highest tariffs, 95 had non-*ad valorem* rates. The simple average applied rate is 13.3% (down from 14.9% in FY2014) for agriculture (World Trade Organization (WTO) definition), and 2.5% for non-agricultural products (down from 3.7% in FY2014) (WTO, 2018[8]).

Japan has bound 98.2% of its tariff (159 lines are unbound). The difference between the average bound MFN tariff (6.2%) and the average applied MFN tariff (6.1%) continues to be negligible; this reflects a high degree of predictability in the tariff. However, the average bound rate remains considerably higher for agricultural products (16.7%) than for non-agricultural products (3.6%) (Figure 3.3). Japan makes use of tariff quotas; there are 158 tariff lines (1.7%) subject to MFN out-of-quota tariffs, of which 11 are under state trading. The quota allocation method and process remain somewhat intricate, while procedures for the allocation of tariff quotas have remained unchanged since 2014 (WTO, 2017[7]).

Figure 3.3. Import tariffs for industrial and agricultural goods

2017 rates for agricultural products, 2015 rates for non-agricultural goods



Note: Tariff rates for agricultural products include both ad valorem duties and specific duties equivalent to ad valorem duties, while tariff rates for non-agricultural products only include ad valorem duties.
Source: (Non-agricultural products) UNCTAD (2018[9]), *Trade Analysis Information System (TRAINS)*, http://unctad.org/en/Pages/DITC/Trade-Analysis/Non- Tariff-Measures/NTMs-trains.aspx. (Agricultural products), WTO (2018[8]), *World Tariff Profiles 2018* (database), http://www.wto.org/statistics.

StatLink http://dx.doi.org/10.1787/888933957610

Foreign Direct Investment (FDI) policy

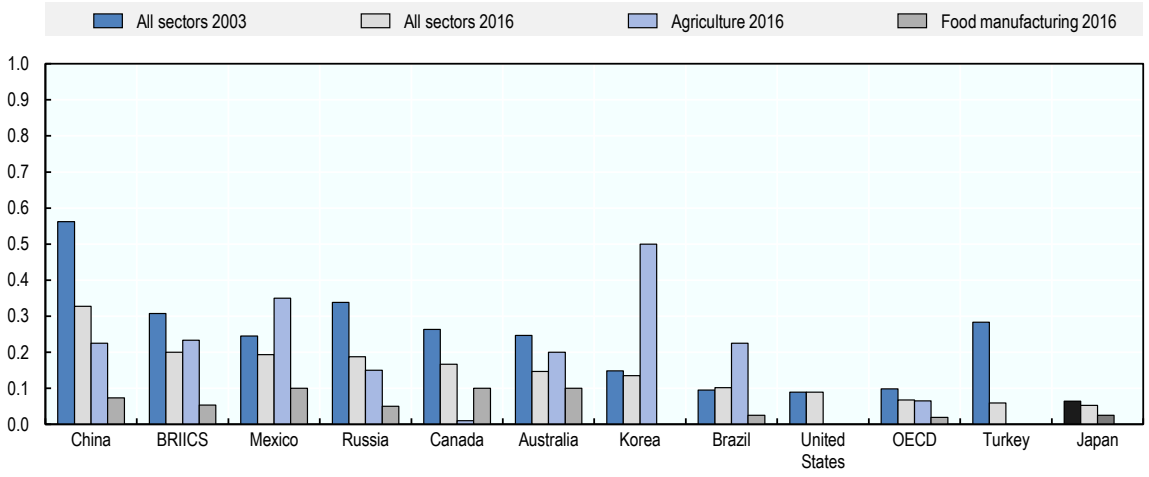
Foreign Direct Investment (FDI) inflows bring important benefits, such as enhancing competition, local technical capabilities and innovation. Access to imported inputs and inflows of FDI and expertise can reduce costs and enhance productivity through technology spill-overs. FDI outflows contribute to diversifying the supply chain and to exploiting opportunities for overseas markets. In the food and agricultural sector, promoting the FDI outflow would increase the export of Japan's technology and production systems, increasing its capacity to supply high-quality and specialised food and agricultural products that are adapted to the needs of overseas markets.

In 2016, the stock of inward and outward FDI remained at around 4% and 27% of GDP, respectively. FDI inflow to Japan continues to be smaller than in other major developed economies. FDI inflow to food and agricultural is lower than for other sectors, but outflow is higher. The stock of inward and outward FDI in the food and agriculture sector are 1% and 45% of value-added in the sector, respectively.

Despite its relatively low FDI inflow, Japan maintains a policy of low regulatory restrictiveness on FDI (Figure 3.4). The government set a target to double the stock of inward FDI in 2020 to JPY 35 trillion (USD 312 billion) from JPY 19.2 trillion (USD 241 billion) in 2012. In 2017, the top three largest investors to Japan were the United States, the Netherlands and France. FDI from Asia to Japan mainly comes from Singapore and Hong Kong, China (JETRO, 2018[10]).

Figure 3.4. OECD FDI Regulatory Restrictiveness Index by sector, 2003 and 2016

Scale from least (0) to most (1)



Note: The FDI Restrictiveness Index covers four types of measures: 1) foreign equity restrictions, 2) screening and prior approval requirements, 3) rules for key personnel, and 4) other restrictions on the operation of foreign enterprises. Countries are ranked according to "All sectors 2016" levels. Indices for OECD and BRIICS are the simple average of member-country indices.
Source: OECD (2019[11]), "OECD FDI regulatory restrictiveness index", *OECD International Direct Investment Statistics* (database), https://doi.org/10.1787/g2g55501-en.

StatLink http://dx.doi.org/10.1787/888933957629

3.4. Policy environment for entrepreneurship

Developing a policy environment to support entrepreneurship is important to promote innovation in agriculture, as entrepreneurs bring innovative ideas, products and processes to markets. In Japan, the entry and exit of new enterprises is relatively inactive. The entry and exit rate of enterprises from 2004 to 2009 was about 4.5% on average, less than half the rate recorded in the United Kingdom and the United States (OECD, 2015[12]). In 2013, the government announced plans to increase this rate to 10%. The dispersion in productivity and labour income between firms is relatively large in Japan and has been widening (OECD, 2017[1]).

Although regulatory barriers to entrepreneurship have fallen below the OECD average, they are well above the leading OECD economies (OECD, 2013[13]). Less restrictive product market regulations promote: entry by new firms; effective diffusion of knowledge from both domestic and overseas sources; improved managerial performance; and private investment in innovation (OECD, 2015[12]). OECD (2017[1]) lists the priorities for regulatory reform to facilitate entry of firms in Japan as: reducing the high level of regulatory protection for incumbents; reducing administrative burdens on start-ups in line with the best-performing countries; and reducing the complexity of regulatory procedures.

On the exit side, the prevalence of personal guarantees and the stringency of the personal insolvency regime are the most important impediments to entrepreneurship (OECD, 2017[1]). Generous support to SMEs also contributes to the survival of non-viable firms, which reduces the efficiency of resource allocation by trapping capital and labour in low-productivity activities and discourages potential entrepreneurs (Box 3.1). In addition to removing the remaining institutional constraints for entrepreneurship, increasing

entrepreneurship requires improving its image: less than a third of the working-age population views entrepreneurship as a good career choice, the lowest among OECD countries (OECD, 2016[5]).

Box 3.1. SME policy in Japan

SMEs account for 70% of employment in Japan, compared to 60% for the OECD area. However, SMEs generate only slightly more than 50% of national value added in Japan, less than in most other OECD countries, indicating lower labour productivity of SMEs. The share of SMEs is particularly high in the food manufacturing industry. In 2016, SMEs accounted for 73% of total employment and 72% of total sales in the food manufacturing industry, while the share of SMEs in employment and sales in manufacturing was 67% and 43%, respectively (METI, 2017[14]).

The government supports SMEs in the form of credit guarantees and low interest loans by public financial institutions, as well as preferential tax rates. Government guarantees for loans to SMEs in Japan were exceptionally high at 5.2% of GDP in 2015.The share of guarantees covering 100% of loans was 40% in 2015. However, given the heavy reliance on bank lending to SMEs, the share of SME loans that are publicly guaranteed is around 11%, compared to 12% in the United States and 15% in Korea (OECD, 2017[1]).

With the increasing importance of incorporated farms and the diversification of their operations from primary agricultural production, the link between SME and agricultural policies becomes more important. The government has promoted the partnership between farmers and SMEs in developing business plans. The law on promoting agriculture-commerce-industry co-operation was elaborated in 2008, and SMEs or farmers are eligible for subsidies, credit guarantees, and preferential lending and taxes if the government approves the business partnership plan to develop new products or services between non-agricultural SMEs and farmers. As of June 2018, 778 business plans were approved.

As part of the reforms to further strengthen agricultural competitiveness, the government reviewed the performance of major agricultural input industries in 2016. They found that the fertiliser and compound feed industries had too many manufacturers offering too many brands of a similar quality, leading to higher retail prices. While the four largest companies account for 80% of domestic sales of farm machinery in Japan, the eight largest companies provide 50% of fertilisers and many small manufacturers remain in the market (MAFF, 2016[15]). Moreover, some regulatory standards on agricultural inputs increase cost and impede innovation in input industries. In addition to the high price of agricultural inputs, the marketing cost of agricultural products is high. In Japan, agricultural co-operatives play a major role in the whole process, from distribution of inputs to marketing of outputs. But their operation is inefficient in some cases.

Based on these assessments, the policy package to improve competitiveness in Japanese agriculture (The Plan to Create Dynamism through Agriculture, Forestry and Fisheries and Local Communities) was announced in November 2016. This programme promotes voluntary industrial restructuring, as well as regulatory reform of agricultural inputs and agricultural product marketing. The JA group, consisting of all primary, prefectural and national level agricultural co-operatives in Japan, implemented a reform to shift more resources from financial services to farming and marketing support, and to offer more competitive services in input supply and product marketing (Box 3.2). Regulatory schemes to mandate prefectures to perform R&D on agricultural machinery, as well as uniformly produce original seed and breeders' seed, were abolished to enhance innovation in agricultural input industries.

Box 3.2. Agricultural co-operatives in Japan

The agricultural co-operatives in Japan (Nokyo, also known as Japan Agricultural Co-operative, or JA) are mutual aid organisations established voluntarily by farmers and non-farm members to improve members' agricultural income. Each member has equal voting rights, but non-farm members (associate members) have no voting rights. Co-operative organisations are usually established to help small enterprises compete with larger ones and, as such, the JA benefits from reductions in corporate tax rates and exemption from certain regulations such as the Antimonopoly Act unless they engage in unfair trading practices or otherwise seek to limit competition.[1]

The JA provides four major services to its members: 1) farming and marketing support such as the supply of farm inputs, sales of member's outputs and farm management assistance; 2) financial services such as credit or saving; 3) insurance services including life insurance, fire insurance and car insurance; and 4) welfare services such as medical and home nursing.

In 2017, the JA operated local services in 679 municipalities. It also has regional headquarters in each prefecture as well as national headquarters that administers the entire group (JA Zenchu), a marketing body that is responsible for wholesale business and supply of production inputs (JA Zen-Noh), a finance body (Norinchukin Bank), and an insurance body (JA Zen-kyoren).

Due to this wide range of services and well-developed network, almost all farmers in Japan are members of the JA, although membership is voluntary. Official membership is limited to farmers (usually those who cultivate more than 0.1 hectares of land and engage in more than 90 days of farming), but non-farmers can become associate members by paying the membership fee. As of 2015, there are 4.43 million official members and 5.94 million associate members.

Each regional JA usually has farm advisors (total of 13 750 in 2016) to provide technical farming and marketing support to farmers. The JA has a large market share in major domestic agricultural products (approximately 30% in rice and vegetables) and in input markets (50% for fertiliser, 60% for pesticides and about 30% for compound feed). However, in many cases, the profit structure of the JA shows that profits from credit and insurance services cover losses in the agricultural business and technical advisory service.

In 2015, the government revised the Agricultural Co-operative Act as part of a key reform of the Japanese agricultural sector. The revised Act aims to strengthen local JA's farming and marketing support business by requiring each local JA to appoint a majority of directors from business farmers and professional salespersons. Also, the Act states that the agricultural co-operatives should not force their members to participate and engage in JA business projects and should allow farmers to select their service freely. In addition, the reform also renounces the exclusive status of JA-Zenchu to audit local JAs.

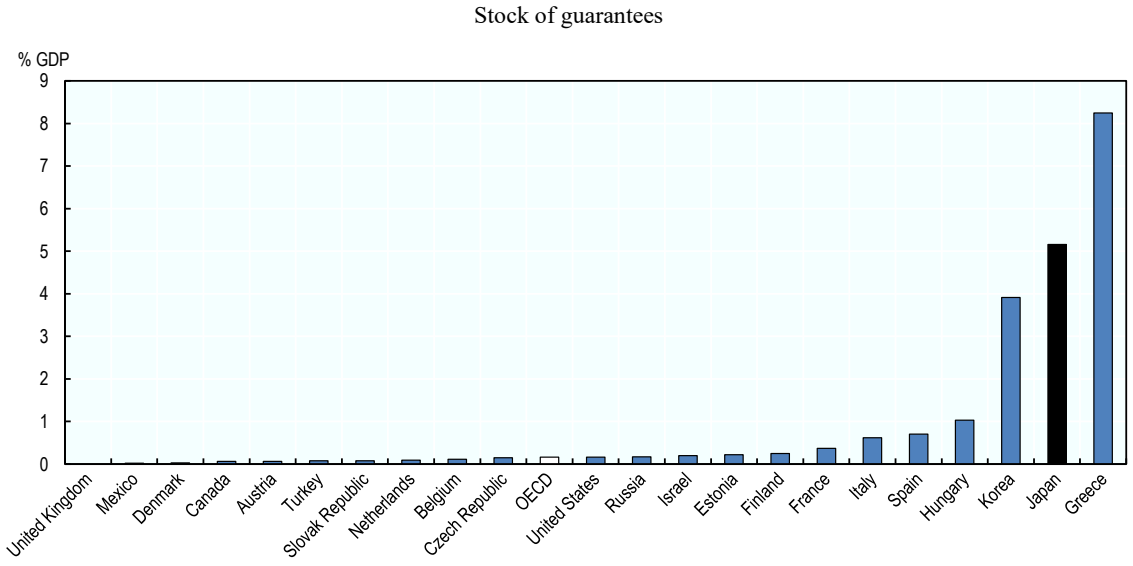
1. The Anti-Monopoly Act (AMA) provides the main framework of Japan's competition policy. Its overarching objective is to promote, *inter alia*, fair and free competition, stimulate the creative initiative of entrepreneurs, and encourage business activities for enhanced economic development and consumer welfare (WTO, 2017[7]). Certain industries or business practices are exempt from the AMA, including certain conduct of agricultural co-operatives. The Japan Fair Trade Commission provides a guideline on specific cases where the AMA can be applied to the conduct of agricultural co-operatives (e.g. allowing the use of collective facilities or the condition for purchasing inputs).

3.5. Financial market policy

The role of commercial banks in agricultural finance is relatively small, accounting for 15% of total lending to agriculture in 2016, and a large part of lending finances household consumption rather than agricultural operations (SMTB, 2013[16]). Instead, government

financial institutions and JA accounted for 47% and 39% of agricultural finance, respectively. In addition, the government plays an important role in credit guarantees, similar to the system provided for SMEs. Japan's credit guarantee system is one of the most generous in the OECD area (Figure 3.5). OECD (2015[12]) reports that government support constitutes 10% of SME financing, increasing to 20%, if guarantees are included. In agriculture, the Agriculture Credit Guarantee Fund Associations established at the prefecture level guarantees 100% of the credit provided by private financial institutions, including JAs. Agriculture, Forestry and Fisheries Credit Foundations at the national level also provide credit insurance, which guarantees 70% of the credit. Guarantees of 100%, however, weakens market forces, giving banks little incentive to monitor loans (OECD, 2017[1]).

Figure 3.5. Credit guarantees for small and medium-sized enterprises in Japan, 2015*



Note: *or latest available year. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: OECD (2017[17]), *Financing SMEs and Entrepreneurs 2017: An OECD Scoreboard* (database), https://doi.org/10.1787/fin_sme_ent-2017-en.

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MAFF provides various subsidised credit programmes, which are channelled mainly through JAs and the Japan Financial Corporation (JFC), established by the national government. The JFC operates the largest subsidised credit programme, which provides long-term, low-interest credit for up to 25 years for certified farmers. As of 2017, this programme had an outstanding credit of JPY 570 billion (USD 5.1 billion), which is equivalent to 11% of value added in agriculture. Another important programme are the subsidised long-term credits of up to 15 years that are mainly provided by the JA. These institutional credit programmes account for 70% of credit to farm operations.

The share of private banks in implementing subsidised credit programmes is negligible at 0.2%. Commercial banks play a minor role in agricultural finance, except for a small number of large, corporate farms that rely on regional commercial banks. Several reasons have been pointed out, such as: the large role of government financial institutions and co-

operatives; the difficulty to collateralise farmland due to strict regulations; agriculture-specific weather and market risks; the lack of schemes to securitise debt and liquidate between financial institutions; and the lack of complete financial statements (SMTB, 2013[16]; BoJ, 2017[18]).

However, direct finance in agriculture has developed less than has credit finance, due partly to the restriction on investment in agricultural corporations that own farmland. The revision of farmland regulations in 2016 extends the possibility for non-farm corporations to invest up to 50% in the ownership of agricultural corporations, when previously only those with a business relationship could invest up to 25%.

In February 2013, the government established the public-private Agriculture, Forestry and Fisheries Fund Corporation for Innovation, Value-Chain and Expansion in Japan (A-FIVE), an investment fund in which the government owns 94% of shares. It was founded for a period of 20 years with a total funding of JPY 31.9 billion (USD 328 million).

A-FIVE provides long-term investments to joint enterprises composed of farmers and companies from other industries to add value to agricultural products in an innovative way, making new combinations, and creating value chains. Half of the investments are co-financed by the private sector and A-FIVE normally invests in limited partnerships established by the private sector, which then invests in business operations mainly owned by primary producers to diversify primary agricultural production. As of the end of FY2017, A-FIVE had invested in 127 projects amounting to about JPY 11.4 billion (USD 102 million).

3.6. Infrastructure development policy

Japan is an outlier in terms of public capital stock, which reached 107% of GDP in 2013, compared to between 34% and 65% of GDP in other OECD countries (OECD, 2017[1]). The marginal return on additional public investment in Japan is estimated to be negative (Fournier, 2016[19]). With public investment falling, the ageing of public infrastructure (Table 3.3) puts financial pressure on local governments. Local authorities need to carefully select which infrastructure to maintain in order to limit maintenance costs in the context of a falling population. However, infrastructure management, particularly for transport, is exceptionally complicated and costly, and many rural communities face unusually severe accessibility challenges. In addition, most of the country is vulnerable to natural disasters, notably earthquakes, typhoons and tsunamis. The Cabinet Office (2013[20]) finds a wide regional variation in the marginal productivity of public capital, suggesting that public investment should focus on projects with the highest returns.

The Ministry of Finance (MOF) (2014[21]) found several major infrastructures in Japan to be saturated. For instance, between 1986 and 2014, the national network of main roads nearly tripled in length, while the number of passenger kilometres driven rose only 3.2%. Japan's road network of 1.27 million km is the sixth largest in the world, falling slightly short of the Russian Federation (1.28 million km) and exceeding that of Canada (1.04 million km), two countries over 20 times the size of Japan (OECD, 2016[5]).

As noted above, the population decline creates significant problems with respect to the operation, maintenance and development of infrastructure. First, a declining population means that the fixed costs of infrastructure are shared amongst fewer people. Second, some infrastructure degrades faster when not used at sufficient capacity. For example, some water lines and older pipes degrade faster without flowing water. Third, decisions about

where to upgrade, extend, maintain or decommission infrastructure assets can have a huge impact on property values and settlement patterns (OECD, 2016[5]).

Table 3.3. Indicators of infrastructure ageing in Japan

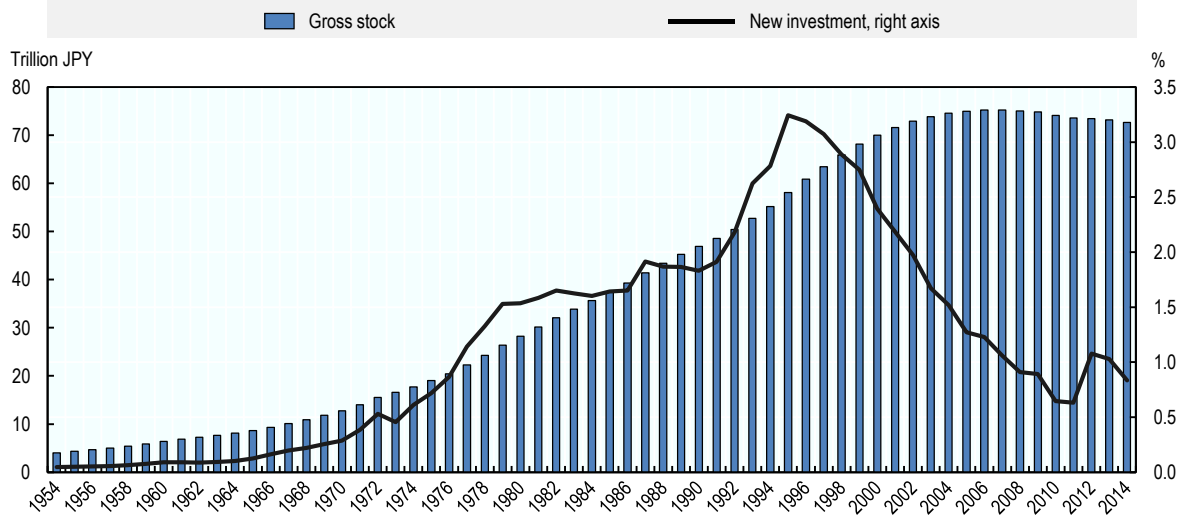
As a percentage share

	SNG share of sector assets	Share of assets over 50 years old		
		2018	2023	2033
Road bridges (length > 2km)	92	25	39	63
Tunnels	72	20	27	42
River management facilities	65	32	42	62
Sewerages	100	4	8	21
Port quays (water depth > 4.5m)	91	17	32	58

Source: MLIT (2018[22]) *White Paper on Land, Infrastructure, Transport and Tourism in Japan*.

According to the Cabinet Office (2017[23]), new investment in agricultural infrastructure such as irrigation facilities and farm roads has declined since 1995, and the share of investment in agricultural infrastructure declined from 13% in 1960 to 4.7% in 2014. Gross stock of agricultural infrastructure also peaked in 2007 and started to decline gradually. Nonetheless, gross stock of agricultural infrastructure exceeds JPY 70 trillion (USD 667 billion), which is 7.6% of total value of infrastructure stock and 1 690% of value added in agriculture. Effective maintenance and renewal of existing infrastructure are fast becoming the most important parts of infrastructure policy, including in agriculture.

Figure 3.6. Evolution of agricultural infrastructure in Japan, 1954 to 2014



Source: Cabinet Office (2017[23]), "Measuring Infrastructure in Japan 2017", https://www5.cao.go.jp/keizai2/ioj/docs/pdf/ioj2017.pdf (in Japanese).

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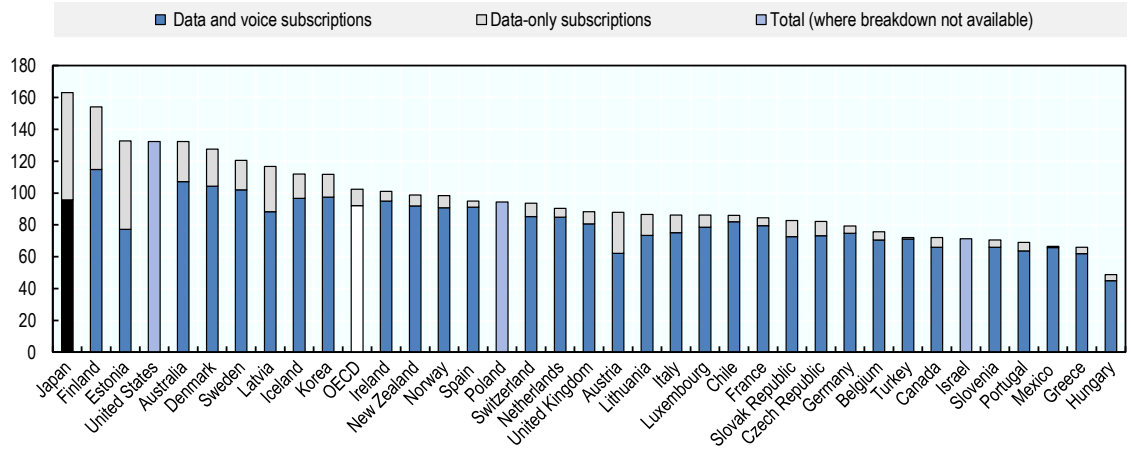
Information and Communication Technology (ICT) infrastructure

Japan's ambitious 2013 declaration to be the World's Most Advanced Information Technology (IT) Nation aims to achieve this goal by 2020. Acknowledging that Japan has

not been able to fully utilise IT, the government launched a strategy to make IT an engine of growth by encouraging the creation of new and innovative industries and services (IT Strategic Headquarters, 2013[24]). Japan's mobile broadband penetration is the highest in the OECD area (163 subscriptions per 100 inhabitants in 2017), and it has the second-highest share of fibre in its fixed broadband connections (Figure 3.7).

Figure 3.7. Mobile broadband subscriptions per 100 inhabitants in OECD countries, 2017



Source: OECD (2018[25]), *Broadband Portal* (database), http://www.oecd.org/sti/broadband/broadband-statistics/.

StatLink http://dx.doi.org/10.1787/888933957686

The development of a physical Information and Communication Technology (ICT) infrastructure has opened the possibility for agriculture to reap the benefits of ICT to improve productivity and sustainability performance at the farm level: using satellite data to monitor crop growth, land quality, water resources, or other environmental outcomes; combining sensors, automated farm machinery and advanced analytics software to fine-tune and automate agricultural production; and machine learning to automate agronomic advisory services. Further, ICT connects farmers with consumers and other industries in new ways; and experimenting with blockchain technology and other innovative data management systems can improve the efficiency and transparency of agro-food value chains.

At the core of these innovations lies "datafication", or the increasing capacity to capture, analyse and exchange agriculture and food data. While the digital transformation and increased capacity to create and share data provide an opportunity to develop new digital services for agriculture, various agriculture-related data, including agricultural land, weather, and research outcomes that are relevant for agricultural production and farm management, are collected and stored separately. As the capacity to store personal and sensitive data grows, farmers and consumers are increasingly asking for clarity that their data is being handled appropriately. Moreover, limited linkages between different agricultural ICT services make it difficult for farmers to integrate and fully utilise the services. The capacity to make use of digital technologies in agriculture depends not only on access to ICT infrastructure, but also on development of a range of data collection and analysis services and also on the regulatory environment (OECD, 2019[26]).

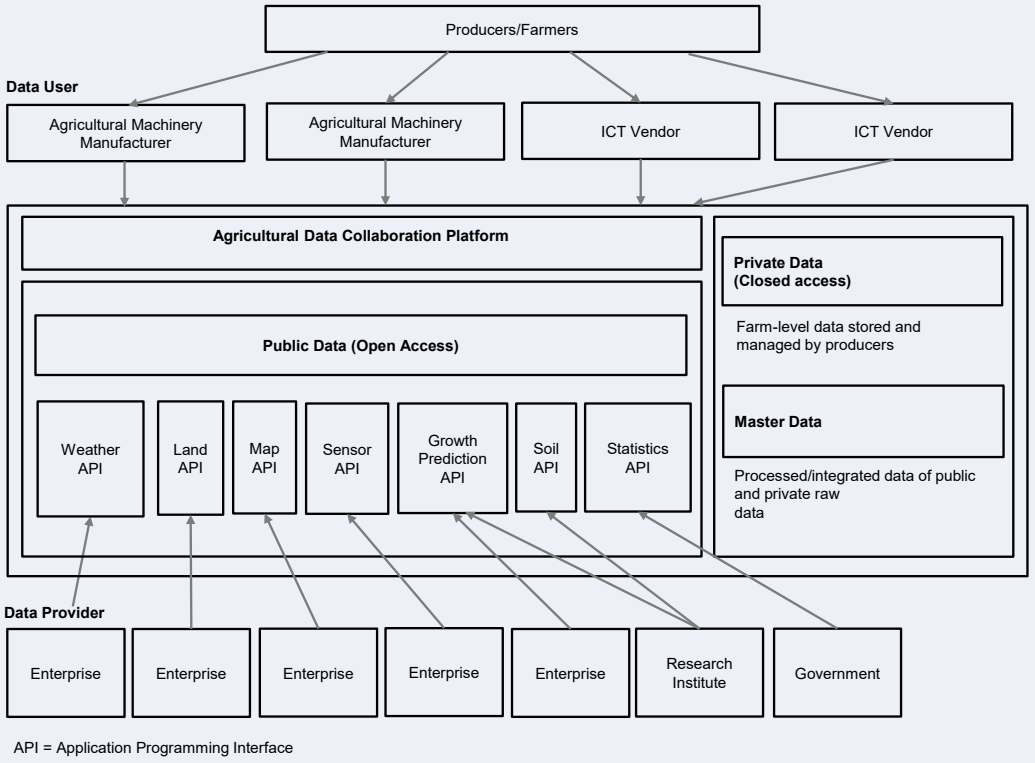
Japan has been increasing its efforts to develop soft infrastructure for the digitalisation of agriculture. For example, it has developed guidelines for agriculture-related data contracts to build assurance in activities operated by different players in the digital space. It also launched a pilot project in 2017 to develop a platform for agricultural data collaboration as part of its effort to develop metadata standards and interoperability protocols for agricultural data (Box 3.3).

Box 3.3. Developing soft infrastructure for digitalisation in agriculture

In 2016, the Cabinet Office published the guideline "Standard Term of Use on Agricultural IT Service", describing the ownership of data by types. It identifies the ownership of processed data such as yield projection and optimum production process should depend on the types of data, but raw data such as production and yield records should belong to the person providing the data (producers). As more diverse agriculture related data services emerged, MAFF developed a Guideline on Data Contract in Agriculture in 2018 with a participation of stakeholders. This guideline categorises three types of situation: one party (typically producers) providing their data to the other party; both parties create new data; and multiple parties share their data. It then provides detailed considerations when writing a contract depending on the type of situation and clarifies legal provisions associated with the types.

The Agricultural Data Collaboration Platform Council (WAGRI) was established in August 2017 by the providers and users of agricultural data from different fields. The prototype agricultural data collaboration platform was released in December 2017 and launched a full-scale operation in April 2019. The platform co-ordinates, shares and supplies agriculture-related data (Figure 3.8). It includes public data, such as the position and size of agricultural lands, and meteorological information, including temperature and precipitation. Future development plans include consolidating data held by farmers, agricultural machinery manufacturers, ICT vendors and others, and utilisation of Big Data to optimise agricultural production management. However, the profit-sharing mechanism for data providers, and rules for the use of such data, remain to be developed.

Figure 3.8. Expected structure of the agricultural data collaboration platform



Source: Adapted from MAFF (2017[27]), *Annual Report on Food, Agriculture and Rural Areas in Japan, FY2016.*

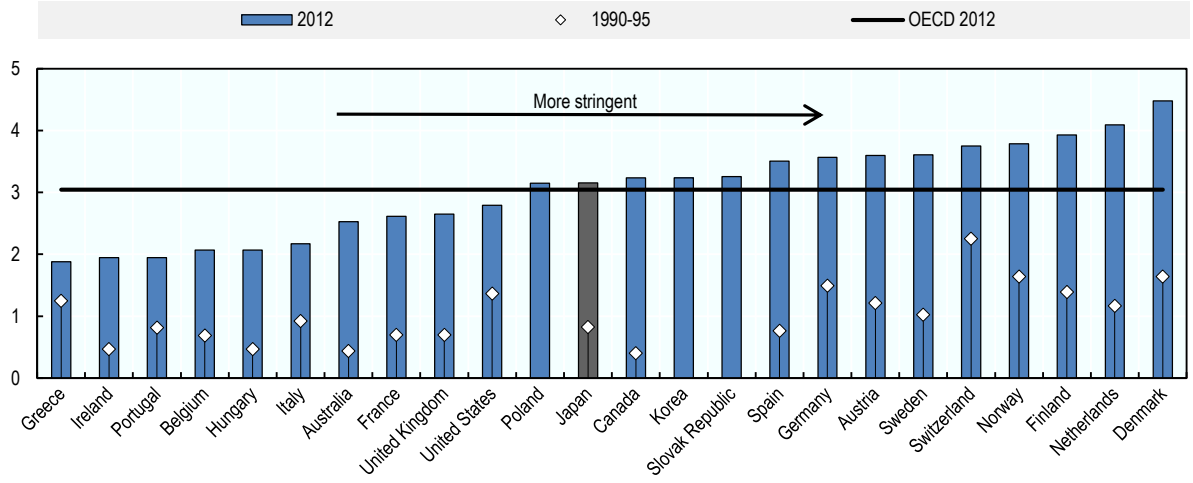
3.7. Natural resource management policy

General environmental policy

Japan's main environmental pressures come from transport, agriculture, industry and, in particular, the growth of energy demand and final consumption by the private sector. OECD (2010[28]) finds that Japanese environmental regulations are strict and well enforced, and enjoy strong monitoring capacities. Environmental policy is more stringent than the OECD average (Figure 3.9). Particularly since the 1990s, significant progress has been made in tackling non-conventional air pollutants (e.g. dioxins, benzene) and waste management (OECD, 2010[28]). Strict standard-setting and financial support for R&D of new environmental technologies and treatment methods have had a positive impact on innovation. This technology-forcing impact has helped assure timely implementation of stringent regulations (OECD, 2010[28]).

Figure 3.9. Stringency of environmental policy in selected OECD countries, 1990-95 and 2012

Scale from least (0) to most (5)



Note: For Korea, Poland and the Slovak Republic, 1990-95 average is not available.
Source: Botta and Koźluk (2014[29]), "Measuring Environmental Policy Stringency in OECD Countries: A Composite Index Approach", http://dx.doi.org/10.1787/5jxrjnc45gvg-en.

StatLink http://dx.doi.org/10.1787/888933957705

Main environmental regulations

General environmental regulations cover pollution from the agricultural sector. The Basic Environment Act stipulates the basic principles for environmental policies, clarifies responsibilities of the national government to prevent pollution including water and soil, as well as taking measure on global environmental issues. Each environmental standard is set by specific laws based on the principles, and most of the laws are administered by MOE.

The Water Pollution Prevention Act provides a regulatory framework on point-source pollution on water quality. In agriculture, only the point source pollution from livestock farms are subject to the regulation which requires farms to report their operations and measure the quality of water emissions.[2] Stricter regulations are applied to livestock operations located near closed sea areas. Local governments may also impose a higher standard considering the local ecological condition. The Act also regulates discharge water in public water areas and several pesticides are designated for control. The Water Supply Act sets standards for drinking water quality. Pesticides which are most likely to be detected in the purified water are listed as items to be monitored by water suppliers.

For soil safety, the Act on Prevention of Soil Contamination of Agricultural Land monitors the use of agricultural land to prevent agricultural products being produced in contaminated land. Cadmium, copper, and arsenic are listed as designated hazardous substances. In case the agricultural land exceeds the contamination limit (cadmium: above 0.4 mg/kg in rice; copper: above 125 mg/kg in land; or arsenic: above 15 mg/kg in land), local governments are responsible for recovering the land, although the national government often provides financial support. Since 1971, 7 592 hectares of agricultural land exceeded the limit but 7 055 hectares of the land completed the treatment as of FY2016.

The Basic Act on Biodiversity and the National Biodiversity Strategy provides the target and the direction for the measures on the conservation and sustainable use of biodiversity. The Act on the Prevention of Adverse Ecological Impacts Caused by Designated Invasive Alien Species prohibits the cultivation, storage, transportation, import and distribution of designated species that are likely to cause Japan's ecosystem and farming. Agriculture is closely related to biodiversity, and impacts ecosystem both positively and negatively (Hardelin and Lankoski, 2018[30]). Recognizing the importance of correlation between agriculture and biodiversity, MAFF announced its comprehensive biodiversity strategy in 2007 and later revised in 2012. The strategy states government's engagement of conserving rural areas (*Satoyama*), evaluating biodiversity, and raising awareness through symposiums.

Specific regulation on farm inputs and emissions

Fertiliser

The Fertilizer Regulation Act controls production and import of fertilisers. The Act categorises fertilisers into two groups – special fertiliser and normal fertiliser. Chemical fertiliser is included in the normal fertiliser category, while simple and organic fertiliser such as rice bran and manure is categorised in special fertiliser. The official standard is set for each type of normal fertiliser, and registration is required for both production and import. The official standard states minimum main ingredients value and maximum permissible value for harmful substances. Fertilisers that are derived from industrial waste need to submit toxicity testing results on plants for registration. The Act also requires producers and importers to attach warranty labels such as the guaranteed active ingredient quantity.

Prefectures often set their fertiliser application guidelines but the Fertilizer Regulation Act does not impose regulations on fertiliser use. In 2017, 47% of farmers in Japan did not conduct soil diagnosis but 68.2% answered that they wish to use a technological instrument to identify the amount of nutrients in the soil (MAFF, 2018[31]). Farm-level assessment and providing training opportunities would promote more efficient and sustainable use of fertiliser. Moreover, the development of accessible soil testing system and affordable fertilisers that have less impact on the environment, e.g. slow release fertilisers, would contribute to reducing nitrogen and phosphorus inputs.

Pesticides

The Agricultural Chemicals Control Act allows only registered pesticides for production, import, distribution and use. Registration is examined based on scientific data including toxicity, residue in crops and soil and safety assessment on human health and environment. MOE establishes specific conditions for pesticide registration with a view to prevent adverse effects on human health caused by pesticide residues in food and feed crops and by water contamination. These conditions also aim to mitigate impacts on certain aquatic animals and plants, however, the effects on local biodiversity are not taken into account unlike the registration procedure in the United States (Box 3.4). The Act sets usage standards to each registered pesticide to prevent excessive pesticides to remain in food. Prefectural governments are allowed to impose additional regulations on certain pesticides which could affect local ecological conditions. The Act was revised in 2018 to require all registered pesticides to be periodically re-evaluated every 15 years.

To prevent the adverse effects on human health, the Food Sanitation Act administered by the Ministry of Health, Labour and Welfare establishes agricultural chemical MRLs in foods. Agricultural chemical residues in food must be below 0.01ppm for all pesticides except when residue limit levels are separately stipulated. Foods found to contain residues exceeding the MRL level are regarded as violations of the Act and are not permitted to be marketed or are rejected at port.

MOE has been conducting several ecological assessments on the impact of pesticide use on several species such as dragonflies and wild bees. Further data collection and research are planned as the correlation between the use of pesticides and the population of these organisms is still uncertain (MOE, 2017[32]; MOE, 2014-2016[33]; MOE, 2017[34]; MOE, 2014-2016[33]). The Agricultural Chemicals Control Act plans to expand the scope of ecological assessment to terrestrial animals and plants in April 2020.

Box 3.4. Pesticide Registration and Biodiversity in the United States

In the United States, the Environmental Protection Agency (US EPA) is responsible for reviewing data to determine pesticide registration. The Endangered Species Act (ESA) requires federal agencies to ensure that any authorisation, funding, or implementation will not likely jeopardise the continued existence of any listed species or destroy any critical habitat for those species.

As part of the registration process, the ESA requires the US EPA to assess whether use of the pesticide affects the listed endangered or threatened species and their habitat. When the US EPA determines that use limitations are necessary to protect listed species, it seeks to establish either generic or geographically-specific pesticide use limitations enforceable under the Federal Insecticide, Fungicide, and Rodenticide Act. If a geographically-specific pesticide use limitation is necessary, this information appears on an Endangered Species Protection Bulletin and is referenced on the pesticide label.

Source: US EPA (2019[35]), *About pesticide registration,* https://www.epa.gov/pesticide-registration/about-pesticide-registration.

Livestock manure management

In 1999, regulatory standards for manure management were established under the Act on Proper Management and Promotion of Use of Livestock Manure. The law sets a mandatory standard for livestock manure management facilities and practice that applies to livestock farms operating more than a certain number of animals (10 for cattle or horses, 100 for pigs, and 2 000 for poultry). As of 2017, almost all livestock farms were in compliance with the facility standard.

Livestock manure with minimum inorganic fertiliser improves soil fertility and crop productivity and mitigate soil degradation (Das et al., 2017[36]). In 2015, 87% of livestock waste was recycled as fertilisers or other sorts of resources (MAFF, 2018[37]). The government has tried to increase the utilisation of livestock waste as a substitute for inorganic fertiliser use. Japan amended the official standard for fertiliser under the Fertilizer Regulation Act in 2012 to add standards for compound fertiliser that allow livestock waste to be combined with inorganic fertilisers for commercial sales. However, the current standard restricts compost included to a maximum of 50%. As the application of livestock manure for rice paddy fields has been decreasing due to the complex nature of

its application, revision of the standard to include livestock waste for commercial fertilisers should be considered to allow further development and innovation.

Climate change policy

According to the 1997 Kyoto Protocol, Japan was subject to 6% of 1990 emission reduction in 2008-2012. The average emission during the period increased by 1.4%, but achieved the target through securing 3.6% of GHG absorption by its forest resources and investing 5.9% amount of emission reduction or removal enhancement projects in developing countries (Clean Development Mechanism). Japan did not commit to the second commitment period (2013-2020), but based on the Cancun Agreements from the United Nations Framework Convention on Climate Change Conference of the Parties (COP16), Japan announced in 2013 a target of 3.8% or more emission reduction in 2020 compared to the 2005 level.

Japan ratified the Paris Agreement in 2016 and submitted its climate action plan, aiming for a 26% reduction of 2013 emissions by 2030 (equivalent to approximately 1.42 billion tonnes of CO_2). Based on the Agreement, the government created a national global warming countermeasures plan in 2016. This plan targets the reduction of GHG emissions by 26% in 2030 and by 80% in 2050 by reducing domestic emissions and securing absorption volume. It also seeks to reduce fuel consumption by shifting to energy efficient horticulture-greenhouse and agricultural machinery, minimizing CH4 emissions by changing rice cultivation methods, and reducing N_2O emissions by improving nitrogen-use efficiency. The plan also includes provisions to enhance soil carbon sequestration.

Based on the national commitment plan, the GHG reduction target was set as 2.8% for the agriculture, forestry and fishery sectors, which includes forest absorption of 2% and farmland carbon sequestration of 0.6%. Practically, a 0.2% GHG reduction commitment is expected by these sectors. The share of GHG emissions from agriculture is minor but the absolute level of agriculture GHG emissions is high compared to other OECD countries.

The Act on Promotion of Global Warming Countermeasures requires large-scale GHG emitters to report the amount of GHG they emit, but does not require business operators – including those in the agricultural sector – to reduce GHG emissions. Japan introduced an environmental tax on petroleum and coal in 2012 to finance energy-oriented CO_2 emissions reduction measures, but diesel fuel used for agriculture is exempted from this taxation. Additionally, heavy crude oil used for agriculture is exempted from the petroleum and coal tax as well as the environmental tax. Also, Japan established J-Credit Scheme, which certifies the amount of GHG emissions reduced and removed through efforts such as energy-saving activities. Under this scheme, however, very few agricultural projects are registered as GHG offset projects. In 2018, agriculture accounted for 2% (five projects) and food-related industry accounted for 7% (19 projects) as offset projects (MAFF, 2018[38]).

In 2017, MAFF announced the Global Warming Countermeasures Plan to reduce GHG emissions from agriculture, forestry and fisheries. It outlines broad directions on GHG reductions, R&D, and international co-operation. Along with this plan, MAFF issued the Climate Change Adaptation Plan including the road map until 2025. This plan states five basic policy principles for adaptation: 1) development of a ten-year adaptation plan based on national assessments and on-site needs; 2) promotion of R&D for high-temperature-resistant variety and adaptation techniques, as well as switchover of breed and plant variety types; 3) preparation for natural disasters and extreme weather events; 4) capitalisation of opportunities by warmer climate conditions; and 5) enhancement of co-operation and clarification of responsibilities between national and local governments. The plan then addresses issues and forecasts by commodities and sets the specific countermeasures.

Water resource management

Agricultural water use is dominated by a water-intensive paddy field rice sector that relies on the natural supply of the rainy season during early summer as well as on irrigation, primarily from surface sources. The area of paddy field accounts for 54% of the total farmland. Agriculture uses 68% of the total water withdrawals from rivers, of which 94% was for paddy field irrigation in 2015. While Japan has abundant rainfall, using river water without dams or reservoirs is difficult due to very steep river channels. The paddy water used upstream returns to rivers, and the returned water is withdrawn again downstream. The paddy fields store the water withdrawn from the river, and plays an important role in groundwater recharge and ecosystem conservation in a watershed or hydrological cycle system.

Agricultural irrigation facilities such as water ducts are important social capital stocks. However, many of these facilities are now due for renewal or rehabilitation; over 20% of facilities exceed the average life span and this number is expected to increase by about 40% over the next ten years. Moreover, recent progress of farm scale expansion has increased the stress on the water supply network, which can hinder efficient farming operations. The improvement of water management using ICT and the Internet of Things (IoT) is essential in the coming years (Box 3.5).

Box 3.5. Use of ICT for water management

Water management is one of the foremost important tasks in paddy rice production. Farmers need to monitor the water level and water temperature every day to control the water in each growing stage of rice since water condition affects the quality and the yield. Water management is time consuming and represents a large part of rice production labour. IoT enables farmers to track water levels and temperatures in paddy fields and manages water levels using a remotely controllable water supply valve via data on their tablet device collected by sensors.

In a test demonstration, the time necessary for water management decreased by 40% on average. This is particularly useful to mitigate the labour shortage in rural areas. The accumulated data can also be used to analyse rice quality and yield in order to improve production for the coming planting year. From FY2018, promotion of water management using ICT has expanded, and the government expects an increase in the number of districts that can efficiently control agricultural water distribution (MLIT, 2018[22]).

Water use rights for irrigation are granted to the owners of irrigation facilities, based on the River Act. With the exception of a few large-scale irrigation systems, the Land Improvement Districts (LIDs) implement the operation and maintenance for most of the irrigation infrastructures such as reservoirs, intakes, pumps and main canals. The LID functions as a water user association that collects from its members a part of the cost to develop or rehabilitate facilities, as well the costs for the operation and management. It also obliges its members to provide labour to maintain irrigation facilities. This participatory irrigation management scheme has contributed to the long-term operation and maintenance of irrigation facilities in Japan.

The share of the cost for the development or rehabilitation of irrigation facilities depends on the scale and type of the project. The Land Improvement Act stipulates that the national government covers two-thirds of the total cost for national projects on the condition that the benefitted area is over 3 000 hectares, and covers half the costs for prefectural projects

on condition that the benefitted area is over 200 hectares. MAFF set guidelines for local governments in terms of cost sharing rates; for example, in the case of new development of irrigation and drainage facilities by a national project, the share of construction costs is 17% for prefectural governments, 6% for local municipalities, and 10.4% for the LIDs, while for a rehabilitation project, the share of the cost is 19.4% for prefectural governments, 9% for local municipalities, and 5% for the LIDs.

New investment in irrigation facilities has declined over time, and the operation and maintenance of the existing infrastructure has become the main task of LIDs. LIDs allocate operation and maintenance costs to members based on the area of paddy land or upland area, often without consideration of the types of crops planted or even whether the land is fallow (Kuramoto et al., 2002[39]). This is partly because rice could be cultivated again in the future or as a second crop even in paddy fields with drainage improved for crop diversification. However, the current cost-sharing mechanism does not provide water saving incentives and impedes the diversification of production away from rice.

Due to mergers of the LIDs, the number of LIDs has declined by 53% and membership in LIDs declined by 29% to 3.6 million between 1975 and 2016, but the share of rented land increased significantly. According to MAFF, owners of 56% of rented land continue to be members of LIDs, although the Land Improvement Act stipulates that cultivators should be a member of the LID in principle. Land owners tend to have less incentive than cultivators to pay the cost of renewal, rehabilitation and maintenance of irrigation facilities. In order to reflect the opinions of the cultivators with respect to the operation and management of LIDs, the Land Improvement Act was amended in 2018 so that more than three-fifths of LIDs directors must be appointed from the cultivators themselves.

The sustainable operation and maintenance of irrigation facilities requires water users to cover the cost of renewal or rehabilitation work on irrigation systems. This should create incentives for more efficient water use in farming (Shobayashi, Kinoshita and Takeda, 2010[40]). Instead of charging the renewal or rehabilitation of irrigation systems on an individual project basis, current and future users should share the cost of maintaining the infrastructure equally.

Land use policy

As a consequence of the post-war land reform programme that redistributed farmland from land owners to tenant farmers, the structure of farmland holdings in Japan are small and fragmented. Stringent regulations for the acquisition of farmland was imposed to maintain this reform, and non-farmers were denied the possibility of purchasing farmland. However, this regulation has been gradually removed to facilitate structural change through a land lease market (Box 3.6). While the conversion of farmland to non-agricultural use has also been limited, speculation by farmers hoping to convert their farmland to non-farm use has been high where urban areas were close by, increasing the difficulty of consolidating farmland.

In 2014, Farmland Banks (Public Corporations for Farmland Consolidation to Core Farmers through Renting and Subleasing) were established in all prefectures to reinforce the intermediary role of the government in land transactions. These replaced the Farmland Holding Rationalization Enterprise established at the prefectural and municipal levels. In addition to intermediate farmland transactions, Farmland Banks can improve farmland conditions and infrastructure (e.g. expansion of plot size and investment in drainage facilities) without the consent and cost sharing of land owners, and then lease the consolidated farmland to business farmers. This system was introduced because even

though business farmers want productive farmland, land owners who rent their land to Farmland Banks are generally not willing to invest in farmland as they plan to retire from agriculture (OECD, 2016[5]).

To provide additional incentives, MAFF introduced subsidies to land owners leasing land through a Farmland Bank. In addition, the land owners also benefit from 50% reduction of the real estate tax for three to five years, while the tax rate on idle land was increased 1.8 times if owners did not lease out idle land to a Farmland Bank or resume cultivation.

Box 3.6. Farmland regulations in Japan

To enforce the post-war land reform programme to redistribute farmland from landlords to tenant farmers, the Agricultural Land Act (ALA) imposes strong regulations on farmland, limiting the size of land holdings and imposing rent control. The ALA strictly protects tenants' rights, prohibiting land owners from cancelling a tenancy contract without the tenant's agreement. It limits acquisition of farmland to those who actually cultivate the land. Land transactions are approved by local agricultural committees established in municipalities. Local mayors appoint committee members, of which half of the members have to be certified farmers.

Since the basic principle of the ALA is to promote the ownership of land by its actual user, an individual can acquire farmland only if he or she engages in on-farm work (owner-cultivator principle). Corporations meeting the definition of an Agricultural Production Corporation (APC) are allowed to own farmland such as the restriction on the ownership share by non-farmers and the requirement for the board of directors to engage in farming. However, these conditions made it impossible for most of the companies to obtain farmland rights.

In 2003, an exemption was added to the ALA allowing non-APC companies to obtain tenancy rights to land in a special structural reformation district if companies sign an agreement with local government regarding their farming plan and involvement in local collective activities.[3] In 2016, the APC system was reformed so that non-agricultural corporations can invest in up to half of an agricultural corporation. The requirement on the board of directors was also relaxed so that only one member or a farm manager need to engage in farm work.

The ALA also regulates farmland conversion to non-agricultural uses, requiring the approval of the local governments. This approval depends on several criteria including the productivity of farmland, such as irrigation access, land fertility and size. A farmland zoning system was also introduced through the Agricultural Promotion Areas Law in 1969. This law requires local governments to prepare a comprehensive regional agricultural promotion plan including for agricultural land use. Farmland within designated farmland zones in the local plan is prohibited from land conversion. As of 2016, 90% of farmland was inside the farmland zone.

3.8. Key points

- Agriculture has long been treated differently in Japan from other parts of the economy based on the implicit policy assumption that government needs to support small-scale family farms that are disadvantaged in the economy. The evolution of the agricultural structure will require a shift in the policy paradigm towards developing policy and market environments that are more conducive to innovation and entrepreneurship.

- Japan maintains a relatively open trade and investment environment, and continues to promote the multilateral trading system, as well as bilateral and regional trade agreements, while high border protection exists on some agricultural products.
- Despite very low restrictions on FDI, the level of FDI inflow stock remains low, including in food and agriculture. Outward investment in food sector is relatively high, reflecting the expansion of a production network in the food manufacturing industry across borders. A more demand-oriented strategy combining export and local production would fully capture the growing demand for Japanese food products in world markets.
- General regulatory barriers to entrepreneurship in Japan have fallen below the OECD average and the revisions of farmland regulations to expand the eligibility of non-farmers to own and rent farmland lowered entry barriers into agriculture.
- Large, incorporated farms increasingly dominate this sector face, and similar management issues as SMEs in other sectors, such as human capital development, business succession and business matching.
- Developing a well-functioning input and output market is crucial to ensure the competitiveness of the agriculture sector. The JA provides integrated services for members, including banking, insurance, farm input supply, marketing, technical advice, and welfare service. The profit structure of the JA shows that profits from banking and insurance cover losses in other business activities. The JA also benefits from a reduction in corporate tax rates and exemption from certain regulations.
- Given its advantageous market position, the JA maintains large shares of certain input and output markets. Japan recently implemented a number of reforms, including of JA groups, to facilitate more competition in domestic input industries and wholesale markets. The JA faces a challenge in meeting the specialised and diversified needs of professional farms. A more competitive market environment between the JA and other players would improve the function of farm input and output markets, and facilitate the emergence of alternative farm service providers.
- The share of commercial banks in agricultural finance is relatively small. Instead, government financial institutions and JAs channel generous government credit programmes to producers. High levels of guaranteed credit are likely to reduce incentives for commercial banks to develop credit evaluation systems and risk management skills for agricultural financing, or to monitor borrowers.
- Japan has developed high-quality physical and digital infrastructures. It has the world's sixth largest road network and the highest rate of mobile broadband subscriptions. The focus of infrastructure development policy has shifted from new investment to effective management of aging infrastructures, including agricultural infrastructures such as irrigation and drainage facilities.
- Japan has an opportunity to make more use of a well-developed digital infrastructure to improve productivity growth and sustainability in agriculture. Facilitating the use of hard digital infrastructures requires the redesign of physical and institutional infrastructures such as radio regulation, design of farm roads and road safety regulations. Recent government initiatives to establish a guideline on agricultural data-related contracts and the platform to share data are part of an effort to develop soft infrastructures so as to facilitate digitalisation of agriculture.

- Japan's general regulatory framework on environmental conservation is strict, well enforced, and based on strong monitoring capacities. While point source pollution from the livestock sector is controlled by water quality and offensive odour regulations, nonpoint source pollution from the crop sector is not subject to general environmental regulations. Japan uses limited economic instruments in the area of natural resource management, with a few exceptions such as the greenhouse gas emission trading scheme.
- Japan shares governance responsibilities between central, prefectural and local governments, but the central government is responsible for a particularly high share of agriculture spending. As policy objectives widen from national food security and income support to production of non-commodity outputs, which are often local public goods, subnational approaches to policy decision making and financing became more important.
- Excluding only a few large-scale irrigation systems, the Land Improvement Districts (LIDs) operate and maintain most of the irrigation infrastructures. LIDs allocate operation and maintenance costs to members according to the land area, often without consideration for the types of crops planted or even whether the land is fallow, based on the assumption that rice could be cultivated again in the future or as a second crop. The current system provides little incentive for producers to economise on water use, and impedes the structural change of agriculture away from rice. Land consolidation into a smaller number of large operations and the development of sensor technology increase the feasibility of imposing a fee based on on-farm water use.
- Japan has invested heavily in irrigation infrastructure over the last 50 years, but more than 20% of the core irrigation facilities already exceed their expected lifespan. While members of the LIDs cover operational and maintenance costs of irrigation facilities, the governments share the cost of rehabilitating irrigation facilities with LIDs. At present, the development, renewal or rehabilitation costs are paid by LID members on an individual project basis, which may create imbalances of cost and benefit between current and future irrigation water users. The sustainable operation and maintenance of irrigation facilities requires current and future users to cover the cost of renewal or rehabilitation of irrigation systems equally.
- The consolidation of fragmented farmland has been a major policy issue in Japan for the last five decades. The Farmland Bank system, established in 2014, increased financial and regulatory incentives for land transactions through Farmland Banks. However, financial incentives attached to these transactions may have discouraged more diverse formats of land consolidation adapted to local conditions, such as contracting out farming operations, the collective use of farm machinery, and the formation of community farm organisations.

Notes

[1] Japan's SNGs are separated into two tiers: 47 prefectures, and 1 718 municipalities and the 23 special wards within Tokyo.

[2] The minimum size of a livestock barn is 50m^2 for hog farms, 200m^2 for cattle farms, and 500m^2 for horse farms.

[3] Special zones have been a prominent feature of Japanese regulatory reform efforts, most notably the Special Zones for Structural Reform launched by the government in 2002. By the end of 2014, there were 1 235 such zones. These created the opportunity to experiment and pilot reform ideas in specific places with the hope that such experiments would be a way to circumvent bureaucratic resistance to reform (OECD, 2016[5]).

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Chapter 4. Agricultural policy environment in Japan

Strengthening the sector's capacity to innovate and improving environmental performance of agriculture will require the agricultural policy environment to be more conducive to innovation and entrepreneurship, as well as more coherent with sustainability policy objectives. The evolution of Japan's agricultural structure and the global trend to more integrated value chains has diversified the types of policy support demanded by professional farms. This chapter provides an overview of developments in agricultural policies and discusses the likely impact of agricultural policy measures on structural changes, environmental performance, and innovation in this sector.

4.1. Agricultural policy objectives

The Basic Law on Food, Agriculture and Rural Areas, which replaced the 1999 Basic Law on Agriculture, lays out the current objectives of agricultural policy. This law requires the government to prepare the Basic Plan for Food, Agriculture and Rural Areas — medium-term policy directions, approaches and targets over a ten-year period, to be revised about every five years. The law establishes four basic principles: 1) securing a stable supply of food; 2) maintaining the desired multifunctional aspects of agriculture; 3) sustainably developing agriculture; and 4) promoting agricultural and rural communities.

In December 2013, Japan announced a new policy package entitled the Plan to Create Dynamism through Agriculture, Forestry, Fisheries and Local Communities. This package marked the biggest agricultural policy change since the introduction of income support payments for rice farms in 2011. The Plan set the following five policy targets: 1) doubling agricultural earnings and overall agricultural village incomes within a decade; 2) doubling agriculture, forestry and fishery exports up to JPY 1 trillion (USD 9 billion) by 2020; 3) doubling the number of new entrants to agriculture; 4) concentrating 80% of farmland among business farmers within a decade; and 5) lowering the cost of rice production of business farmers by 40% within a decade.

To achieve these goals, policies were restructured under four pillars: 1) expanding food demand through export promotion and local consumption; 2) enhancing food value chains through diversification of farm activities into areas such as processing and rural services; 3) improving farm productivity through farmland consolidation, rice production adjustment system reform, and reforms to other subsidy schemes; and 4) a new payment to improve the multi-functionality of agriculture.

The Plan was reflected in the Basic Plan for Food, Agriculture and Rural Areas, released in March 2015 (Box 4.1). In November 2016, Japan revised the Plan by adding several policy packages to improve competitiveness and to promote agro-food exports. The new Plan included a policy package to reduce input costs, an introduction of revenue insurance programmes, the reform of raw milk distribution system, measures to improve the productivity of beef and dairy sectors, reforms of agricultural supply chains, and the promotion of feed rice production. The Plan also aims to boost agro-food exports by promoting production according to international standards, protecting intellectual property rights, and promoting Japanese cuisine and food culture. The Plan was also revised in December 2017 and June 2018 to add additional reform agendas such as farmland policy reform and the promotion of ICT in agriculture.

Box 4.1. Basic Plan for Food, Agriculture and Rural Areas for 2015-2025

Japan's food self-sufficiency ratio in 2014 was 39% on a calorie supply basis and 64% on a production value basis. Under the new Basic Plan, the government set the calorie-based food self-sufficiency target for 2025 at 45%, while the target for the production-value-based sufficiency ratio was set at 73%.

The new Basic Plan introduced a new indicator, Food Self-sufficiency Potential, to evaluate potential food production capability. The aim of this new indicator is to promote public awareness and understanding of the current state of Japan's food security potential. It shows how much food can be produced domestically if all farmland in Japan (including abandoned farmland and farmland planted with non-food such as flowers) was cropped to maximise food production on a caloric basis under several food production and consumption scenarios.

The Basic Plan has two overriding policy principles: 1) turn agriculture and food industries into a growing industry (industrial policy); and 2) maintain and develop multi-functionality approach in agriculture and rural areas (regional policy). The following key policies stem from these basic principles.

- *Exports and overseas expansion of the food industry:* The government promotes food exports and overseas expansion of the food industry by sharing information on trade procedures, facilitating the acquisition of certificates such as Halal, promoting the protection of intellectual property rights, and strengthening international publicity activities on Japanese cuisine and food culture.
- *AFFrinnovation:* To bring greater income opportunities to rural society, the government encourages farmers to work on "AFFrinnovation", or adding value to agricultural, forest and fishery products in an innovative way, to create new combinations or create a value chain.
- *Labour policy:* To achieve a more efficient and sustainable agricultural structure, the government provides intensive support such as subsidies, loans, and financing to business farms (*Ninaite*) certified by local authorities. It also promotes the transfer of farmland to business farms, incorporation of farms, and recruitment of farmers.
- *Land policy:* To reduce land fragmentation, public corporations – called Farmland Banks – rent small, scattered pieces of farmland, and consolidate and lease them to business farms. The government also works to prevent farmland abandonment.
- *Rice policy:* Farmers are allowed to choose their production based on market demand without relying on quotas allocated by the government. The government provides detailed market information on rice, such as price, supply, demand, and stocks.
- *Rural area development:* To maintain food supply and public goods that agriculture provide, the government promotes community network development and rural migration and settlement, as well as a multifunctional payment system and wildlife damage control.
- *Agricultural co-operatives and committees:* The government facilitates the reform of JAs so that they can engage in more profitable activities and contribute to an increase in farm incomes.

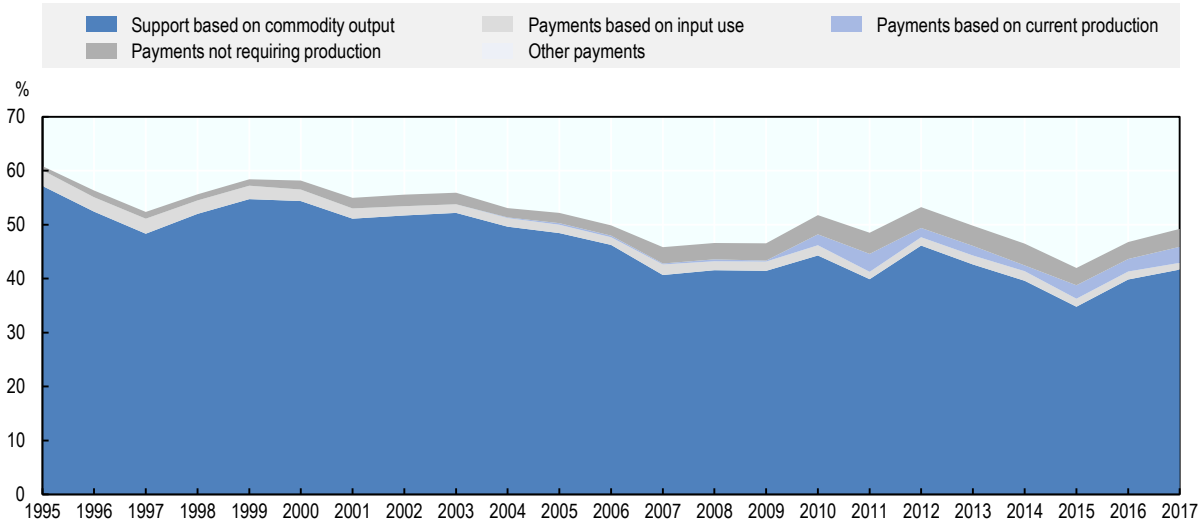
Source: (MAFF, 2015[1]), *Summary of the Basic Plan for Food, Agriculture and Rural Areas: Food, agriculture and rural areas over the next the years*, http://www.maff.go.jp/e/pdf/basic_plan_2015.pdf.

4.2. Overview of agricultural policy

Japan gradually reduced its support to agricultural producers, but the change was moderate among OECD countries. The producer support estimate (PSE) was about 46% of gross farm receipts in 2015-17, down from 63% in 1986-88 but still much higher than the OECD average (Figure 4.1). Market price support (MPS) remains the main element of the PSE, mainly sustained by border measures. Prices received by producers are on average 72% above world market prices. MPS for rice, milk and pork account for a half of Japan's MPS in 2015-17.

Figure 4.1. Evolution of Japan's PSE, 1995 to 2017

As a percentage of gross farm receipts



Source: OECD (2018[2]), "Agricultural support estimates (Edition 2018)", *OECD Agriculture Statistics* (database), https://doi.org/10.1787/a195b18a-en.

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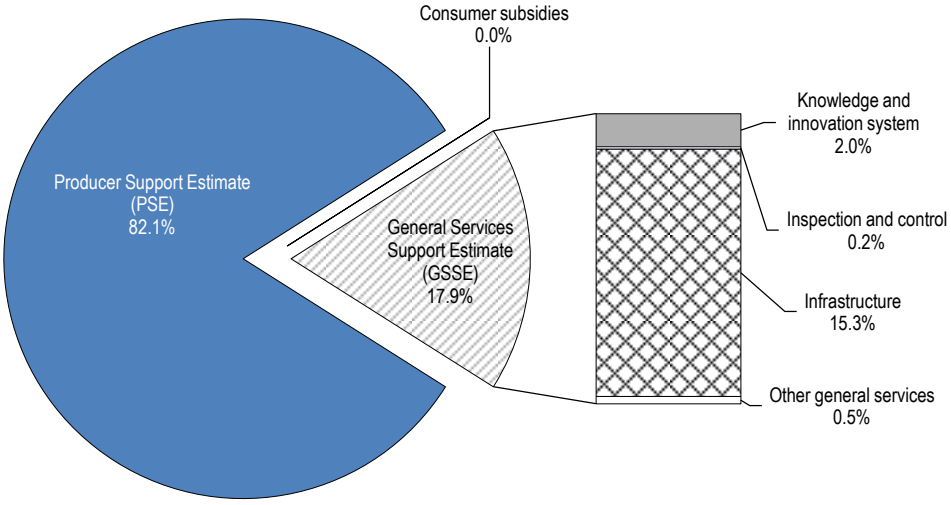
While the most potentially distorting forms of support (MPS, support based on output and variable input use without input constraints) have declined, they still account for 85% of producer support. The share of direct payments in the PSE has increased in recent years, particularly in the form of area- and income-based payments. The total support estimate to agriculture (TSE) represented 1.0% of Japan's GDP in 2015-2017, of which the PSE represented 82%, while the other 18% was support for general services provided to agriculture (GSSE) (Figure 4.2).

Around 84% of GSSE was directed to the development and maintenance of infrastructure, such as irrigation facilities and disaster prevention in 2015-17. Japan's share of the expenditure for infrastructure investment and maintenance is particularly high compared to other OECD countries, reflecting the large stock of infrastructure for paddy farming (Figure 4.3). More than 40% of infrastructure expenditures in 2015-17 was directed towards the development and maintenance of hydrological infrastructure. The share of expenditure for agricultural knowledge and innovation systems, on the contrary, is one of

the lowest among OECD countries. Only 12% of GSSE financed the agricultural knowledge and innovation system in 2015-17.

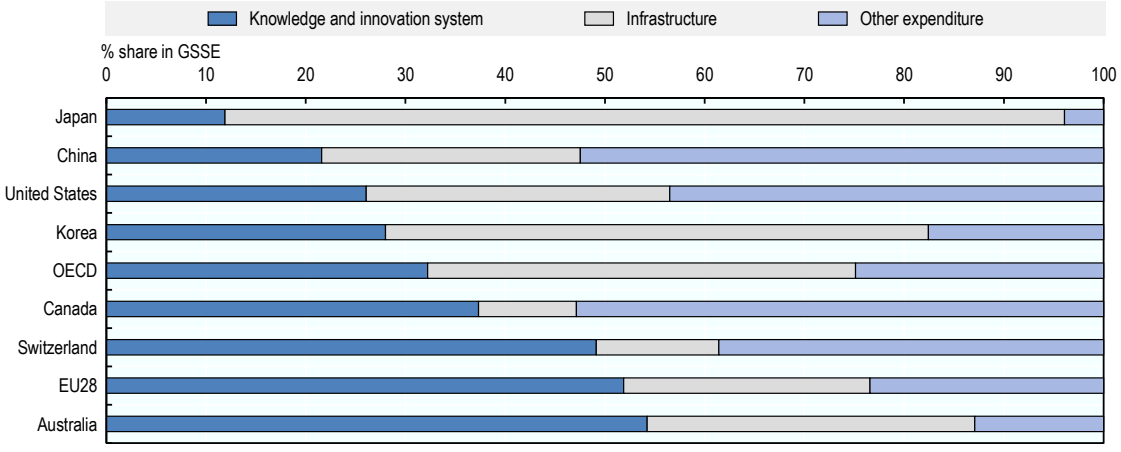
Figure 4.2. Composition of support to agriculture in Japan, 2015-17



Source: OECD (2018[2]), "Agricultural support estimates (Edition 2018)", *OECD Agriculture Statistics* (database), https://doi.org/10.1787/a195b18a-en.

StatLink http://dx.doi.org/10.1787/888933957743

Figure 4.3. Composition of General Service Support, 2015-17



Source: OECD (2018[2]), "Agricultural support estimates (Edition 2018)", *OECD Agriculture Statistics* (database), https://doi.org/10.1787/a195b18a-en.

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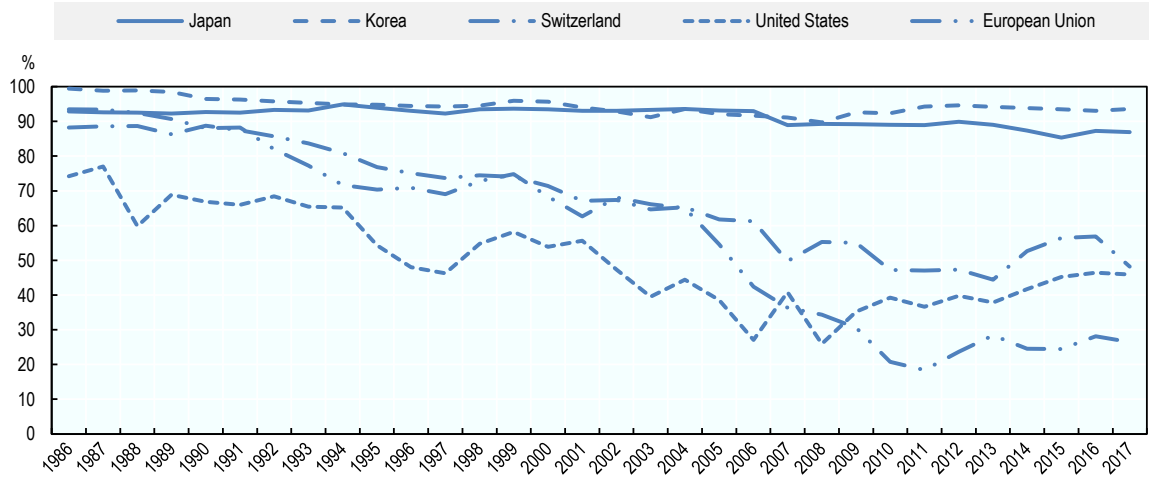
Transfers to specific commodities continue to represent close to 90% of support to producers, while the European Union, the United States and Switzerland significantly reduced the share of such support overtime (Figure 4.4). The level and structure of the Single Commodity Transfers (SCT) vary greatly by commodity. SCTs above 50% of

commodity gross farm receipts are maintained for barley, rice, sugar, milk, pork, cabbage, and grapes (Figure 4.5).

Figure 4.4. Share of single commodity transfer, 1995 to 2017

As a percentage of Producer Support Estimate

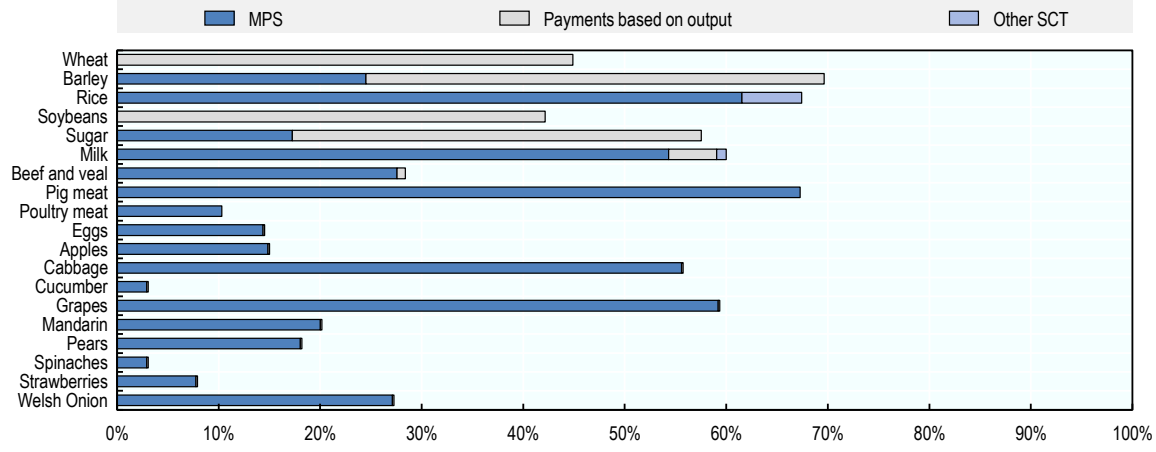


Note: European Union refers to EU12 for 1986-94, EU15 for 1995-2003, EU25 for 2004-06, EU27 for 2007-13 and EU28 from 2014 onwards.
Source: OECD (2018[2]), "Agricultural support estimates (Edition 2018)", *OECD Agriculture Statistics* (database), https://doi.org/10.1787/a195b18a-en.

StatLink http://dx.doi.org/10.1787/888933957781

Figure 4.5. Transfer to specific commodities (SCT) in Japan, 2015-17

As a percentage of commodity gross farm receipt for each commodity



Source: OECD (2018[2]), "Agricultural support estimates (Edition 2018)", *OECD Agriculture Statistics* (database), https://doi.org/10.1787/a195b18a-en.

StatLink http://dx.doi.org/10.1787/888933957800

4.3. Agricultural trade policy

In general, Japan's average tariffs of 16.3% on agricultural products (according to World Trade Organization (WTO) definitions) are higher than tariffs on non-agricultural products, which have an average of 3.6%. Furthermore, the standard deviation of 33.4 for tariffs on agricultural products indicates that tariffs vary considerably among agricultural products, with over one-quarter duty free and a maximum tariff (*ad valorem* equivalent) of about 390%. In addition, 17.5% of agricultural tariff lines are non-*ad valorem*.

Tariff-rate quota systems with high out-of-quota tariffs apply to major commodities such as rice, wheat, barley and dairy products. Following the conclusion of the Uruguay Round Agreement on Agriculture (URAA) in 1993, Japan replaced all its quantitative restrictions on imports with tariff-rate quotas, with the exception of rice which was replaced by a tariff-rate quota in 1999. Currently, the out-of-quota tariff-rate of rice is JPY 341 (USD 3.0) per kg, the tariff-quota for rice is 682 200 tonnes (milled rice), and the maximum mark-up for rice imports is set at JPY 292 (USD 2.6) per kg. Japan must import at least 7.2% of domestic consumption in the base period.[1] However, due to a decline in rice consumption, the minimum access import of rice was equivalent to 8.9% of domestic rice consumption in 2017.

An *ad valorem* tariff of 4.3% is imposed on fresh, chilled or frozen pork, when the import price is above the gate price of JPY 393 (USD 3.5) per kg; when the import price is JPY 48.9 (USD 0.4) per kg or less, JPY 361 (USD 3.2) per kg is imposed as a specific duty. When the import price is higher than JPY 48.9 (USD 0.4) per kg but lower than the gate price, importers are required to pay the difference between the actual and standard import prices. The standard import price for pork is equal to the gate price plus the 4.3% *ad valorem* tariff, making the gate price effectively a floor on the price of pork imports. As a result of the URAA, the gate price and tariff rate for carcasses were reduced from JPY 447.6 (USD 4.4) per kg and 5.0% in 1994 to JPY 393 (USD 3.6) per kg and 4.3% in 2000, respectively. To compensate for applying a gate price below the bound level, Japan can, as an emergency measure, raise the gate price to a level under conditions specified in the official letter of General Agreement on Tariffs and Trade.

Special safeguard actions are taken for a number of products in accordance with the WTO Agricultural Agreement. Import spikes trigger emergency safeguard measures, which were applied on beef imports in FY2017 for the first time since FY2003.[2]

Promotion of bilateral and regional Economic Partnership Agreements

After 2000, Japan began to actively pursue bilateral and regional Economic Partnership Agreements (EPAs). The first agreement was signed with Singapore in 2002 and the second with Mexico in 2004; the latter was the first agreement which included agricultural products. So far, Japan has 17 EPAs in force (bilateral agreements with Singapore, Mexico, Malaysia, Chile, Thailand, Indonesia, Brunei Darussalam, ASEAN, the Philippines, Switzerland, Viet Nam, India, Peru, Australia, Mongolia, and the European Union, as well as the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)). Japan is currently engaged in several other EPA negotiations such as bilateral talks with Colombia and Turkey, and multilateral negotiations including the Japan-China-Korea Free Trade Agreement, and the Regional Comprehensive Economic Partnership (RCEP).

In March 2018, Japan and ten other Pacific Rim countries signed the CPTPP, and the agreement came into force in December 2018. The CPTPP incorporates most of the provisions of the original Trans-Pacific Partnership (TPP) from which the United States

withdrew in early 2017. Under the CPTPP, market access for Japanese agricultural products — including sensitive products such as rice, pork, dairy products, beef, wheat, barley, and sugar — is expected to be improved by tariff elimination and reduction, as well as by the introduction of tariff-rate quotas.

Japan and the European Union signed the EPA in July 2018, and the agreement entered into force in February 2019. The EPA is expected to improve access to the Japanese market for EU agricultural products, including dairy, pork, beef, and wheat, while rice is excluded from any market access commitment. Import tariffs on hard cheese will be gradually eliminated over a 15-year period, while a tariff rate quota for soft cheese will be created, set to be 20 000 tonnes in the first year, increased to 31 000 tonnes in the 16th year, while the in-quota tariff should be phased out over 15 years. Tariffs on pasta, biscuits, and chocolate are set to be phased out in 5 or 10 years. Tariffs on beef and pork will be gradually reduced. In addition, the Japan-EU EPA set specific rules for protecting agricultural goods and liquor from a particular geographical origin (Geographical Indication (GI)) (Box 4.2). Specifically, 56 Japanese GIs (48 agricultural goods and 8 liquor) and 210 EU GIs (71 agricultural goods and 139 liquor) are protected.

Box 4.2. Geographical indication system for agricultural goods in Japan

There are a variety of distinctive regional agricultural products in Japan as a result of natural conditions and traditional production methods. Japan has created a system of intellectual property rights to protect the names of these products. In 2015, the Act on Protection of the Names of Specific Agricultural, Forestry and Fishery Products and Foodstuffs (GI Act) came into force. This Act protects GIs for agricultural goods from imitations.

Based on the GI Act, a producer group can apply for a registration of a GI product. The application must include specifications of the product and a quality control plan. To be registered, the agricultural good must be linked with the location where it is produced, and the quality, reputation, or other characteristic of that good must be essentially attributable to its geographical origin. Once the product is registered, MAFF monitors compliance and regulates the use of GIs. As of March 2019, 76 agricultural goods were registered as GIs in Japan.

The GI Act was amended in 2017 to enable reciprocal GI protection with foreign countries based on international agreements. Under the Japan-EU EPA, Japan and the European Union agreed to protect their respective GI products. In particular, 48 Japanese agricultural GIs (e.g. Kobe Beef) are protected in the European Union and 71 agricultural GIs from the European Union (e.g. Roquefort from France and Gorgonzola from Italy) are protected in Japan. The use of a GI is prohibited in both Japan and the European Union when the good in question does not meet the official requirements of the GI even if it indicates its true origin, uses GI in translation, or accompanies expressions such as kind, type, and style.

The government revised its comprehensive policy guidelines in 2017 to cushion the impacts from EPAs. As agriculture is one of the most affected industries, the agricultural policy programme is included as a main component of the guidelines. The comprehensive measures in agriculture include structural reforms and policy assistance for sensitive products. The structural reform programme has four pillars: 1) cultivation of human resources capable of leading future farming generations; 2) enhancement of sector competitiveness through innovations; 3) improvement of livestock and dairy profitability; and 4) promotion of agricultural exports. Japan committed an annual average of JPY 325 billion (USD 2.9 billion) to these programmes between FY2015-17.

The government offers policy assistance to sensitive products —rice, wheat, sugar crops, beef, pork and dairy— in order to protect farmers from income instability after the entry into force of the CPTTP and the Japan-EU EPA. For example, the effects caused by reducing import tariffs for beef feedlot and hog producers would be alleviated through increasing the coverage rate of the existing deficiency payment programmes from 80% to 90% of the gap between average production costs and average gross income. The hog producers' contribution rate to the mutual fund for the deficiency payment programme was reduced from 50% to 25%.

Export promotion policy

Japan has accelerated its policy effort to promote the export of agro-food products in the last decade, mainly via marketing promotion, harmonisation of quality, and sanitary standards (Box 4.3). The government set an export target for agriculture, forestry and fishery products of JPY 1 trillion (USD 9 billion) by 2019. The value of exports of these products marked a record high of JPY 907 billion (USD 8.2 billion) in 2018, reflecting an increasing demand for Japanese products, and public and private efforts in export promotion. Exports grew for a wide range of agricultural products such as rice, beef, strawberries, green tea, alcohol drink (sake), and garden trees (bonsai).

MAFF launched the Rice Overseas Market Expansion Strategy Project in September 2017. The project seeks to raise the export volume of rice products to 100 000 tonnes by 2019, and to strengthen and expand links between rice exporters and areas with stable production of rice for export. In 2017, the Japan's Food Export Fair was held for the first time, with more than 300 companies – including agricultural producers, food manufacturers and trading companies – exhibiting and having direct contact with buyers from all over the world. The Japan Food Products Overseas Promotion Centre was founded in 2017 to boost the export of Japanese agricultural, forestry, fishery and food products by creating a stronger platform for overseas business-to-consumer promotions and branding projects.

Box 4.3. Food safety and standardisation policy in Japan

In 2003, the emergence of bovine spongiform encephalopathy, commonly known as Mad Cow Disease, led to the reform of Japan's food-safety-risk management. The importance of balancing both producer and consumer interests and responsibilities and cross-departmental co-operation led to the establishment of the Basic Principles of Food Safety Policy. The Food Safety Commission was also founded to perform independent risk assessment.

The Food Sanitation Act is one of the main sanitary and phyto-sanitary regulations under the SPS agreement together with the Plant and Animal Quarantine Regulation. The Food Sanitation Act and the Act on Japanese Agricultural Standards (JAS Act) provide the major regulatory framework for food labelling with an objective to ensure food safety and consumer choice. The Food Sanitation Act requires safety assessments and labelling for genetically modified foods, as well as the labelling of seven allergenic food materials (eggs, milk, wheat, buckwheat, peanuts, shrimps, and crabs). The labelling of place-of-origin to indicate the original prefecture, or country in case of imported products, became mandatory in 2000 for fresh foods. The JAS Act, the national standard to assure the quality of agricultural products, also requires the labelling of processed foods to indicate the raw materials, and processing country for imported foods, since 2001. The JAS Act introduced place-of-origin labelling for certain processed foods in 2001 to indicate raw materials that comprise more than half of the total weight, and in 2004 widened this scope to 20 categories of processed foods, which covers most lightly processed foods. The JAS standard for organic foods was established in 2000 according to the Codex Alimentarius guideline for the

Production, Processing, Labelling and Marketing of Organically Produced Foods, requiring producers to be certified by a registered body in order to label their products as organic. In 2015, the Food Labelling Act, came into force, integrating food labelling provisions of the Food Sanitation Act, the JAS Act, and the Health Promotion Act. The JAS Act was revised in June 2017 to expand its scope to the manufacturing process, service, management system, and evaluation methods.

4.4. Domestic agricultural policy

Domestic price support programmes

MPS measures the value of transfers arising from any policy that affects domestic market price. In addition to border measures, such as tariffs and import quotas, domestic price support programmes also create gaps with international prices, which include production quotas, administered prices and public stockholding.

Rice

The administered price of rice was in place until 1995 when the new Staple Food Law reduced the role of the government to stockholding and deregulated the marketing of rice. Over time, rice consumption has decreased at an average rate of 80 000 tonnes annually due to falling per-capita consumption from changing dietary patterns along with reductions in dietary intake due to the ageing of the Japanese population.

For the last 40 years, the government set the rice production target based on demand projections and allocated a production quota to each prefecture. The quota was then either reallocated to individual farmers within the same prefecture or traded across prefectures in order to maintain the overall production volume at the national level. The programme controlled the supply of rice by allocating a production quota to rice farmers, which contributes to keeping the price above market equilibrium. In 2018, Japan ended the production quota system, replacing with a voluntary scheme that would enable farmers to plan their production based on market demand. The government supports this voluntary scheme by providing detailed market information on rice such as price, supply, demand, and stocks. However, subsidies that incentivise crop diversification continue to be paid to farmers who shift from table rice production to other crops (e.g. wheat and soybean).

The government stockholding programme was reformed significantly in 2011 to clarify the role of public stockholding as an emergency stock and to limit the use of stocks to influence domestic rice prices. Before the reform, rice for the public stock was bought after harvest (around December), the amount of which varied each year, and the stored rice was sold as food. Since 2011, rice for the public stock is contracted in fixed amounts (of around 200 000 tonnes per year, equivalent to 2% of total rice production) before planting so as to maintain an appropriate stock level (1 million tonnes); the rice is mainly sold as feed through auctions at prices that are close to the domestic market price.

Milk

Domestic dairy policy is focused on supporting producers of milk that is used for processing; this has a lower price than drinking milk and faces international competition. The association of JA-related co-operatives, the Japan Dairy Council, has managed a voluntary supply control system since 1979, in which almost all milk producers participate.

The council announces the target supply amount of raw milk and allocates a production quota to producers through its regional associations.

Programmes to support farm income or reduce costs

The direct payment to farmers in hilly and mountainous areas was introduced in 2000 to avert the increase of land abandonment. Land abandonment in hilly and mountainous areas is mainly due to disadvantages in agricultural production. However, agricultural production in these areas serves as a means to prevent soil erosion, preserve water resources, support rural communities, and maintain the rural landscape.

The direct payment is designed to compensate 80% of the difference in production costs between hilly and mountainous areas, and flat areas. Recipients are required to continue farming for more than five years and to carry out activities that bring multifunctional benefits, such as preventing floods, soil erosion, preserving biodiversity or conserving ecosystems. In FY2017, 663 000 hectares of land received this payment, covering 84% of eligible farmland.

The Law on Farm Income Stabilization introduced three new direct payments for core farmers[3] in 2007 as a main direct payment programme for the crop sector. The first payment was based on historical area planted. Wheat, barley, soybeans, sugar beet and starch potatoes are eligible for this payment. The aim was to correct disadvantages in domestic agriculture caused by geographical handicaps compared to other countries. The second payment covered the same commodities, but based on output, and sought to encourage quality improvement of domestic products by differentiating payment rates according to product quality. However, the law was modified in 2015 to convert payment eligibility from historical area to current area of production, to include rapeseed and buckwheat, and to remove the minimum farm size condition.

The third payment compensates up to 90% of lost income compared with the average income of the five previous years (excluding the highest and lowest years) in order to mitigate income instability caused by price fluctuations. This payment includes rice and five upland crops (wheat, barley, soybean, sugar beet and starch potato), and is covered by a government fund in which three-quarters of contributions come from the government and the rest from participating producers. Similar to the first two components, eligibility conditions related to minimum farm size were abolished in 2015.

In 2011, Japan introduced income support payments for rice farmers who met the production quota set by the government. The payment was made based on current area of production, with both predetermined and price-contingent components. However, in 2014 the price-contingent payment for rice was eliminated and the rate of predetermined payment was halved to JPY 7 500 (USD 71) per 0.1 hectare. The payment was provided for a limited period of four years and expired in 2018.

The government, however, maintained incentives to divert land from staple rice production, and instead produce feed rice, rice flour, wheat and soybeans. Measures include increasing the amount of diversion payments and introducing a quantity-based payment to support rice farmers who want to shift from table rice production to other crops. Although the production quota was abolished in 2018, the government still uses diversion payments to discourage production of table rice.

The payment for manufacturing milk is intended to ensure the production of milk in remote areas, particularly Hokkaido, where milk production is concentrated. This payment system

was revised in 2001 to an output-based direct payment, which has a fixed rate on the basis of the production cost (JPY 10.55 (USD 0.09) per kg in 2007).

In 2018, Japan reformed production and distribution systems for raw milk. In the previous system, subsidies for manufactured milk production were only given to farmers who consigned raw milk to ten designated JA-related co-operatives that manage the voluntary supply control system of milk. In fact, 97% of farmers consigned their products to the JAs. The revised system provides access to subsidies to all farmers regardless of where they consign their products on the condition that they submit their annual sales plans to the government. This reform allows farmers to select the most suitable consignees and helps streamline the current distribution system.

Programmes to support farm risk management

Price and income stabilisation payments

In addition to measures to support income, Japan has developed a number of commodity-specific risk management programmes. Producer price stabilisation policies partially or fully compensate differences between sales and target prices or historical average prices for beef calves, fruits, vegetables and some other products. In the case of vegetables, the government, prefectures, and participating producers set up the Vegetable Production and Shipment Stabilization Fund, which compensates participating farmers in general 90% of the difference between average market price in a season and the guaranteed standard price for targeted vegetables (14 types). The level of the guaranteed standard price is set at 90% of the average wholesale price for the last six years. An additional 35 types of vegetables have similar price stabilisation schemes in place, managed at the prefectural level.

For the livestock sector, a deficiency payment scheme called the Beef Calf Production Stabilization System was implemented in 1990. This deficiency payment sets two trigger prices: the guaranteed standard price that aims to maintain the reproduction of beef calves and the rationalisation target price that is set lower than the guaranteed standard price, taking into account the international beef price and domestic production costs. Two types of funds operate within the system. One is funded by the national government and the other by producers, and the national and local governments. A payment is made when a registered calf is sold at a lower price than either of the target prices. If the average market price falls between the guaranteed price and the rationalisation target price, the deficiency payment is financed from the national government fund. If the average market price is below the rationalisation target price, a payment equivalent to 90% of the difference between the rationalisation target price and the average market price is financed from the latter fund.

The deficiency payment is also available for beef feedlot, which compensates 90% of the difference between average production cost and gross margin at the prefectural level. Producers fund 25% of the mutual fund established by the Agriculture & Livestock Industries Corporation. Similar schemes are available for hog and egg producers, in which producers finance 25% and 75% of the mutual funds, respectively.

Agricultural insurance programmes

Since 1947, the government has been supporting an agricultural insurance scheme for yield risk. As a general rule, the government contributes approximately 50% of the premiums. The current crop insurance programme mainly covers commodity-specific yield losses for rice, wheat, and barley, livestock, fruits, field crops, silkworms, and greenhouses.

In 2019, Japan introduced a revenue insurance programme. This programme insure total farm revenue, taking both market price and yield fluctuations into account. Revenue is calculated at a whole-farm level, and not at the regional level or by commodity as is the case in current risk management programmes. Under the new programme, the average revenue of the last five years for each individual farmer is generally set as the benchmark revenue, and the programme compensates up to 90% of revenue loss from 90% of the benchmark revenue if the revenue for a year falls by more than 10% of its benchmark. Farmers participating the programme select the triggering level of revenue between 50% and 80% of the benchmark revenue, and a coverage rate between 50% and 90% of lost revenue. Additionally, farmers can choose to participate in the mutual fund to increase the trigger revenue to up to 90% of the benchmark. The insurance premium is determined according to the risk grade of the farm, and tax declarations based on double bookkeeping are required to participate in the programme. The government finances 50% of the insurance premium and 75% of the mutual fund.

With the abolishment of mandatory requirement for rice, wheat and barley producers to participate in the crop insurance programme in 2019, farmers can now freely choose any risk management programme. However, the revenue insurance programme cannot be combined with other risk management programmes, such as other agricultural insurance programmes, the Farm Income Stabilization Programme or commodity-specific price stabilisation programmes. Additionally, producers of beef cattle and calves, hogs, and poultry for eggs are excluded from the revenue insurance programme as they are covered by other income loss support programmes.

Producers also benefit from disaster restoration programmes. They are available when natural disasters damage farmland and agricultural facilities. In principle, the government covers 50% of the restoration of farmland (65% in the case of agricultural facilities), but a higher support rate is applied as the costs of restoration increase. JFC provides a low interest safety net credit to business farmers affected by natural disasters and epidemics, as well as other economic and social risks.

Experience in other OECD countries shows that if the risk management instrument in place covers risks too comprehensively it increases: 1) the incentive of farmers to specialise in riskier products; and 2) the crowding-out of other risk management programmes for handling marketable risks, which may transfer to taxpayers risks that should be borne by farmers (OECD, 2011[3]). Alternatively, the government can provide voluntary risk-management programmes to help producers manage risks arising from normal variations in production, prices and weather, while providing protection from more extreme market-related shocks. One example is the voluntary savings account scheme matched with government transfer (Box 4.4).

Box 4.4. Voluntary risk-management programmes to manage normal business risk

The *Farm Risk Account* is a voluntary savings account, which draws on the experience of other OECD countries to manage risk, such as Canada's *AgriInvest programme*, a government-matched producer savings account for moderate income declines or for making investments in farming operations to mitigate risk (OECD, 2016[4]).

A part of a farmers' direct payments could be deposited in the special account, to be drawn on in the case of income losses from operational risks (such as market volatility or unexpected weather conditions). To provide an incentive for farmers to save, deposits of direct payments could be deducted from farmers' taxable income, and do not have to be taxed when disbursed

(in the case of losses) or at the closure of the account when used to supplement pension payments. Use of the *Farm Risk Account* would be mandatory in the event of a temporary shortfall in income from operational risks. Pay-out rules could limit access to the account to losses that lead to an income level below a certain percentage, for example 80%, of the reference income, with losses up to that level to be treated as a normal individual business risk.

Source: Gray et al. (2017[5]), "Evaluation of the relevance of border protection for agriculture in Switzerland", *OECD Food, Agriculture and Fisheries Papers*, No. 109, OECD Publishing, Paris, https://doi.org/10.1787/6e3dc493-en.

Preferential tax treatment

To mitigate the impact of natural disaster on farm income, Japan's Income Tax Act allows farmers to defer the loss of agricultural assets to a natural disaster for a period of three years after the incidence in their income declaration. Farmers who are self-employed or have multiple sources of income are required to file a tax return. Farmers declaring income based on double book-keeping receive various tax benefits, including accelerated depreciation of capital and full deduction of compensation to farm workers. Moreover, farmers can defer the loss of farm income for three years (nine years in the case of corporate farms) irrespective of the cause of income loss.

Moreover, farmers receiving the direct payment for core farmers are allowed to accumulate their payments for future investment as expenses on the condition that they declare income based on double book-keeping. The accumulated payments can be deducted from the declared farm income on the condition that the accumulated payments will be used to acquire farmland, farm buildings, or farm machines within five years. An increased depreciation rate applies to the acquired assets using the accumulated payments in the year of asset acquisition.

Farmers benefit from fuel tax exemptions. Importers and manufacturers of heavy crude oil used for agriculture, which is mainly used for heating on horticultural farms, are eligible for an exemption from petroleum and coal taxes. Farmers are also eligible for exemption from diesel tax when this fuel is used for agricultural machinery. This tax break is currently extended to 2021.

4.5. Agri-environmental policy

Japan has a relatively brief history of agri-environmental policy. In 1999, the Basic Law on Food, Agriculture and Rural Areas first mandated the government to ensure the appropriate use of pesticides and fertilisers, and the effective use of livestock manure to promote the eco-system service of agriculture. The certification of Eco-Farmers was established in 1999. The prefectural governments set the guidelines to introduce sustainable production practice sand certify producers as Eco-Farmers. To be certified, producers must submit a five-year plan to introduce sustainable agricultural production practices, including application of composts to improve the soil quality, and reducing the amount of synthetic chemical fertilisers and synthetic chemical pesticides. The renewal of a certification requires the introduction of updated sustainable agricultural production practices. The number of certified farmers was 111 864 in 2017, which is less than 10% of commercial farmers.

Although improving the environmental performance of agriculture is a policy objective, the quantitative agri-environmental policy target has not been set at either the national or

regional levels. The preparation of a quantitative policy target and action plan would require the systemic assessment of the impact of agriculture on the environment at the national and local levels (Box 4.5).

Box 4.5. Agri-environmental monitoring in Switzerland

In Switzerland, agriculture plays a key role in the national sustainable development strategy. The Federal government established a number of intermediate agri-environmental targets, including nutrient balance, pesticides, ammonia and biodiversity.

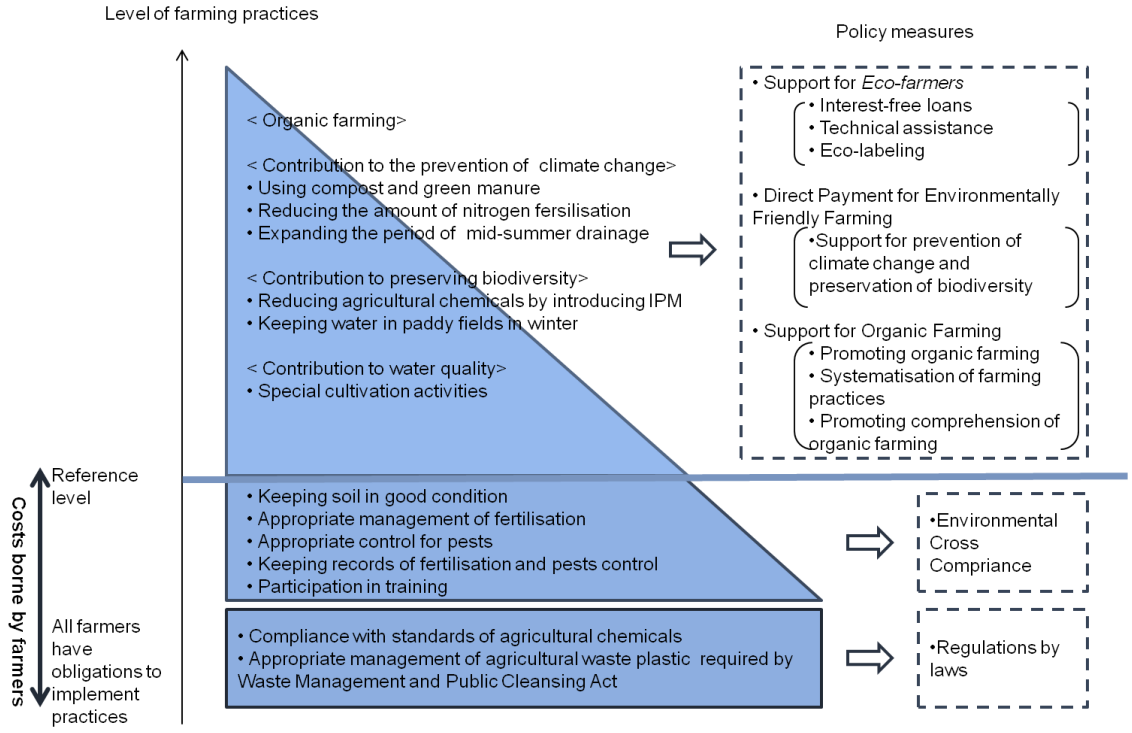
The Federal Office for Agriculture is carrying out agro-environmental monitoring (AEM) based on the Federal Act on Agriculture (Art. 185) and the Ordinance on the Evaluation of Sustainability in Agriculture. The goal of the AEM is to assess the impact of agriculture on the environment. A set of 17 agro-environmental indicators (AEI) provides the base for the AEM. The AEI are split into six areas (nitrogen, phosphorus, energy/climate, water, soil and biodiversity) and two indicators (driving forces and environmental effects). As the competence centre for AEI, the Institute for Sustainability Sciences at Agroscope is responsible for the centralised evaluation of AEI, including the development of AEI methods. Data for the calculation of the AEI have been collected since 2009, in a network of currently 300 farms, to obtain agro-environmental information at the regional level and by type of farm.

Source: OECD (2015[6]), *OECD Review of Agricultural Policies: Switzerland 2015,* https://dx.doi.org/10.1787/9789264168039-en.

Designing a framework for agri-environmental policies requires defining environmental targets and reference levels.[4] In 2005, the Principles of Agricultural Production Practice Harmonized with the Environment laid out a list of agricultural production practices that farmers are expected to adopt for environmental preservation. In Japan, these principles define the environmental reference level beyond the mandatory regulations (Figure 4.6). However, the scope does not include a wider set of environmental practices, such as climate change mitigation, biodiversity, landscape management and animal welfare like the European Union (Box 4.6). A major direct payment programme, including the Farm Income Stabilization Programme, imposed a cross-compliance condition with these principles.

While cross-compliance conditions increase the coherence of direct payment programmes with environmental policy objectives, the experience in OECD countries shows that such conditionality would not be effective unless it was adapted to the diversity of local farming practices and conditions. Moreover, some of the literature finds that the set of production practices may not guarantee that farmers will adopt cost-effective means to improve their environmental performance as opposed to the performance-based policies in which producers can choose the most cost-effective way in their operation (OECD, 2019[7]).

Figure 4.6. Structure of agri-environmental policy in Japan



Source: MAFF (2018[8])*), Policy Measures for Promoting Environmentally Friendly Agriculture* (in Japanese). http://www.maff.go.jp/j/seisan/kankyo/hozen_type/attach/pdf/index-37.pdf.

Box 4.6. Mandatory environmental requirements attached to agricultural support in the European Union

The European Union's direct payments under the Common Agricultural Policy (CAP) are typically conditional on mandatory cross-compliance. The regulation foresees that if the conditions are not fulfilled the payment is disrupted and penalties may apply. Cross-compliance refers to environment, climate change and good agricultural condition of land as well as public, animal and plant health, and animal welfare. It applies to direct payments and environmental Rural Development Programmes payments. Cross-compliance applies to all agricultural land including land which is left fallow and no longer used for production purposes.

Cross-compliance combines so-called Statutory Management Requirements that relate to the implementation of legislative standards in the field of the environment, food safety, animal and plant health and animal welfare (18 EU Directives and Regulations) and the standards for Good Agricultural and Environmental Condition (GAEC) of land.

GAEC standards define minimum agricultural management practices addressing water quality, soil cover and erosion, biodiversity, conservation of habitats, flora and fauna and landscape features. GAEC standards establish buffer strips along water courses, minimum soil cover and land management to limit erosion, maintenance of soil organic matter level, retention of landscape features.

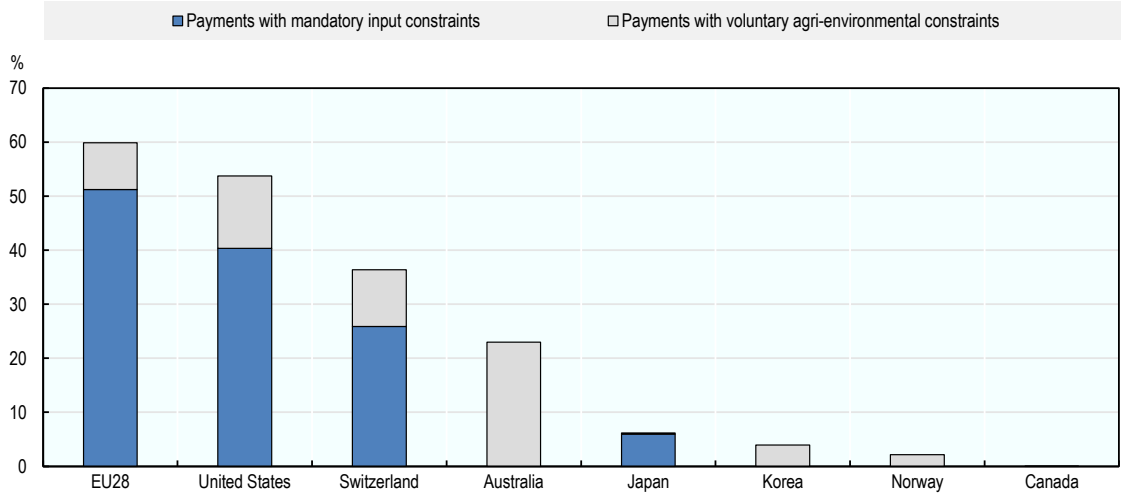
Source: OECD (2017[9]), *Evaluation of Agricultural Policy Reforms in the European Union: The Common Agricultural Policy 2014-20*, https://dx.doi.org/10.1787/9789264278783-en.

Japan's first environmental payment scheme was introduced in 2007 as part of the Rural Development Programme. It supports environmentally-friendly farming activities that reduce the application of chemical fertilisers and pesticides by more than half compared to conventional farming practices in the region. This payment evolved in 2011 into direct payments for environmentally-friendly agriculture. In addition to the reduction of chemical fertiliser and pesticide use, farmers were required to adopt one of the environmentally-friendly production practices including organic farming, planting of cover crops, and use of manure compost. In addition, prefectures are allowed to include regionally specific environmentally-friendly production practices. In 2018, the requirement for the payments was revised so that only farmers who practice Good Agricultural Practice (GAP) are able to receive it, requiring them to participate in training and submit an activity report to assess the implementation of GAP.[5]

However, the environmental payment covers only about 2% of total farmland in Japan. The share of the payments with voluntary agri-environmental constraints in producer support was 0.2% in 2015-17 in Japan compared to 9% in the European Union and 13% in the United States in 2015-17 (Figure 4.7). Moreover, the share of payments with mandatory cross-compliance condition was 6% of producer support in 2015-17, where 51% of support in the European Union had such conditionality. When comparing the share in the budget expenditure, these payments conditional on adopting specific production practice account for 30% of budgetary transfer to producers in Japan, which is much lower than in the European Union and the United States.

Figure 4.7. Support conditioned on adoption of specific production practices, 2015-17

As a percentage of Producer Support Estimate



Source: OECD (2018[2]), "Agricultural support estimates (Edition 2018)", OECD Agriculture Statistics (database), https://doi.org/10.1787/a195b18a-en.

StatLink http://dx.doi.org/10.1787/888933957819

In Japan, organic farming is increasing slowly, accounting for only 0.5% of total farmland. The Law on Promotion of Organic Agriculture was established in 2006, and governments promote R&D and extension services for organic farming, increase awareness of organic farming among consumers and establish organic farming promotion plans at prefectural

and town/village levels. In 2000, MAFF introduced a labelling system of organic products which requires producers to be certified by a registered organisation (Box 4.3).

Private standards for environmentally friendly products also exist. Some local governments and producer organisations have created labelling systems to certify products as respecting biodiversity in the local environment. In 2010, MAFF published a guidebook of best practices in implementing voluntary standards schemes. Currently, around 30 to 40 agricultural products are certified by the private standards for biodiversity (Shobayashi and Sasaki, 2018[10]).

The national government has been playing a predominant role in agricultural policy design and implementation in Japan. However, public goods such as water quality and bio diversity are closely to local environment (OECD, 2015[11]). Sub-national or local approaches in both decision making and financing to provision of local public goods are superior (van Tongeren, 2008[12]). Indeed, some sub-national governments in Japan design and implement the regional agri-environmental policy, including setting regional plan and locally adapted environmental targets and reference levels (Box 4.7).

Box 4.7. Regional agri-environmental policy: The case of Shiga prefecture

Some subnational governments introduced environmental payment schemes. In 2001, Shiga prefecture set an ambitious policy target to reduce the use of pesticides by 70% and introduced an environmental certification scheme for the producers who reduced the application of pesticides and inorganic fertilisers by 50% relative to the local conventional level.[6] The prefecture also clarified a wider set of environmental reference levels adapted to the local condition by the prefectural ordinance such as refraining from emitting muddy water. They also introduced environmental payments in 2004 for producers who signed a five-year contract with the prefecture to reduce their chemical input by more than 50%. In 2012, the prefecture introduced another agri-environmental payment for farmers who act collectively to raise the water level so that fish can swim from the lake to paddy fields for reproduction as a regionally specific production practice under the national payment programme for environmentally-friendly agriculture.

4.6. Key points

- The types of policy support demanded by professional farms has evolved overtime. Agricultural policy should provide diverse policy tools that are better targeted to producers' management constraints and to creating business opportunities for innovation.
- Japan provides one of the highest levels of support to agricultural producers among OECD countries, but its producer support is dominated by commodity-specific support, which limits the flexibility of farmers to produce based on market demand. Agricultural policy reforms in the last decade have increased non-commodity specific support, such as the Farm Income Stabilisation Programme, as the main payment programme in the crop sector. The recent introduction of a revenue insurance programme is a milestone in this direction.
- Rice policy is at the core of agricultural policy issues in Japan. Government control of production and marketing has decreased over time. Termination of the rice production quota and the abolishment of rice income support payments in 2018 was

an important step. Nevertheless, payments to divert production away from table rice continues to limit the supply of table rice.

- The role of risk management programmes is expected to increase as professional farms are more vulnerable to market and production risks, with increasing weather related disasters due to climate change in Japan. The introduction of a revenue insurance programme in 2019 increased the choice of risk management tools for producers. However, various overlapping payment and insurance programmes make the role of each policy less clear. Moreover, many programmes tend to trigger payment or indemnity for a relatively small reductions in farm revenue, due to what would usually be considered as normal business risks.
- Healthy risk-taking behaviour by producers is one driver of innovation and entrepreneurship at the farm level. Current risk management programmes leave relatively little room for producers to take the risks associated with new opportunities. Policy coverage to normal business risk could crowd out market-based solutions and own-farm risk management strategies, and incentivise farmers to take more risk through less diversification.
- Although improving environmental performance of agriculture is set as an objective of agricultural policy, the quantitative policy target has not been defined both at national and regional level. Systemic assessment of environmental performance of agriculture to define policy targets, and to monitor and evaluate the policy progress is not in place at both the national and regional level.
- Agri-environmental payments in Japan cover a small part of production in the sector. Environmentally-friendly farming payments cover less than 2% of cultivated area. Policy makers need to pay more attention to improving the environmental performance of a vast majority of farmers who do not participate in the agri-environmental payment programme.

Notes

[1] Japan fulfils this import requirement for rice through two different channels: the Ordinary Minimum Access (OMA) and the Simultaneous Buy and Sell (SBS) tender system. The OMA part of the quota is the main channel for rice imports, which is stored in the OMA working stocks and then sold for food processing and food aid. While rice imported though the SBS tender system is sold as table rice, an equivalent amount of government-purchased domestic rice is allocated to food aid and feed to ensure that rice imports do not affect the domestic rice price or the effective domestic self-sufficiency for table rice (OECD, 2009[13]).

[2] The URAA permits emergency measures if the respective import volume of chilled or frozen beef from the beginning of the fiscal year up to the end of the relevant quarter exceeds more than 117% of the corresponding import volume of the preceding year. In this case, a higher tariff rate of 50% applies for the rest of the year or the first quarter of the following fiscal year.

[3] Core farmers are defined as farm management units aiming to be or already efficient and stable business farms. Two basic criteria currently certify farms as business farms: 1) certified farmers and certified new farmers submit farm management plans approved by authorities; and 2) community-based farm co-operatives are the local unit of farm households which conduct farm management collectively.

[4] Environmental reference levels are defined as the minimum level of environmental quality that farmers are obliged to provide at their own expense. Environmental targets are defined as the desired levels of environmental quality that go beyond the minimum requirements or minimum levels of environmental quality for the agricultural sector in a country (OECD, 2001[14]).

[5] MAFF has strengthened the support for producers implementing GAP, which include a wider set of sustainable production practices. An integrated guidelines for GAP was published in 2010. MAFF aim to triple the number of producers acquiring GAP certification by 2020 and expand the application of GAP to almost all producing regions by 2030 through increasing support to GAP advisors and training activities. The types of agricultural policy programmes which provide preference to the producers implementing GAP have also increased recently.

[6] This policy draws on the efforts begun in the 1970s by the prefectural government to reduce the flow of chemicals into the lake which occupies one-sixth of their territory. The initial target was to reduce emissions from point sources, such as sewage facilities and manufacturers, by a series of strict regulations. Consequently, the share of these point sources of the total emissions into the lake gradually decreased; this then required policy measures to tackle non-point sources, especially agriculture (OECD, 2013[15]).

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Chapter 5. Agricultural innovation systems in Japan

Innovation policy is moving beyond supply-driven approaches that focus on R&D and specific technologies to a network-based setting, in which a more inclusive, interactive, and participatory approach fosters greater innovation in response to pressing challenges facing the food and agriculture systems. This chapter describes the agricultural innovation system in Japan and outlines the recent changes it has undergone. It provides an overview of the general innovation system, presents agricultural innovation actors and governance of the innovation system, outlines changes in roles and themes of R&D, and presents the main policy instruments and monitoring efforts. It then reviews the main trends in public and private investments in R&D, the funding mechanism, as well as the means used to foster knowledge markets and networks.

The predominant model for innovation has been mostly supply-driven: scientists in the public sector create new technologies which are then disseminated by extension officers to farmers who are asked to adopt them. Many countries have reviewed their Agricultural Innovation System (AIS) in response to concerns about its low rate of adoption of innovation and the need to increase AIS performance in order to respond to emerging and pressing challenges (IO, 2012[1]). Although R&D remains important, innovation policy is moving to a more systemic approach that takes into account the many factors and actors that play a role so as to better reflect user demand and to implement more innovative solutions effectively (OECD, 2010[2]).

5.1. General characteristics of innovation systems in Japan

Japan has an economy-wide framework for science, technology, and innovation that provides incentives for all sectors. It is one of the few OECD countries where R&D expenditure exceeds 3% of GDP (OECD, 2018[3]). The intensity of private investment in R&D is one of the highest among OECD countries (Figure 5.1). However, private R&D investment concentrates on large enterprises. Enterprises with less than 250 workers accounted for only 4% of total business R&D, compared to the OECD average of 33%, in 2011 (OECD, 2013[4]).

Japan also generates a high level of human capital, with the highest proficiency in literacy and numeracy among adults in all countries participating in the OECD survey of adult education (OECD, 2016[5]). However, potential in science and technology is under threat, as indicated by a low number of students advancing to doctoral courses in these fields and a low number of papers published in leading journals. In terms of public investment in R&D, Japan ranks relatively high among OECD countries, but growth in expenditure has slowed (OECD, 2016[6]).

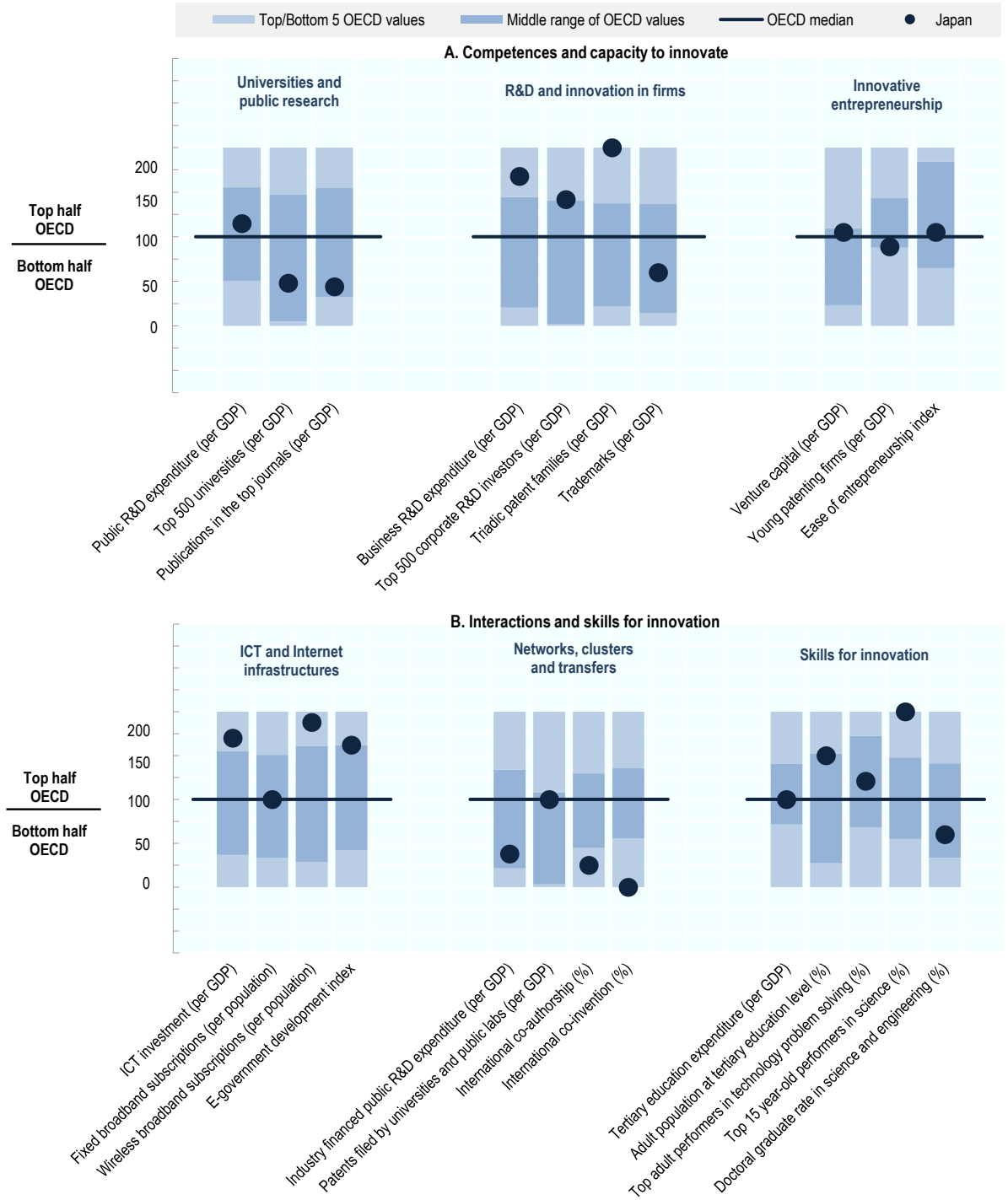
Despite strong public and private investment in R&D, collaboration between public and private actors and across sectors is relatively weak. The level of international co-authorship and co-invention are amongst the lowest in OECD countries (Figure 5.1).

The number of industry-academia collaborative activities remains small, and the mobility of personnel between organisations or across sectors is limited. Private companies prefer producing their own technology without collaborating with other private or public actors (OECD, 2016[6]). In Japan, 99% of business-financed R&D is carried out by firms, leaving little room for co-operation with universities and government research institutions. This sectoral approach, however, does not leverage the potential of the important innovations that occur between sectors.

Japan seeks to make use of its strength in information and communication technology (ICT) infrastructure. In June 2017, the government announced its "Future Investment Strategy 2017: Reforms Toward the Realization of Society 5.0". According to this strategy, the key to medium- to long-term economic growth is realising "Society 5.0", which adopts diverse ITs developed so far to "new innovation" such as IoT, Big Data, artificial intelligence (AI), robots and the sharing economy. Developing technology to analyse and formalise Big Data of meteorological information, crop development, market information, food trends, and needs is a vital tool for the sector's efficiency. New types of innovation – such as stabilising food supply, reducing food loss, and promoting food consumption – are expected to help fix major issues in agriculture.

Figure 5.1. Comparative performance of Japan's science and innovation systems, 2016

Normalised index of performance relative to median values in the OECD area (Index median=100)



Source: OECD (2016[6]), "Japan", in *OECD Science, Technology and Innovation Outlook 2016*, Paris, https://doi.org/10.1787/sti_in_outlook-2016-70-en.

StatLink http://dx.doi.org/10.1787/888933957838

National innovation policy framework

The Council for Science, Technology and Innovation (CSTI) in the Cabinet Office leads science, technology and innovation policies in Japan. It overlooks and co-ordinates all of the nation's science, technologies and innovation (STI) policies, with specific measures formulated by the relevant national ministries and agencies. CSTI is chaired by the Prime Minister and composed of the Chief Cabinet Secretary, the Minister of State for Science and Technology Policy, and other relevant ministers including from the Ministry of Internal Affairs and Communications (MIC), the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Ministry of Economy, Trade and Industry (METI). The president of the Science Council of Japan and other experts from academia and industry also constitute members of CSTI. One of CSTI's principal duties is to formulate the Science and Technology (S&T) Basic Plan every five years based on the Basic Act on Science and Technology.

Since 2013, CSTI has prepared a Comprehensive Strategy on Science, Technology and Innovation every year, which specifies and prioritises measures based on the direction of the S&T Basic Plan but tailored to annual changes in conditions. Based on this strategy, the government allocates its overall science and technology budget. In 2018 – the mid-year of the fifth S&T Basic Plan – CSTI formulated the Integrated Innovation Strategy to evaluate the progress of various measures contemplated in the Comprehensive Strategy, to examine the wide range of STI-related policies and socio-economic systems, and to ensure implementation of the policies. In this Integrated Innovation Strategy, CSTI focuses on agriculture as one of the major strategic fields of innovation.

The government's overall budget for STI policies was JPY 3.84 trillion (USD 34.2 billion) in FY2018, of which MEXT accounts for more than half. MEXT supports R&D in life sciences, materials and nanotechnology, disaster prevention, space, oceans, and nuclear energy through pubic research institutions such as RIKEN (Japan's largest research institution), and the Japan Aerospace Exploration Agency. MEXT also supports basic research by funding agencies such as the Japan Society for the Promotion of Science (JSPS) and the Japan Science & Technology Agency (JST). JSPS and JST also provide competitive research funds in agricultural science.

The Japanese government promotes industry-academia-government collaboration in R&D under CSTI's leadership. This includes, for example, implementation of the Cross-Ministerial Strategic Innovation Promotion Program (SIP) started in 2014 and the Public/Private R&D Investment Strategic Program created in 2018. CSTI allocates the budget beyond ministerial boundaries and policy areas, and oversees the entire R&D flow from basic research to application and commercialisation of STI. By taking a top-down approach, CSTI prioritises R&D agendas – including agriculture – that are expected to solve social issues, strengthen industrial competitiveness, and revitalise the economy.[1]

The country's regional innovation policies have long been characterised by cluster initiatives. Specifically, various programmes support industrial and knowledge clusters depending on the sectors and supporting ministries. MEXT promotes large-scale research collaboration among universities and companies for innovation. In addition, METI has extensive programmes to revitalise SMEs through innovation. Although initiatives by different ministries are gradually being integrated and co-ordinated, they remain rather fragmented and complex (OECD, 2016[6]).The new Program for an Open Innovation Platform with Enterprises, Research Institutes and Academia encourages industry-university partnerships, involving SMEs at the pre-competitive stage of development, and the SME Training Institute offers seminars for owners and managers of SMEs.

5.2. Main actors and governance of the agricultural innovation system

Establishing an effective AIS requires that its governance shifts towards a more collaborative and demand-driven approach. A longer-term strategy for agricultural innovation, which takes into account long-term challenges as well as consumer and societal demands, must be coordinated and clearly communicated. A greater engagement of AIS actors in the definition of objectives and funding is a common characteristic of more collaborative and demand-driven AIS.

Economy-wide processes and organisational innovation, developments in ICT, and the bio-economy increasingly drive innovation in agriculture. The integration of the agricultural system into 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-overs across sectors.

The role of AIS actors in Japan

Government

The MAFF plays a central role in the governance of Japan's AIS. Under the MAFF, the Agriculture, Forestry and Fisheries Research Council (AFFRC) is in charge of planning and implementing relevant technology R&D policies. Founded in June 1956, AFFRC formulates the Basic Plan for R&D in Agriculture, Forestry and Fisheries Research. AFFRC also co-ordinates, examines and evaluates R&D conducted by public agricultural research organisations such as NARO and the Japan International Research Center for Agricultural Sciences (JIRCAS), universities, other public R&D agencies, and some private companies. AFFRC communicates with CSTI and manages competitive research grants.

National agricultural research organisations (NARO)

NARO is an offshoot of the Agricultural Experiment Station founded in 1893 and which is the largest knowledge generator in the field of agricultural science in Japan. With 21 research centres and departments, NARO engages in wide-ranging research relating to agriculture, food and the environment. In 2001, it converted its legal status to a National Research and Development Agency. Since then, the government has reduced institutional funding for operating cost subsidies yearly; this new legal status provides NARO with more freedom to acquire external funding and manage its human resources.

NARO has five regional agricultural research centres that engage in the development of technology suitable for each regions' particular weather and climatic conditions. As a regional hub of agricultural research, the centres are mandated to reflect farmer needs in the area of technological development.

To strengthen the regional hub function, NARO implemented an organisational reform of regional agricultural research centres in 2016, including:

- creating an advisory board composed of local leading farmers
- setting up a unit specialised in planning, and proposing and co-ordinating joint research in collaboration with prefectural agricultural research organisations, extension offices and private companies;

- designating an agricultural technology communicator to engage in daily exchanges of information with prefectural agricultural extension officers
- designating an industry-academia co-ordinator to proactively engage in co-ordination that would make greater use of NARO intellectual property.

The Agri-Food Business Innovation Center (ABIC) was established by NARO in 2016 to promote industry-academy-government collaboration. ABIC matches activities with external organisations and the private sector to make use of research outcomes and intellectual property. The Bio-Oriented Technology Research Advancement Institution (BRAIN) also acts as a means of transferring knowledge to universities, technical colleges, other national research organisations and private companies

There are two additional national public research organisations in agriculture. The Japan International Research Center for Agricultural Sciences (JIRCAS) is responsible for R&D in technology relating to agriculture, forestry and fisheries in tropical, subtropical and other developing regions, with the aim of solving food and environmental problems at a global level, and to ensuring a stable supply of agricultural, forest and fisheries products. The Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries (PRIMAFF) specialises in social sciences and provides knowledge for MAFF's policy planning and proposals.

Prefectural agricultural research organisations

Prefectural governments have their own agricultural research organisations, with agricultural R&D at the local level focussing on developing technologies which are adapted to local conditions. In particular, prefectural research stations help develop cereal varieties such as rice, wheat and soybean suitable for the region.

The national and prefectural research centres complement each other. For example, national research centres collect genetic resources and develop advanced breeding technologies, as well as pioneer plant varieties and breeds, while prefectural research stations develop regional brand varieties utilising generic resources and technologies.

Recent efforts have made agricultural research more demand-oriented. For example, farmers and extension organisations are required to participate in regional agricultural R&D projects funded by the national government. Collaboration in on-site experimental research is promoted between NARO's regional agricultural research centres, prefectural research stations and extension services, and farmers knowledgeable in the field by imposing conditionality on national-level project funding.

Prefectural extension services

Farm advisory systems play an important role in the transfer and successful adoption of innovation, in particular at the early stages of development. Prefectural governments deliver public agricultural extension services as an integrated system with prefectural agricultural research organisations. The prefectural agricultural extension stations played a major role in facilitating the adoption of breeding and farming techniques developed by the prefectural agricultural research centres.

Universities

Japanese universities play an important role as agriculture-related knowledge generators. Most prefectures have a national, public or private university to carry out programmes

related to agricultural science. These universities engage in education and wide-ranging research activities, including both basic and applied research.

Private companies, associations and producers

AIS actors include producers, private agri-business companies and JAs. Private agri-business companies and JAs often provide farmers with technical advice in combination with the sale of inputs. However, agricultural R&D in the private sector is limited. Contrary to public research organisations, private R&D plays a marginal role in the development of the main cereal crops; instead it concentrates on non-cereal crop research such as vegetables and flowers. Private companies also play a major role in R&D in agricultural input industries such as farm machinery and agricultural chemicals.

Governance of AIS in Japan

Policy framework and funding mechanisms

The Basic Plan for Agriculture, Forestry and Fisheries Research sets the overall direction of public agricultural R&D in Japan over a ten-year period. AFFRC has formulated the Basic Plan every five years since 2005 in parallel with preparation of the Basic Plan for Food, Agriculture and Rural Areas by MAFF.[2] The Basic Plan also takes into consideration the Integrated Innovation Strategy formulated by CSTI.

The Basic Plan for Agriculture, Forestry and Fisheries Research defines a specific R&D target by both research area and commodity, and it prioritises research to quickly solve problems faced by producers. It also sets the direction of the medium- to long-term research agenda, including on global warming. The current basic plan sets 32 priority targets related to industry-academia-government collaborative research. The examples include seed development in collaboration with ICT and robotic technology, and the development of value chains for agricultural, forestry and fisheries products.

NARO is a central player in public R&D projects based on the Basic Plan for Agriculture, Forestry and Fisheries Research. Based on five-year operational objectives set by MAFF, NARO formulates a medium- to long-term plan as well as annual operation plans. NARO set four priorities for the current medium-term operational plan (2016-20), namely: 1) strengthening the capability and management of production sites; 2) developing new plant cultivars and agricultural products through genomic and agri-biological research and new industrial innovation; 3) producing high-quality agricultural products and food while ensuring safety and reliability; and 4) solving environmental problems and using local resources sustainably.

The research projects in the Basic Plan are funded mainly from the government budget allocated to MAFF. In FY2017, JPY 98.4 billion (USD 877.2 million) was allocated for research, or 7.5% of the overall government budget allocated to science and technology promotion.

The budget of NARO and other agriculture-related national public research institutions is comprised of operational cost subsidies and research funds. Operational cost subsidies are institutional funding that cover the expenses of public research institutions to perform tasks commissioned by the government. This subsidy accounts for around 90% of science and technology promotion expenditure allocated to MAFF. The government also allocates its budget to project funding through a research fund. There are two research fund schemes; namely, project research contracts and competitive research grants. The topic of project

research contracts is pre-determined by MAFF, but applicants can propose research topics for the competitive research grants. In both cases, AFFRC is responsible for all operations, such as setting research subjects, allocation of budgets and selecting projects.

In FY2017, the project research contract and competitive research grant received JPY 4.1 billion (USD 36.5 million) and JPY 5.1 billion (USD 45.5 million) of budget, respectively, or 4% and 5% of science and technology promotion expenditure allocated to MAFF in 2017. A series of OECD country reviews on innovation, agricultural productivity and sustainability indicate that despite an increase in the project research contracts and competitive research grants, Japan's share of project-based funding in total funding for agricultural R&D remains one of the lowest (Table 5.1).

Table 5.1. Share of project-based funding in total funding for agricultural R&D

0-20%	Argentina, Brazil, China, Korea, Japan
20-40%	Canada, Latvia, Turkey
40-60%	Australia, Sweden
60-80%	Columbia, Estonia, United States
80-100%	Netherlands

Source: OECD (2019[7]).

NARO and other public research organisations in agriculture are eligible for the external competitive research grant. For example, 66% of the competitive research grants NARO received in 2017 were from MEXT, while grants from MAFF accounted for 29% (MAFF, 2018[8]). However, competitive research grants account for only around 3% of NARO's total budget. Moreover, funding from the private sector to public agricultural research institutions such as NARO is negligible. In FY2017, NARO financed 88% of its budget from institutional funding from MAFF.

As public funding in agricultural R&D declines, prioritising research targets within public research and enhancing private investment in agricultural R&D has become an important point of the policy agenda. AFFRC and other national agencies have started new schemes for government-funded R&D projects and competitive research grants to increase incentives for the private sector to participate in R&D activities with universities or public research organisations, as well as to commercialise technologies and expertise acquired through R&D.

In 2018, MAFF introduced new selection criteria for project funding contracts, designated as for need-based R&D projects. First, inquiries were organised to ascertain the needs of farmers. Specifically, MAFF staff visited farmers and conducted hearings, inviting 300 participants to regional meetings. It also conducted opinion surveys to understand research needs. Second, funding was given only to a consortia of farmers, private companies, universities, research institutions, and other related organisations. Finally, the research agenda for project funding contracts is based on the opinions of 12 experts. In FY2018 and the supplementary budget of FY2017, 23 need-based research projects were selected.

Another type of project funding is available for projects that develop pioneering technology and solve medium- to long-term issues. Unlike the need-based project funding, this contract does not require a research consortium. In FY2018, three research topics were selected and included research on food distribution and smart breeding system using AI.

The experience of other OECD countries shows that demand-oriented agricultural research requires strong partnership with stakeholders. In some countries, farmers contribute to funding agricultural R&D through statutory or voluntary levies. This helps ensure that research adapts to their needs and will be widely adopted, and to channel public R&D expenditure into more pre-competitive R&D agendas. The Australian Research and Development Corporation (RDC) model, based on 50-50 co-funding by farmers and the government, channels a large part of agricultural R&D funding (Box 5.1). While organised by commodity sectors, some RDCs have wide coverage, including small and emerging industries (OECD, 2015[9]). The Federation of Swedish Farmers (LRF) created the Swedish Farmers' Foundation for Agricultural Research in 1996 as an independent legal organisation, receiving funding from both the LRF and the government. Every year it distributes about SEK 57 million (USD 6.7 million) to support agricultural-needs-driven research, of which about two-thirds goes to private sources.

Box 5.1. Co-financing model of agricultural R&D

Top Sector policy in the Netherlands

The Top Sector policy limits the granting of public funds to public-private partnerships within top sectors and gives industry a leading role in setting innovation agendas. One original objective of the Top Sector policy was to leverage business-sector R&D and increase the applicability of public research. The policy was also expected to promote closer co-operation between knowledge institutes, public authorities and business.

Public funds have to be matched with an equivalent contribution from the private sector (50-50), which can be in kind (access to facilities) or financial, in which case it can benefit from public support (investment or tax rebates). In the Top Sector policy, the business community sets the agenda for R&D investments in its field together with the government and scientists. The government invites businesses and scientists to draw up action plans, which serve as a base for developing concrete lines of action. Each top sector created one or more Top Consortia for knowledge and innovation, where entrepreneurs and researchers work together in innovative products and concepts. The government is an observer on the board.

Australian Rural Research and Development Corporation model

The RDC model of co-financing rural R&D activities was established in 1989. It places interaction between public R&D and agricultural industries at the heart of rural innovation systems, and channelled a significant share of Australian government spending on rural R&D in recent years.

Under the RDC model, the Australian government matches dollar for dollar industry R&D funds collected from primary producers via statutory or voluntary levies, with maximum matching contribution per year of 0.5% of an industry's gross value of production.

This co-investment model generates greater spending capacity, ensures that producers who benefit from research contribute to its costs, ensures that research is of practical value, and facilitates greater and faster uptake of research outputs.

Originally competitive and market-driven, the model became more collaborative and inclusive. However, it does not directly integrate agri-business processing and retailing stakeholders in funding decisions, potentially limiting capacity to respond to demand for product and process development along the food chain. Similarly, its design is more adapted to marginal improvements than fundamental changes in production systems and resource management. Past evaluations questioned the complex arrangements and unclear funding flows, making evaluation difficult.

Source: OECD (2015[10]), OECD (2015[9]).

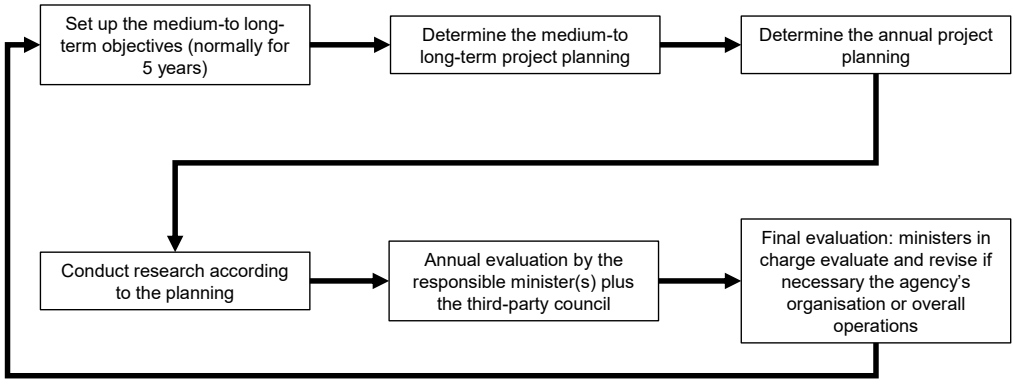
Monitoring and evaluation

Agricultural R&D projects with public funding or in government research organisations are evaluated at four stages in accordance with the General Guidelines for R&D Evaluation: 1) preliminary evaluation at the planning and proposal stage; 2) interim evaluation at the middle stage for improvement or revision; 3) final evaluation of the extent to which the project was achieved, the significance of the outcome obtained, the outcome's practical application and commercialisation, and the efforts required for such purposes; and 4) follow-up evaluation after completion of the project to see what has been achieved. An external evaluation committee composed of farmers, members of the private sector, and other relevant actors is in charge of the evaluation.[3]

Follow-up investigations on how farmers adopted new agricultural technologies, their impact, and feedback to developers are important to the process of innovation. Since 2007, AFFRC conducts an annual selection of new technologies and crop varieties among the research outcomes achieved, as well as follow-up surveys after two or five years of development through prefectural extension services.

In addition to the evaluation of R&D projects, national research and development agencies such as NARO are evaluated as an institution by the ministers in charge (Figure 5.2). NARO introduced a new evaluation system to reinforce the Plan-Do-Check-Act cycle since the latest medium- to long-term objective period (FY2016-FY2020). NARO set up the Office of Evaluation to handle performance evaluations and organise the evaluation committee by research pillar. More specifically, NARO set up an evaluation strategy council and an evaluation committee that includes external members to evaluate NARO's operation from diverse, multiple viewpoints. NARO modifies research subjects, research budget allocations, and human resource allocations based on the result of its evaluation. Additionally, overseas experts review the research subjects that involve international aspects. However, there is a potential risk that such strict research management may impede creation of knowledge from a long-term perspective.

Figure 5.2. Evaluation system for national R&D agencies in Japan



Source: MIC (2018[11]), *Evaluation System of Independent Administrative Corporations*, http://www.soumu.go.jp/main_sosiki/hyouka/dokuritu_n/index.html.

5.3. Investment and outcomes in agriculture and food R&D

Trends in public and private R&D investment

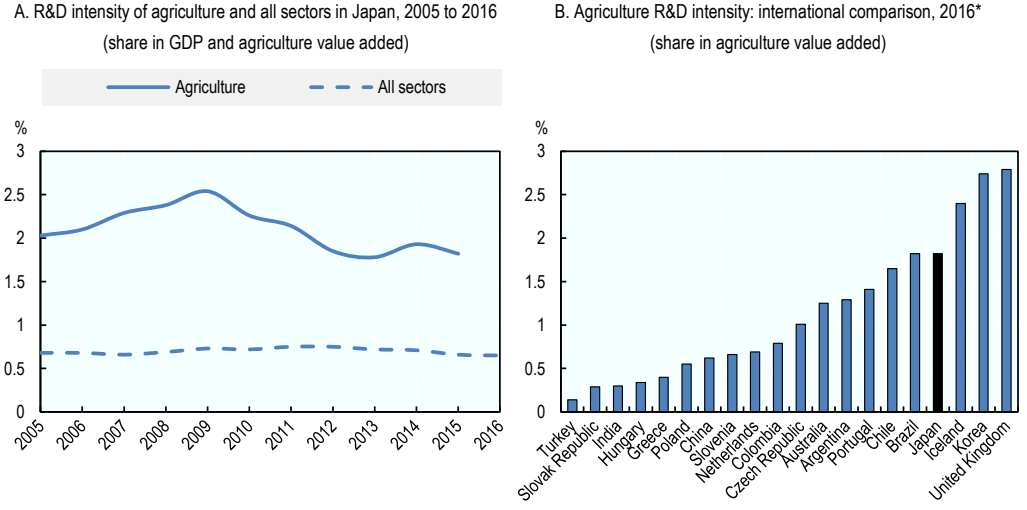
Japan maintains a relatively high level of R&D investment, with the ratio of Gross Domestic Expenditure on R&D (GERD) to GDP staying in the upper 3% in 2007-16. While GERD is the sum of public and private R&D investments, private investment accounts for around 70% of GERD during the last ten years, followed by universities (20%) and public institutions (7%). Around 70% of private R&D investment is concentrated on large enterprises with capital of JPY 10 billion (USD 82.6 million) or more, and 98.3% of private R&D expenditure was self-financed in 2015.

In comparison, the public sector accounts for the majority of agricultural R&D investment in Japan. The intensity of public R&D investment is higher than that of other sectors, but private investment was only 0.03% of agricultural value added, much lower than for most OECD countries (Figure 5.3). In the food and beverage industry, while the intensity of private R&D investment is lower than other sectors, it is higher than in other OECD countries (Figure 5.4). The ratio of government appropriations or outlays for agricultural R&D to gross agricultural output peaked in 2009 at 2.54%, and then continued to decline until 2013. The intensity of public investment in agricultural R&D nevertheless remains higher than in most other OECD countries.

To date, agricultural R&D is mainly conducted by public research organisations such as NARO. Researchers in agriculture tend to be less conscious of commercialising their research outcomes than other sectors. A limited collaboration of universities and public research organisations with industry results in the situation that a majority of agricultural R&D projects targets improvement or modification of existing technologies and the extension of outcomes to producers.

Figure 5.3. Intensity of public agricultural R&D investment

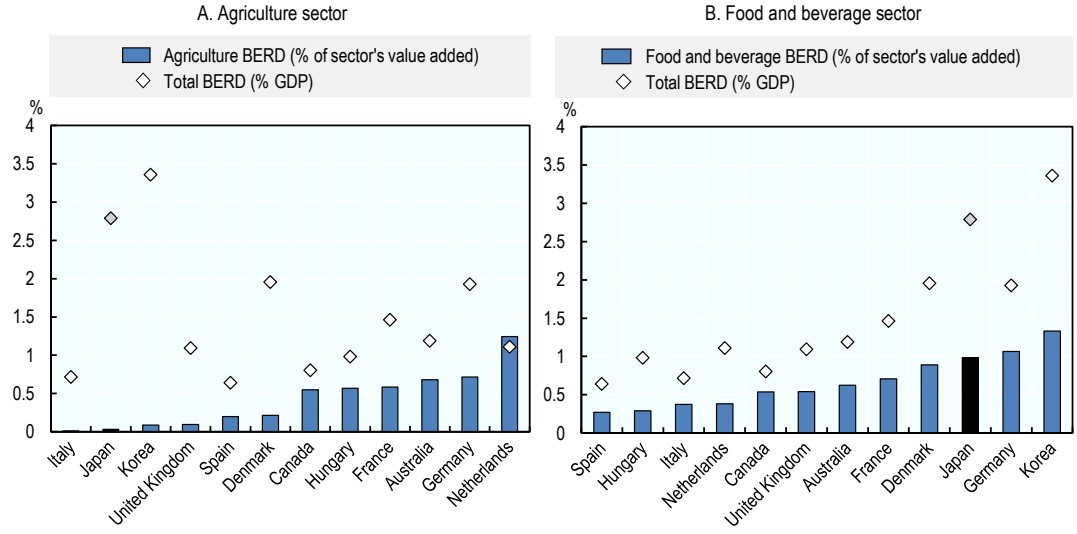
Government budget appropriations or outlays for R&D as a share of value-added



Note: * or latest available year
Source: OECD (2016[12]), *OECD Science, Technology and R&D Statistics* (database), https://doi.org/10.1787/48768e54-en; OECD (2017[13]), *OECD.Stat* (database), https://stats.oecd.org; ASTI (2017[14]), *Agricultural Science and Technology Indicators 2017* (database), https://www.asti.cgiar.org/data.

StatLink http://dx.doi.org/10.1787/888933957857

Figure 5.4. Business Expenditures on R&D (BERD) in the agriculture and food and beverage sectors



Note: The figures are based on data for the latest available year for each country: 2013 and 2014 for the agriculture sector (panel A), except 2010 for Canada; 2010 for the food and beverage sector (panel B), except 2009 for Korea and 2006 for Australia.
Source: OECD (2016[12]), *OECD Science, Technology and R&D Statistics* (database), https://doi.org/10.1787/48768e54-en; OECD (2017[13]), *OECD.Stat* (database), https://stats.oecd.org.

StatLink http://dx.doi.org/10.1787/888933957876

R&D outcomes

The outcome and impact of innovation can be examined via proxy data such as the number of patents issued, and the number of scientific papers published and cited (OECD, 2015[15]). The number of patents in the agri-food sector in Japan is the second highest, after the United States (Table 5.2). However, the number of patents issued is not necessarily a comprehensive indicator of the performance of innovation systems (OECD, 2018[16]) because not all technological components of innovation systems hold patents, and those that do are not always used effectively.

The number of scientific papers on agricultural subjects published by research institutions in Japan has decreased in the last decade, while it increased in the People's Republic of China (hereafter "China") and Korea over the same period. However, Japan's share in global publications on agriculture remains higher than the average of OECD and EU15 countries.

Table 5.2. Japan's agriculture and food R&D outcomes in international comparison, 2007-12

	Japan	Korea	China	United States	Netherlands	BRIICS average	OECD average	EU15 average
Specialisation: agri-food science outputs as a share of country's total, %								
Patents	**3.5**	4.3	2.8	6.8	8.8	3.8	5.6	6.6
Publications	**6.8**	6.1	5.1	6.7	6.9	12.3	9.4	8.1
Citations	**6.9**	5.8	6.8	6.3	6.4	12.0	11.9	10.8
Contribution to world agri-food science output, %								
Patents	**3.7**	1.2	1.0	10.8	1.0	0.3	0.7	0.6
Publications	**4.3**	1.8	8.3	18.3	1.6	3.1	2.0	1.8
Citations	**4.2**	1.4	6.7	27.2	2.8	1.8	2.4	2.4

Source: SCImago (SJR) (2018[17]), (2014).

Clarivate Analytics, a data analysis firm, defines Essential Science Indicators (ESI) as the number of outstanding papers ranked among the top 1% internationally based on the number of citations in pertinent fields. The ESI database classifies the entire field of science into 22 categories. Japan ranks eighth worldwide in the fields of botany and zoology, which are closely related to agriculture (2007-17). Within Japan, public research organisations (i.e. national research and development agencies) rank high in botany and zoology compared with other fields. NARO and JIRCAS ranked third and seventh respectively among institutions in Japan.

5.4. Creating knowledge markets and networks

Public-private collaboration in agricultural R&D

Innovation in agriculture today is more dependent on the technologies developed outside agriculture such as genetics and digital technologies, requiring collaboration between public and private actors across the sectors. OECD countries apply a variety of institutional and funding mechanisms: public funding to foundations, institutions, and research projects requiring public and private participation and co-funding.

For example, USDA's Agricultural Research Service engages in R&D partnerships to address major challenges in agriculture. An agriculture-specific institution, the Foundation for Food and Agricultural Research, was created in 2014 as an independent, board-driven, non-profit organisation, to foster collaboration between government, university, industry, and non-profit researchers (OECD, 2016[18]). Public-private partnerships (PPPs) are based on Co-operative Research and Development Agreements, which allow both parties to keep research results confidential for up to five years under the Freedom of Information Act, shared patents, patent licenses and permits where one partner can retain exclusive rights to a patent or patent license. The Netherlands goes furthest in placing PPPs at the heart of R&D strategy. However, by giving industry a leading role in setting innovation agendas, this approach risks focusing public funds on low-risk and short-term R&D activities, away from research with more fundamental public goods aspects that need to be addressed for long-term challenges.

There is significant room to strengthen the links between public and private AIS actors in Japan. In 2016, MAFF launched the Council of Industry-Academia-Government Collaboration in the Field for Knowledge Integration and Innovation (FKII). The Council

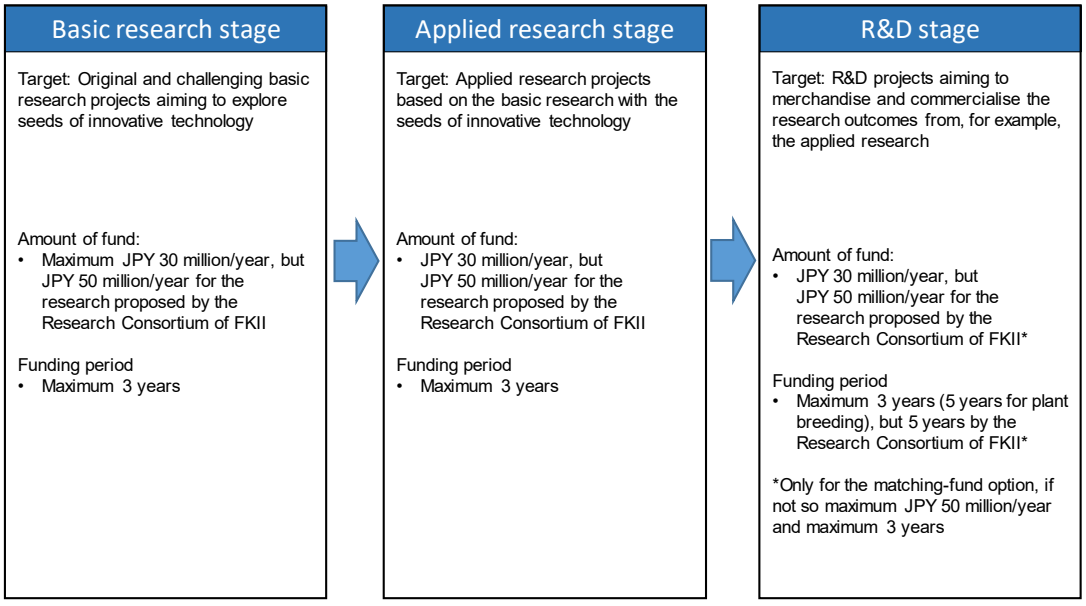
consists of private companies, universities, and research institutions from non-agricultural sectors, and it serves as a platform for exchanging information (Box 5.2). The seminars and workshops organised in different regions assist Council members with shared challenges to form a cross-sectoral R&D platform and conduct joint research.

In 2018, MAFF introduced a new competitive research grant to give preference to research proposed by the Research Consortium formed by FKII (Figure 5.5). To promote collaboration of R&D across sectors, research groups eligible for this competitive grant must comprise organisations from at least two of the following categories of actors in case they conduct research at either the applied or adaptive research stage:

- *Category I:* Prefectures, municipalities, prefectural research organisations, independent regional administrative agencies.
- *Category II:* Universities, Inter-University Research Institute Corporations.
- *Category III*: Incorporated administrative agencies, government-affiliated special corporations, government-authorised corporations.
- *Category IV*: Private companies, non-profit organisations, co-operatives, farmers, fishermen and foresters.

Proposals from the Research Consortium of FKII have advantages, such as higher upper grant limits, extension of research periods, and additional consideration given during selection. Furthermore, to encourage private-sector investment and promote the commercialisation of research outcomes, a matching funds scheme is used in the adaptive research stage, in which private business finances at least half the research expense.

Figure 5.5. Scheme for new competitive research grants in Japan



Source: MAFF (2016[19]), *Field for Knowledge Integration and Innovation: Organization and Evolution Since Fiscal Year 2016*.

Box 5.2. Platform for open innovation in agriculture

The Council of Industry-Academia-Government Collaboration of the Field for Knowledge Integration and Innovation (FKII) aims to be a cross-sectoral platform of people, information, and funds for agricultural research. It is composed of three levels:

- *The Council of Industry-Academia-Government Collaboration* that exchanges information among member,s such as producers, private companies, universities, and research organisations.
- *A R&D Platform* that engages in collaborative research led by a designated research director.
- *A Research Consortium* that performs joint research.

As of May 2018, FKII included 1 751 organisations and 690 individual members in the council, and launched 118 R&D platforms.

Cross-sectoral collaboration through FKII is expected to promote the commercialisation of new technology and enhance incentives for private investment in agricultural R&D. Most private companies engaged in R&D are interested only to the merchandising or commercialisation of their own products or services. Universities and public research organisations have played a central role in basic and applied research, which requires a long term horizon before results can be commercialised.

FKII is intended to connect each R&D stage with diverse actors of the Agricultural Innovation System. Financial support through FKII focuses on the commercialisation of research output from basic to applied over a three- to five-year period.

BRAIN, the institution managed by NARO, provides support for R&D via a matching fund method that is designed to encourage collaboration with private-sector companies. A total of 17 agricultural, forestry and fisheries projects were adopted in model projects selected from public proposals in 2016-17. These include, "development of a model plant factory system for the Asian monsoon region" and "development of an AI robot-operated greenhouse."

Source: MAFF (2016[19]), *Field for Knowledge Integration and Innovation: Organization and Evolution Since Fiscal Year 2016*.

Intellectual property protection

Because of the fragmented structure of agricultural production, comprising relatively small operations producing multiple, homogeneous products, few farms are willing to invest in private R&D. Furthermore, because of the biological nature of agriculture, improved crop seed and animal breeds are self-replicating. This complicates the ability of innovators to protect intellectual property. In addition, many agricultural technologies tend to be geographically specific, meaning they do not transfer easily to other locations with different soil types, weather patterns, or topography. These features imply that unique policies to foster innovation in agriculture are required (OECD, 2016[18]).

Japan maintains a high level of intellectual property protection (Figure 5.6, Panel C). Patent protection increased rapidly in the 1980-90s, leading to a level of protection equivalent to that in the Netherlands or France from around the 1990s to 2000s (Figure 5.6, Panel A). According to the Plant Variety Protection Index created by Campi and Nuvolari (2013[20]),

Japan's score now stands at the same level as France, though lower than that of the Netherlands or the United States (Figure 5.6, Panel B).

Japan developed a comprehensive framework of Intellectual Property Rights (IPRs), including patent, trademark, plant variety, and GI protection systems (Table 5.3). While MAFF is in charge of plant variety and GI protection systems for agricultural goods, the National Tax Agency protects GI for Japanese liquor. Japan's Patent Office administers patents, trademarks, designs and utility models, and the Agency of Cultural Affairs protects copyrights.

In 1999, Japan introduced the Bayh-Dole system to its Industrial Technology Enhancement Act, drawing on the US Bayh-Dole Act, to allow private companies which receive project funding to own 100% of the intellectual property rights. The application of this measure is conditional on: 1) notifying the government when the research outcome is achieved; 2) licensing such IPR to the government for free in case when the latter needs it for public interest; and 3) licensing the IPR to a third party at the request of the government if the contractor has not used it within a reasonable time.

Table 5.3. Japan's legal framework for intellectual property protection in agriculture

Types of rights protected	Details	Protection period
GI Protection system	Protection of the names of agricultural, forestry or fisheries products or foods whose quality, reputation or other established characteristics is attributable to their place of production	Unlimited
Registration of plant variety	Right to exclusively utilise a new variety of plant	25 years
Trademark right	Right to exclusive use of names and marks for a product or service	10 years
Regional collective trademark	Right to exclusive use of a trademark consisting of a regional name and common (customary) name of goods and services	10 years
Patent right	Right to the exclusive use of an invention	20 years
Utility model right	Right to exclusive use of a device relating to the shape, structure or combination of goods	10 years
Design right	Right to exclusive use of a design consisting of shape, pattern or colours of goods that have a creative, aesthetic appearance	20 years

Source: MAFF (2014[21]), *Manual for Strategic Use of Intellectual Property Rights* (in Japanese).

In 2007, MAFF announced an integrated Intellectual Property Strategy with the aim to prevent technology outflow, promote brand management, and accelerate the use of intellectual property. The strategy was renewed in 2010 and 2015. The current strategy adds a new element to promote intellectual property management in ICT-related businesses, and in the seed and seedling industry.

While NARO and other public agricultural R&D institutions under MAFF hold a number of IPRs, these have not necessarily been well utilised by private companies or local governments. AFFRC recently strengthened IPR management within NARO by appointing full-time co-ordinators at regional agricultural research centres. They are expected to engage in: 1) promoting the use of intellectual property, including license grants; 2) collaboration with external experts in technology, business models and intellectual property management; and 3) promoting joint research with the private sector, including venture capital firms that undertake commercialisation of intellectual property.

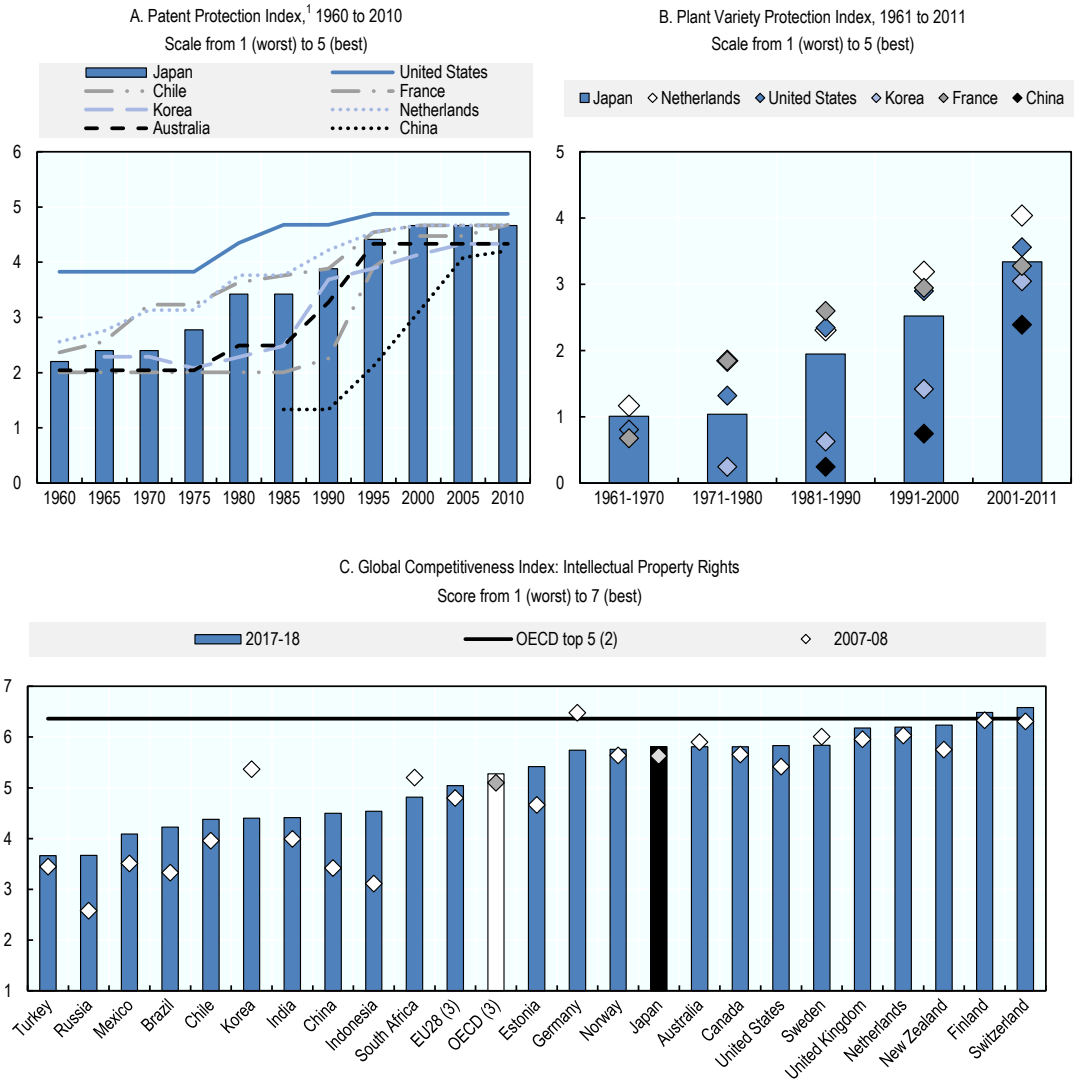
Japan is a member of major international treaties on intellectual property. These include the Paris Convention for the Protection of Industrial Property (1899), the Berne Convention for the Protection of Literary and Artistic Works (1899), the Patent Co-operation Treaty (1978), the Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks (2000), the Patent Law Treaty (2016), and the Agreement on Trade-related Aspects of Intellectual Property Rights (1995).

The International Convention for the Protection of New Varieties of Plants (UPOV Convention) was adopted in 1961 and amended in 1978 and 1991. The 1991 Act took effect in April 1998. Japan acceded the 1979 Act in 1982 and the 1991 Act in 1998. The International Union for the Protection of New Varieties of Plants (UPOV) aims to promote an effective system of plant variety protection with a view to encourage the development of new plant varieties. The UPOV Convention provides basis for member countries to encourage plant breeding by granting breeders an intellectual property right for the new plant varieties.

Japan provides plant variety protection system based on the Plant Variety Protection and Seed Act. Plant breeding is encouraged under the Act as it contributes to the development of agriculture. Around 800 new plant varieties are registered per year in Japan – the fifth largest number among UPOV members after the European Union, China, the United States and Ukraine in 2017 (UPOV, 2018[22]). Of those who hold plant breeder's right, 50% is seed companies, 25% is individuals and 15% is public sectors. This shows that various sectors engage in breeding activities in Japan.

Japan took the initiative to establish the East Asia Plant Variety Protection Forum (EAPVP Forum) in 2007. It is composed of ASEAN Member States, China, Korea, and Japan. Japan has been supporting EAPVP Forum activities in collaboration with the UPOV and UPOV members. The 11th EAPVP Forum Annual Meeting in August 2018 adopted the Common Direction of the 10-Year Strategic Plan; it aims to achieve that all Forum members which are also members of UPOV will serve as the basis for further harmonization and co-operation of plant variety protection in the region.

Figure 5.6. Intellectual property protection indicators



1. Overall index is the sum of indices for duration, enforcement, loss of rights, membership and coverage.
2. OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries in 2017-18 (Switzerland, Finland, Luxembourg, New Zealand and Netherlands).
3. Indices for EU28 and OECD are the simple average of member-country indices.

Source: (Panel A) Adapted from Park (2008[23]), "International Patent Protection: 1960-2005", *Research Policy*, No. 37. (Panel B) Campi and Nuvolari (2013[20]), *IP Protection in Plant Varieties: A New Worldwide Index (1961-2011)*, http://hdl.handle.net/10419/89567. (Panel C) WEF (2017[24]), *The Global Competitiveness Report 2017-2018: Full-data Edition*, http://reports.weforum.org/global-competitiveness-index-2017-2018/.

StatLink http://dx.doi.org/10.1787/888933957895

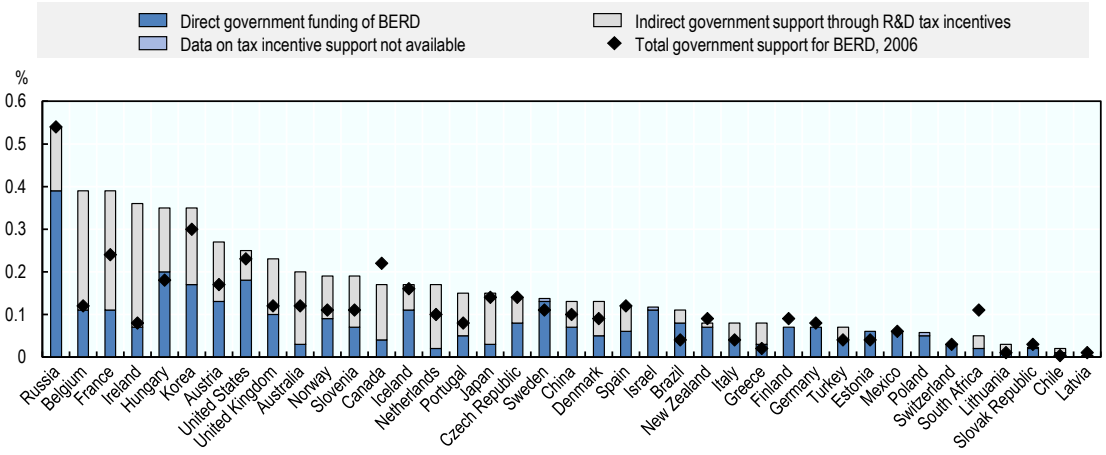
Preferential taxation and R&D

Japan has developed a tax credit system to allow enterprises to deduct certain R&D-related expenditures, and thus reduce the amount of corporate taxes. The total tax credit, when all available tax credits are applied, is capped at 40% of applicable corporate income taxes. As of April 2017, in addition to R&D in manufacturing, ICT-related service development

became eligible for tax credit. Developing agriculture support services using ICTs, such as agricultural data collection and analysis, is one form of R&D eligible for tax credit. Overall, indirect support through preferential taxes accounts for most government support to private R&D in Japan (Figure 5.7).

Figure 5.7. Direct government funding and tax support for business R&D, 2015

As a percentage of GDP



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: OECD (2017[25]), *Innovation in Firms*, https://doi.org/10.1787/sti_scoreboard-2017-graph135-en.

StatLink http://dx.doi.org/10.1787/888933957914

R&D tax credits apply to all companies irrespective of its size, but grant higher tax incentives, such as a higher percentage of R&D expenditure deduction, to SMEs with a capital of JPY 100 million (USD 891 000) or less. Moreover, the R&D tax system provides additional incentives to increase R&D expenditure, or to maintain high levels of R&D expenditure in addition to performing collaborative R&D. For example, 30% of collaborative R&D expenditure with national research institutions and universities (20% in the case of other research partners) is deductible from taxable corporate income.

Besides preferential tax treatment, the Small Business Innovation Research programme supports R&D and the commercialisation of its outcomes by SMEs. An SME that receives certain grants from the government is eligible for preferential loans from JFC to cover capital spending or the working capital required to commercialise the technology developed; they are also eligible for reduced patent fees.

5.5. International R&D collaboration

The benefits of international R&D collaboration for national innovation systems stem from the specialisation it allows and from international spill-overs. International collaboration in agricultural R&D is particularly effective in cases where a large initial investment is required to finance R&D that produces solutions for global issues (e.g. climate change) or transboundary issues (e.g. spread of animal diseases).

Promoting international joint research

Despite a higher number of patents in the agri-food sector, the share of patents jointly owned with foreign researchers is only 5.2% of the total Japanese-owned patents. Similarly, the share of internationally co-authored papers in the field of agriculture and food in Japan is lower than the OECD average (Table 5.4). Low levels of international co-operation in R&D are not limited to the agri-food sector. Japan ranked 16th out of 24 OECD countries in a 2008-10 study on the share of external knowledge sources for innovation (OECD, 2013[4]). Only 0.5% of the R&D carried out in Japan in 2013 was financed from abroad.

Table 5.4. Japan's agri-food R&D co-operation, 2006-11

Agri-food R&D outputs with foreign co-authors, as a share of economies' total agri-food R&D outputs, %

	Japan	Korea	China	United States	Netherlands	BRIICS average	OECD average	EU15 average
Agricultural science collaboration								
Patents	5.2	5.8	21.8	14.3	27.1	23.7	11.8	36.2
Publications	31.5	31.4	23.6	36.4	65.1	38.9	50.8	57.7

Source: OECD (2014[26]), *OECD Patent Database* https://doi.org/10.1787/patent-data-en; SCImago (SJR) (2018[17]), *SCImago Journal & Country Rank*, http://www.scimagojr.com.

To accelerate international co-operation in agricultural research, MAFF has been assisting Japanese research agencies since 2014 in signing Memorandums of Understanding (MoUs) with foreign or international research organisations. As a result, JIRCAS and NARO have so far concluded 121 MoUs and 72 MoUs, respectively, with more than 40 countries. In 2017, AFFRC entered into a Memorandum of Cooperation on joint research with the Russian Science Foundation and the Ministry of Agriculture and Rural Development of Israel. In 2018, NARO dispatched a liaison scientist to Wageningen University and Research in the Netherlands in an effort to develop networks with the university as well as other EU research institutions.

Technology in developing countries and responses to global issues

To achieve the Sustainable Development Goals set by the United Nations General Assembly, MAFF makes financial contributions to international research organisations as well as research projects by domestic research organisations that address global issues such as climate change.

JIRCAS is the only Japanese national research organisation explicitly mandated by law to engage in technological experiments and research related to agriculture, forestry and fisheries in tropical, subtropical or other developing regions overseas. At present, JIRCAS engages in 14 international joint research projects in four programmes. These cover the development of agricultural technologies for sustainable environment and natural resource management in developing regions, technology development for stable production of agricultural products in the tropics and other adverse environments, the development of high-value adding technologies and utilisation of local resources in developing regions, and the collection, analysis and dissemination of information to grasp international trends in agriculture, forestry and fisheries.

NARO also focuses on the resolution of environmental issues and the sustainable use of local resources in developing countries. For instance, in co-operation with the International Rice Research Institute and other Philippine, Thai, Vietnamese and Indonesian research

institutions, NARO engages in research on water-saving cultivation technology to reduce greenhouse gas emissions from paddy fields in various parts of Asia (Greenhouse Gas Mitigation in Irrigated Rice Paddies in Southeast Asia). NARO also contributes to the development of agricultural technology and capacity development in developing countries by sending experts and researchers.

In addition to the activities mentioned above, the Science and Technology Research Partnership for Sustainable Development programme has promoted since 2008 a large-scale programme to promote joint research between Japan and developing countries. This is co-managed by JST and the Japan International Co-operation Agency (JICA). The budget is approximately JPY 100 million (USD 891 000) per project per year. To date, 133 projects have been implemented in 50 countries.

Participation in international frameworks for agricultural research

Participation in international frameworks for agricultural research will help Japan develop an international network of researchers and to introduce outside expertise in domestic agricultural research. The country's participation in the G20 Meeting(s) of Agricultural Chief Scientists (MACS) is one such initiative. Chief scientists and high-level research administrative officials of G20 countries and international research organisations discuss research priorities, thereby strengthening collaboration between countries and international research organisations. Representatives from AFFRC and JIRCAS participate in all MACS meetings, and Japan hosted the eighth meeting held in Tokyo in April 2019. Japan also participates in the OECD Co-operative Research Programme to promote personnel exchanges between Japanese and overseas researchers by supporting conferences held in Japan, as well as dispatching Japanese researchers overseas and accepting foreign researchers to Japanese research organisations.

In 2017-18, Japan chaired the Global Research Alliance on agricultural greenhouse gases, an international network of 50 countries focused on reducing greenhouse gas emissions in agriculture. Japan assigned funded projects to the Consultative Group on International Agricultural Research (CGIAR) to promote international research in agriculture, forestry and fisheries to resolve global issues. JIRCAS engages in joint research with the International Rice Research Institute (IRRI), the International Maize and Wheat Improvement Center, the International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), World Agroforestry Centre and the Africa Rice Center, all of which are research organisations of CGIAR. One JIRCAS researcher is part of the CGIAR System Management Office.

Japan and CGIAR actively collaborate in Public-Private Partnerships (PPPs) in an effort to link private-sector capabilities to the development, extension and improvement of technology. For example, the Nutrition Japan Public Private Platform is a government and private-sector collaboration that promotes food supply businesses and improves nutrition in developing and emerging countries by taking advantage of Japanese technologies and knowledge. Other examples of PPPs include: collaboration between Bioversity International's Kenya office and Nissin Food Products Co. Ltd. for the development of instant noodles; IITA and Taiyo-Industry Co. Ltd. for the development of technology to produce fishing feed; IITA and Honda Motor Co. Ltd. for the introduction of small agricultural machinery; and CIAT and Ajinomoto Co. Inc. for the supply of disease-resistant cassava.

As a member of the executive committee of the Coalition for African Rice Development and the Initiative for Food and Nutrition Security in Africa, JIRCAS has built international

research networks for rice blast and soybean rust diseases, and collaborates with international organisations and African countries to solve food and nutritional problems in Africa. NARO also participates in the Global Strategic Alliances for the Co-ordination of Research on the Major Infectious Diseases of Animals and Zoonoses International Research Consortium.

The Japan Intellectual Support Network in Agricultural Sciences (JISNAS) was created in 2009 to promote collaboration among young researchers at universities that participate in international co-operation in the field of agronomy and to increase their partnerships with JIRCAS and JICA. Currently, JISNAS has 49 members composed of domestic universities and associations. MEXT and MAFF also participate in JISNAS as observers.

5.6. Key points

- Innovation policy is moving beyond supply-driven approaches focused on R&D and specific technologies towards a network-based setting, in which a more inclusive, interactive, and participatory approach fosters greater innovation in response to emerging and pressing challenges facing the food and agriculture systems. This means that farmers and their organisations, extension services, research institutions and universities, vocational education centres, agri-business companies, and the government interact and participate in the innovation process, jointly generating, learning and using knowledge.
- Despite efforts to engage the private sector, public research institutions continue to play a major role at every stage of agricultural R&D in Japan, with the exception of certain farm inputs such as machinery and chemicals. In principle, public agricultural research should concentrate on pre-competitive research areas with medium- to long-term perspectives that are not specifically tied to commercial production. Further clarification of the role of public agricultural R&D would harness the participation of a wider range of actors in the innovation process and increase private investment in agricultural R&D.
- While project-based funding increased, institutional funding to NARO and other public research institutions accounts for a large part of the agricultural R&D budget. NARO finances around 90% of its budget through institutional funding from MAFF. The share of institutional funding in the public agricultural R&D budget remains particularly high in Japan.
- Across OECD countries, efforts to improve the governance of the agricultural innovation system focus on developing more coherent and longer term strategies for innovation in food and agriculture, involving stakeholders more formally and at earlier stages, and strengthening evaluation frameworks. Efforts to integrate farmers in the innovation process are growing in some countries.
- Japan strengthened the engagement of farmers and other stakeholders in R&D planning, implementation and evaluation. Going forward, developing co-financing schemes for agricultural R&D investment with producers would allow the agricultural R&D system to be more demand driven. Co-financing schemes also allow the government to channel more funds to medium- and long-term research while boosting overall spending capacity for agricultural R&D. However, individual producers are not able to finance R&D projects and have little incentive to do so as the benefits of R&D accrue to other farmers in the same sector. Building

co-funding schemes with producers requires a legal and fiscal system that encourages producers to form industry groups to fund R&D projects.

- Japan has strengthened the planning and evaluation systems of public research institutions, including the preparation of annual project plans and annual evaluations by the relevant ministries and third-party council. While strict research management is needed to monitor project progress, the annual process of evaluation could impede the long-term research agenda and discourage other AIS actors from collaborating with public research institutions.
- As NARO's regional centres are mandated to perform demand-oriented research in collaboration with regional producer groups, their role and the role of prefectural agricultural research stations converge with Japan's AIS. National and subnational regional agricultural research organisations could consolidate their efforts by improving co-ordination between national and regional research organisations and clarifying the role of each.
- Innovation in agriculture in agriculture today is more dependent on the technologies developed outside agriculture, such as genetics and digital technologies. This requires collaboration between public and private actors across sectors, and Japan needs to further strengthen the interconnections between AIS actors across sectors. While FKII and tax incentives for research collaboration are useful initiatives in this direction, Japan should remove the remaining impediments to cross-sectoral collaboration and further integrate agricultural R&D system with the economy wide innovation system.
- International research collaboration in agriculture strengthens Japan's own innovation system as it allows specialisation and gains from international spill-overs. It is also important to address global challenges such as climate change and transboundary issues. However, the degree of international co-authorship in agri-food R&D outputs in Japan is lower than the OECD average.

Notes

[1] The first SIP in 2014-18 selected 11 projects, one of which was to develop technologies for creating next-generation agriculture, forestry and fisheries. The second SIP, 2018-22, selected 12 projects, including technology for smart bio-industry, expected to promote innovation in the field of agriculture. The project aims to develop a smart food chain that will enable efficiency by using AI, ICT or other means.

[2] The latest Basic Plan for Agriculture, Forestry and Fisheries Research covers the 2015-25 period. The process of preparation began in February 2014 with seven regular AFFRC board members and three special members selected from consumers and mass media. AFFRC organised more than 150 workshops, conducted opinion surveys and interviews with private companies and universities. The information collected was discussed in the final version of the basic research plan, published on 31 March 2015.

[3] National R&D agencies including NARO are evaluated by the responsible ministers in accordance with the uniform governmental guidelines established by MIC. In the case of NARO, the Ministers of MAFF and MOF are in charge of evaluation. AFFRC takes the opinions of the external evaluation committee into consideration and gives guidance on revisions if necessary. At the end of a medium- to long-term objective period, the ministers in charge evaluate and revise the R&D agency's organisation and overall operations.

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Chapter 6. Human capital development in Japan's agriculture

Empowering people to innovate is one of the five priorities for government action identified in the OECD Innovation Strategy. People generate ideas and knowledge that power innovation, and they apply this knowledge and the resulting technologies, products and services in the workplace and as consumers. Innovation requires a wide variety of skills, as well as the capacity to learn, adapt or retrain, particularly following the introduction of radically new products and processes. Fostering the skills of farmers to innovate, to solve new problems and to engage with other stakeholders is at the heart of AIS and the improvement of education and training enables AIS to function effectively. Empowering people to innovate relies not only on broad and relevant education, but also on the development of wide-ranging skills that complement formal education. This chapter presents an overview of the development of agricultural education, extension and advisory system in Japan, and of the agricultural policies currently in place.

6.1. Changing skill needs for agriculture in Japan

Agriculture in Japan has been suffering from an ageing farm population and lack of interest among younger generations to farm as a profession. The rapid retirement rate of many older farmers over the last decade has nevertheless created opportunities for young farmers to expand their operations and bring fresh capital to the sector. Large, corporate farms have also increased their role in agriculture, including in rice farming. Unlike traditional family farms, the management of corporate farms often separates day-to-day agricultural production operations from farm management decisions, and experts in various fields such as agricultural production, processing, marketing, IT and financial and human resource management are regularly hired.

The skills and qualifications required today for a farm manager are very different from those of the past and will continue to evolve with the rapidly changing economic, technological and social conditions around agriculture in Japan. Innovative farming technologies require greater professional skills and call for new capacities if farmers are to work effectively. With the development of modern agricultural value chains, farm managers are increasingly required to acquire entrepreneurial and digital skills in order to develop integrated business plans beyond agricultural production; this includes making use of external resources such as professional farm advisory services.

Innovation in agriculture today is increasingly dependent on technology and skills from other sectors, thus requiring that farmers collaborate with a diversity of public and private stakeholders. The capacity of the food and agriculture sector to innovate also depends on its ability to attract skilled labour. Improved remuneration and working conditions in agro-food jobs, relative to competing sectors, is an important factor, but this sector must develop policy and market conditions that are in favour of entrepreneurship.

Despite the mechanisation of major farming operations, the sector depends on seasonal labour. There is a clear shortage of skills and labour in Japan as evidenced by the more than 1.6 job offers per job applicant since May 2018. The 2015 Manpower Talent Shortage Survey found that 83% of Japanese employers struggled to fill vacancies, the highest level among the 42 participating countries, for which the average was 38% (ManpowerGroup, 2015[1]). Due to the high competition with other sectors, meeting temporary labour demands has become a major constraint (Box 6.1).

Box 6.1. Perception of challenges and opportunities by Japanese farmers

In 2017, MAFF conducted an online survey on how farmers less than 50 years old managed their agricultural business and their expectations for the future. When asked what problems they faced (multiple answers allowed), 47% of respondents identified manpower shortages as the biggest problem, followed by inadequate selling prices relative to the product quality. Lack of technical skills (32% of respondents replied) ranked fourth amongst all farmers, but first among crop farmers. New farmers tended to lack technical skills or faced difficulty in financing, and labour shortages become more problematic when they expanded their farm operations.

Another question (multiple answers allowed) focussed on future business strategies. Increasing yields was most frequently cited as the preferred strategy (71% of respondents), followed by improving quality and branding (53%). Introducing IoT and other emerging technologies, and collaboration with other industries become more important the larger the farm size.

Source: MAFF (2018[2]), *Annual Report on Food, Agriculture and Rural Areas in Japan FY 2017*, http://www.maff.go.jp/e/data/publish/attach/pdf/index-93.pdf.

The mismatch between supply and demand of skills limits the capacity of the sector to develop and uptake innovation. Responding to the evolving need for skilled labour in modern agriculture requires retraining and regular adjustment of agricultural education and training programmes. In this process, some countries tried to identify the skill priorities in the sector with the participation of stakeholders. For example, Australia has implemented since the late 2000s a series of initiatives to improve the quality of agricultural technical-vocational education and training to meet the demands of the labour market. The Australian agro-food industry also announced its skill priorities and strategies for action (Box 6.2).

Box 6.2. Australia's initiative to identify skill priorities and strategies in the agro-food sector

The level of available skilled labour supply in the agro-food industry is a continuing concern in Australia. For example, in general only 75% of vacancies are filled in agriculture and horticulture occupations and in 2013-14 of a total of ten applicants per vacancy, only two were suitable for the proposed vacancy.

Agrifood Skills Australia, one of 11 Australia's Industry Skills Councils mandated to link the industry and educators, released the agro-food industry's vision of skill priorities and strategies for action. This is a broad framework spanning from business capacity to jobs and the promotion of skills. It seeks to attract a new skilled generation, enhance and make better use of the knowledge and skills of the existing workforce. In addition to issues common to many sectors, this framework emphasises the need to tackle the specific challenge of encouraging students to opt for agro-food careers. It also stresses the importance of exploiting the potential of on-the-job training through informal education, reflecting the important role of acquired knowledge in agriculture.

Source: OECD (2015[3]), *Innovation, Agricultural Productivity and Sustainability in Australia*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, https://doi.org/10.1787/9789264238367-en.

6.2. Agricultural education

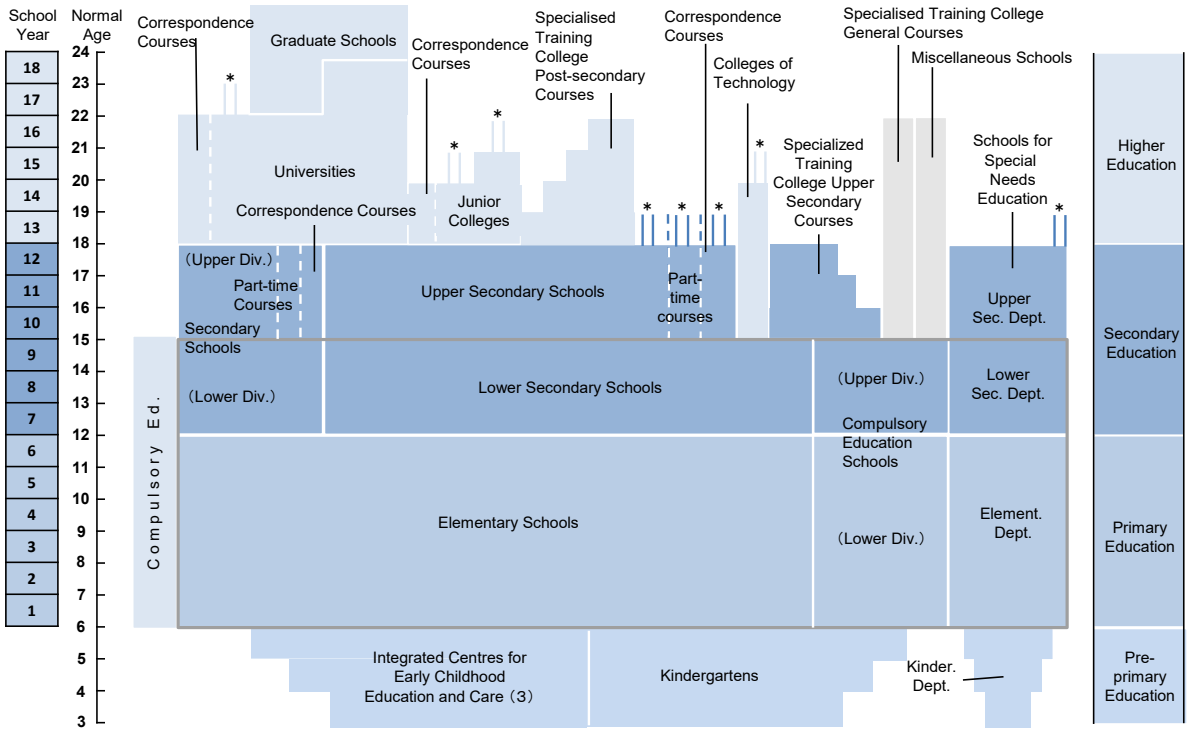
Overall, Japan achieves high levels of performance and equity in education. In the OECD Programme for International Student Assessment, it continues to rank in the top performing group in reading, and scientific and mathematical literacy. The high ratio of students who complete higher education leads a large number to join the intellectual labour force.

Japan is a top performer in developing skills, but falls short in using those skills at work, an important aspect of a country's economic growth and productivity. Japan ranked first in the OECD Survey of Adult Skills in both literacy and numeracy of workers, while use of reading skills in the workplace is close to the OECD average, and use of numeracy skills is below average. The results of the survey underline the need to move from a reliance on initial education to fostering lifelong, skills-oriented learning (OECD, 2013[4]). While more than two-thirds of Japanese workers believe they need training, the survey finds that participation in lifelong learning in Japan is in the bottom quartile of countries.

Moreover, the share of workers in Japan who find education and training useful for their job is much lower than the OECD average (OECD, 2018[5]). Only 18% of Japanese believe that school helped them develop initiative and an entrepreneurial attitude, the lowest ranking among OECD countries and well below the OECD average of 52% (OECD, 2013[6]). Japan's educational system is presently in transition towards developing

competency, and mobilising the necessary knowledge, skills, attitudes and values in order to meet today's complex demands beyond acquisition of knowledge and skills (OECD, 2018[7]).

Figure 6.1. The education system in Japan



Notes: 1. * indicates specialised courses
2. Higher education schools, secondary education school/latter period courses, universities, junior colleges, and special needs schools can have separate courses with course terms of 1 year or more.
3. A child aged from 0 to 2 years old can attend the centre because it functions as school and child welfare.
4. Age and admission requirements for Specialised Training College General Courses and Miscellaneous Schools are not defined uniformly.
Source: MEXT (2019[8]) *Principles Guide Japan's Educational System*, http://www.mext.go.jp/en/policy/education/overview/index.htm .

The Japanese educational system emphasises general education, and the share of agriculture, forestry, fisheries and veterinary subjects in upper-secondary education is the highest among OECD countries (OECD, 2018[9]). However, education in agricultural high schools and agricultural faculties at universities or junior colleges is not necessarily oriented towards developing skills of future farmers. In most cases, the mission of agricultural high schools is to provide a wide-ranging education related to agriculture. Agricultural university faculties teach agricultural sciences. The share of graduates from agricultural high schools and agricultural faculties in universities or junior colleges employed in the farming and forestry sector was around 3% in 2016 (Table 6.1).

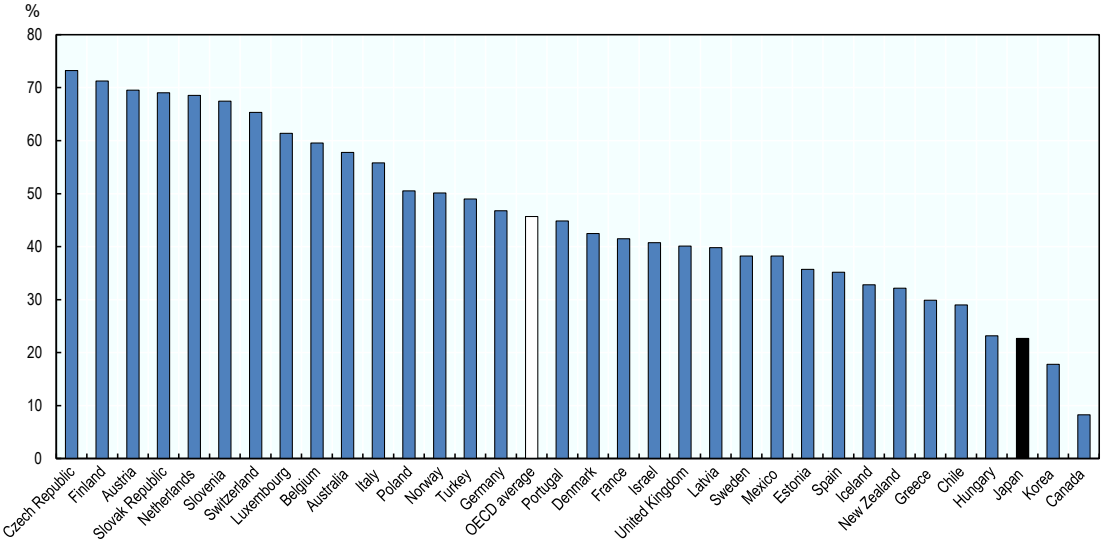
Table 6.1. Share of graduates entering the farming sector by agricultural educational institution in Japan, 2016

	Agricultural High Schools	Prefectural Agricultural Colleges	University (incl. junior college)
Number of schools	303	42	63
Number of graduates	26 856	1 741	22 891
Share of graduates employed in farming, %	3.0	57.1	2.8

Source: MEXT (2016[10]) *School Basic Survey 2016* (database), https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00400001&tstat=000001011528; National Council of Agricultural Colleges

The role of vocational education is, however, relatively minor with the share of students in vocational programmes in all upper-secondary education (23%) being around half the OECD average (Figure 6.2). Graduates from agricultural vocational institutions account for only 5% to 10% of new farmers aged less than 49 years.

Figure 6.2. Share of students in upper-secondary vocational programmes in OECD countries, 2015



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: OECD (2017[11]), *Education at a Glance 2017: OECD Indicators*, https://doi.org/10.1787/eag-2017-en.

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In Japan, it is primarily prefectural agricultural colleges which provide vocational education although several private institutions offer a vocational education for future farmers. There is an agricultural college in all but five prefectures. These 42 agricultural colleges offer two-year programmes for high school graduates that combine classroom lectures and practical field training. The majority of graduates become farm workers upon graduation. In the past, the majority of graduates entering the farming sector returned to their family farms, but as more students were from non-farming families, graduates now become more often farm employees.

Prefectural agricultural colleges were developed as part of the prefectural extension system and follow MAFF guidelines for prefectural extension services. Teachers are often

extension officers rather than farming practitioners. Field training is provided in co-operation with the public extension services, prefectural research stations, and farms. The curriculum of these colleges focuses on the acquisition of agricultural production techniques.

The core direction in improving the vocational education system is towards developing the necessary technical and management skills to undertake innovative strategies. This would allow farmers to adapt to new environments, solve new problems, and collaborate with a diverse network of stakeholders. It requires educational programmes that reflect the technological, economic and environmental changes that are currently underway, as well as taking into account current demand from the industry and consumers. According to the OECD, an effective vocational system would include: meeting the needs of the labour market; providing good core academic skills; and the integration of work-based learning (Box 6.3).

Box 6.3. Selected key characteristics of effective vocational systems

Policy recommendations stemming from OECD work on vocational education and training at upper-secondary level include the following characteristics to ensure an effective vocational educational system:

How the mix and content of vocational programmes are determined

- Mechanisms to ensure that the mix of vocational provision corresponds to the needs of the labour market.
- Ensuring that adequate core academic skills, pertaining especially to literacy and numeracy, are built into vocational programmes.
- Good upper-secondary level of vocational qualifications allows for a greater access to higher-level vocational and academic programmes.

How vocational skills are imparted to learners

- High-quality apprenticeship systems covering a wide range of professional domains and including high-level apprenticeships.
- Work-based learning systematically integrated into all vocational programmes.
- A vocational teaching workforce that offers a balance between teaching skills and up-to-date industry knowledge and experience.

How skills are assessed, certified and exploited

- Qualifications developed with actors from the labour market.
- High-quality assessments of vocational skills built into qualifications.
- Effective competence-based approaches, including both professional examinations and recognition of prior learning.

Policies, practices and institutions that underpin vocational education and training

- Vocational programmes should be developed in partnership with government, employers, and trade unions.
- Effective, accessible, independent, proactive career guidance backed by solid career information.

Source: OECD (2014[12]), *Skills beyond School: Synthesis Report,* OECD Reviews of Vocational Education and Training, https://doi.org/10.1787/9789264214682-en.

In 2019, a new four-year professional and vocational university and two or three-year professional and vocational junior college was introduced with the aim to establish tertiary institutions providing vocational education in partnership with industry and local communities. The standard for professional colleges requires that more than 40% of full-time teachers must be practitioners and the curriculum must include internships. This system intends to provide a model of dual education to allow students to learn about their profession in school while gaining practical work experience. Agriculture is one of the main industries where this new educational orientation is in place.

Country experiences have shown that proactive industry engagement is key to meeting the needs of the labour market in agricultural vocational education. For example, the Human Capital Agenda developed in the Netherlands is an integral part of the country's R&D strategy to become more involved and responsible for developing agribusiness in the areas of education and skills development, and to attract a sufficient number of students at various levels to ensure an adequate future supply of qualified employees in agriculture and horticulture. *Green Education* in the Netherlands promotes agri-food careers that emphasise opportunities for high-skilled and knowledge-intensive jobs and attracts interest from a broader range of students who do not have a rural background (Box 6.4).

Box 6.4. Netherlands: Developing a green education

Agricultural education in the Netherlands is embedded in the so-called *Green Education* (agriculture, nature and food) which is organised in close co-operation with the agro-food private sector. Secondary education includes pre-vocational secondary education programmes (four years) that combine general and vocational education and prepares students for senior secondary vocational education and training (four years). Higher education is provided by two types of institutions: research universities and universities of applied sciences. Research universities are primarily focused on research-oriented programmes, while universities of applied science offer programmes to prepare students for specific professions.

The *Human Capital Agenda* was developed as a part of the Netherlands R&D strategy. It aims to achieve greater involvement and responsibility on the part of agribusiness in education and skills development, and to attract sufficient students at various levels to ensure there is an adequate supply of qualified employees in agriculture and horticulture. The Human Capital Agenda identified three important themes: improving the sector's image and being a good employer; developing a job-oriented curriculum; and promoting life-long-learning. To stimulate the involvement of agribusiness, the stakeholders co-finance vocational education. In return, tools, trainings and internships are provided, and students and teachers undertake projects (e.g. research) for their agribusiness partners

Methods to deliver education are also changing: life-long learning and distance learning programmes are developing rapidly, allowing for a larger potential student base. The need to focus vocational education on entrepreneurship and managerial training is also increasingly recognised.

Source: OECD (2015[13]) *Innovation, Agricultural Productivity and Sustainability in the Netherlands, OECD Food and Agricultural Reviews*, https://dx.doi.org/10.1787/9789264238473-en.

Providing continuous education is an important opportunity for farmers to acquire new industry knowledge and technology. Although Japan has strengthened continuing education, adult participation in education remains lower than for most OECD countries (OECD, 2018[9]). In agriculture, prefectural governments have started to offer agricultural management seminars to teach marketing, organisational management, and financing. The courses often invite managers from other industries, tax advisors, management consultants,

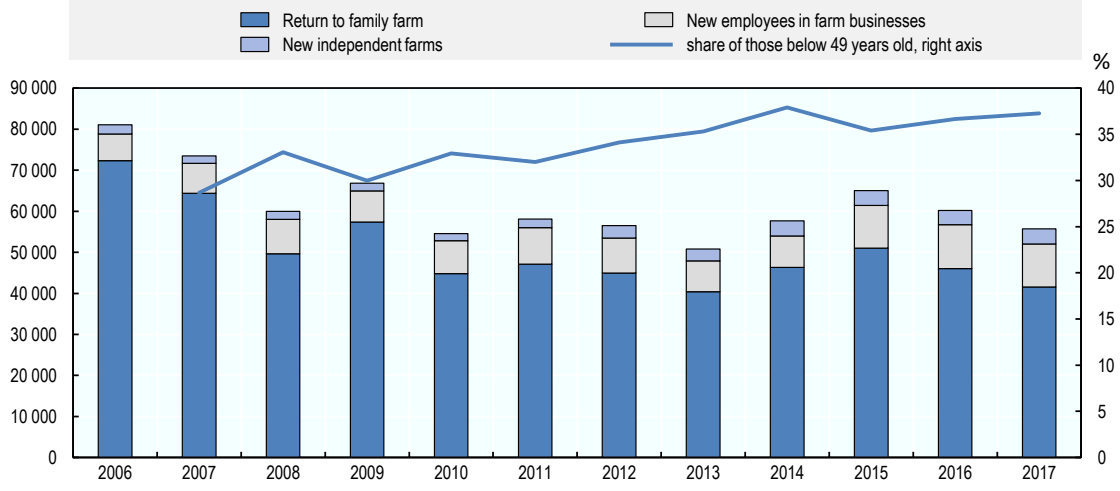
and university professors. In FY2018, 25 prefectures offered such seminars. In addition, a publicly-funded SME University with nine campus across Japan offers training opportunities for SME managers and employees. Local universities sometimes offer continuing education programmes in agriculture with a view to developing the potential of regional leaders and innovators.

6.3. Policies to support new entrants and farm succession

The number of farm workers exiting the agricultural sector in Japan exceeds that of new entrants, leading to an overall decline in the number of agricultural workers. Labourers returning to family farms account for close to 80% of new entrants (Figure 6.3), but the majority are more than 60 years old, implying that they start farming after their retirement from non-farm jobs. Nevertheless, the number of new entrants to agriculture who were less than 49 years old exceeded 20 000 for four consecutive years, that is from 2014 to 2017.

Employment in corporate farming is main driver for the increase in young new entrants. In 2017, 43% of new entrants aged less than 39 years were employees, creating a channel for young workers with no agricultural background to enter the sector. The number of new entrants establishing farms also increased, but the share was less than 7% in 2017. It is expected that farm employees will become independent farmers once they have acquired farm management skills.

Figure 6.3. Number of new entrants to farming in Japan, 2006 to 2017



Source: MAFF (2018[14]), *Survey on new farm entrants*, http://www.maff.go.jp/j/tokei/kouhyou/sinki/.

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Policies to support new entrants to farming

The government has strengthened policy measures to promote new entrants to the sector. Advisory centres were established at the prefectural level to introduce a variety of ways to become a farmer. In 2012, MAFF introduced two types of financial support for new entrants. One programme pays JPY 1.5 million (USD 13 400) per year to those who plan to enter the sector before the age of 50, providing one to two years of training in a prefectural agricultural college. The second programme pays up to JPY 1.5 million

(USD 13 400) per year for a maximum of five years to support the income of new farmers who are less than 50 years. This programme is available to who take up the family farms and who seek to improve and modernise their operation. New entrants are required to submit their business plan and obtain certification from the local municipality. Certified new entrants are eligible for interest-free credit from the JFC to finance the initial cost of investment.

MAFF has also developed a farm employment aid programme for new entrants. Under this programme, the employer can apply for financial support for new employees on the condition that they provide him/her with sufficient on-the-job training for up to two years. To be eligible, new employees must be: under 50 years of age; have no or limited farm work experience over the last five years; and have no kinship with the employer.

Measures to facilitate a smooth farm succession

Japan's tradition of inheritance based on primogeniture with priority for the male child was applied to the succession of family farms. However, Japanese civil law guarantees equal rights of inheritance to all heirs. To avoid the subdivision of farms, inheritance or gift tax is exempted, in principle, if one heir inherits the farmland and continues to farm for 20 years after the inheritance transfer. However, this discouraged heirs from renting out their land during the 20-year period as they would be liable for the deferred inheritance or gift tax. In 2009, this system was revised so that these heirs could benefit from the exemption from inheritance and gift tax even if they rented the land, as long as the land located outside the urbanisation promotion areas, remained farmland during their lifetime.

Since 1970, Japan maintains an additional pension scheme for farmers that encourages early farm retirement by paying a 50% premium on the basic indemnities when a registered farmer to that scheme retires from farming between the ages of 60 and 65, and transfers the farm assets to his/her successor. However, as this scheme was designed as a pay-as-you-go system, it became financially unsustainable and in 2002 was transformed into a defined contribution system. Farmers certified by the municipality presently benefit from monthly government contributions which match equally their own contributions over a maximum period of 20 years.

6.4. Extension and advisory service

Agricultural extension and advisory services can help improve the production and management skills of farmers. Extension services serve as a broker for technology and practices that facilitate the adoption of innovations and knowledge at the farm level. In many countries, reforms of public extension services have led to the emergence of mixed advisory systems in which a broader range of actors provide services. Private companies, non-governmental organisations, and producer organisations currently play more active roles alongside traditional public sector extension providers (Box 6.5). This is highly relevant as farmers differ in their resources, gender, market access, crops and livestock systems, and thus require different types of information and services to achieve sustainable productivity growth.

Box 6.5. International comparison of farm advisory services

Farm advisory services vary between countries and often include many public and private service providers, allowing farmers to choose which service they will avail to (Table 6.2). The role of government varies from being the main funder and provider, such as in Japan and Korea, to co-funding and guiding services managed by independent organisations, such as is the case in Estonia. In some countries, farmer organisations play an important role in providing advice with farmers paying either collectively or individually for the services received. In the Netherlands, the national advisory system was privatised and replaced by diverse private providers. Consulting firms can also play a major role in some countries, in particular for specialised knowledge such as management and ICTs. Small subsidies are available to farmers to access services.

Table 6.2. Characteristics of advisory services

	Main institutions	Source of funds	Countries
State-run	Public organisations at regional and national level	Wholly financed from public funds	Brazil for smaller farms, Colombia, Japan, Korea, Sweden, Turkey, United States
Public-Private Service	Increasingly provided by private consulting firms	Farmers partly or wholly pay for services; centralised and decentralised	Canada, China, Estonia, Australia, United States
Farmers' Organisations	Farmers' organisations	Membership fees and payments by farmers	Australia, Canada, Colombia, United States
Commercial	Commercial firms or private individuals	Payment through project implementation or grants	Netherlands, commercial farms in Brazil, Turkey, United States

Note: Several systems can co-exist in the same country.

Source: Adapted from OECD (2013[15]), *Agricultural Innovation Systems: A Framework for Analysing the Role of the Government*, https://dx.doi.org/10.1787/9789264200593-en; OECD (2015[16]), *Fostering Green Growth in Agriculture: The Role of Training, Advisory Services and Extension Initiatives*, https://dx.doi.org/10.1787/9789264232198-en.

Advisory services provided by participants in the agro-food value chain – such as agricultural input suppliers, or buyers of farmers' produce – are often embedded services, that is where advice is given when a farmer buys a product (e.g. pesticides, fertilisers). Contract farming is a potentially effective way to deliver expertise to farmers, especially in supply chains with a high degree of vertical integration that requires compliance with standards needing the correct application of inputs as well as entrepreneurial capacities. In many OECD countries, commercial farm advisory services have evolved over time.

In Japan, the prefectural government and local JAs deliver technical advisory services free of charge, but a commercial farm advisory service is rare, except in the livestock sector where a variety of specialists provide paid management and production advice.

Traditionally, prefectural agricultural research centres developed breeding and farming techniques, and agricultural extension offices in each prefecture incorporated them into farming. MAFF provides guidelines for agricultural extension services and controls the quality of the prefectural extension advisors. Prefectural extension advisors need to pass a MAFF qualification examination. Prefectures receive subsidies from the national government that cover 5% of the cost of agricultural extension services. The number of agricultural extension advisers and expenditure for extension services decreased by around 30% over the last 20 years, and extension service offices decreased from 510 to 360

between 1998 and 2018. Local JAs provide technical advisory services to its members. In 2016, JAs had 13 750 farm advisors, double the number of prefectural agricultural extension advisors. It also sets its own standards for technical advisors.

The public agricultural extension services in Japan were originally established to financially help disadvantaged small family farms to acquire modern production techniques developed by public research stations and to improve their livelihood through housing, nutrition and health advice. Although extension services continue to play such a role, they face difficulties to respond to the diverse and specialised technological needs of today.

In 2012, MAFF introduced a system of agricultural innovation support experts to respond to the technical needs of advanced professional farmers. These experts are also expected to increase the level of partnership between research and educational institutions and the government. All prefectures established an agricultural innovation support centre and a total of 609 agricultural innovation support experts were appointed in 2018 from amongst the prefectural extension advisors having a high level of technical knowledge and co-ordination capacity. Similarly, the JA group strengthened its technical advisory service to advanced professional farms. Specifically, it promotes the Team for Agricultural Co-ordination which establishes ties with leading farmers, gathers information, and provides solutions for their needs.

Establishing a demand-driven advisory service that mixes both public and private services would facilitate the effective adoption of evolving technologies at the farm level. In a pluralistic setting, effective coordination assures a good mix of services to meet the diverse demands and needs of farmers. Privatisation of services can strengthen the efficiency and effectiveness of extension and advisory services.

For example, the Netherlands privatised its public advisory system and there is no evidence that this resulted in an inadequate supply or insufficient access to services. The government also supports farmers' access to training, extension, innovation brokerage, and advisory services. The privatisation of extension services transformed smaller operations with limited innovative capacity into firms that were larger in scale, more knowledge-intensive, and with stronger innovative power; these firms have become better at articulating their demand for knowledge. Farmers hiring advisors are more critical on getting value for money and request specific advice, e.g. on legal issues or farm expansion, and this has given room to new specialised entrants in the advisory business, leading to increased competition. Increasingly specialist advisors participate in network projects which allows them to stay up-to-date and maintain contact with farmers.

The government in the Netherlands continues to have a role in co-ordinating pluralistic advisory systems so that the activities, and scope and scale of the different service providers are aligned and inclusive; the quality of services is assured; providers are accountable; farmers are able to influence advisory services; and lessons learned are shared among service providers. In particular, the government needs to ensure the provision of extension service which private service is unlikely to offer such as environmentally friendly production practice, services in geographically disadvantaged area and compliance with regulation and policy requirement. For example, the EU Farm Advisory System is mandated to help with cross-compliance conditions attached to the payments (Box 6.6).

Box 6.6. Farm advisory services in EU Member States

As a condition to receiving direct payments under the CAP, EU farmers are required to comply with specific standards of good agricultural and environmental management, and with certain regulations on the environment, animal health and welfare. Since 2007, the Member States have been legally obliged to set up a national Farm Advisory System (FAS) with the broad objective to help farmers meet cross-compliance standards. In around half of the Member States, the FAS is set up as a specific service, complementing existing extension services; in the others, the FAS has been integrated with existing services. Agencies delivering the service to farmers are selected by calls for tender in 14 Member States, and by designating private or public providers (five Member States in each case).

A farmer's first contact with the FAS is usually via telephone help lines, but on-farm one-to-one advice is the approach most widely adopted, complemented by on-farm small group discussions. Computer-based information tools and checklists are used in several countries. One-to-one on-farm advice is provided free of charge in some countries, others require the farmer to contribute to the costs (this varies from 20% to 100%). Although raising farmers' awareness of cross-compliance standards is the main purpose of the FAS, Member States can choose to include advice on other issues. Around half do so, offering advice on broader issues such as the competitiveness of the holdings, the environmental impact of farming practices, and support for implementation of rural development measures such as agri-environmental contracts.

Source: OECD (2015[16]), *Fostering Green Growth in Agriculture: The Role of Training, Advisory Services and Extension Initiatives*, https://dx.doi.org/10.1787/9789264232198-en.

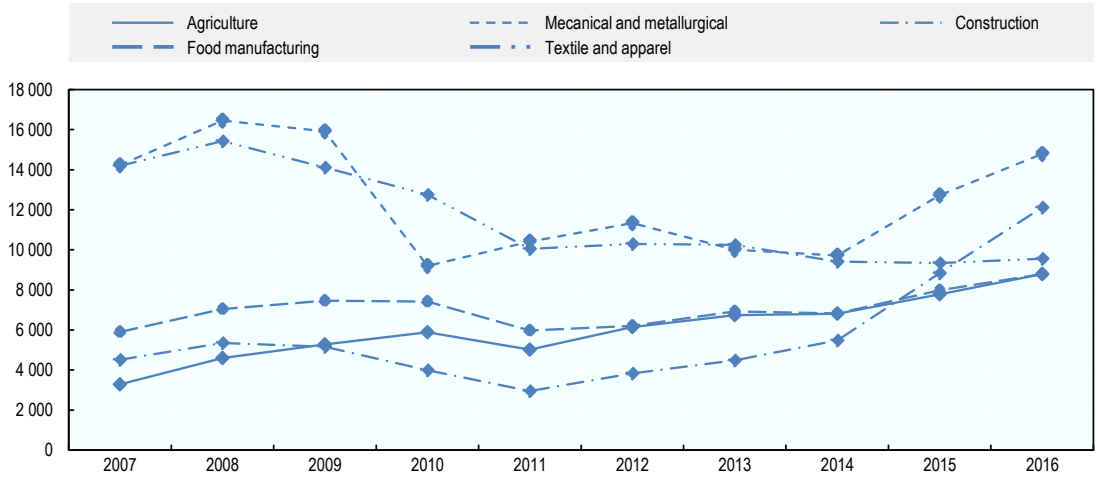
6.5. Labour market policy

The Labour Standards Act sets minimum standards for working conditions. However, it does not apply to family labour and agriculture is excluded from the minimum standards of working hours, break time, holidays, and extra pay due to the nature of agricultural work. The government, however, encourages family farms to form "Family Management Agreements" to clarify working conditions and the share of farm management responsibility.

Large commercial farms are increasingly dependent on hired labour. Among commercial farms with more than JPY 30 million (USD 248 000) of sales, 72% hired labour and 48% employed regular labour, on average 3.4 persons in 2015. Under the current system, participation in labour and social security is mandatory for incorporated farms or family farms hiring more than five people, including temporary workers. Securing competitive working conditions that are comparable to those of other industries has become vital if farm operations are to retain their human resources.

Foreign workers account for 2% of Japan's labour force, among the lowest of OECD countries, but reliance on foreign agricultural workers has increased in the food and agriculture sector. In principle, Japan's immigration policy does not accept unskilled labour in any sector. It did, however, introduce in 1993 a technical training programme for foreign interns to transfer skills, technologies and knowledge to developing countries. This programme is meant as an international co-operation programme and not as a measure to respond to labour shortages in Japan. The number of foreign workers (including trainees) exceeded one million for the first time in 2016, up from 0.7 million in 2013. Agriculture and food manufacturing are two of the major sectors accepting foreign interns (Figure 6.4).

Figure 6.4. Foreign technical trainees in Japan, by main job category, 2007 to 2016



Note: The number includes only those qualified for more than one year of training.
Source: JITCO.

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The foreign technical intern training programme offers employment contracts with corporations under the supervision of non-profit organisations, such as business associations. The employer must prepare a training plan for trainees to acquire or enhance skills that would be difficult to master in their home countries. The training period is a maximum of five years. Agricultural work eligible for the training programme beyond the second year of training is limited to facility horticulture, field crops and vegetables, fruits, swine, poultry, and dairy. Despite the objectives of the programme, some farm operations depend on these foreign trainees, although this is limited given the requirement to hire trainees for the entire year.

The foreign technical intern training programme was revised in 2017 to strengthen the supervision of training and to protect trainees. The revision also extended the maximum training period from three to five years and expanded the quotas for technical interns accepted by well-performing supervising organisations and firms.

Japan introduced a new scheme in 2017 to place foreign agricultural workers in National Strategic Special Zones. Under this scheme, a human resource company accepts foreign workers and sends them to farms. They can stay up to three years, but are allowed to engage in agricultural support activities only during busy farm seasons and leave Japan during the off-season. This scheme is expected to provide a solution for seasonal labour needs in agriculture. In 2019, the government also introduced a new residential status to allow foreign workers in certain industries, including agriculture, to stay for up to five years as long as they successfully pass both occupational and language proficiency tests. These tests are waived for people who have completed a technical training programme; in this case, they can now stay for up to ten years. Under this residential status, the government expects to accept 345 510 foreign workers over the period 2019-24 in 14 sectors, including agriculture.

6.6. Key points

- Attracting skilled labour to agriculture requires making agricultural industries more appealing and conducive to innovation and entrepreneurial opportunities. Skilled labour from different education backgrounds can also enrich the innovation process in the sector. More entry of private service providers, such as technical advisory services, would enhance skill supply in the sector.
- The skills and qualifications required of farm managers in Japan evolved with the rapidly changing technological conditions around agriculture and agro-food value chains, and with the structural move towards business-oriented, corporate farms. Farm managers increasingly need entrepreneurial and digital skills to develop integrated business plans beyond agricultural production, making use of both internal and external human capital and knowledge resources for farm management.
- A mismatch between supply and demand of skills limits the capacity of the sector to develop and uptake innovation. Responding to the evolving need for skilled labour in agriculture requires retraining and regular adjustment of education programmes that reflect industry demand.
- Making agricultural education and training more attractive and relevant can play a critical role in drawing talent and resolving potential mismatches of skills in the labour market. Continuous learning is necessary to allow farmers to keep up-to-date on new technologies. More iterative co-creation and co-development processes that involve multiple stakeholders are necessary to identify skill needs in agriculture and to improve the agricultural education system in Japan.
- Currently, prefectural agricultural colleges are the main provider of vocational education in agriculture. However, they do not necessarily attract the most qualified and enthusiastic students who wish to be future farm managers. They also face difficulty in adjusting their education and training programmes to the more diversified and specialised skill requirements in Japan's agriculture today.
- Strengthening partnerships with the agricultural industry would allow agricultural colleges to expand their capacity and meet the labour-market needs more effectively, for example through more systematic participation of professional farms and agro-food industries in teaching and funding.
- Agricultural colleges are established at the prefectural level, as part of the prefectural extension system makes it difficult to respond to the diversified and specialised needs of professional education in agriculture. Consolidation at a wider regional level would allow agricultural colleges to pool their resources and provide more unique and specialised education that is better adapted to regional agricultural conditions.
- The curriculum of the agricultural college should be diversified from agricultural production techniques to broader skills required for future farm managers. Work-based training allows students to work on farms and study at the same time. The conversion of agricultural colleges to newly created professional colleges is one way to strengthen the partnership with industry and reorient the curriculum.
- The government has strengthened support to young farmers entering the sector. The programme provides income support payments for young famers for up to seven

years before and after entry. However, providing more structured opportunities for learning and training that combines both lectures and internships in advanced farming is more important for acquiring the necessary skills to become a viable farmer.

- Prefectural extension services and local JAs provide technical advisory service free of charge, but commercial technical advisory services are relatively underdeveloped with the exception of the livestock sector. Both prefectural extension services and JAs face constraints in updating their skills and knowledge as quickly as current technology and industry develop, and in mainstreaming entrepreneurial and risk management skills.
- Japan's agricultural extension system must evolve towards more demand-driven pluralistic advisory systems that mix both public and private services. The public extension service should focus on areas of public interest, such as adopting sustainable production practices, supporting disadvantaged producers, and co-ordinating government policy in the field. Government can play a more proactive role to strengthen support for continuous education and training for farmers. JA's technical advisory services should be more competitive and should include paid services.
- Despite the mechanisation of agriculture, the sector still depends on seasonal labour. With a declining working population, limiting temporary workers in agriculture is increasingly constraining farm management. Japan faces a challenge in meeting the shortage of seasonal labour through labour market and immigration policies, and developing labour-saving technology in agriculture.

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Innovation, Agricultural Productivity and Sustainability in Japan

In Japan, agriculture has been treated differently from other parts of the national economy. However, policy needs to evolve with new agricultural structures and the global trend towards more integrated value chains, enabling innovation and entrepreneurship in agriculture, and imposing a greater environmental responsibility on producers. Modern agriculture is a technology- and data-intensive industry, and Japan is well-positioned to introduce its competitive technology and skills to agriculture through building more collaborative agricultural innovation system.

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