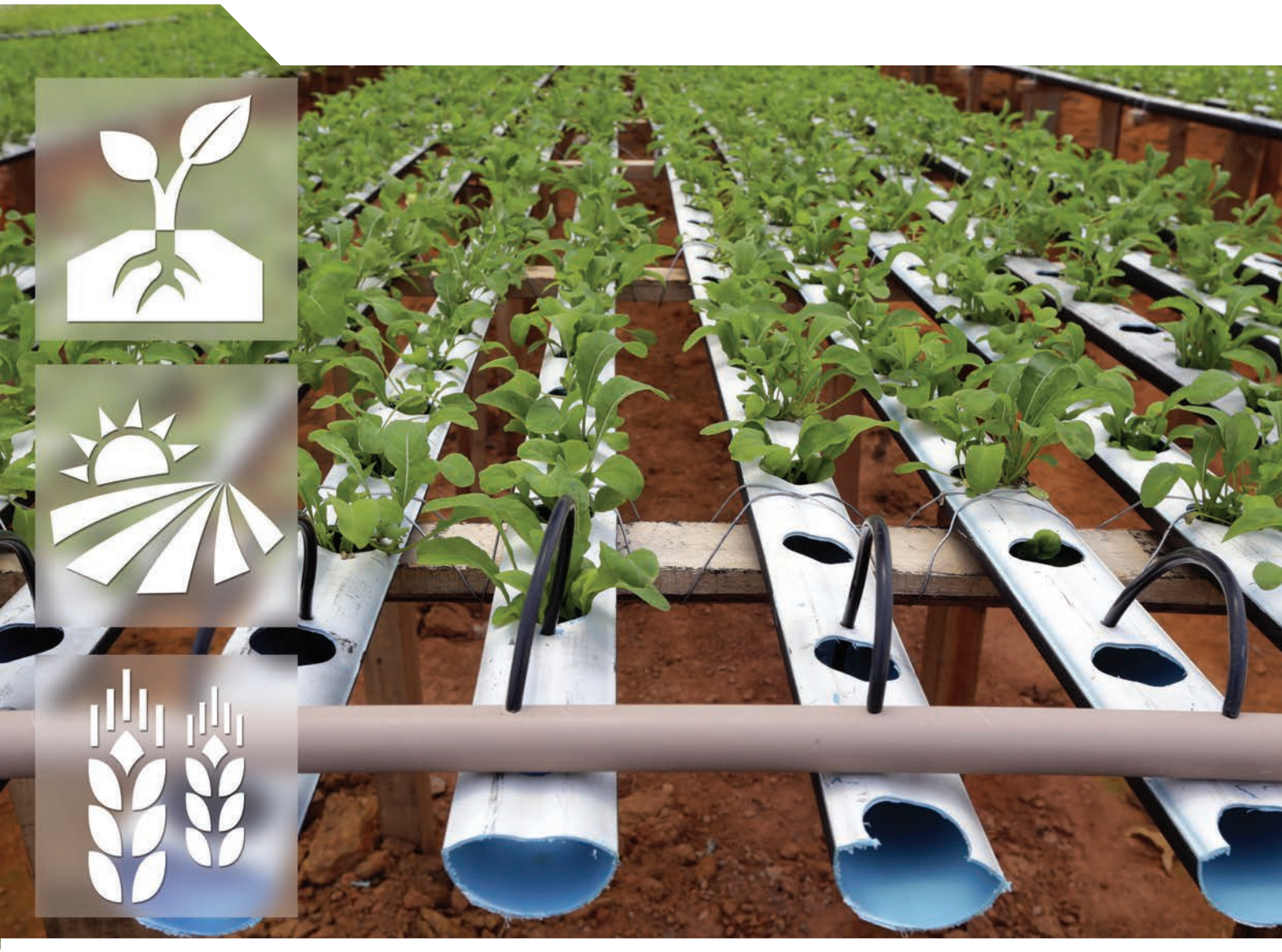
OECD Food and Agricultural Reviews

Innovation, Agricultural Productivity and Sustainability in Brazil



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Foreword

Innovation, Agricultural Productivity and Sustainability in Brazil is part of the OECD Food and Agricultural Reviews series. It was undertaken at the request of the Brazilian authorities, represented by the Ministry of Agriculture, Livestock and Food.

The report examines Brazil's policy conditions surrounding business and allowing innovation in the agriculture and food sectors for increased productivity and environmental sustainability. It starts with an overview of the food and agriculture sector and outlines development challenges and opportunities (Chapter 2). A wide range of policies which influence incentives for innovation are then examined: economic stability, governance and trust in institutions (Chapter 3); a favourable and predictable environment for investment (Chapter 4); capacities and public services enabling business development (Chapter 5); agricultural policy (Chapter 6) and the operation of the agricultural innovation system (Chapter 7).

Country policies are analysed following a framework developed by the OECD as part of its work on agricultural innovation and in response to a request from the G20 in 2012 under the Presidency of Mexico, although all aspects may not be fully covered. In this first test phase, the framework has also been applied to Australia and Canada. Additional countries will be studied in subsequent work and the framework is being continuously revised and improved, in particular to reinforce the coverage of sustainability and structural adjustment issues

This review was prepared by Olga Melyukhina and Catherine Moreddu. Lihan Wei and Christine Arriola provided statistical support. Hélène Dernis from STI and Douglas Lippoldt, formally of the OECD, provided data and expertise on intellectual property protection. Martina Abderrahmane provided editorial assistance and Michèle Patterson editorial and publication support. It benefitted from comments by Ken Ash and Frank Van Tongeren, and Jens Arnold from the OECD Economics Department

The report draws on Brazil's responses to the innovation framework questionnaire and other information provided by the Brazilian government, complemented by a consultants' report on Brazilian agricultural innovation system by Elisio Contini and Antonio Flavio Dias Avila from the Brazilian Enterprise for Agricultural Research (EMBRAPA). The report also draws on OECD analysis in other economic and social policy fields, and uses cross-country indicators from the OECD (for example Product Market Regulation, Education, Foreign Direct Investment, Taxation, Science, Technology and Innovation indicators) and other international institutions, such as the World Bank Group and the World Economic Forum (notably the World Economic Forum's Global Competitiveness Indicators).

This work benefited greatly from co-operation with Brazilian government. We would like to thank Roberto Doring Pinho da Silva from the Ministry of Foreign Affairs and Antonio Luiz Machado de Moraes from the Ministry of Agriculture, Livestock and Food for their continuous support to this project. We are also grateful for the most useful feedback from the Ministry of Agriculture, Livestock and Food (MAPA), Ministry of Agrarian Development (MAD), Ministry of Science, Technology and Innovation (MCTI), EMBRAPA, Ministry of Foreign Affairs (MRE), the National Council for Scientific and Technological Development (CNPQ), the Funding Authority for Studies and Projects (FINEP), and the National Bank for Economic and Social Development (BNDES) whose experts participated in the videoconferences organised to discuss the draft of this Review.

This report was declassified by the Working Party on Agricultural Policies and Markets in November 2014.

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Acronyms

ABIOVE	Brazilian Association of Vegetable Oil Industries (Associação Brasileira das Indústrias de Óleos Vegetais).
BNDES	Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development)
BRIICS	Brazil, Russia, India, Indonesia, China and South Africa
BRL	Brazilian real
CET	Common External Tariff
CPI	Consumer price inflation
CSE	Consumer Support Estimate
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Research)
ESA	Early-stage activity
FAT	Fundo de Amparo ao Trabalhador (Fund for Worker's Support)
FDI	Foreign direct investment
FGV	Fundação Getulio Vargas (Getúlio Vargas Foundation)
FINEP	Financiadora de Estudos e Projetos (Funding Authority for Studies and Projects)
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
GSSE	General Services Support Estimate
IBGE	Instituto Brasileiro de Geografia e Estatistica
ICMS	Imposto sobre Circulação de Mercadorias e Serviços (Tax on Circulation of Goods and Services)
ICT	Information and communication technologies
IMF	International Monetary Fund
IPCA	Indice National de Preços ao Consomidor Amplio (National Broad Consumer Price Index)
MAPA	Ministério da Agricultura, Pecuária e Abastecimento (Ministry of Agriculture, Livestock and Procurement)
MAPA	Ministério da Agricultura, Pecuária e Abastecimento (Ministry of Agriculture, Livestock Production and Food Supply)
MCTI	Ministério da Ciência e Tecnologia e Inovação (Ministry of Science and Technology)
MDA	Ministério do Desenvolvimento Agrário (Ministry of Agrarian Development)
MFN	Most Favoured Nation (tariff)

OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
PROGER	Programa de Geração de Emprego e Renda (Programme for Employment and Income Generation
PRONAF	Programa Nacional de Fortalecimento da Agricultura Familiar (National Programme for Strengthening Family Agriculture)
PSE	Producer Support Estimate
R&D	Research and development
SELIC	Sistema Especial de Liquidação e de Custódia (Special system for Settlement and Custody)
SINE	Sistema Nacional de Emprego (National Employment System)
SNCR	Sistema Nacional do Credito Rural (National Rural Credit System)
SOE	State owned enterprise
TFP	Total Factor Productivity
TSE	Total Support Estimate
USD	US dollar
UPOV	International Convention for the Protection of New Varieties of Plants
VAT	Value Added Tax
WDI	World Development Indicators (data base)
WEF	World Economic Forum
WTO	World Trade Organization

Executive summary

Agriculture and the agro-processing sector in Brazil have shown impressive growth over the past two decades. This has been largely driven by productivity improvements and structural adjustment resulting from broad economic reforms, as well as new technologies developed by agricultural science. Government policy and industry initiatives are increasingly focussed on sustainability of agricultural development.

Sustaining high agricultural growth is critical to Brazil's overall development given the importance of agriculture and agro-industries to the national economy and the resource potential that has yet to be exploited. Agricultural growth is also critical from a social perspective as it means making more income opportunities and more affordable food available to poor people. It is also important globally due to Brazil's role as a leading supplier on international agricultural markets.

Key drivers of agricultural growth in the past have weakened, necessitating increased cost competitiveness. The economic reforms of the 1980s and 1990s provided a strong impulse for agricultural development, but their potential to add as much to future growth is diminishing. External demand, which strongly drove sector expansion in the previous decade, is affected by slow growth in developed countries, loss of momentum in key emerging economies, and greater competition in global agricultural markets. Brazil's biggest challenge today is to sustain high agricultural growth in these changed conditions. This places the sector's cost-competitiveness into the foreground and increased innovation can play an essential role in achieving it.

Agricultural growth and fundamental societal objectives must be reconciled. One challenge is to ensure that the sector expands sustainably. Another is to reconcile agricultural growth – and the pressure that structural adjustment puts on small family farmers – with poverty alleviation objectives.

Overcoming structural deficiencies characteristic of an emerging economy is also a challenge. Brazil's capacity to realise its agricultural growth potential is becoming progressively contingent on overcoming the structural deficiencies, such as gaps in physical infrastructure, capital market scarcity and low overall skills levels. Although the country has already made large strides to catch up, structural gaps continue to be significant and hinder development.

The framework conditions for innovation are a significant constraint. Macroeconomic and business conditions have improved, but in many areas they are still highly constraining to business development. Further reforms are needed in various policy areas outside agricultural policy or innovation policy as such. Efforts to stimulate innovation through agricultural measures or support to agricultural innovation system will bring the best outcomes if broader constraints to innovation are eased.

Businesses face restrictive and complex regulations and incur high costs for doing business. Brazil's regulatory framework is relatively restrictive, particularly as concerns the complexity of regulations and administrative burdens on start-ups. Regulations translate into direct and indirect costs of doing business, which are estimated to be in Brazil one of the highest across the world.

Tariffs for capital and intermediate goods are high, increasing the cost of imported farm inputs, including technological items. At the same time, the Foreign Direct Investment (FDI) regime

has been substantially liberalised, although certain constraints exist, such as related to purchase of agricultural land.

Domestic credit is generally costly and long-term credit is scarce. Innovation is often associated with financing from the sources outside the innovating firm. Interest rates in Brazil are high in international terms, largely due to high risk premiums on lending. The segment for short-term bank credit is represented by many competing private and public banks, including foreign banks. Domestic long-term credit, however, is scarce and available mostly from a single state development bank which relies on public funding and provides loans at reduced cost. The limited domestic market for investment credit affects, in particular, small and medium-size businesses which have fewer opportunities to tap into international sources of finance.

Businesses bear a substantial tax burden and high costs to comply with taxes. Taxation affects the returns to innovation, and thus the decisions of firms and individuals to invest. The total tax rate on Brazil's company profits is estimated to be above average for Latin America and OECD countries. Taxes are not only high but burdensome to comply with, mainly due to the complexity of the indirect tax system, particularly the state-based value-added tax.

The commitment to accelerate infrastructure development and foster education must be sustained. The government has undertaken institutional and regulatory reforms in the infrastructure sectors, increased public spending, and has provided regulatory, tax and credit incentives to encourage private investment in infrastructure. Impressive progress has been made in education, particularly in expanding access and making it more equitable. These efforts are expected to take effect in the longer-term and need to be pursued continuously to overcome the significant gaps that still remain in these areas.

Agricultural policy could be more strongly oriented to productivity and sustainability outcomes. New agricultural programmes have been introduced recently to support investments in innovation, and to encourage environmental improvements and infrastructure development. Still, policy could be better targeted to these outcomes. Although agricultural policy on aggregate only moderately distorts farm prices and current costs, over three-quarters of producer support comes from distorting measures, with support levels highly variable across commodities. These policies reduce the incentives to use production factors more efficiently and to innovate so as to become more competitive. This also impedes structural adjustment and in the long run results in a less productive agricultural sector.

Further refocussing of support on adoption of innovations, environmental, and infrastructure improvements will be conducive to productivity gains. Reducing distortive support could strengthen the incentives for productivity improvements and allow for structural adjustment. Important opportunities for such policy change may be present in refocussing of the existing rural credit policy from that which predominantly supports short-term lending to support of investments in innovation, environmental, and infrastructure projects. This may also provide additional resources for essential general services for agriculture.

The capacity to adopt innovation needs to be improved. The agricultural innovation systems benefits from the good governance of public research institutions, notably the Brazilian Corporation for Agricultural Research (Embrapa), which has permitted the development of innovations adapted to practical problems. These innovations have been quickly adopted by large, commercial farms. Embrapa, by demonstrating the positive impact of its activities on the economy and the environment, and the high returns on investment, has enjoyed increasing public support and has become a nationally and internationally a recognised institution. The role of the private sector in the provision of innovation is growing but remains limited to specific input sectors such as seeds, tractors and the bioeconomy. The main challenge of the innovation system is to reduce the lag between the creation and adoption of innovation and to improve its diffusion among poorer farmers. Recognising the importance of extension services to meet this challenge, the Federal government created the Agency for Technical Assistance and Rural Extension (ANATER) in 2013 and budgeted additional resources

for more staff and to subsidise access by poor farmers. This should strengthen the capacity of the system to cover more farmers and issues, as well as facilitate access by poor farmers, with the aim of increasing the productivity and environmental sustainability of farms and to link them to markets.

Policy recommendations encompass the following four key areas:

- ***Improve overall conditions for doing business*** by easing the regulatory burden on businesses; reducing industrial tariff protection; facilitating the development of private long-term finance by creating a level playing field for state and private lenders; and simplifying the tax system, including by moving towards a single national system of indirect taxes.

- ***Enhance the economy's capacity for development*** by continued acceleration of infrastructural development; modernisation of labour regulations and enhancement of labour market insertion programmes; further broadening of access to education while improving its quality and further advances in its equity; strengthening the agricultural vocational training system; and promoting industry-school co-operation in the development and adjustment of curricula and the funding of education.

- ***Strengthen agricultural policy incentives for innovation*** by moving away from distortive support to producers through a gradual downsizing of concessional loans for working capital to commercial producers and focussing credit support to investments in projects that explicitly incorporate technological innovations, and advanced farm management and environmental practices; maintaining the new focus on development of on-farm infrastructure; easing access to credit by rural borrowers though simpler regulations and procedures; and promoting private non-bank financial instruments for agriculture and agro-industries.

- ***Strengthen direct incentives to innovation in food and agriculture*** by increasing Embrapa's capacity and flexibility to collaborate with other research and development (R&D) providers domestically and abroad; promoting research co-operation across sectors; supporting networking and actions to raise awareness and providing training opportunities; reinforcing technical assistance and rural extension services for small family farms; strengthening links between R&D and technical assistance; and continued promotion of forward-looking thinking.

Chapter 1

Overall assessment and recommendations

This chapter presents the framework applied in the review to analyse the extent to which Brazilian policies are supportive of innovation for productivity and sustainability, and the findings of the review of a wide range of policies in Brazil. In each policy area, it develops specific policy recommendations.

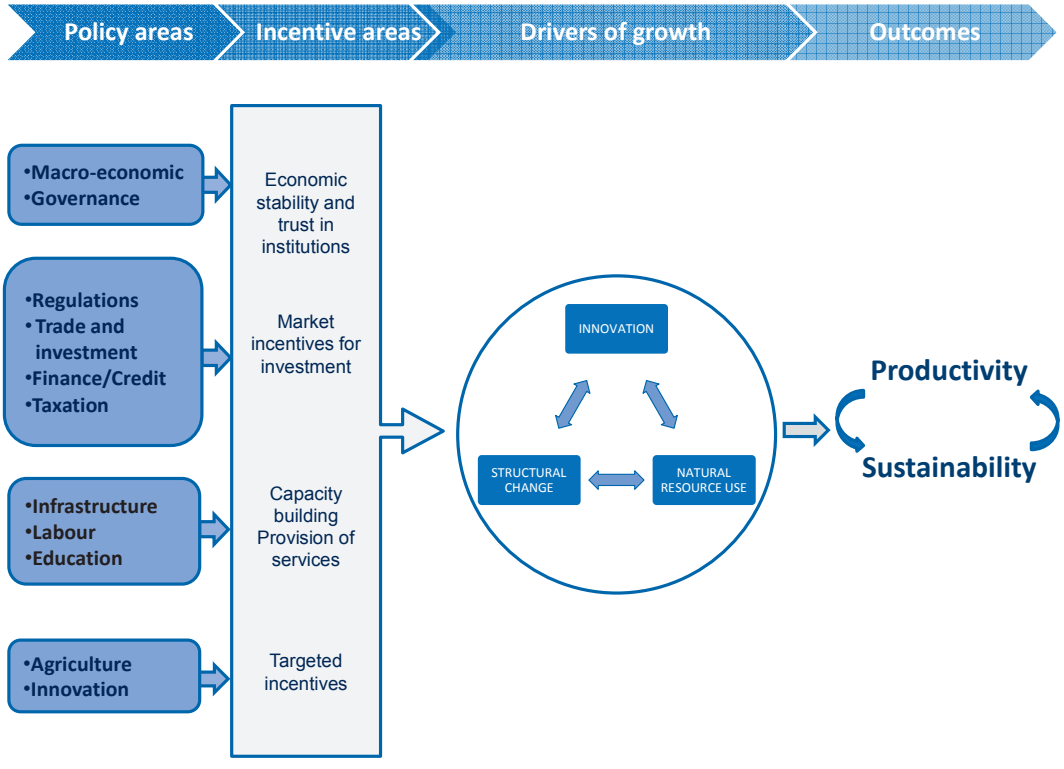
A framework for analysing policies for innovation, productivity and sustainability in the food and agricultural sector

Improvements in agriculture productivity growth are required to meet the growing demand for food, feed, fuel and fibre, and must be achieved sustainably through the more efficient use of natural and human resources. A common finding is that a wide range of economy-wide policies affect the performance of the food and agriculture sectors, and thus need to be considered alongside agriculture-specific policies. Recognising that innovation is essential to improving productivity growth sustainably along the whole agri-food chain, OECD work has focused on the performance of agricultural innovation systems.

The framework used in this report to review Brazilian policies considers policy incentives and disincentives to innovation, structural change and access to natural resources, which are key drivers of productivity growth and sustainable use of resources (Figure 1.1). The current focus is mainly on agricultural innovation systems. The Oslo Manual defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD and Eurostat, 2005).

This review begins with an overview of the characteristics and performance of the food and agriculture sector, which outlines the challenges and opportunities (Chapter 2). A wide range of policies is then considered according to the four main channels or incentive areas through which they affect drivers of productivity growth and sustainable use of resources.

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



Source: OECD (2014), "Analysing Policies to improve agricultural productivity growth, sustainably: Revised framework", www.oecd.org/agriculture/policies/innovation.

- Economic stability and trust in institutions (justice, security, property rights), both of which are essential to attract long-term investment in the economy (Chapter 3).
- Private investment, which in turn requires a transparent and predictable environment that balances the interests of investors and society (Chapter 4).
- Capacity building, including provision of essential public services (Chapter 5).
- Targeted incentives to food and agriculture, which ensure agriculture innovation systems align the supply of innovation with sector demand and facilitate the adoption of innovation at farm and firm levels (Chapters 6 and 7).

A policy area can affect innovation through more than one channel. Policies can affect innovation positively or negatively depending on the type and intensity of measures. This review reports country-specific information when readily available.

This report aims to review the extent to which the Brazilian policy environment contributes to improving productivity growth and sustainable use of resources in the agriculture and agri-food sector by fostering the creation and adoption of innovation. Throughout the report, the likely impacts of each policy area on innovation are first discussed in general terms. Specific country measures are then analysed in this regard. Overall assessment and recommendations are drawn from this review on a large range of policy areas.

Challenges to increase agricultural productivity and competitiveness

The impressive growth of Brazilian agriculture over the past two decades was largely driven by rising productivity. Sustaining agricultural growth is critical to Brazil's development given the weight of agriculture and agro-industries in the national economy and the resource potential that can yet be exploited. Agricultural growth is critical from a social perspective as it means making more income and more affordable food available to poorer people. And finally, it is also important globally due to Brazil's role as a leading supplier on international markets.

The economic reforms of the 1980s and the 1990s gave substantial impulse to agriculture and the associated agro-industries, but their potential to add as much to future growth is diminishing. At present, Brazil's trade opportunities are affected by slow growth in developed economies, loss of momentum in key emerging economies, and greater competition in global agricultural markets. Brazil's broadest challenge today is to sustain high agricultural growth in the conditions when its past powerful supply and demand drivers have weakened. This puts the sector's cost competitiveness into the foreground where increased innovation will play an essential role in achieving it.

The country faces the challenge of reconciling its agricultural growth with fundamental societal objectives. One is to ensure that growth is achieved sustainably. Some environmental issues, such as deforestation, have long attracted policy attention, while others, such as air and water pollution, and climate change, are becoming more prominent. Another societal objective in a country where poverty is still high is to reconcile agricultural growth – and the pressure that structural adjustment places on small farmers – with poverty reduction goals.

Brazil's capacity to realise its agricultural growth potential has become progressively contingent on overcoming its considerable structural deficiencies. These concern its physical infrastructure, the failure of private capital markets to provide adequate resources for long-term development, and low overall education and skills levels. Brazil has made large strides to catch up, but the remaining structural gaps are significant and continue to hinder development.

For a large agro-food exporter such as Brazil, future growth also hinges on increased access to external markets, meaning that the country has a high stake in further opening global markets through the multilateral and plurilateral process.

Moving towards a supportive overall policy framework is the main challenge to fostering innovation

Impressive progress in research and development needs to be matched by better conditions for doing business

Brazil's macroeconomic conditions have considerably improved over the past decades. Today, local businesses operate in a more stable macro-economic environment and with improved ***public*** governance. Nevertheless, this review finds that the most important constraints to innovation still concern the general conditions of doing business in Brazil. Easing these constraints requires action, or further reform, in policy areas that are outside agricultural policy or innovation policy as such. Furthermore, efforts to stimulate innovation through agricultural measures or support to agricultural innovation system will have the best outcomes if broader constraints to innovation are eased.

The economy has performed well, but it is vulnerable to short- and longer-term macroeconomic risks

Brazil has been praised for its successful economic transition from the tumultuous decades of the 1980s and 1990s. This success is largely due to the ability of the government to pursue stable and predictable macroeconomic policies based on stable inflation, declining public debt, and a flexible exchange rate. Macroeconomic stabilisation has been essential to reducing risk perceptions of Brazilian investors and enhancing incentives for innovation. However, economic growth has been less strong than in other large emerging economies and will need to come increasingly from improvements in productivity. There are current and longer-term risks to macroeconomic stability, including the risk of high inflation, the deterioration of fiscal performance, rising household indebtedness levels, and uncertainties of global economic conditions. Consolidating confidence in the macroeconomic framework requires strengthening the existing system for inflation targeting, tighter fiscal stance, improved clarity of fiscal and quasi-fiscal operations, and greater flexibility to conduct countercyclical fiscal policy.

Businesses face fairly restrictive and complex regulations, and incur high costs for doing business

As measured by the OECD Product Market Regulation (PMR) indicators, Brazil's regulatory framework is generally more restrictive of competition than in OECD and some other BRIICS countries. The most constraining are the barriers to entrepreneurship, due to complexity of regulations and relatively high administrative burden on start-ups. Regulations translate into ***direct*** and indirect costs for doing business. According to the World Bank's *Doing Business* survey, they are estimated to be one of the highest internationally in Brazil. Although direct compliance costs to do business in Brazil are typically comparable, for example, with the OECD area or neighbouring Latin American countries, the indirect costs, such as the number of procedures and the time required to accomplish them, are with few exceptions much higher.

Tariff protection for capital and intermediate goods is high, increasing the cost of agricultural inputs

Brazil's overall trade regime is characterised by relatively high tariffs and barriers to trade facilitation. Tariff protection is high for capital and intermediate goods, although tariff concessions for ***these*** goods are included in Brazil's free trade agreements. This increases the cost of agricultural inputs, including advanced technological items. In addition to protection at the border, Brazil uses local content provisions in publicly-financed projects; this condition is also applied by the National Bank for Economic and Social Development (BNDES) to loans for capital goods, including by the agro-food and agro-processing sectors. At the same time, the Foreign Direct Investment (FDI) regime has been substantially liberalised, although certain constraints exist, e.g. related to the purchase of agricultural land. Foreign investment, for example, has contributed to the development of fertiliser production in Brazil; FDI has also been very important in the sugar and ethanol sectors, driving their technological development.

Domestic credit is generally costly and difficult to access, while long-term credit is scarce

Brazil's domestic finance market is small compared to large OECD economies. Interest rates are high in international terms, largely due to high risk premiums on lending. Opinion surveys show that local businesses feel there is limited availability of financial services and venture capital opportunities and they consider loans difficult to obtain. The short-term bank credit segment is represented by many competing private and public banks, including foreign banks. At the same time, long-term bank credit is scarce and concentrated in one state bank, the BNDES, which provides loans at reduced interest rates and relies on public support. This limited domestic market for investment finance affects in particular small and medium size businesses which have fewer opportunities to tap into external finance sources. Satisfying Brazil's financing needs as the economy develops will require increased private sector participation in the long-term credit market and well beyond distributing BNDES loans. Given the dominant role of BNDES in long-term lending, not least due to its privileged access to state funding, a more level playing field is required to attract private lenders. Increased participation of private providers will ease credit constraints and improve allocation of credit.

Businesses bear a substantial tax burden and high costs to comply with tax regulations

The World Bank estimates the total tax rate on Brazil's company profits – including all taxes on income and factor usage above the average in Latin America and in OECD countries. Brazil's taxes are not only high, but burdensome to comply. The principal reason why Brazil compares poorly to other countries in terms of tax compliance costs concerns indirect taxes, including the state value-added tax, for which each of Brazil's states has its own tax code, tax base and tax rates. Due to the "origin-taxation", companies operating nationwide are required to comply with each state's individual tax rules, and credits for interstate transactions are frequently delayed or refused. Brazil needs to establish a simpler tax system that imposes fewer compliance costs. An important move in this direction would be further progress towards the unification of indirect taxes into a national unified system.

Recommendations on the overall policy framework for innovation

- Reduce overall regulatory burden on entrepreneurship, particularly, by simplifying regulatory procedures and easing administrative burdens on start-ups.
- Undertake a comprehensive review of regulations that govern agriculture and agro-industries to identify areas where the burden of these regulations could be reduced. This includes stronger coherence of regulations across regulatory areas and different administrative levels.
- Reduce industrial tariff protection to lower the cost of imported inputs and technological items, including for the agricultural and agro-processing sectors.
- Facilitate the development of private long-term finance, including, as an interim approach, by requiring private co-financing of BNDES loans. In the longer-term, phase-out financial support to BNDES and concentrate its lending on infrastructure, small and medium-sized enterprises, and on innovation.
- Simplify the tax system, in particular, by further efforts to unify indirect taxes into a single national system.

The momentum to closing infrastructure and education gaps should be sustained

Agriculture is set to gain substantially from infrastructure improvements

Weaknesses in transport and other physical infrastructure hinder the country's economic development. Road and railway availability in Brazil are below the levels of its main agro-food trade competitors. The gap in quality of infrastructure is also considerable, as evidenced by the opinions of Brazilian businesses. The country is less deficient, however, in terms of ICT development, an important factor for innovative businesses. The deficiencies in infrastructure are well recognised by

the government, which has undertaken institutional and regulatory reforms in the infrastructure sectors. Governments at the federal and state levels have also introduced various tax and credit incentives to encourage private investment in infrastructure, and public investment has recently been increased within a range of national and state-level programmes. These efforts are expected to take effect in the longer-term and need to be pursued. A further challenge would be to inject more competition into the infrastructure sectors where dual public and private service provisions exist, such as in the electricity and network sectors. Investment delays could be reduced and private investment in infrastructure increased with further simplification of regulatory procedures. The agro-system is set to gain a lot from the national infrastructure development projects, which will improve the capacity and the time involved in the handling and transport of agricultural commodities.

Labour regulation framework requires modernisation

Labour regulations affect innovation through the cost and conditions of employing labour, as well as by their impact on labour mobility. Labour income played a key role in reducing poverty and income inequality in Brazil, helped by the strong rise in minimum wages and the steady decline in unemployment. Minimum wage is subject to an automatic indexation rule and since the early 2000s it has almost doubled, also driving up the average wage level. This indexation rule is scheduled for a review and needs to be adjusted to better connect wages to labour productivity, while protecting the purchasing power afforded by the minimum wage. The minimum wage indexation, a relatively high tax wedge on labour, and the policy focus on consumption stimulus have contributed to a fast rise in labour costs in Brazil. Labour regulations emphasise conditions of work and pay and are quite rigid. This sometimes impedes the establishment of mutually beneficial labour agreements, resulting in discrepancy between common practice and the law and posing legal risks to companies. Policies for the unemployed or those who are at risk of losing their jobs consist predominantly of compensation measures, although there are efforts to enhance market insertion measures. Skills improvement and self-employment as part of the labour market insertion programmes receive more attention, particularly for young people who account for the majority of the unemployed. However, the training component of the labour programmes seems to be inadequate in terms of the resources involved and its outreach, whereas it could play an important role in labour market adjustment to support the innovation process.

Education improvements have been impressive but there is much scope for further catch up

The nation's education improvement became a policy priority in Brazil in the 1980s. It was seen as a prerequisite to achieving social progress as well as an investment in future development. Brazil has made impressive advancement in access to and greater equity in education. These outcomes were largely driven by a boost to public expenditures on education to attain mandated per student levels of spending and conditional social transfers. Increased funding was complemented by incentives for good performance at the local level. Agricultural education has seen a strong rise in university enrolments and in the disciplines offered, driven by the agricultural boom in Brazil.

The considerable success notwithstanding, Brazil continues to lag in education both in terms of education attainment levels and student performance. The share of 25-64 year-olds who received at least an upper secondary or tertiary education is relatively low compared to some BRIICS and OECD countries, while among those who received an education below the upper secondary level, nearly three-quarters have only pre-primary or primary education. Although Brazil has recently shown the fastest improvements in the performance of 15-year old students, they still need to catch up with their peers from OECD and other BRIICS countries, particularly the students from rural areas. The challenge is to keep the quality of education at par with the broadening access to it.

Recommendations on capacity for innovation

- Sustain the commitment to accelerated development of infrastructure and move forward planned infrastructure projects; reduce investment delays and increase private investment in infrastructure through further simplification of regulatory procedures.
- Modernise labour regulations to allow for greater flexibility in establishment of labour agreements and to reduce uncertainties in the interpretation and application of regulations. Enhance labour market insertion programmes with a greater focus on training and re-training of job seekers.
- Maintain progress in education by ensuring that improvement in its quality is on par with a wider access to it.
- Support the advancement of poor students, particularly from rural areas, to higher levels of education and performance.
- Continue to develop the agricultural vocational training system and facilitate greater use of apprenticeships to enhance agricultural skills.
- Promote co-operation between agri-business and educators in the development of curricula and their adjustment to business demands. Encourage arrangements for industry-public co-funding of training and job placement programmes.

Agricultural policy can be better targeted to productivity and sustainability outcomes

Agricultural policy serves two distinct farm segments and is driven by different rationales

Agricultural policy rationale, objectives and programmes differ between commercial agriculture and small-scale family farming. For the commercial sector, policy objectives consist of boosting production, while making it more technologically advanced and sustainable. Policy towards family farming is predominantly driven by an equity rationale. The agricultural support programmes for both commercial and small farm segments use a broad range of instruments, including price support, concessional credit and insurance support. These are complemented by various regulations on land use, agricultural zoning requirements, regulations on biofuel use and organic production. Brazil also directs substantial public funds into land reform to empower the poor to generate better incomes. This consists of providing to disadvantaged groups access to agricultural land, financial resources, and knowledge and skills necessary to undertake farming and other economic activity.

Agricultural policy has been liberalised and increasingly incorporates sustainability criteria

The economic deregulation in the late 1980s and 1990s has progressively enabled agricultural resources to be re-allocated to where Brazil has a comparative advantage. Agricultural growth has been increasingly subjected to sustainability criteria through government policy and industry initiatives. A spectrum of new agricultural programmes has recently emerged which provide incentives to commercial and family farmers to follow environmental criteria or undertake environmentally beneficial activities. Regulations have become more constraining of environmentally harmful practices.

But it can be more strongly oriented to productivity and sustainability outcomes

At present, agricultural policy results in a relatively moderate aggregate support to farmers. However, over three-quarters of this support is provided through measures that alter farm prices and current costs, with a strong variation of support levels across commodities. Being still predominantly based on such measures, agricultural support diminishes producer incentives to employ production factors more efficiently and to innovate so as to become more competitive. Such policy also impedes structural adjustment and in the longer run, results in a less productive agricultural sector. A relatively small part of total support is directed to systems which would ensure long-term productivity gains, such as knowledge system, infrastructure, and supporting institutions. Altogether,

this suggests there is a scope for policy to become better targeted to productivity and sustainability outcomes.

Refocussing credit support to well-specified investments could spur innovation

An important opportunity for such policy re-orientation may be present in the reform of rural credit policy. The system works to provide commercial producers, family farmers, and, to a lesser extent, the agro-industry with reduced-cost credit. It employs public funds and also obliges private banks to use their obligatory reserves for lending to rural borrowers. The main rationale of the rural credit policy is to reduce the high cost of domestic borrowing to agriculture. However, it also creates a crowding-out problem: the availability of subsidised credit reduces the opportunities for provision of credit on market terms for lenders and the incentives to take up such loans for borrowers.

Annual allocations through rural credit system are concentrated on working capital loans to commercial producers. The focus of credit policy on subsidising current costs through provision of reduced-interest working capital loans makes producers less responsive to market conditions and weakens their incentives to adopt cost-reducing strategies. Borrowers have perverse incentives to build-up debt. In fact, farm debt to the rural credit system undergone major rescheduling in the late 1990s and 2000s, and was further re-negotiated on several occasions. The government should consider a gradual downsizing of working capital loans to commercial producers. On-going efforts to simplify procedures for access to bank credit by rural borrowers, to expand agricultural insurance, and to promote non-bank financial instruments would facilitate such a move. Credit resources could be re-directed to support long-term investment and increasingly allocated to well-specified innovation, environmental, and infrastructure projects.

Recommendations on agricultural policy

- Move away from interventions that lower producer current costs and eliminate cross-commodity variations in support levels as a broad policy re-orientation.
- Underpin this re-orientation by a reform of the concessional credit system with the view to gradually limiting the scope of eligible commercial producers and their supported activities. Consider a gradual downsizing of concessional loans for working capital to commercial producers.
- Further promote the development of private non-bank financial instruments for agriculture and agro-industries, subject to a review of existing instruments.
- Pursue efforts to ease access to credit by rural borrowers though simpler regulations and procedures.
- Assess concessional investment credit with the view to streamlining existing programmes and simplifying access procedures, particularly for newly-introduced programmes that support innovation and environmental projects. Enhance criteria for loan eligibility to better screen out borrowers that would have invested without support.
- Increasingly shift concessional investment credit to projects that explicitly incorporate technological innovations, and advanced farm management and environmental practices.
- Maintain the new focus of concessional investment credit on farm infrastructure support, subject to performance assessment of new infrastructure credit programmes.

The agricultural innovation system is an effective provider of innovation, but adoption could be faster and more widespread

Science and technology played an important role in the spectacular development of the Brazilian agricultural sector. Investment in research and development (R&D) has resulted in high growth in Brazilian scientific production, in particular as concerns tropical agriculture. The system met the strong demand for technological innovation generated by agribusiness development and

technological improvements resulted in fast rising agricultural production, with a diversification of products, and high levels of total factor productivity growth.

The Brazilian Corporation for Agricultural Research (Embrapa) plays a central role in the system

Embrapa has provided comprehensive recommendations ranging from how to correct acid soils and low fertility, the development of varieties that are adapted to the low latitudes and higher temperatures of tropical environments, and to pest and disease control and production systems. It is a major contributor to research in tropical agriculture. The main strengths of Embrapa are: 1) good governance mechanisms, including a leading role in the coordination of public research and regular performance and impact evaluation that demonstrate high returns on investment; 2) a focus on applied research of direct interest to the Brazilian agribusiness; 3) good spatial distribution of the agricultural R&D infrastructure; 3) highly qualified human resources; 4) sustained support to public R&D from the Federal government; and 5) the emphasis on R&D collaboration, which has facilitated integration into the international innovation system and training. Embrapa has facilitated the creation of solutions to practical problems, which were quickly disseminated to commercial farmers.

Universities contribute with high quality education and research

Universities also produce high level research in areas complementing Embrapa's activities, such as in nutrition, health and the environment. They are an essential link between research and education. They contribute to basic and general-purpose research, which is crucial for applied research. The federal and state universities are also active in applied research in the agrarian sciences, especially those linked to the agricultural sciences.

Foreign R&D co-operation is developing fast

Foreign co-operation, which focused traditionally on tropical areas in Latin America, is developing with a wider range of countries in the OECD area, in Africa and in South-East Asia. The collaboration of Embrapa with other developed countries benefited from a pioneer mechanism, the LABEX (Virtual Laboratories Program), which is being implemented by a growing number of OECD countries. This mechanism could also facilitate participation in global or regional agricultural research networks. Embrapa is also actively collaborating on technology transfers with developing economies, with an emphasis on tropical areas in Latin America, the Caribbean and Africa. With this strategy, the Brazilian government is stimulating public R&D organisations and the private sector to expand their international actions.

The contribution of agribusiness should continue to increase

The role of the private sector in Brazilian agricultural innovation system has grown significantly over the last two decades due to the boom in agribusiness, especially in the Cerrado region located in central Brazil. Its role is primarily oriented to the supply of inputs and technical assistance to farmers, but agricultural research is growing (seeds, equipment, machines, feed, agrochemicals, etc.).

There is still unrealised potential for contributions by the private sector in agricultural innovation due to the general business environment and lack of capacity of local companies to do this. The main constraints to investment in innovation for the private sector, in particular for the bioeconomy, are the confused and complex regulatory framework, the deficient basic infrastructure for development of cutting-edge technology, and the lack of qualified human capital, of public investment in private R&D, of management flexibility, and of synergy between the private sector, government and academia.

It is important to foster and support private investment in agricultural R&D by reducing regulatory and policy impediments for investment in innovation and simplifying programmes that finance private innovation. The capacity of businesses to participate in local innovation projects

could be strengthened, for example by supporting networking and actions to raise awareness and facilitate exchanges of staff and trainees with public research organisations.

The agricultural innovation system benefits from well-established governance mechanisms

The Ministry of Agriculture, Livestock and Food Supply (MAPA) is responsible for the coordination of agricultural research through Embrapa, and the Ministry of Agrarian Development (MDA) is leading rural technical assistance and extension services which focus on family agriculture. At the national level, the priorities for R&D are established by the national government through the different ministries involved in innovation, led by the Ministry of Science and Technology (MCT) which also has a strong role in the coordination of agricultural research, especially at the university R&D level. Coordination of agricultural research is thus integrated into the general innovation system and follows clear mechanisms at both the federal and state levels. Stakeholders are represented in councils and boards that discuss sectoral demands and priorities. Embrapa applies regular performance and impact evaluations, internally or with outside experts, and the results are made available to the public. Estimates of the social benefits of research have been published yearly for over ten years.

Reinforcing the capacity of extension services to reach poorer farmers would help reduce the technology gap

The main weakness of the Brazil agricultural innovation system reflects the duality of the agricultural sector, with the coexistence of large commercial farms and small farms imperfectly connected to markets and operated by poor households. Commercial farmers are well-served by R&D and have access to technical assistance from input suppliers, cooperatives, private services, and public rural extension services. These same assets are not available to poorer farmers who are not linked to a supply chain or the credit market. The National Agency for Technical Assistance and Rural Extension (ANATER) was created in 2013 by the Federal government to expand the resources and scope of public extension services to poorer farmers and to address sustainability issues. Once fully operational, this new agency is expected to increase the capacity of public services to reach poor small farmers and to facilitate their integration into the market. In implementing ANATER, it would be important to include research organisations and universities.

Recommendations to strengthen incentives to innovation

- In supporting Embrapa's activities, strengthen its capacity and flexibility to collaborate with other researchers in universities and the private sector in Brazil and abroad. Possible actions could be to remove restrictions for public institutions to hire foreign researchers and trainees, to facilitate temporary transfers of Brazilian researchers abroad, and to explore arrangements regarding the sharing of property rights, and which could facilitate public-private partnerships.
- Promote research co-operation across sectors (Centres of Competitiveness or Excellence).
- Strengthen the capacity of businesses to participate in local innovation projects by supporting networking and actions to raise awareness and providing training opportunities.
- Consider strengthening Intellectual Property Right protection (e.g. by signing the International Convention for the Protection of New Varieties of Plants of 1991, UPOV-91) to attract private investment.
- Reinforce technical assistance and rural extension services to ensure they provide expected services and improve opportunities for small family farms. Financial assistance to poor farmers, as planned under ANATER, should improve access, in particular if clear eligibility rules are set and impact monitored. Broaden the scope of advisory services to cover technical, financial and organisational aspects to improve the social, economic and environmental performance of farm households and their contribution to the rural economy.
- Strengthen links between R&D and technical assistance, for example by adding a technology transfer component to research projects, or by encouraging networking between researchers, advisors and producer groups.
- Continue to promote forward-looking thinking as done within the Agropensa system.

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Chapter 2

Overview of the food and agriculture situation in Brazil

This chapter provides an overview of the situation of the food and agriculture sector in Brazil. It describes the overall economic, social and environmental context in which the sector operates, and the natural resource base upon which it relies. It provides an overview of the general geographical and economic characteristics of Brazil and outlines the contribution of the agri-food system to the economy. It identifies the main structural characteristics of the primary agricultural and upstream and downstream industries; describes the main food and agriculture outputs and markets; and reviews trends in agricultural productivity and sustainability.

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.

Challenges and opportunities: The need for innovation

Brazilian agriculture and agro-processing sectors have shown impressive growth over the past two decades. The abandonment of the industrial import substitution strategy in the late 1980s and broad economic reforms have enabled agricultural resources to be re-allocated to areas where the country has a comparative advantage. Agriculture has also benefitted from the dynamic growth of the overall economy which has driven demand for food and non-food agricultural products. Social policy had a particular impact on domestic demand by putting many people out of extreme poverty and contributing to a steady decline in poverty rate. The benefits of domestic reform were increased with the substantial opening of opportunities on global markets as agricultural commodity prices soared and demand from emerging and developing economies grew rapidly.

Sustaining high agricultural growth is critical to Brazil's further development, given the aggregate weight of agriculture and agro-industries in the national economy and the resource potential that can yet be exploited. Brazil's agricultural growth is also important globally, due to the country's role as a leading supplier on international markets. The economic reforms of the 1980s and 1990s provided a strong impulse for agricultural development, but their potential to add as much to future growth is diminishing. Brazil's trade opportunities are affected by a slow recovery in developed countries, a loss of momentum in key emerging economies, and a tightening of competition on global agricultural markets to capture trade growth. Brazil's broadest challenge today is to sustain high agricultural growth in the conditions when its powerful supply and demand drivers in the past have weakened. This puts the sector's cost competitiveness into forefront where increased innovation will play an essential role in achieving it.

Brazil faces another difficult task – that is reconciling its agricultural growth with two fundamental societal objectives. One is to ensure that growth is achieved sustainably and without damaging the environment. Past agricultural expansion in Brazil has been associated with a shift of land away from non-agricultural use, a significant expansion of areas under regular cultivation, increases in agricultural greenhouse gas emissions and livestock densities. Some environmental issues related to agriculture, such as deforestation, have long attracted policy attention, while others, such as air and water pollution, as well as climate change will become more pressing in the future. Another societal objective is to reconcile agricultural growth – and the pressure that structural adjustment puts on small farmers – with poverty reduction objectives. The provision of land and credit is likely to be not enough for small farms to develop into viable businesses, while the long-term future of many other small rural households most probably lies outside agriculture. A comprehensive human development effort is required to enable the rural poor to generate adequate incomes both within and outside agriculture. Otherwise, agricultural growth risks compromising poverty reduction objectives.

Brazil's capacity to realise its agriculture growth potential becomes progressively contingent on overcoming the considerable structural bottlenecks. These concern deficiencies in physical infrastructure and low overall skill levels. Brazil has already made large strides to catch up, but the remaining structural gap is still significant and continues to hinder the country's development. A further reform impulse is required to support development of private finance for investment and reduce regulatory barriers to entrepreneurship. For a large agro-food exporter such as Brazil, future growth also hinges on increased access to external markets, meaning that the country has high stake in further opening global markets through the multilateral and plurilateral process.

General context: Natural endowment and economic development

Brazil is the world's fifth largest country, both by land area (8.5 million square km) and population (197 million); it is also the largest country in Latin America (Table 2.1). It spans three time zones and is the only equatorial country in the world with contiguous territory outside the tropics. The vast area and varied relief result in a diverse climate, but most of the country is tropical.

Brazil's spatial development is uneven with the main economic activity and population concentrated in the band along the country's Atlantic coast, while most of the northern and north-western parts are occupied by Amazonia. Brazil is abundantly endowed with agricultural resources – its agricultural land area is exceeded only by China, Australia and the United States, and Brazil is estimated to concentrate the world's largest reserves of potentially cultivable land. Its overall freshwater resources are the largest in the world. Brazil's river system is the most extensive in the world and includes the Amazon, the world' second longest river and the largest one by water flow.

Table 2.1. Contextual indicators for Brazil

	GDP	GDP per capita	Population	Total land area	Agricultural land	Arable land per capita	Freshwater resources	Freshwater resources per capita
	Billion USD (2012)	PPP USD (2012)	Million (2012)	'000 km^2 (2012)	'000 km^2 (2011)	Hectares (2011)	Billion m^3 (2011)	m^3 (2011)
Brazil	**2 253**	**11 716**	**197**	**8 459**	**2 750**	**0.37**	**5 418**	**27 512**
Brazil's world ranking	*7*	*88*	*5*	*5*	*4*	*30*	*1*	*28*
Australia	1 532	44 407	23	7 682	4 097	2.14	492	22 039
Canada	1 821	41 150	35	9 094	626	1.25	2 850	82 647
China	8 227	9 059	1 377	9 327	5 191	0.08	2 813	2 093
European Union	16 687	34 064[1]	504	4 238	1 879	0.21	1 505	2 963
India	1 842	3 813	1 237	2 973	1 798	0.13	1 446	1 184
Indonesia	878	4 876	247	1 812	545	0.10	2 019	8 281
Russia	2 015	23 501	143	16 377	2 153	0.85	4 313	30 169
South Africa	384	11 255	52	1 213	964	0.24	45	886
United States	16 245	51 689	314	9 147	4 113	0.51	2 818	9 044

Source: WDI (2013), *World Development Indicators Database*, http://data.worldbank.org/data-catalog/world-development-indicators.

StatLink http://dx.doi.org/10.1787/888933242835

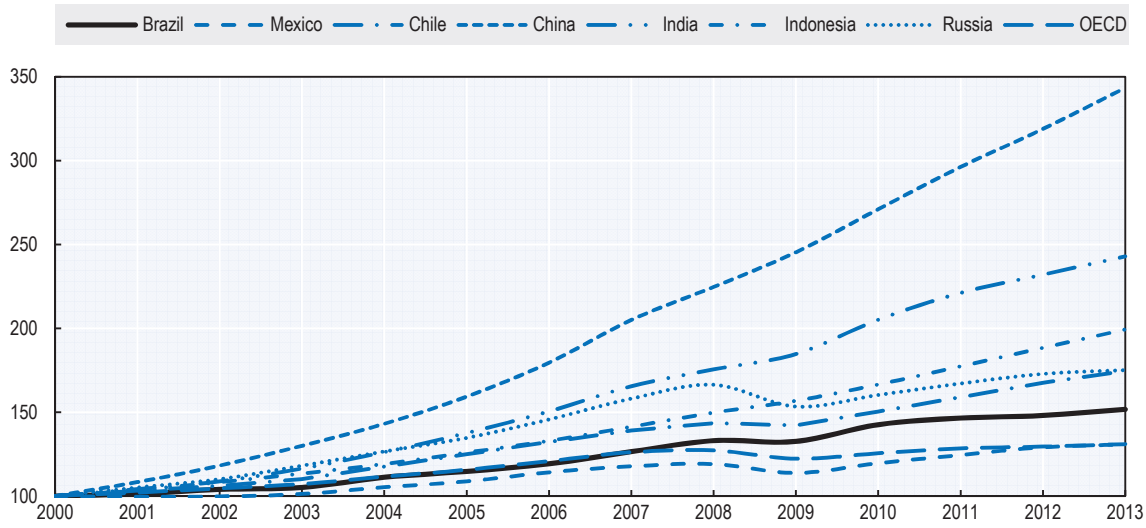
Brazil is a major player in the global economy. Since the turn of the millennium Brazil has achieved dynamic growth to become the seventh largest world economy in 2012 and has moved up to the rank of upper middle income economy (WDI, 2013). Economic development has been more inclusive than in the past, and poverty and inequality have been significantly reduced. Poverty, nevertheless, remains high, with over one-half of households living with per capita income at or below the minimum wage, and income distribution is one of the world's most uneven (IBGE, 2013).

Brazil's GDP growth since 2000 has been dynamic, but less strong than in other large emerging economies (Figure 2.1). More than 40% of the economy's potential growth over the last decade was due to increasing labour input, considerably above the same share estimated for India, Indonesia, China and South Africa (around 25%). Brazil's Total Factor Productivity (TFP) has contributed less to overall economic growth than in most of the BRIICS and OECD area, and declined in pace, with a negative average annual TFP rate (-0.3%) observed over the 2000-12 period. Brazil's exports tended to increase more slowly than its export markets, suggesting that the country has been losing international competitiveness. While over the second half of the 2000s the gap in per capita income and labour productivity has been closing between Brazil and OECD countries, it widened again in the early 2010s. This can be partly related to cyclical factors, but also to deeper structural features. As evidenced by a steady rise in real labour cost in the manufacturing sector, Brazil's labour market is tightening. The levels of savings and investment, although they have somewhat increased since 2000, have remained below those observed in other fast growing regions. Infrastructure deficiencies, a lack of robust long-term finance market, and skill shortages continue to hinder more efficient use of labour and capital, although these areas have seen considerable improvements. Based on these

trends, the latest OECD *Economic Survey of Brazil* concluded that the country's future economic growth will need to come increasingly from productivity improvements, which have so far contributed less to economic growth than in other regions (OECD, 2013).

Figure 2.1. Brazil's real GDP growth in international comparison, 2000-13

At purchasing power parity, 2000=100



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Importance of agriculture in the economy

Primary agriculture contributes 5% to Brazil's GDP – a higher share than in the most advanced economies, but much smaller than in some large emerging economies, such as India, Indonesia or China (Table 2.2). The agricultural sector absorbs 17% of Brazil's employment or over three times its share in GDP. The implied low labour productivity compared to the rest of the economy reflects in part the dualistic nature of farming in Brazil, where capital-intensive and large-scale production co-exists with numerous small and relatively unproductive farms. Nevertheless, the labour productivity gap in agriculture is closing – this sector has seen the most rapid labour productivity growth across the whole economy in the past two decades. Agriculture is a buyer and supplier for a significant part of the rest of the economy – the agricultural input sectors, agro-processing and retailing altogether contribute an additional 17% to GDP and around 18% to employment (FGV, 2013). Primary and processed agricultural products account for nearly one-third of the country's exports and are a large source of foreign currency earnings which more than offset other trade deficits. Agriculture in Brazil is an important contributor to the country's energy supply. Renewable energy accounts for around 42% of the total energy supply, with over one-third of that share produced from sugar cane biomass (Brazilian Ministry of Mining and Energy, 2013).

The role of agriculture in Brazil should also be considered from the perspective of poverty reduction. The country is relatively urbanised and the majority of the poor live in urban areas and spend a significant share of their income on food. The rural poor are less numerous, but the incidence of poverty is much higher in rural areas. Agricultural efficiency gains are estimated to have reduced by half the real cost of Brazil's average food basket between 1975 and 2010 (Martha et al., 2010). Agriculture is the principal source of income and principal employer in rural areas, but the evidence on the impact of agricultural growth on poverty is mixed. The OECD analysis

undertaken for the period between 1991 and 2000 indicated a growth in rural incomes in Brazil and a decline in the incidence of rural poverty, including extreme rural poverty. At the same time, rural inequality during this period had increased as evidenced by the increase in the rural Gini co-efficient. The analysis also pointed out that the reduction in rural poverty during that period may have been helped by migration from rural areas, as well as by welfare programmes (OECD, 2005).

Table 2.2. Importance of agriculture in the economy, 2011

Percentage

	Gross Value Added	Employment	Exports	Imports	Total land area	Total water withdrawals[1]
Brazil	**5.2**	**17.0**	**31.9**	**4.8**	**32.5**	**54.6**
Australia	2.8	2.8	13.1	4.8	53.3	73.8
Canada	1.9	2.0	9.2	7.0	6.9	..
China	10.1	34.8	2.3	5.1	55.7	64.6
European Union	1.7	4.6	6.5	5.9	44.3	..
India	17.4	47.2	..	..	60.5	90.4
Indonesia	14.7	35.8	21.0	10.7	30.1	81.9
Russia	4.3	7.9	1.7	12.2	13.1	19.9
South Africa	2.4	5.1	7.7	6.3	79.4	62.7
United States	1.2	1.6	9.8	4.7	45.0	40.2

.. not available.
1. Latest available year.

Source: OECD stat; IBGE (2013), *On-line database*, Instituto Brasileiro de Geografia e Estatística, http://www.ibge.gov.br/home/ ; FAOSTAT (2013), *On-line database*. FAO, http://faostat.fao.org ; AQUASAT (2013), *On-line database*. FAO, http://www.fao.org/nr/water/aquastat/dbase/index.stm.

StatLink http://dx.doi.org/10.1787/888933242846

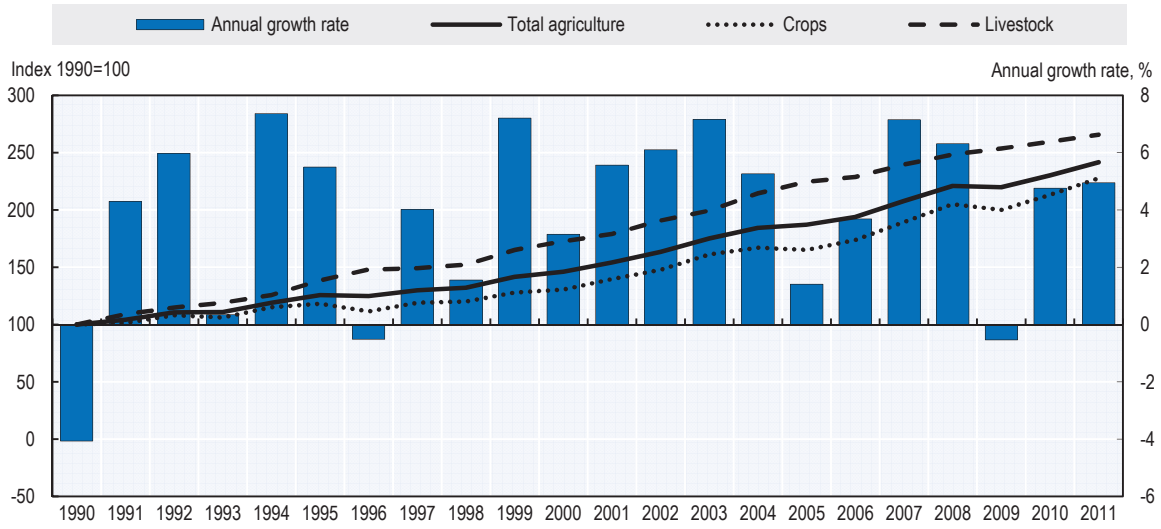
Characteristics of agriculture and the agri-food sector

Brazil's varied climate leads to diversified agriculture of both temperate and tropical products. The southern one-half to two-thirds of the country have higher rainfall, better soils, and more developed infrastructure. Farms in these regions are equipped with higher technologies and more intensive input use. Most of Brazil's grains, oilseeds and other export crops are produced in these regions. The North-East and the Amazon basin area lack well-distributed rainfall, good soils, adequate infrastructure and capital. Farmers in these areas produce mostly for their own consumption; however, exports of forest and tropical products have become increasingly important. Central Brazil contains substantial areas of grassland.

Brazilian agriculture saw strong growth in the past three decades, although not without troughs in certain years as a result of poor harvests. Total agricultural output more than doubled in volume compared to its level in 1990 and livestock production almost trebled (Figure 2.2).

Deep economic reforms that began in the late 1980s spurred agricultural growth. The abandonment of the import substitution strategy led to broad trade, exchange rate and domestic market liberalisation. Although the first half of the 1990s proved to be extremely tumultuous and destabilising for the agriculture sector, by the end of that decade macro-economic stabilisation had been achieved. Agricultural policies were liberalised as part of the overall reform: previous production and supply control systems were dismantled and price interventions scaled down and re-instrumented. Trade policy liberalisation removed export licensing, quantitative restrictions on agro-food exports, and abolished state control of wheat, sugar and ethanol trade. Brazil entered key trade agreements, such as WTO and Mercosur Customs Union.

Figure 2.2. Brazil's agricultural output indices, 1990-2011



Source: FAOSTAT (2013), *On-line database*. FAO, http://faostat.fao.org/.

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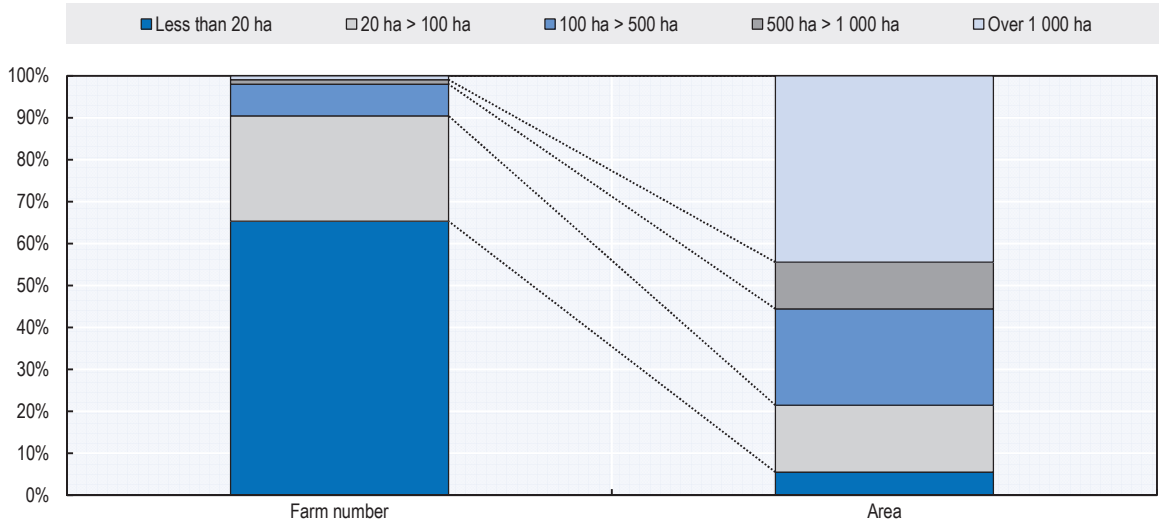
These reforms have shaped Brazil's current agricultural policy. They have progressively enabled agricultural resources to be re-allocated to activities where the country has a comparative advantage and to tap the potential of world markets. The farm structure underwent considerable change with the exit of less efficient producers and the development of large farms which have exploited economies of scale and technical progress, particularly in the Centre West. However, these adjustments also contributed to increasing the dualism of Brazilian agriculture. According to the most recent 2006 Agricultural Census, units of less than 20 hectares constitute two-thirds of the total farm number in Brazil, but occupy less than 5% of farmland. On other end, there are holdings of over 1 000 hectares accounting for only 1% of total farm number and concentrating 44% of farmland (Figure 2.3). Unequal land distribution and its impact on poverty is a long-standing concern that gave rise to agrarian reform in Brazil. Land reform initiatives to integrate poor households into the general economic development were accelerated in the late 1990s. They provided for a free of charge settlement for disadvantaged people on lands, facilitation to purchase land, and starting up agricultural activity. Established and newly settled small-scale producers received substantial credit concessions and benefitted from a range of other rural development and social programmes targeted to the rural poor.

Figure 2.3. Brazil's farm structure, 2006



Source: IBGE (2006), *Censo Agropecuário 2006*, Instituto Brasileiro de Geografia e Estatística, Rio De Janeiro.

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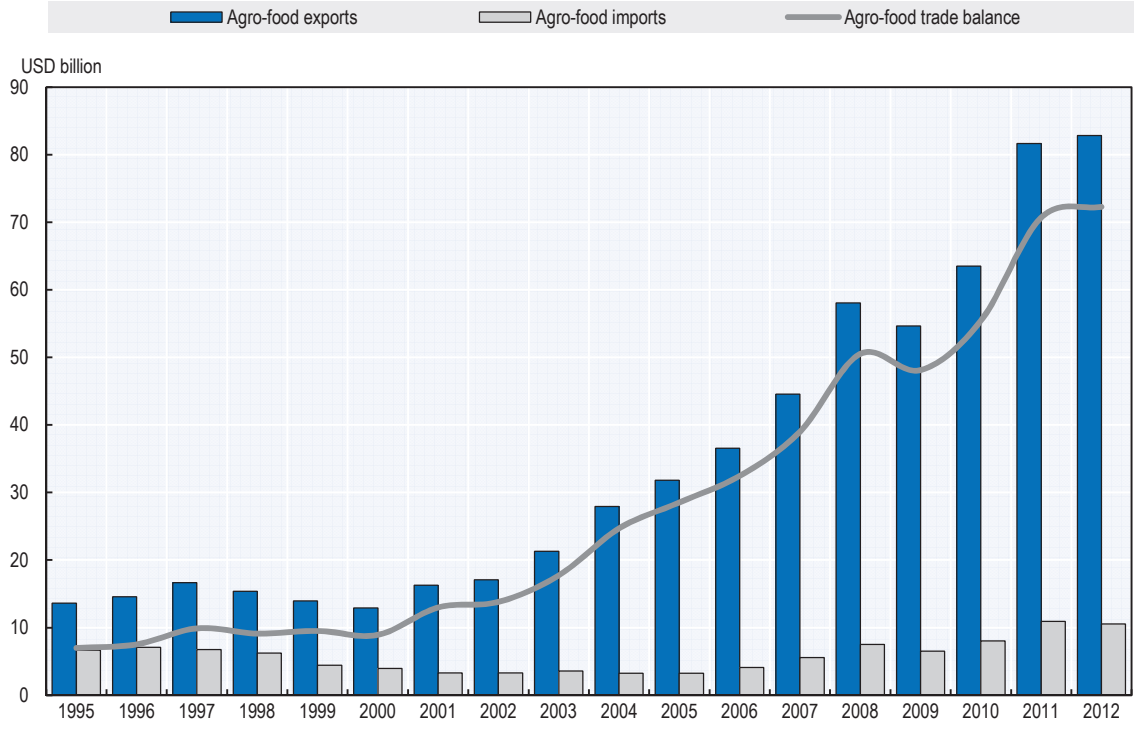
Figure 2.4. Brazil's agro-food trade, 1995-2012



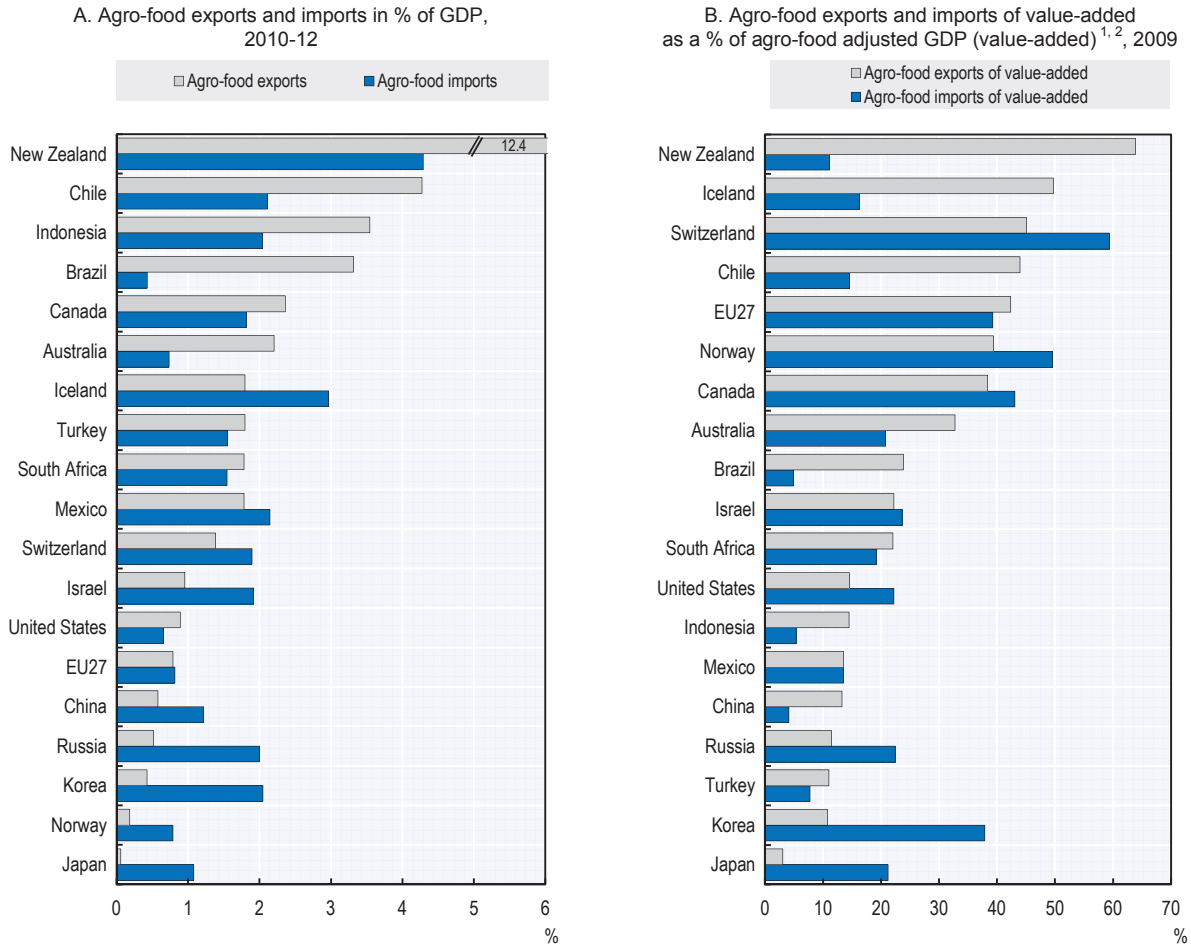
Source: International Trade by Commodity Statistics (ITCS) database, http://www.oecd.org/std/its/itcsinternationaltradebycommoditystatistics.htm

StatLink http://dx.doi.org/10.1787/888933242339

Brazil is a large net exporter of agricultural products with a surplus of almost USD 70.7 billion in 2012.[1] With the economic liberalisation and rapid growth of demand from emerging economies, particularly China, agro-food exports have grown exponentially (Figure 2.5). The export boom was also initially helped by a considerable depreciation of the domestic currency. The country is the world's largest supplier of raw and refined sugar, orange juice and coffee, the second biggest in soybeans and beef, and third in maize, poultry, soybean meal and soybean oil (2013). Brazil's largest trading partners are the European Union, China and Asian countries. Nevertheless, while contributing weighty shares to world agro-food markets, most of the production in Brazil serves the domestic market.

Among OECD and BRIICS countries, Brazil has relatively high exposure to agricultural trade, which is expectedly more significant on the export side (Figure 2.5).

Figure 2.5. Brazil's exposure to trade in agriculture and food products, international comparison



Countries are ranked by the shares of agro-food exports.

1. Value-Added embodied in Foreign Final Domestic Demand shows how industries export value both through direct final exports and via indirect exports of intermediates through other countries to foreign final consumers. They reflect how industries (upstream in a value-chain) are connected to consumers in other countries, even where no direct trade relationship exists. The indicator illustrates therefore the full upstream impact of final demand in foreign markets to domestic output. It can most readily be interpreted as "exports of value-added".

2. Foreign Value-Added embodied in Final Domestic Demand shows how industries abroad (upstream in a value-chain) are connected to consumers at home, even where no direct trade relationship exists. It can most readily be interpreted as 'imports of value-added'

Source: International Trade by Commodity Statistics (ITCS) Database
http://www.oecd.org/std/its/itcsinternationaltradebycommoditystatistics.htm and OECD WTO Trade in Value-Added Database, 2013, http://www.oecd.org/trade/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm.

StatLink http://dx.doi.org/10.1787/888933242348

Productivity and sustainability performance of agriculture

Trends in agricultural productivity

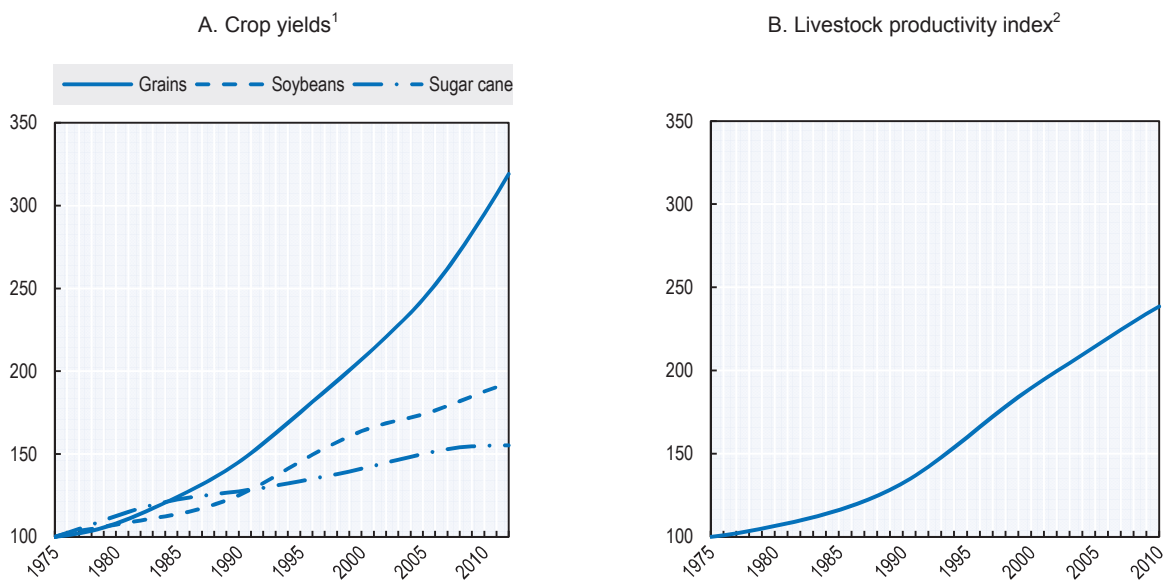
Brazil's agricultural growth was underpinned by significant productivity gains. The yields of main crops nearly doubled or trebled since the mid-1970s, yield improvements were particularly strong in the 1990s. A similar trend has been observed in animal production where output growth outpaced the increase in animal numbers (Figure 2.6).

The estimates by Gasques et al. (2013) show that output growth in agriculture reflects rapidly increasing efficiency in utilisation of production factors, particularly land and labour (Figure 2.7). As for labour, agriculture was the dominant driver of labour productivity within the overall economy, contributing 85% to the aggregate labour productivity growth in the four sectors (agriculture, manufacturing, mining and services) between 2002 and 2007, and almost one-half between 2007 and 2012 (OECD, 2013b). Productivity improvements were in part an effect of capital replacing labour. Policy stimulus has propelled the rapid mechanisation and replacement of obsolete machinery in agriculture between the mid-1970s and mid-1990s; for example, the total tractor fleet more than trebled during this period and the value of the machinery and equipment stock more than doubled in constant prices (FAOSTAT, 2013).

TFP in Brazilian agriculture was increasing 3.5% per year between 1975 and 2012, with the rates increasing to over 4% in the 1990s and 2000s (Figure 2.8). This contrasts with the trends in the rest of the economy, where growth was achieved mostly due to increased employment of production factors with the TFP falling.

Figure 2.6. Long-term trends in crop and livestock productivity in Brazil, 1975-2012

Indexes 1975=100



1. Indexes are based on yields smoothed using a Hodrick-Prescott filter.

2. Livestock productivity index is the ratio of livestock output index to the index of total livestock capital on farms expressed in "cattle equivalents". Indexes are based on series smoothed using Hodrick-Prescott filter.

Source: Calculations based on data from USDA (2013) and FAOSTAT (2013).

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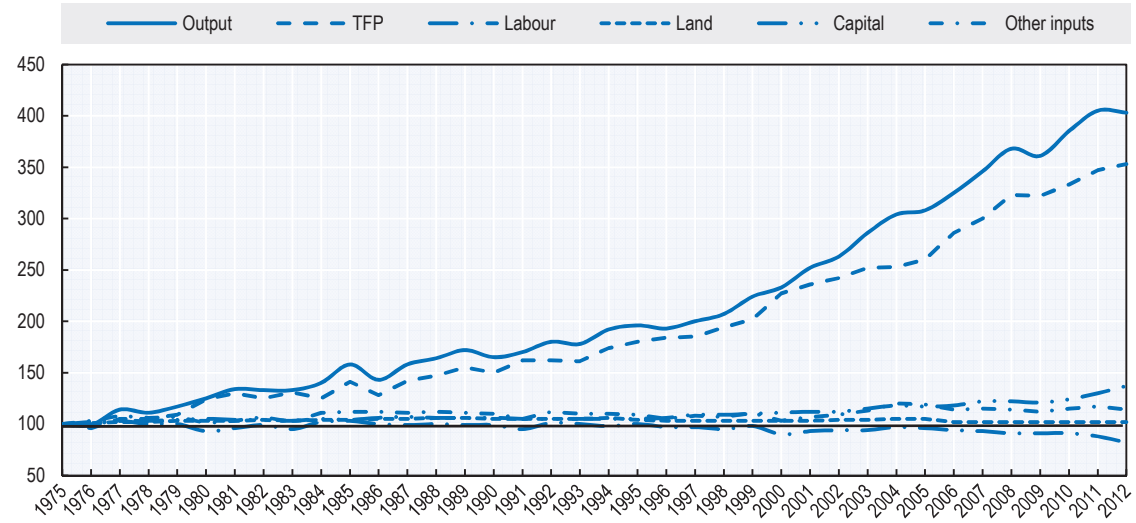
Figure 2.7. Long-term trends in output and productivity of key agricultural factors in Brazil, 1975-2012

1975=100



Source: Gasques et al. (2013).

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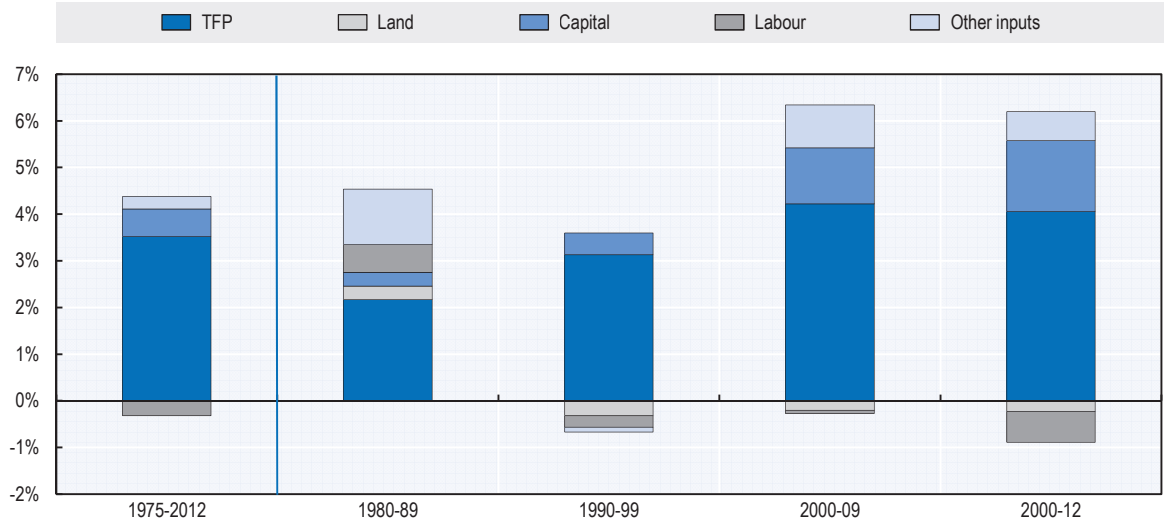
Figure 2.8. Contribution of Total Factor Productivity and other factors to agricultural output growth in Brazil, 1975-2012

Period average growth rates



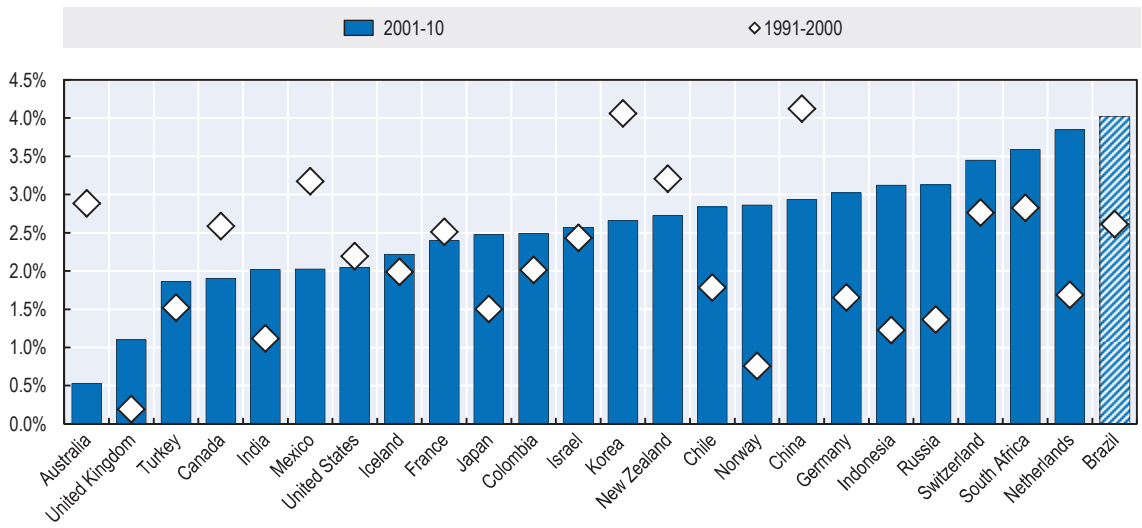
Source: Gasques et al. (2013).

StatLink http://dx.doi.org/10.1787/888933242374

Brazil emerged as one of the top global performers in TFP growth in agriculture. Of the 172 countries covered by the TFP study by USDA (2013), it ranked 12th by the rate of TFP growth between 2001 and 2010.[2] Accordingly, Brazil demonstrated the strongest TFP improvements in agriculture among the BRIICS and the OECD countries (Figure 2.9). Nevertheless, the cross country comparison needs to be made with care due to many factors contributing to differences in productivity growth rates. In particular, much stronger performance of Brazil and BRIICS overall reflects their catching-up stage with low initial productivity levels in these countries.

The productivity improvements of Brazilian agriculture were driven by advances in agricultural research, which made better crop and livestock technologies available to producers and the agro-industry, notably tropical technologies making possible the incorporation of Brazilian *cerrados* (savannah areas) into productive use. Most important were the technologies of nitrogen fixation, particularly in soybean varieties, no-tillage systems and the emergence of new grain varieties and livestock breeds adapted to the tropics. The impact of new technologies was later compounded by the economic reforms which enabled the re-allocation of resources and the structural changes in agriculture and its associated industries. By establishing a more competitive environment, the economic reforms also strengthened producer incentives to increase productivity and therefore to uptake innovations.

Figure 2.9. Average annual growth rates in agricultural Total Factor Productivity, international comparison



Source: USDA (2013), *Economic Research Service International Agricultural Productivity database*. www.ers.usda.gov/data-products/international-agricultural-productivity/documentation-and-methods.aspx#excel.

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Sustainability performance of agriculture

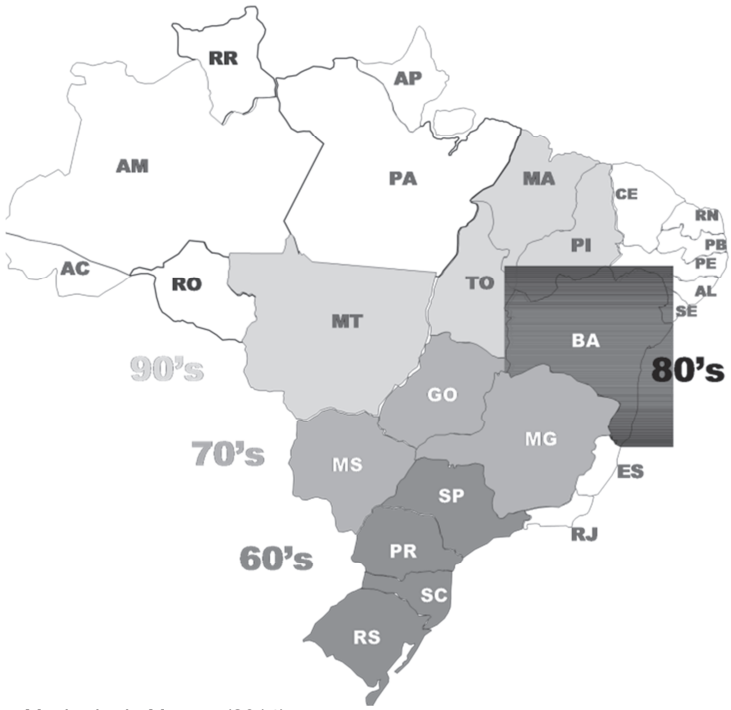
Agricultural growth was associated with considerable expansion of agricultural land, which increased by 33 million hectares between 1990 and 2010 (Figure 2.10). On a global scale, this was one of the largest expansions during that time period. In the first half of the 1990s, this occurred mostly due to the outstretching of pastureland – a process driven by the introduction of new land management technologies and policy stimulus, but which virtually stopped by the end of that decade. Since then, agricultural land has increased mainly due to expansion of arable areas, which in over only four crop years, 2000/01 to 2003/04, soared by 9 million hectares, with soybean plantings increasing by 50%. The expansion of soybean area, particularly in the Centre West, has in turn boosted plantings of crops that are rotated with soybeans, notably second crop maize and cotton.

The increase in agricultural area went in parallel with the shrinkage of forest land, the share of which in total land fell from 68% to 61% between 1990 and 2011. This led to concerns on the expansion of agriculture in the Amazon region in particular, which together with surrounding *cerrado* savannah contains the largest portion of the world's terrestrial biodiversity. The accumulated area of deforestation in the legal Amazon[3] increased from 43 million hectares in 1990 to 75 million hectares in 2010 (IBGE, 2013). The peaks in deforestation rates in the mid-1990s and mid-2000s prompted a progressive tightening of land use monitoring and liability enforcement for illicit actions. Since the mid-2000s, Amazon deforestation has been consistently decelerating, but

this trend reversed in 2013. Some analyses tend to link this "outbreak" of deforestation with infrastructure projects carried out in the Amazon region, rather than with the expansion of agriculture (FGV, 2013). Nevertheless, the indications from the monitoring in 2014 are that the recent rise in the rate of deforestation in the Amazon may have been temporary (ABIOVE, 2014). The impact of agricultural expansion on Amazon deforestation has received much public attention, both nationally and internationally, and there is continued debate on how and to what degree agriculture contributed to this process.[4] There are also concerns about the environmental impact of agricultural expansion on the *cerrado*. While agriculture has expanded rapidly in this region, some estimates indicate that there remains approximately over 0.5 million square kilometres of undeveloped *cerrado* land with agricultural potential (Brandão et al., 2005).

The available data suggest that fertiliser and agricultural chemical use in Brazil has intensified, as evidenced by an increase in their per hectare use (Table 2.3). However, according to the 2006 Agricultural Census, almost 70% of farms reported they did not use any fertilisers during the census year, and the same share reported no use of agricultural chemicals. This implies that the impacts of fertiliser and chemical use are strongly differentiated by the type of agricultural system and region where different systems prevail. Given the abundance of rainfall and water resources, the importance of irrigation in Brazil is small, with only around 2% of agricultural land equipped with irrigation.

Figure 2.10. Expansion of agricultural frontier in Brazil



Source: Based on Machado de Moraes (2014).

Table 2.3. Brazil's selected agro-environmental indicators, 1990-2011

	1990	1995	2000	2005	2010	2011
Land						
Forest area (% of land area)	68	66	65	63	61	61
Agricultural land (% of land area)	29	31	31	32	32	33
Agricultural land use (in %):						
Arable land	21	22	22	25	26	26
Permanent crops	0.8	0.9	0.9	0.9	0.8	0.8
Permanent meadows and pastures	76	75	75	72	72	71
Organic area (% of agricultural land)	..	..	..	0.31	0.65[6]	..
Water						
Total area equipped for irrigation (% of agricultural land)	1.1	1.0	1.3	1.7	..	..
Annual freshwater withdrawals:						
Total, billion cubic meters	..	..	..	..	..	32[4]
Agriculture withdrawals as % of total	..	..	..	..	..	55[5]
Air and climate change						
Agricultural methane emissions						
1 000 metric tons of CO2 equivalent	209 522	..	245 495	302 637	327 166	327 166[8]
% of total	66	..	72	61	74	74[8]
Agricultural nitrous oxide emissions						
1 000 metric tons of CO2 equivalent	102 540	..	122 725	157 462	165 031	165 031[8]
% of total	66	..	73	66	80	80[8]
Livestock						
Livestock number per ha of agricultural area[1]	3	4	4	5	6	6
Fertiliser and pesticide use						
Fertiliser use on arable and permanent crop area, tonnes per 1 000 ha[2]	..	..	65	66	78	96
Pesticide use on arable and permanent crop area, tonnes per 1 000 ha[3]	0.4	0.7	1.0	..	..	..
Energy						
Energy use in agriculture and forestry (% of total energy use)	5.4	5.4	4.7	4.9	4.9[7]	..
Bioenergy production (% of total renewable energy production)	73	68	64	69	69[(2007)]	..

1. Cattle, buffaloes, pigs, sheep, goats, and poultry. 2. In nitrogen and phosphate nutrients. 3. An active ingredient. 4. For the year 2006. 5. For the year 2007. 6. For the year 2008. 7. For the year 2009. 8. For the year 2010.

Source: FAOSTAT (2013); AQUASTAT (2013); WDI (2013).

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This share, nevertheless, has tended to increase since 1990, with agriculture currently making almost 60% of annual freshwater withdrawals. Brazil ranks fifth worldwide in terms of overall greenhouse gas (GHG) emissions. Agriculture is the dominant source of GHG emissions, and its contribution to air pollution was increasing, at least up to 2010, in absolute and relative terms. This reflects both land-use changes and considerable growth in livestock inventories. USDA (2013) estimates that they rose in Brazil by almost 40% between 1990 and 2010 in cattle equivalents, one of the most important increases among the 172 countries covered by this study. The expansion of inventory doubled livestock density, from three heads per hectare of agricultural land in 1990 to 6 heads in 2011. These levels are comparable with those in New Zealand where a pastoral system prevails, but are low compared to world regions with more intensive livestock production (e.g. the European Union with an average total cattle number per hectare of 9.6 heads).

All the indicators above reflect the country's average situation, but disguise substantial differentiation in the nature and scale of environmental pressures across Brazil resulting from different farming systems. For example, commercial farming in the southern states of Rio Grande do Sul, São Paolo and Paraná is input intensive, with high fertiliser use. Farming systems in these areas are associated with concerns on the impact of agricultural water use on resource levels, and pesticide use on water quality. In the Centre West farming systems are more extensive and farmers in these regions increasingly use direct planting which reduces the risks of erosion, protects soils, and requires less fuel, however, a loss of natural forest cover and biodiversity is a significant concern in these parts of the country (OECD, 2005).

Notes

1. This value does not include fish and fish products.
2. USDA use data published by FAOSTAT to calculate TFP growth as the difference between output growth and input growth. The aggregate index of output volume is based on Agricultural Gross Production in constant 2004-06 USD, smoothed over time using a Hodrick-Prescott filter. The aggregate index of input use is calculated as the average of land, livestock, machinery, fertiliser and feed use indexes, weighted by the shares of these inputs in agricultural production available in the literature.
3. "Legal Amazon" encompasses nine Brazilian states and covers five million square kilometres – more than 50% of Brazil's total area.
4. The different perspectives are summarised, for example, in Box 1.1, "The impact of agriculture on the Brazilian Amazon" in OECD (2005), and in FGV (2013), pp.26-29.

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Chapter 3

Economic stability and trust in institutions in Brazil

This chapter outlines the importance of economic stability and public institutions in fostering public and private investment. It provides an overview of the performance of the overall economy, outlines macroeconomic developments and challenges, and presents an evaluation of public institutions.

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.

Macroeconomic policy environment

The framework conditions for innovation encompass macroeconomic performance, financial and tax systems, openness to international trade and foreign direct investment, infrastructure, labour and education systems. Stable macroeconomic framework and good performance of public governance and institutions are a prerequisite for unleashing and fostering innovation. Innovation is an activity of medium- or long-term horizon that requires a stable environment. Under conditions of economic and political instability and weak institutions, potential innovators will perceive significant risks to longer term undertakings and are unlikely to invest in activity that does not generate rapid returns (OECD, 2010a; OECD, 2010b).

Brazil has been praised for its successful economic transition from the tumultuous decades of the 1980s and 1990s. This success is largely due to the ability of the government to pursue stable and predictable macroeconomic policies based on stable inflation, declining public debt, and a flexible exchange rate. Several key indicators show considerable improvement in macro-economic fundamentals in Brazil over the past two decades, with consumer inflation brought down to one-digit levels, a significant reduction in public debt, an accumulation of international reserves, and a fall in unemployment rate (Table 3.1).

Macroeconomic stability has been essential to building resilience to external shocks, including the global crisis of 2008-09. Specific policy responses to this crisis were appropriate, aimed at increasing liquidity, resolving the credit crunch and providing fiscal stimulus. The economy returned to growth in 2010, but it has lost its earlier momentum. According to the World Economic Forum's 2013-14 *Global Competitiveness Index*, Brazil performed somewhat below the majority of OECD countries and some BRIICS countries (Brazil, Russia, India, Indonesia, China and South Africa). This evaluation is based on the index of macroeconomic environment aggregating key macroeconomic indicators such as the government's budget balance, gross national savings, inflation, government debt, and country credit rating in terms of stability of macroeconomic environment (Figure 3.1).

Table 3.1. Brazil's key indicators of macroeconomic performance

	1995	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014e	2015e	2016e
Real GDP growth, %	..	1.3	3.2	3.9	6.1	5.2	-0.3	7.5	2.7	1.0	2.5	0.3	1.5	2.0
General government financial balance[1]	..	-3.3	-3.6	-3.6	-2.8	-2.0	-3.3	-2.5	-2.6	-2.5	-3.3	-3.9	-3.1	-3.0
Current account balance[1]	-2.4	-4.1	1.6	1.3	0.1	-1.7	-1.4	-2.2	-2.1	-2.4	-3.6	-3.9	-3.6	-3.3
Exchange rate, BRL per USD[2]	0.92	2.35	2.44	2.18	1.95	1.84	2.00	1.76	1.67	1.95	2.16	2.34	2.53	2.53
Inflation, annual %, CPI all items	..	6.8	6.9	4.2	3.6	5.7	4.9	5.0	6.6	5.4	6.2	6.5	5.4	5.1
Unemployment rate, %[3]	..	..	9.9	10.0	9.3	7.9	8.1	6.7	6.0	5.5	5.4	4.9	5.1	5.4

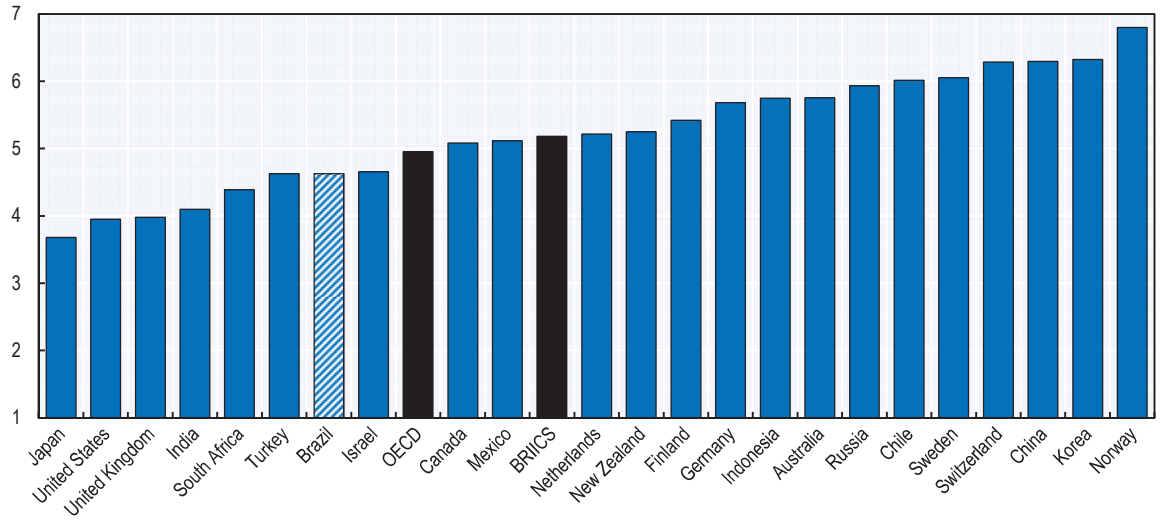
e: *OECD Economic Outlook* estimate.
1. As a percentage of GDP.
2. Period average.
3. End year, as a percentage of total labour force.

Source: OECD Economic Outlook 96 database – November 2014. http://dotstat.oecd.org/.

StatLink http://dx.doi.org/10.1787/888933242860

Figure 3.1. Global Competitiveness Index: macroeconomic environment, 2013-14

Scale 1 to 7 (best)



1. Indices for BRIICS and OECD represent simple averages of member-country indices.
Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014*, http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

StatLink http://dx.doi.org/10.1787/888933242403

According to the latest *OECD Economic Outlook* (November 2014), after real GDP declines in the first half of 2014, activity is set to recover gradually in Brazil. Nonetheless, growth will remain modest due to tighter monetary and fiscal policies, weak external demand, low levels of investment and persistent infrastructure bottlenecks. Inflation will only come down slowly, as overdue increases in administered prices are likely to push up inflation temporarily (OECD, 2014).

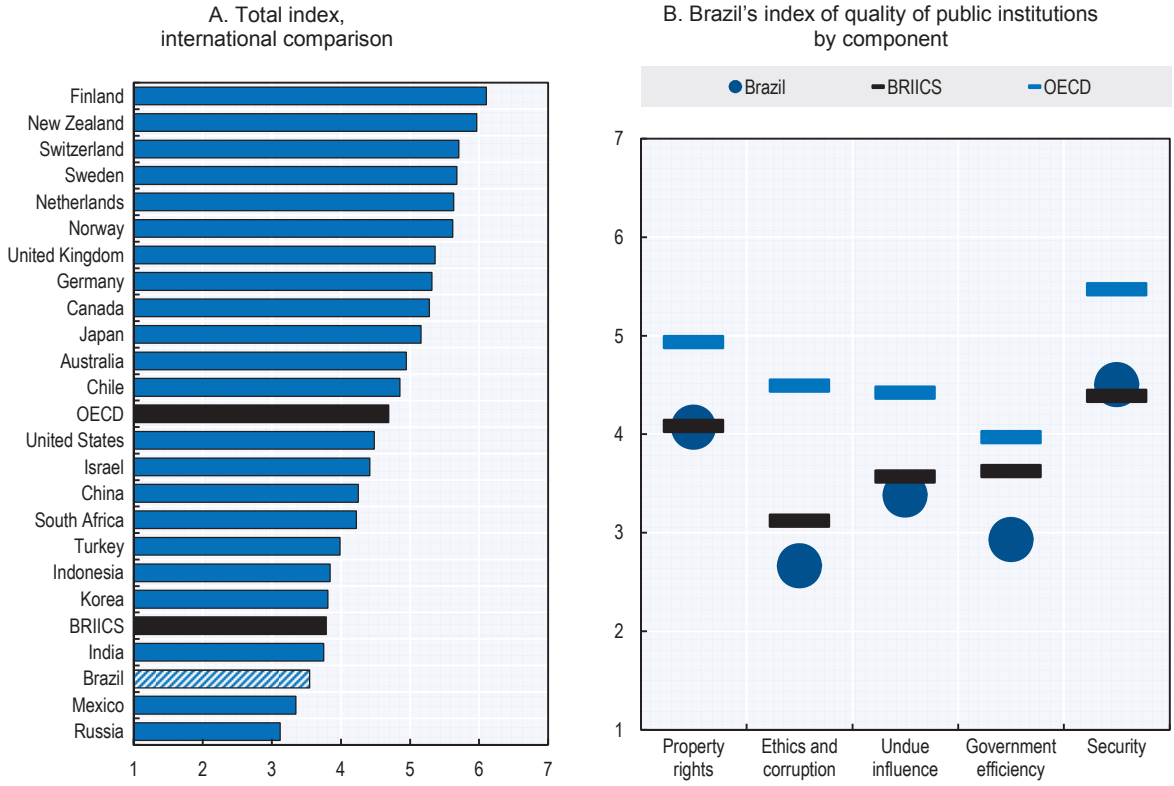
High inflation continues to be a strong factor affecting macroeconomic stability in Brazil. The central bank has appropriately raised its policy rate to reduce inflation. Keeping inflation expectations anchored on the inflation target may require continued tight monetary policy in 2015, despite the weakness of growth. As fiscal performance has deteriorated, more fiscal discipline will be needed in the coming years to ensure a sustainable reduction of gross public debt (OECD, 2014). Another source of uncertainty is the rising household indebtedness, with a debt-service to income ratio of 21%, which exceeds the levels in the United States and many Latin American countries. External risks come from the possible deterioration of global economic conditions. A longer-term challenge is to contain pension expenditures in view of an expected rise in the old-age dependency ratio. Consolidating confidence in the macroeconomic framework in Brazil requires strengthening the existing system for inflation targeting, a tighter fiscal stance with improved clarity of fiscal and quasi-fiscal operations, and greater flexibility to conduct countercyclical fiscal policy (OECD, 2013).

Governance and quality of public institutions

Governance systems and institutions fundamentally affect risk perceptions of potential innovators. When government is accountable, transparent, predictable and non-corrupt institutions work well, and economic agents see their risks reduced and are more willing to exploit the opportunities and invest in innovation. Governance systems play an important role in addressing market failure, influencing the behaviour of firms as well as the efficient functioning of farm input and output markets.

Figure 3.2. Global Competitiveness Index: quality of public institutions, 2013-14

Scale 1 to 7 (best)



Indices for BRIICS and OECD represent simple averages of member-country indices.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014*, http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933242403

OECD Integrity Review for Brazil (OECD, 2012) commends Brazil for continuous reform over the past decade to enhance integrity and prevent corruption within its public administration. These reforms have focussed on increasing transparency and direct citizen oversight over public service delivery; introducing a risk-based approach to internal control within public organisations, and promoting high standards of conduct among federal public officials, in particular to create a culture of integrity and prevent corruption. Acknowledging the progress made, this review, however, stresses the importance of going further in these directions and outlines a broad set of actions required.

The need for further improvement in overall governance is indeed evidenced by the World Bank's governance indicators, which in 2012 positioned Brazil around mid-point in the world ranking on the dimensions of governance, such as voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. These mid-points, however, are far below the performance levels of OECD countries (WGI, 2013). This is broadly in agreement with the opinion of Brazilian business, as reflected by the WEF's Global Competitiveness Index, which gives relatively modest scores to the quality of the country's public institutions, particularly as this concerns ethics and corruption and government efficiency (Figure 3.2 above).

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Chapter 4

Investment in the Brazilian food and agriculture system

This chapter presents an overview of Brazilian regulations that govern entrepreneurship, access to natural resources, products, and processes and the extent to which they affect the adoption of innovative practices and the introduction of new products. It also discusses Brazilian policies related to trade, investment, finance and taxation and their impact on the capacity of farms and agri-food firms to invest and take advantage of market opportunities.

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.

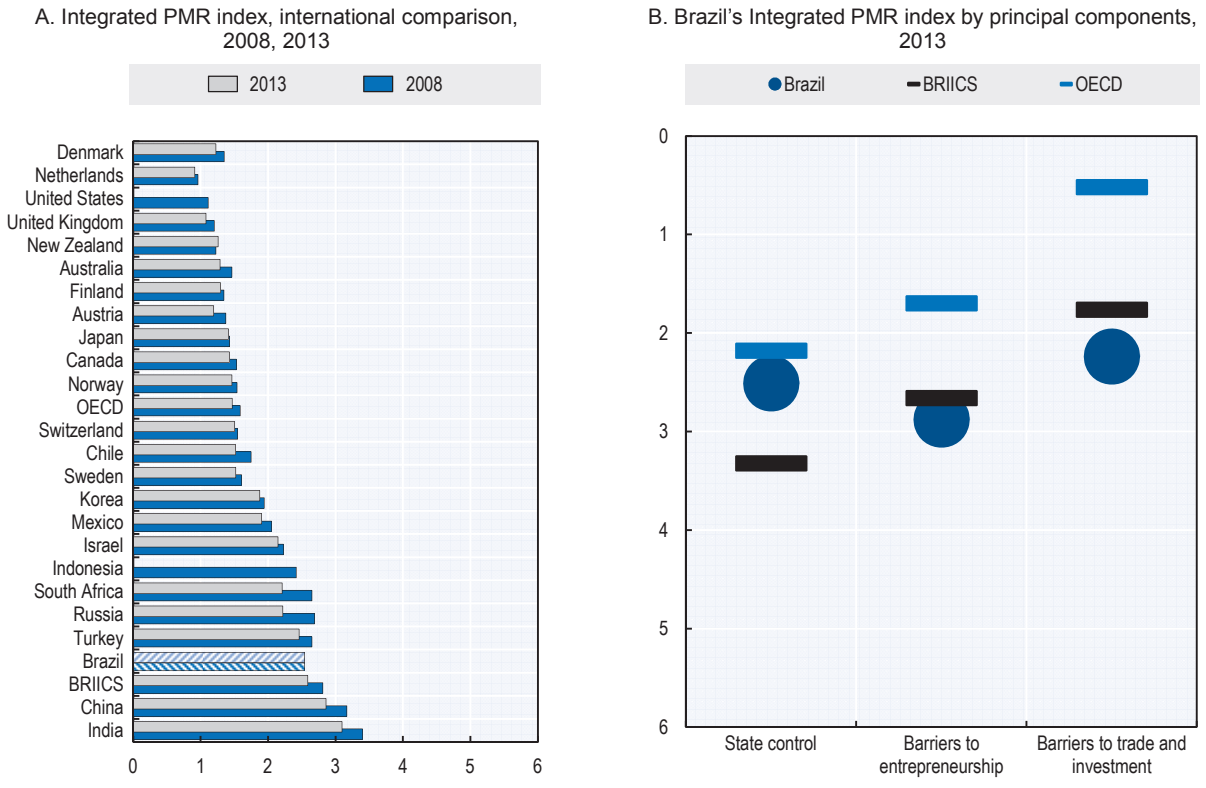
Regulatory environment

Regulations affect innovation through many links and may increase or impede knowledge advancement and technology transfer. Regulations influence the size and behaviour of firms, the ease of entry into and exit from markets, they set standards and impose administrative burden on doing business – all of these factors determine the costs and risks for businesses to innovate.

A broadly recognised link between regulations and innovation is that they determine conditions for competition, and thus incentives for companies to increase productivity. Empirical evidence shows that competition-restraining regulations slow the rate of catch-up with the technological frontier, where labour productivity is the highest (OECD, 2007, based on Conway et al., 2006). Low barriers to enter the markets favour innovation as new companies tend to exploit technological or commercial opportunities which have been neglected by more established companies. While entry and growth of new firms is important, so is their ability to exit (OECD, 2010a). There is also evidence that good product market regulation is associated with increased inflows of foreign direct investment and thus technology spill-overs (OECD, 2011; Nicoletti et al., 2003).

Figure 4.1. OECD's Integrated Product Market Regulation (PMR) indicato. 2008 and 2013

Scale from 0 (least) to 6 (most) restrictive



Indices for BRIICS and OECD represent simple averages of member-country indices.

Source: OECD (2014), *OECD Product Market Regulation Database*, www.oecd.org/economy/pmr.

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The OECD Product Market Regulation (PMR) indicators measure the degree to which countries' regulatory framework promotes or inhibits competition in the product markets. They cover key regulations in the areas of state control, barriers to entrepreneurship, and barriers to trade and investment and quantify them as an entirety and according to specific dimensions. The integrated PMR indicator indicates that on a scale from 0 (least) to 6 (most) restrictive regulation, Brazil scores more restrictive on aggregate than OECD and other BRIICS countries (except China and India), with barriers to trade and entrepreneurship representing the most important constraints (Figure 4.1).

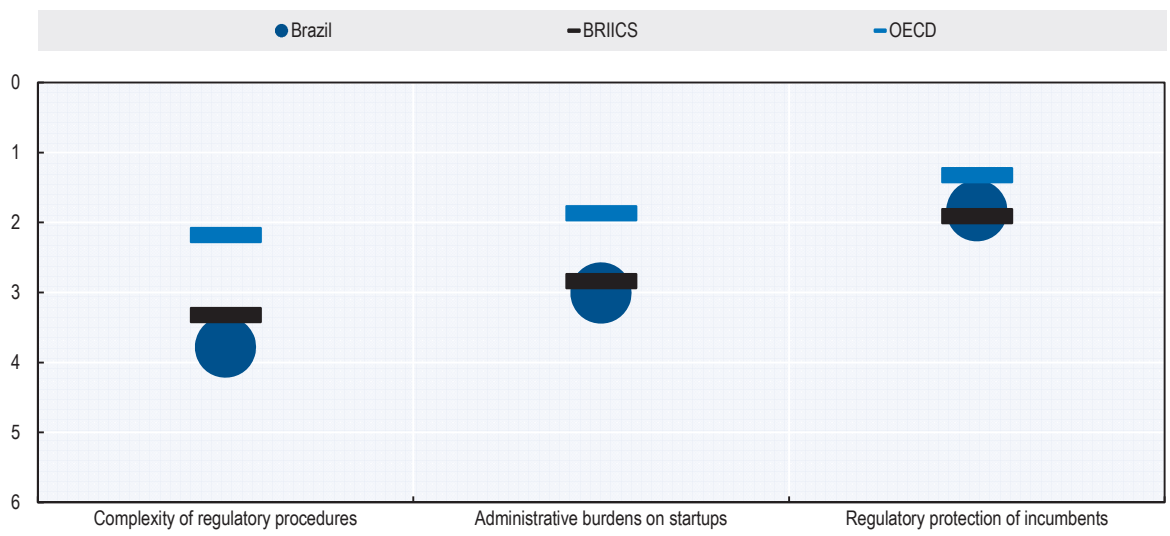
Entrepreneurship regulations

A dynamic business is a key source and channel for innovation. Regulatory barriers to entrepreneurship form the environment for dynamic business as they determine the ease of entry into business and exit from it, the number and complexity of regulations, the time that businesses spend to comply with these regulations, as well as regulatory protection of incumbents (Figure 4.2). Of these different dimensions, complexity of regulations is constraining and administrative burdens on start-ups are estimated to be quite high in Brazil, particularly as they apply to sole proprietor firms, although constraints to sole proprietor start-ups are less in Brazil than in India, China, Mexico or Chile.

Regulations translate into direct and indirect costs of doing business. The World Bank's *Doing Business* survey evaluates procedures required to start a business, obtain various permits, register, get credit, pay taxes, and trade across-borders. In 2012, Brazil ranked 116th among the 189 surveyed economies, suggesting that entrepreneurs in Brazil face more significant administrative barriers than in the majority of the world (Table 4.1). Although direct compliance costs to do business in Brazil are typically comparable, for example with the OECD area or neighbouring Latin American countries, the indirect costs, such as the number of procedures and time required to go through these procedures, with few exceptions, are much higher (Table 4.A1.1).

Figure 4.2. Barriers to entrepreneurship indicator for Brazil by regulatory area, 2013

Scale from 0 (least) to 6 (most) restrictive



Indices for BRIICS and OECD represent simple averages of member-country indices.
Source: OECD (2014), *OECD Product Market Regulation Database*, www.oecd.org/economy/pmr.

StatLink http://dx.doi.org/10.1787/888933242434

Table 4.1. Brazil's ranking in Word Bank's Ease of Business

Overall rank out of 189 economies	116
Ranking by specific regulatory area	
Starting a business	123
Dealing with construction permits	130
Getting electricity	14
Registering property	107
Getting credit	109
Protecting investors	80
Paying taxes	159
Trading across borders	124
Enforcing contracts	121
Resolving insolvency	135

Source: World Bank (2013), *Doing Business 2014*, http://www.doingbusiness.org/reports/global-reports/doing-business-2014.

StatLink http://dx.doi.org/10.1787/888933242875

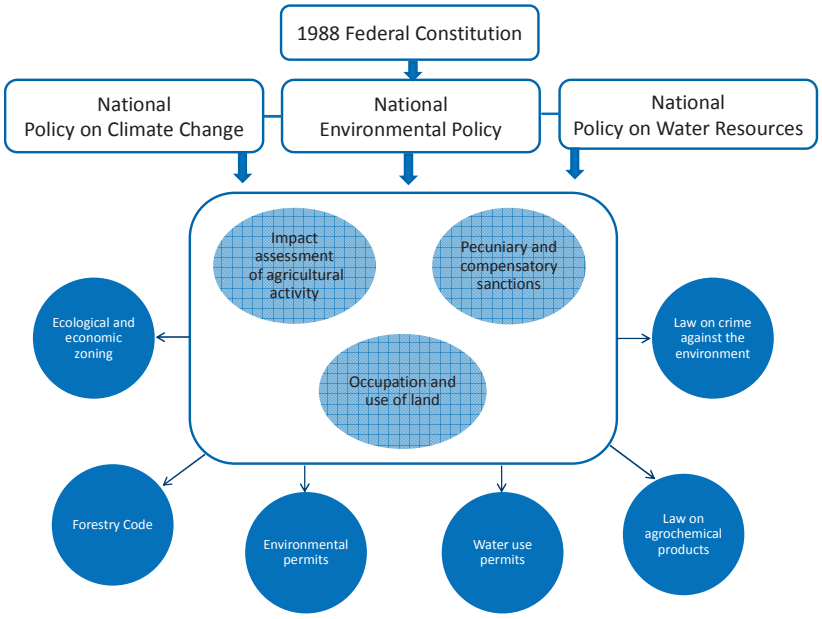
Regulations on natural resources

Brazil's environmental policy is based on the provisions of the national Constitution and a number of basic environmental laws. Current environmental objectives and strategies are outlined in three principal frameworks: the *National Environmental Policy*, the *National Policy on Water Resources* and the *National Policy on Climate Change*. A broad range of regulatory instruments underpins these frameworks, including environmental quality standards, environmental zoning, permits, impact assessments, licensing and review of polluting activities, creation of special protected areas, penalties for environmental degradation, and incentives for the introduction of technologies designed to improve environmental quality. A National System of Environmental Information gathers essential information to carry out environmental monitoring, control, enforcement and planning. Institutionally, Brazil's environmental policy is implemented by agencies and environmental institutions at all governance levels, with state and municipal authorities empowered to develop additional and complementary environmental regulations and programmes beyond those set up at the federal level. The principal laws and activities that concern agriculture are depicted in Figure 4.3.

Brazil's environmental regulations affect agriculture first of all through provisions related to land use. The *Brazilian Forestry Code* is the most important nation-wide act regulating land use. It defines forest and other forms of vegetation as so-called "public interest" goods, thus effectively setting the limits on private property rights and implying restrictions on land use in private farms (Box 4.1).

A closely related stream of regulatory activity affecting agriculture is implemented within the programmes to combat deforestation of the Amazon and *cerrado*. An *Action Plan to Prevent and Control Deforestation in the Amazon and an Action Plan to Prevent and Control Deforestation and Fires in Cerrado*, launched respectively in 2004 and 2010, contain measures to orient farmers towards environmental objectives, mostly consisting of regulations, monitoring, control and other administrative instruments to curb illegal deforestation in these two regions. These plans rest on two principal axes: the creation of natural protected areas in endangered zones and a more rigorous enforcement of land use regulations.

Figure 4.3. Brazil's key environmental policy areas and regulatory instruments related to agriculture



Source: Adapted from a presentation by Daniela Aparecida Pacífico, "Project on Agro-environmental Policy", FAO and the Ministry of the Environment of Brazil.

Box 4.1. Brazilian Forestry Code and agricultural land use issues

The *Brazilian Forestry Code* distinguishes between permanent protection areas and a legal reserve. The natural vegetation on permanent protection areas should be preserved, meaning that it cannot be used for farming, grazing or any other agricultural activity. A legal reserve is defined as a share of rural private properties, beyond permanent protection areas,[1] where only sustainable activities may be performed, including "the conservation and rehabilitation of ecological processes, biodiversity conservation and shelter for native flora and fauna." These shares are region-specific and vary on average from 20% of the farm area in the south, central and north-eastern Brazil, to 80% in forest areas of the Amazon region. The Rural Environmental Cadastre is an instrument of land use control, forming a part of the National System of Environmental Information. It represents a national electronic register, containing geo-referenced information on the borders of each agricultural holding, areas within the holding covered with indigenous vegetation, representing areas under permanent protection, restricted use, or belonging to the legal reserve (see below). A new *Law on Forestry Code*, which came into effect in 2012, made registration in the Rural Environmental Cadastre obligatory for of all rural properties.

Inadequate enforcement of the Forestry Code during the previous decades led to the expansion of agriculture into areas not eligible for exploitation, as defined by this act. No official figures on compliance with the legislation exist, but even government officials assume that full compliance is rare. The Forestry Code has been the source of controversy between environmental and farm groups. While the former have insisted on the reinforcement of monitoring and control of the Forestry Code, farmer groups considered the norms inadequately adapted to real situations and advocated to make them less restrictive. In recent years, this debate has come to the forefront of agricultural and environmental agendas, leading to the adoption in 2012 of a law that introduced comprehensive amendments to the Forest Code, which covered also restrictions related to land use.

1. Permanent protection areas are defined as specified-width margins along rivers, lakes and other water bodies and areas around water springs, top of hills and mountains, areas with specified altitudes and slopes, dunes, mangroves and cliffs.

Source: Zanella, M.A. and L.V. Cardoso (2011), "Agri-environmental Policies in Brazil and Perspectives for Evaluation", Paper presented at the OECD Workshop on the Evaluation of Agri-environmental Policies, 20-22 June, Paris.

The climatic risks zoning and the palm and sugar cane agroecological zoning (*Zoneamento Agroecologico*, ZAE) as instruments of territorial planning are other regulatory instruments having an important bearing on agriculture as a sector dependent on rules for spatial allocation of economic activity. They were designed to minimise natural risks in agriculture and prevent the expansion of sugar cane and the agricultural frontier into sensitive areas. These programmes allow each municipality to identify the best time for crop planting based on a methodology designed by the Brazilian Agricultural Research Corporation (EMBRAPA). The methodology quantifies agricultural risks using parameters such as climate, soil, and crop cycles. Compliance with zoning is not legally binding, but incentives are generated by making the provision of credit and insurance subsidies conditional on compliance with zoning rules (Chapter 6). Furthermore, private providers of financial services increasingly condition their services on the respect of zoning rules. By 2012, zoning rules were applied to 40 crops in 25 of the 26 Brazilian states.[1]

A Law and various by-laws regulate organic farming, covering: a) organic primary animal and crop production, b) organic extractive production, c) production of processed organic products, d) quality control of organic products, and e) labelling of organic products. In order to obtain a status of organic producer, entities are required to undergo conformity assessment, audit and inspection of the entire network of organic production and trade. In October 2013, Brazil launched a *National Plan for Agro-ecology and Organic Production* with the aim to coordinate policies and actions for environmentally friendly agriculture and the organic food production. The areas covered are certification, research and education, technical assistance, financing and accessible prices for consumers. The programme's initial budget allocates BRL 8.8 billion for 125 initiatives across the country.

Among other important acts are: a Law on Access to Genetic Resources regulating the use of gene pool in support of technological innovation for sustainable development; a Law on Management of Public Forests enabling forestry concessions based on sustainable practices with the aim of generating social, environmental and economic benefits. Agricultural activity is also subject to regulations on recycling of waste water and control of water quality and regulations on utilisation and disposal of elements with toxic content.

In addition to regulations, the Brazilian government has been introducing various economic incentives for environmentally-friendly agricultural practices. Thus, a number of programmes targeted to agricultural producers and rural families have been introduced since the mid-2000s providing credit concessions, specific payments and cash transfers for various environmental actions. These programmes are reviewed in Chapter 6.

Trade and investment policy

Trade openness and foreign direct investment (FDI) are critical parts of framework conditions for innovation. The expansion of markets worldwide has been a main driver behind technological innovation and productivity gains as larger sized markets have become available to innovators and consumers (OECD, 2010). The countries that have shown high innovation performance have in common that their growth strategies are oriented towards international markets. Besides increasing external markets, international openness results in more competition domestically and thus increases the pressure on companies operating on the domestic market to innovate in order to hold up to competition.

Apart from creating market size and competition drivers for innovation, trade and FDI operate as immediate channels of technology, know-how and managerial expertise, they also have indirect effects on innovation. Inward FDIs not only bringing innovations to the businesses directly involved, but may have spill-over effects on other companies in the same industry. This may come through a competition effect when domestic businesses improve their processes and products in response to FDI; through demonstration effect when domestic actors imitate better practices of companies with foreign capital; or through labour market effect when training of local workers prompts a learning

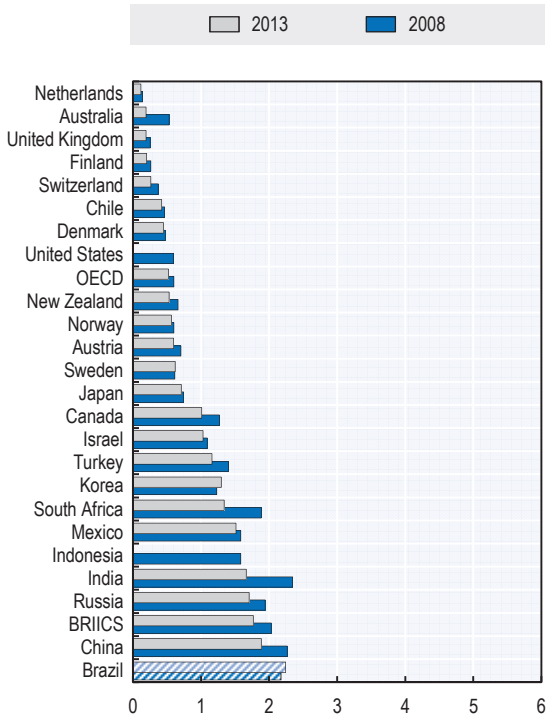
process that can, with time, reach out to the rest of the economy. FDI spill-overs may also go through the businesses upstream or downstream the firm with FDI which may face the need to meet new standards to adapt to the requirements of that firm (ECLAC, 2013 based on Havarnek and Irsova, 2012).

Exposure of Brazil's overall economy to foreign markets is low in international comparison; an average of total imports and exports was around 7% of GDP in 2009-11, one of the lowest shares among OECD and BRIICS countries. Low overall trade exposure is in part explained by the fact that Brazil has a large domestic market and is geographically remote from some of its principal external markets. However, agriculture and agro-processing sectors are more exposed to trade than the economy overall (Chapter 6).

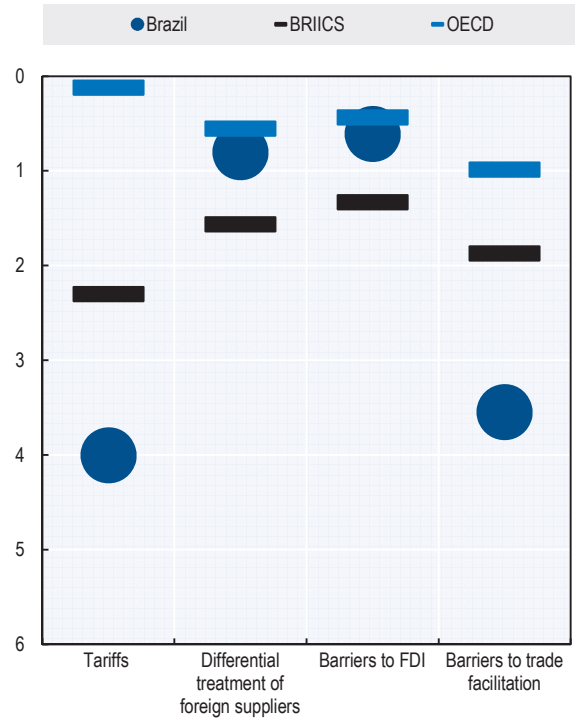
Figure 4.4. Index of regulatory restrictions to trade and investment, 2008 and 2013

Scale from 0 (least) to 6 (most) restrictive

A. Index of regulatory restrictions to trade, international comparison, 2008 and 2013



B. Brazil's index of regulatory restrictions to trade by principal components, 2013



Tariff index is based on an average effectively applied tariff, scaled within a range between 0 and 6 points, whereby a tariff below 3% is attributed zero points and a tariff above 19.5%, 6 points.

Indices for BRIICS and OECD represent simple averages of member-country indices.
Source: OECD (2014), *OECD Product Market Regulation Database,* www.oecd.org/economy/pmr.

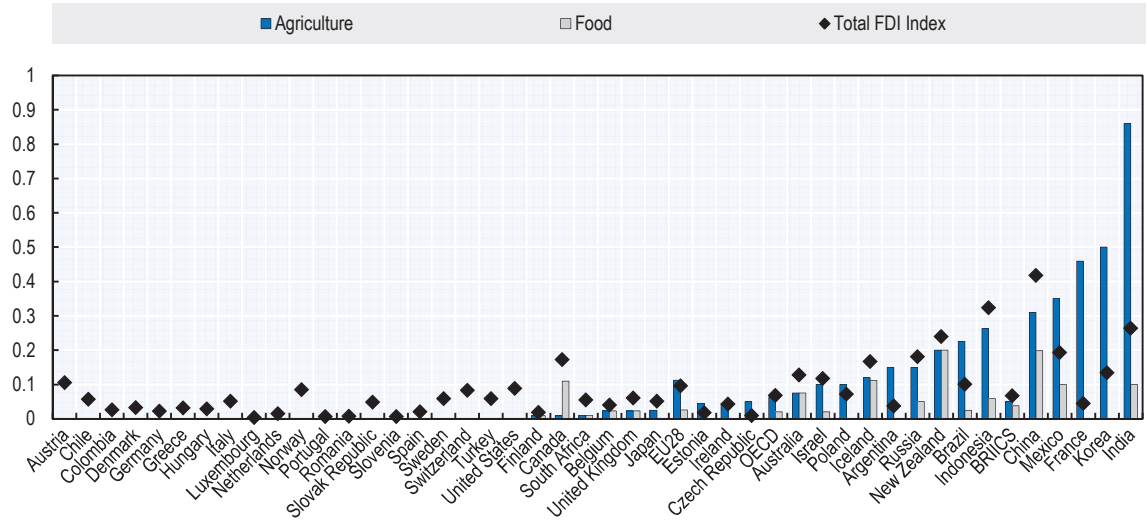
StatLink http://dx.doi.org/10.1787/888933242424

The integration of sectors of the economy with international markets, apart from geographic characteristics and the size of markets, is facilitated or impeded by trade policies. Protection of domestic markets through tariff and non-tariff barriers weakens competitive pressure on local producers and thus affects their incentives to innovate and their capacity to do so if protection relates to capital and intermediate goods. OECD evaluates Brazilian trade and investment regulations to be among the most restrictive across OECD and BRIICS countries (Figure 4.4.A). Brazil's relatively

restrictive score on trade regulations is due to high overall tariff protection and barriers to trade facilitation (Figure 4.4.B).

Figure 4.5. OECD FDI Regulatory Restrictiveness index, 2012

Scale from 0 (least) to 1 (most) restrictive

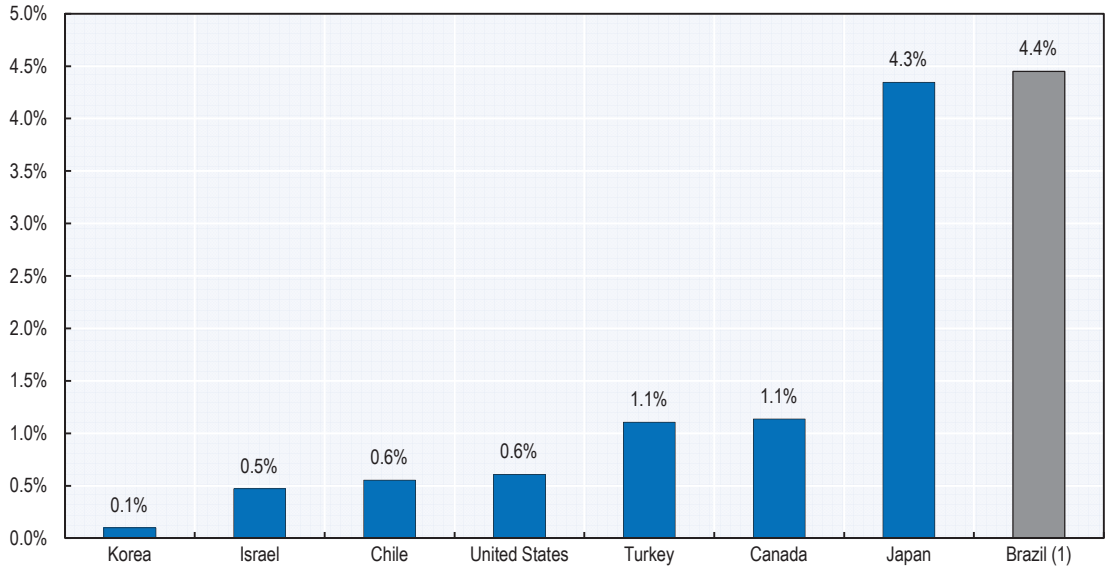


Source: OECD (2013c), *OECD FDI Regulatory Restrictiveness Index*. http://www.oecd.org/investment/fdiindex.htm.

StatLink http://dx.doi.org/10.1787/888933242440

Figure 4.6. Inward FDI stock in the agriculture and food processing sectors, 2012

As a percentage of GDP



1. For Brazil, 2011 data is presented; data does not include the FDI in the ethanol sector.

Source: OECD International Direct Investment Database; Central Bank of Brazil.

StatLink http://dx.doi.org/10.1787/888933242451

Box 4.2. Foreign Direct Investment in Brazil

Brazil implemented a major FDI liberalisation in the late 1980s when foreign investors were entitled to repatriate their investments and/or profits. Reforms continued in the 1990s by allowing foreigners to organise companies and fully own them. Some activities, formerly closed to foreign participation, were opened, notably in the sectors of resource exploration and mining, banking and insurance (OECD, 2004).

A general FDI restriction that applies to the agricultural and agro-processing sectors is that access of foreign companies to the national financial system may be restricted by the Central Bank in case of balance of payments disequilibrium. There is also a restriction that applies specifically to the agricultural sector (as well as to the forestry sector) which concerns acquisition and leasing of rural land by foreign legal or physical persons. To purchase or lease, they must be residents in the territory concerned and can only purchase land plots that do not exceed a specified size and there is also a limitation on total land area purchased or leased by foreigners. Foreign residents are permitted to acquire up to three modules of land without an official approval and foreign acquisition is limited to fifty modules (a standard parcel with the size ranging from 5 to 100 hectares depending on the region). Acquisitions of between three and fifty modules require approval by the Ministry of Agricultural Development. Foreign companies can only acquire rural land for crop farming, cattle-raising, and industrial or development projects. The total land area purchased or leased by foreigners must be no greater than 25% of the rural area of any municipality (*município*) to which the property belongs and no more than 10% may be owned by foreigners of the same nationality. This restriction is more flexible when the foreigner is married to a Brazilian citizen or has Brazilian descendants. Specific authorisation is required, depending on the size of the property, for it to be purchased or rented by foreigners (OECD, 2013a).

A controversial issue related to land access by foreigners has been the legal distinction between national and foreign enterprise, which has been subject to different interpretations by the authorities. The current interpretation is that Brazilian enterprises in which the majority of capital is owned by foreigners are subject to the same provisions as foreign enterprises authorized to operate in Brazil. The previous interpretation of this same law treated such enterprises as national (Government of Brazil, 2013).

Brazil today is a net FDI recipient and has seen a surge of inward FDI since the late 2000s. The total stock of inward FDI amounted to almost one-third of the country's GDP in 2012, which places Brazil ahead of the rest of BRIICS. It is the largest regional recipient of total FDI, e.g. in 2012 it attracted almost 40% of total inflows into Latin America and the Caribbean. Uncertainties in the developed economies amidst the economic crisis displaced investments towards emerging markets. Local conditions in the Latin American region, such as good natural resource endowments, also attracted investors at a time of commodity price boom, while the region's fast economic growth created strong demand. Natural resource-based activities and services account for a large and growing share of FDI inflows into Brazil, with the telecommunications sector virtually dominated by transnational corporations (ECLAC, 2013).

Transnational companies control a large share of the fertiliser industry in Brazil. These companies include Bunge Fertilisantes, the largest fertiliser company in South America, Mosaic Company (United States), and Yara (Norway) (ECLAC, 2013). Trans-Latin companies operate in the Brazilian meat sector, including JBS-Friboi, the world's largest meat producer, BRF Foods Group, Grupo Marfig and Grupo Minevra. Four leading transnational companies – ADM, Bunge, Cargill and Louis Dreyfus – account for around a quarter of the country's total volume of soybean crushing. However, Brazil's sugar and ethanol sectors are those where there has been the strongest foreign investor activity, particularly since the late 2000s. The four transnationals mentioned above and 17 other companies, wholly or partially foreign-owned, concentrated 23% of operating sugar and ethanol production capacity in Brazil in 2008 and had new facilities under construction. According to the Brazilian Sugar Cane Industry Association (UNICA), the share of foreign-owned sugar cane processing may further increase, with major global petroleum companies becoming more active in mergers and acquisitions. The ethanol sector is an illustrative case of FDI's role as a driver of innovation when foreign companies entrusted the entire task of technological development to Brazilian scientists. The transnationals may have a similar role in the development of second-generation (biomass) ethanol (ECLAC, 2013).

At the same time, Brazil applies little discrimination of foreign suppliers and has a pretty open FDI regime, although certain constraints exist as reflected in the OECD FDI Regulatory Restrictiveness index, covering 22 economic sectors in each country (Figure 4.5).[2] Restrictions to FDI in the agricultural sector are scored substantially above the cross-sectoral aggregate, while the agro-processing sector faces much fewer restrictions. An FDI restriction that is specific to the agricultural sector (as well as the forestry sector) concerns acquisition and leasing of rural land by foreign legal or physical persons (Box 4.2).

FDI in agriculture and the agro-processing sectors is a small share of Brazil's overall inward FDI, but are more important to the overall economy than in some other countries (Figure 4.6). Brazil is the largest recipient of such investments in Latin America and the Caribbean. The country's

attractiveness is due to its good agricultural resource endowment, the considerable overall deregulation of the sector implemented in the 1990s, the relatively favourable FDI regime, and the important technological advancements and promotion policies in some sectors, e.g. the biofuel sector.

Finance policy

Innovation typically requires borrowing or other types of external funding, particularly by start-up businesses. A well-functioning domestic financial system with sufficient provision of varied services to borrowers of different profiles facilitates the innovation process. As innovation usually requires long-term investment, a strong long-term finance segment is of critical importance. An adequate domestic financial system is important from the perspective of innovating SMEs as they are likely to depend more on internal sources of finance compared to large businesses capable of drawing on international funding. This is particularly relevant in the rural context where SMEs dominate.

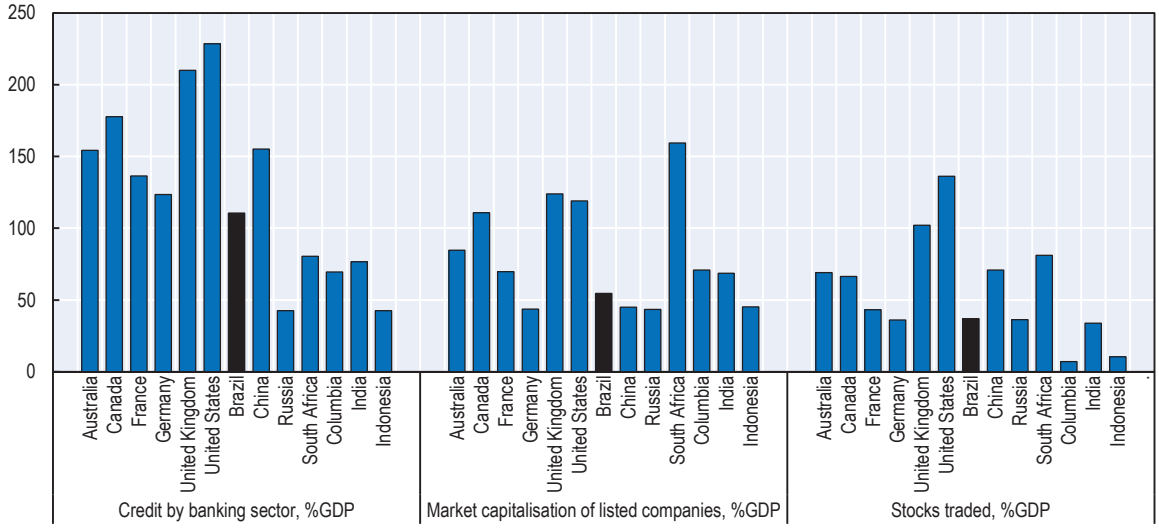
Considering the level of market capitalisation of listed companies and the value of stocks traded relative to GDP, Brazil's equity market is fairly small, even in comparison with BRIICS countries such as China and South Africa (Figure 4.7). Financial markets in Brazil are largely bank-based. Bank credit relative to GDP in Brazil is the second-largest among BRIICS after China, but is nevertheless significantly below the levels of some of the largest OECD economies. Bank's intermediation spreads are high by international standards (Figure 4.8). This increases the cost of capital and creates a bias toward short-term high-risk investment instead of long-term investment. High borrowing costs are particularly onerous for small and medium firms whose access to foreign finance is limited. Several factors may explain the increased borrowing costs in Brazil: a high Central Bank refinancing rate, high by international standards compulsory bank reserves, a high level of taxation of the banking sector, and the existence of directed credit which banks are obliged to provide at regulated interest rates, possibly leading to high spreads charged on non-regulated lending (OECD, 2011).

In its global competitiveness report, the World Economic Forum scored Brazil's financial market development at 4.4 points on a scale of 1 to 7 (best) (Figure 4.9.A). This evaluation is based on the opinions of Brazilian business on key dimensions of credit markets. Their evaluation of the trustworthiness and confidence in the financial markets is mixed: while they evaluate the soundness of banks and the regulation of security markets to be relatively high, they give a low score to the degree of legal protection of borrowers. Similar to businesses in OECD countries and the rest of the BRIIS group, Brazilian businesses consider access to finance through local equity markets and venture capital insufficient and access to loans difficult (Figure 4.9.B). Difficulties in obtaining credit are also diagnosed by the 2013 World Bank's *Doing Business* evaluation, which ranks Brazil 109 out of 189 economies for ease of getting credit (World Bank, 2013).

The short-term bank credit segment is represented by many competing private and public banks, including foreign banks. At the same time, long-term bank credit is poorly developed, with one public institution, the National Bank for Economic and Social Development (Banco Nacional de Desenvolvimento Econômico e Social – BNDES) operating as a dominant long-term lender. Satisfying Brazil's financing needs as the country develops will require increased private sector participation in the long-term credit market beyond merely distributing BNDES loans (Box 4.3).

Figure 4.7. Selected indicators of financial markets, 2012

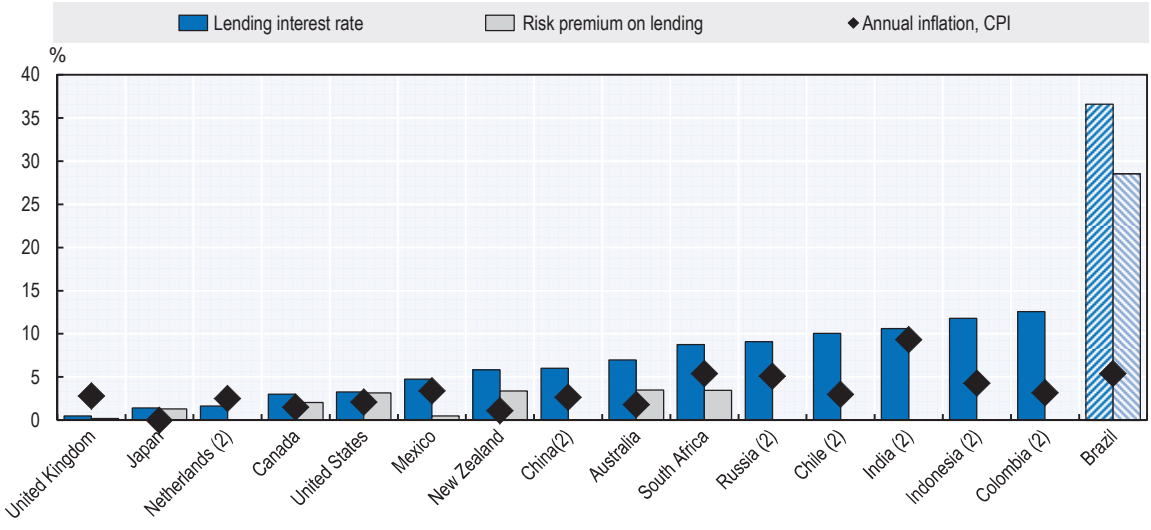
As a percentage of GDP



Source: WDI (2013), *World Development Indicators Database*, World Bank, http://data.worldbank.org/data-catalog/world-development-indicators.

StatLink http://dx.doi.org/10.1787/888933242467

Figure 4.8.Lending interest rates and lending risk premiums, international comparison,[1] 2012



1. Lending interest rate is the bank rate that usually meets the short- and medium-term financing needs of the private sector. This rate is normally differentiated according to creditworthiness of borrowers and objectives of financing. The terms and conditions attached to these rates differ by country, however, limiting their comparability. Risk premium on lending is the lending rate minus treasury bill rate.

2. Data on risk premiums are not available for these countries.

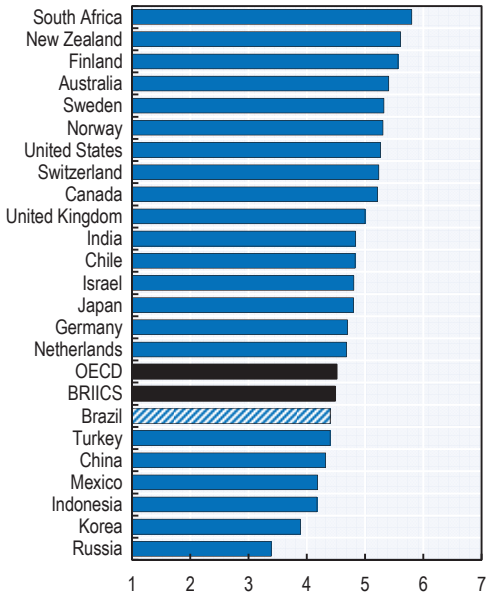
Source: WDI (2013), *World Development Indicators Database*, http://data.worldbank.org/data-catalog/world-development-indicator.

StatLink http://dx.doi.org/10.1787/888933242472

Figure 4.9. Global Competitiveness Index: Financial market development, 2013-14

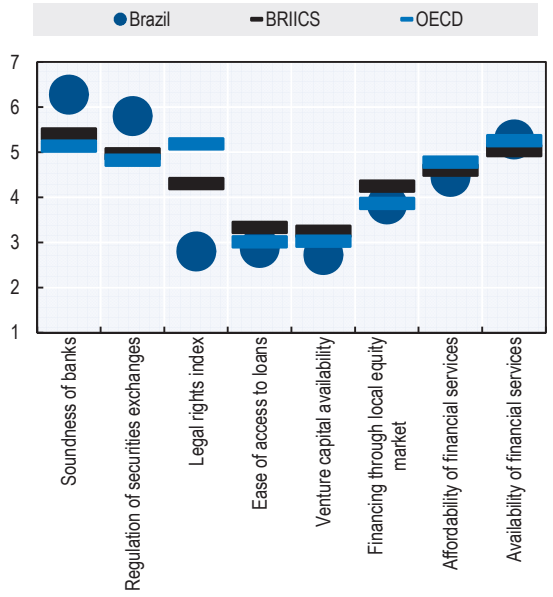
Scale 1 to 7 (best)

A. Total index of financial market development, international comparison



Indices for BRIICS and OECD represent simple averages of member-country indices.

B. Brazil's index of financial market developments by component



Legal rights index has been rescaled from a 1 to 10 scale. The average for BRIICS reflects significant variations of this index across the group: from 3 points for Indonesia and Russia, 6 points for China, 8 points for India and 10 points for South Africa.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

StatLink http://dx.doi.org/10.1787/888933242482

Box 4.3. A challenge of private long-term credit in Brazil

Long-term lending is dominated by the BNDES state bank. Its original mandate was to function as the main financing agent for industrial development, but subsequently evolved to include strategic areas of innovation, local development and socio-environmental development. BNDES does not have agencies and the majority of its operations are carried out through a nationwide network of accredited financial institutions which perform credit analysis and approval. It offers a variety of financial products to support various investments, some cross-sectoral, others targeted to specific sectors, including agriculture (Chapter 6). Beyond that, BNDES has a dedicated credit programme to support the creation and adoption of innovations.

BNDES is financed through contributions from the Fundo de Amparo ao Trabalhador (FAT), a tax-financed workers' welfare fund. Direct transfers from the national budget are another principal source of capital; these have substantially increased since 2009 to reach, by 2013, over half of the Bank's total funding. Increased availability of budgetary funds has enabled BNDES to double its loan volume since the beginning of the economic crisis.

BNDES dominates long-term lending in Brazil, not least due to its privileged access to state funding. Increased participation of private providers can help relieve long-term credit constraints and improve allocation of credit. This may be achieved in several stages; iInitially, by requiring private co-financing for BNDES loans and subsequently by reducing BNDES own lending volumes outside areas where market failures tend to be pervasive. Over time, the expansion of private finance will allow financial support to BNDES to be phased out or limited to specific lending for specific projects, e.g. to those that have social or environmental objectives. In the latter case, private lenders should have access to state support as well.

Attracting private lenders could also help concentrate BNDES lending in areas likely to be more exposed to market failure problem. Around two-thirds of BNDES lending is currently provided to large and very large companies, which may be best placed to receive credit from other sources. BNDES credit portfolio could focus more on traditional development areas, such as financing SMEs, infrastructure and innovation. This would be beneficial for agricultural, agro-processing and agro-food businesses, generally characterised by a smaller scale structure compared to some other Brazilian industries and facing significant infrastructure gaps.

Source: OECD (2013b), *OECD Economic Surveys: Brazil 2013*. DOI: http://dx.doi.org/10.1787/eco_surveys-bra-2013-en.

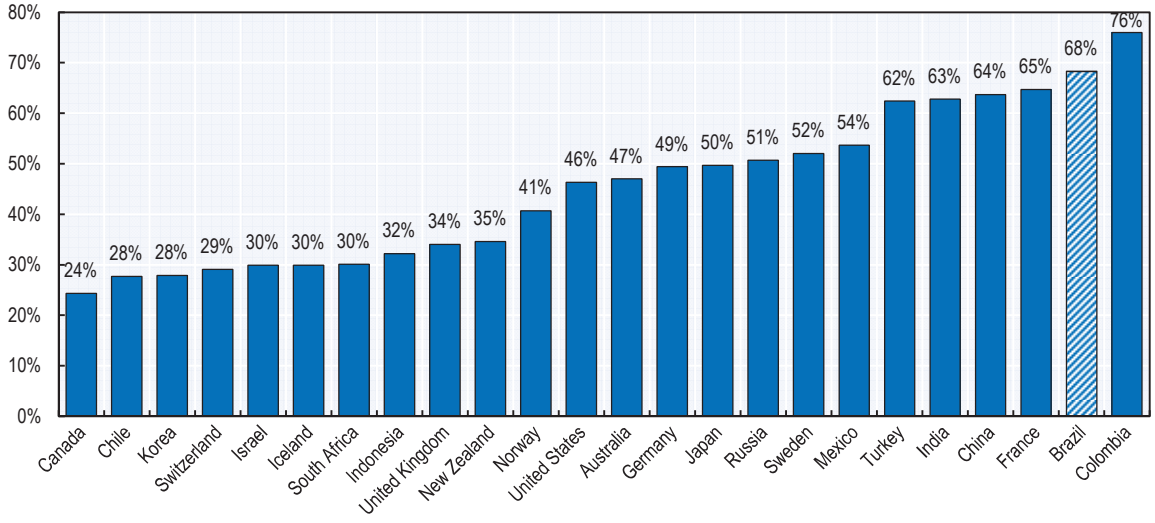
Tax policy

The principal link between tax policy and innovation is that taxation affects the returns to innovation and thus the decisions of firms and individuals to invest. Taxation also affects the relative price of production factors and therefore priority areas for innovation. Beyond that, taxation often acts as a targeted tool to stimulate innovation, e.g. through providing preferences to private businesses that invest in R&D, through preferential regimes for young innovative companies, VAT concessions on innovative products, etc. Furthermore, tax policy can steer innovation towards specific areas, for example, to address particular societal concerns and towards greener technologies and practices, or environmental R&D. Tax policies can also work on the consumer side of innovation by creating incentives for households to purchase products with particular characteristics, for example, by providing consumer tax concessions on newly developed national products or environmentally friendly goods.

Over the last two decades, Brazil's tax and contribution systems increased revenues from 24% to 34% of GDP, a share which is comparable to that of many developed economies but is high relative to most Latin American and other BRIICS economies (e.g. 17% in China, 18% in India, 12% in Indonesia and 27% in South Africa) (OECD, 2013b). High revenues translate into a high tax burden: the World Bank estimates the total tax rate on Brazil's company profits – including all taxes on income and factor usage – at 67%, above an average of 47% in Latin America and 43% in OECD countries (Figure 4.10). These estimates, however, may not take into account the long-term incidence of some elements of this tax burden, such as employer-paid social security contributions or payroll taxes, parts of which may fall on employees rather than employers.

Figure 4.10. Total tax rate on company profits for Brazil, international comparison, calendar year 2012

As a percentage of commercial profit



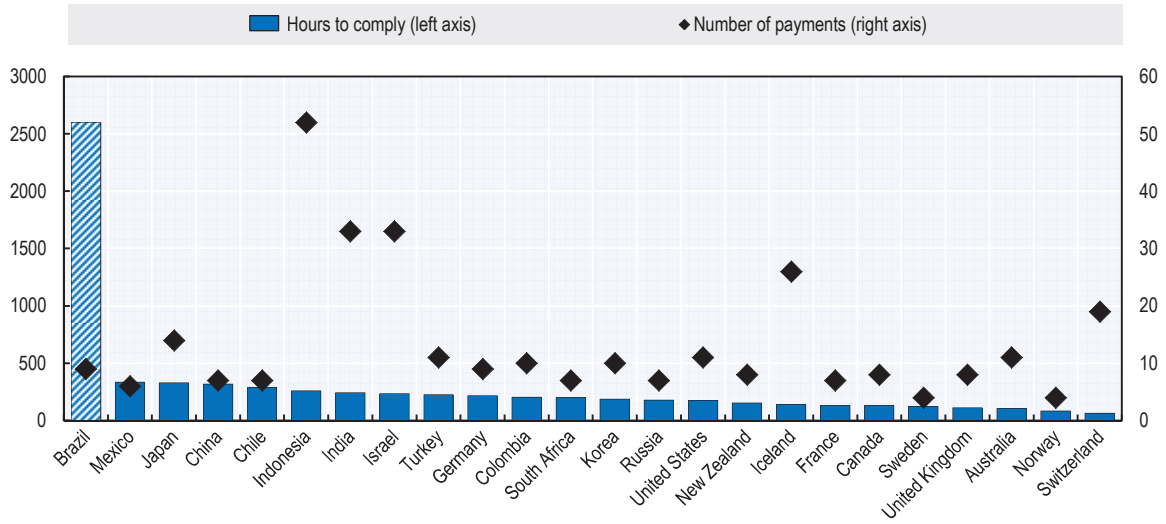
The evaluation uses a concept of a "standardised business", defined on the basis of several criteria, including the legal form of business (limited liability), start date of operation (January 2010), geographic location (the largest business city in the country), origin of ownership (100% owned by domestic natural persons), type of activity (general industrial and commercial), size (own capital, number of employed, turnover, etc.) and others. Total tax rate is the sum of taxes and contributions payable after accounting for allowable deductions and exceptions related to commercial profit of businesses before all taxes borne. The groups of taxes covered include: profit or corporate income tax; employer's social contributions and labour taxes; property taxes; turnover taxes and other (such as municipal fees, vehicle and fuel taxes).

Source: World Bank Group and PwC (2013b), *Paying taxes 2014 – The Global Picture*, http://www.pwc.com/payingtaxes.

StatLink http://dx.doi.org/10.1787/888933242490

Brazil's taxes are not only high, but burdensome to comply with, in particular as this relates to indirect taxes, including the state VAT tax (*Imposto sobre Circulação de Mercadorias e Serviços*, ICMS), for which each of Brazil's states has its own tax code, tax base and tax rates. Due to the origin-taxation, companies wishing to offer goods and services nationwide are required to comply with each state's individual tax rules, and credits for interstate transactions are frequently delayed or refused. This cumbersome situation is the principal reason why Brazil compares so poorly to other countries in terms of tax compliance costs (OECD, 2013b). When measuring the time requirement to comply with taxes in 183 jurisdictions across the world, the World Bank finds that Brazil comes a distant last, with 2 600 hours required as opposed to 367 on average in Latin American countries or 176 in OECD countries (Figure 4.11).

Figure 4.11. Number of taxes for a business company and hours required to comply, calendar year 2012[1]



1. The evaluation uses a concept of a "standardised business", defined on the basis of several criteria, including the legal form of business (limited liability), start date of operation (January 2010), geographic location (the largest business city in the country), origin of ownership (100% owned by domestic natural persons), type of activity (general industrial and commercial), size (own capital, number of employed, turnover, etc.) and others. Total tax rate is the sum of taxes and contributions payable after accounting for allowable deductions and exceptions related to commercial profit of businesses before all taxes borne. The groups of taxes covered include: profit or corporate income tax; employer's social contributions and labour taxes; property taxes; turnover taxes and other (such as municipal fees, vehicle and fuel taxes).

Source: World Bank Group and PwC (2013b), *Paying taxes 2014 - The Global Picture*, PwC, World Bank and IFC, Washington, DC. http://www.pwc.com/payingtaxes.

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It is important to highlight that the World Bank-PwC's business taxation indicators relate to a "standardised business," which is defined using a number of assumptions. They include, among others, the assumptions that only companies performing general industrial and commercial activities and which do not participate in foreign trade are covered. Both these criteria narrow the inference that can be made from these estimates with respect to agriculture and agro-processing firms. However, to the extent the latter faces a taxation regime similar to World Bank-PwC's "standardised" company, the estimates remain instructive.

Brazil's agriculture and agro-processing sectors benefit from a range of tax concessions; there are also tax incentives to support the development of the sectors important for technological advancement and innovation (Box 4.4).

Box 4.4. Tax concessions to Brazilian agro-food sector and priority sectors for industrial development

Agriculture and agro-processing sectors, as Brazil's principal exporting sectors, benefit from tax preferences generally applicable to exporters and from some sector-specific preferences. One is the exemption from the ICMS tax of raw material and semi-processed products destined for export, which effectively applies to the bulk of Brazilian agricultural exports. This preference, since its introduction in mid-1990s, has contributed to the expansion agro-food exports.[1] ICMS preferences are also granted on sales of agricultural inputs. Thus, various reductions in the ICMS taxable base apply to inter-state trade in agricultural inputs. Federal legislation also empowers states to adopt similar preferences for transactions within states.[2] Other preferences concern social security contributions. Exports, including agro-food exports, are free from PIS/COFINS taxes; PIS/COFINS rates are also set at zero on imported agricultural inputs, and the payment of these taxes is suspended on some domestically produced primary agricultural products supplied for processing. Agricultural producers also have the right to write off losses incurred in the previous year from taxable income, and companies engaged in agricultural activity may depreciate the integrity of the value of acquired capital goods in the same fiscal year (OECD, 2005; World Bank and PwC, 2013a).

Brazilian tax policy allows for a range of incentives to support the development of the sectors important for technological advancement and innovation. Special tax regimes apply to the computer and automation industries, the development of infrastructure and telecommunications networks, information technology services and some others activities. Typically, these activities are exempt from social contributions, and may benefit from other preferences. A special tax regime applies to companies undertaking technological innovations in general; they may benefit from deductible expenses, full depreciation, accelerated amortisation and deductions from 60% to 80% of some expenses from corporate income tax. A range of additional tax incentives for technical innovation and research were introduced in 2011 as part of the government's Greater Brazil (Brasil Maior) plan. Thus, the IT industry, among several others, has benefitted from a reduction of payroll costs (World Bank and PwC, 2013a).

1. Before the introduction of this exemption, agriculture was the only sector eligible for ICMS on raw material and semi-processed products destined for export.

2. These provisions are aimed at reallocating economic activity across different Federative Units of Brazil by promoting investments in certain territories. There is a view that this proves to be ineffective as a stimulus and worsens the allocation of resources and overall competitiveness of agriculture.

A micro-level analysis undertaken as part of the OECD *Economic Survey of Brazil* (OECD, 2013b) finds that the tax burden is negatively related to the productivity of Brazilian firms. These results support the view that the tax burden on companies should be reduced to improve both productivity and the competitiveness of Brazilian firms. This would require moving towards a more simple tax system, including making further progress towards a unification of indirect taxes into a national unified system. Current efforts to provide tax stimulus to selected sectors through a replacement of a payroll-based by turnover-based contributions and other special preferences may make corporate taxation more distortionary. The use of less distortionary taxes, such as well-designed consumption or property taxes, should be considered.

Notes

1. For example, the Sugar Cane Agroecological Zoning (Zaecana) identifies areas: (1) with climate and soil potential for sugar cane production with mechanical harvesting; (2) with potential for sugar cane production previously used for livestock production; and (3) without environmental restrictions and with potential for sugar cane production (no irrigation). The main environmental restrictions of Zaecana are: (1) exclusion of the Amazon and the Pantanal Biomes and Upper Paraguay River Basin; (2) exclusion of the national parks, indigenous areas, urban areas and other protected areas; and (3) prohibition of deforestation for planting sugar cane. 92.5% of Brazilian territory was set aside for sugar cane production after Zaecana was concluded. Some policies related to the sugar cane sector expansion are guided by Zaecana, such as (1) provision of public and private funding; (2) installation of new ethanol plants; and (3) environmental license procedures.

2. Certain limitations on foreign citizenship of investors exist in radio, TV and publishing activities; foreign participation is restricted in air and road transport and fishing and it is forbidden in security and transport of valuables, as well as in the health sector, except in cases established by law (OECD, 2013a).

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Table 4.A1.1. Ease of doing business in Brazil, 2014

Action	Brazil's rank out of 189 economies	Procedures				Time				Cost			
		Unit	Brazil	Latin America and Carribean	OECD	Unit	Brazil	Latin America and Carribean	OECD	Unit	Brazil	Latin America and Carribean	OECD
Starting a business	123	Number of procedures	13	9	5	Days	108	36	11	% of income per capita	5	33	4
Dealing with construction permits	130	- "-	15	13	13	- "-	400	216	147	- "-	35	137	84
Getting electricity	14	- "-	4	6	5	- "-	58	65	89	- "-	34	503	79
Registering property	107	- "-	14	7	5	- "-	30	65	24	- "-	3	6	4
Getting credit	109	..	..	..	..	..	..	..	..	..	..	..	..
Protecting investors	80	..	..	..	..	..	..	..	..	..	..	..	..
Paying taxes	159	Payments per year	9	30	12	Hours per year	2 600	369	175	Total tax rate in % of profit	68.3	47.3	41.3
Trading across borders	124	Documents to export/ import	6	6	4	Days export/ import	13/17	17/19	11/4	USD per container export/import	2 215/ 2 275	1 283/ 1 676	1 070/ 1 090
Enforcing contracts	121	Number of procedures	44	40	31	Days	731	734	529	% of claim	17	31	21
Resolving insolvency	135	..	..	..	..	Years	4.0	2.9	1.7	% of estate	12	16	9

Source: World Bank (2013), *Doing Business 2014*, http://www.doingbusiness.org/reports/global-reports/doing-business-2014.

StatLink http://dx.doi.org/10.1787/888933242825

Chapter 5

Capacity building and services for the Brazilian food and agriculture system

This chapter outlines the role of infrastructure capacity, skills and education in facilitating innovation in agri-food. It describes the governance of policies to improve rural infrastructure, outlines the main regional programmes, and reviews briefly the quality and coverage of rural services. It then discusses efforts to respond to skill demands from the agri-food sector through labour, immigration and education policies. It also reports on trends in education expenditure and outlines the performance of the education system. Finally, it provides an overview of education levels in agricultural, and enrolment in agricultural programmes, outlining the gap between supply and demand of skills in the sector.

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.

Infrastructure and rural development policies[1]

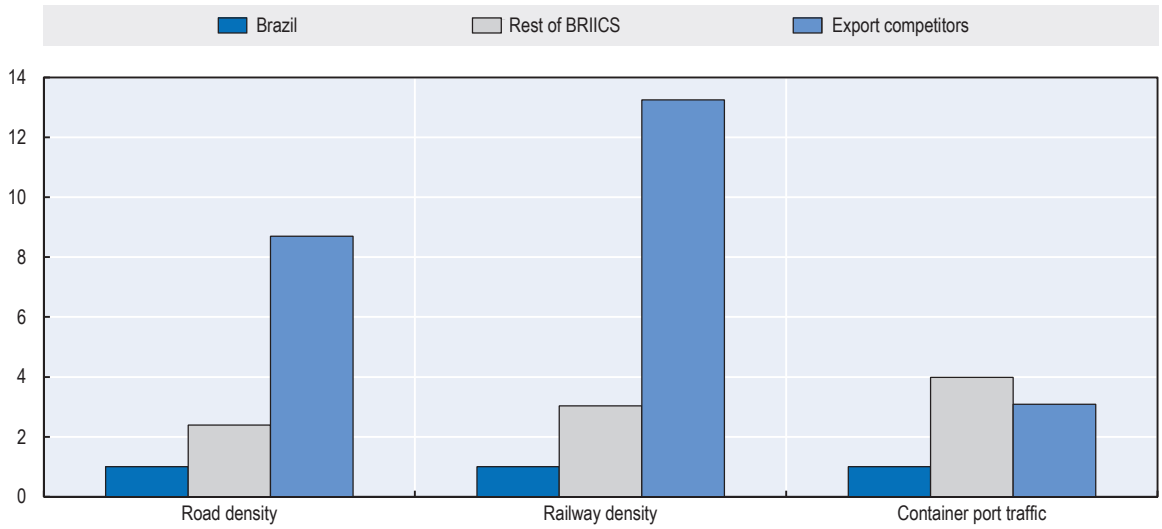
Infrastructure is a linking element of the economic system that enables the movement of factors of production, goods, and information across agents and markets. As such, infrastructure is important in determining the location of an economic activity and the kinds of activities or sectors that can develop within the economy. The availability and quality of infrastructure affect the decisions of firms and individuals to invest, including in innovation.

The various analyses of Brazil commonly cite weaknesses in transport and other physical infrastructures as a critical structural impediment to the country's economic and social development. It is also viewed that infrastructure improvements could considerably leverage the country's economic growth.

As Figure 5.1 shows, road and railway density in Brazil is less than half of the average for the rest of BRIICS, and by far below that of the key OECD economies (although such a comparison is limited given the differences in the countries' geographic conditions and development levels). The gap with the BRIICS and developed economies in terms of the quality of infrastructure is also considerable, as evidenced by the opinions of Brazilian businesses (Figure 5.2). They attribute low quality scores to all types of transport (around 3 points on a 7-point scale), with a particularly low evaluation for rail transport.

Figure 5.1. Brazil's availability of transport infrastructure, international comparison

Normalised to 1 for the value of Brazil

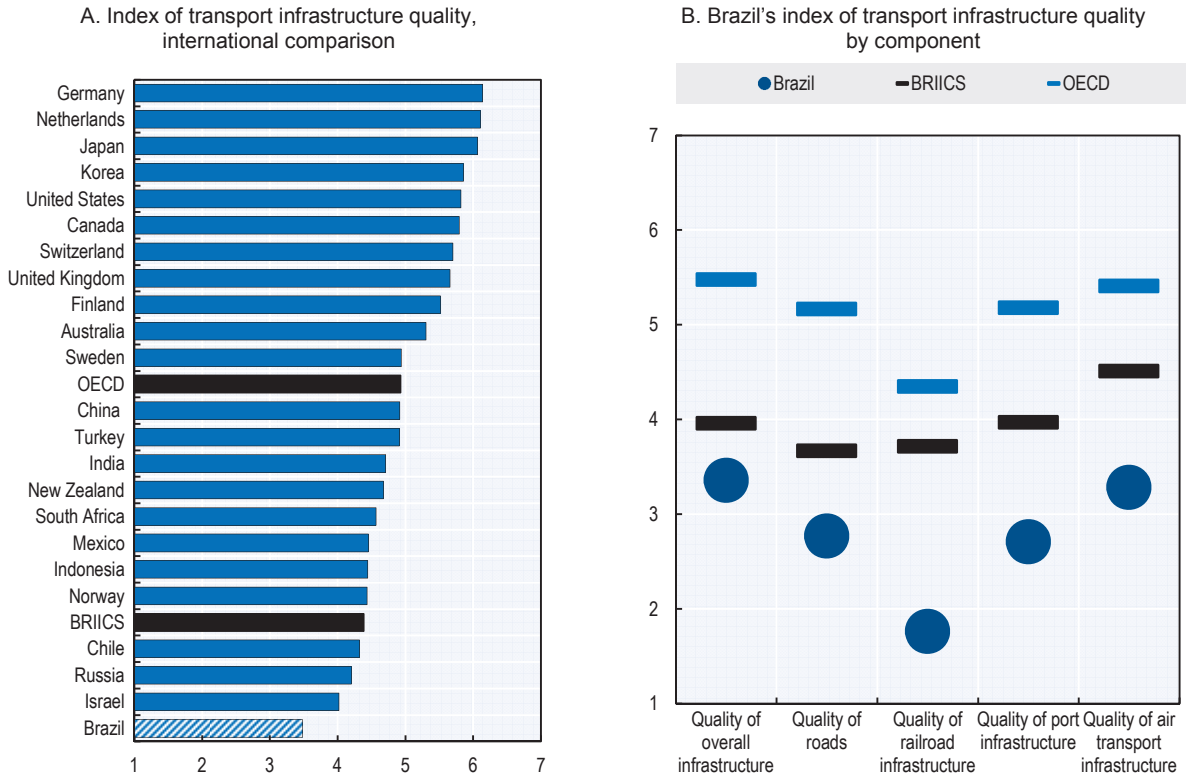


Export competitors are top 10 world exporters relative to Brazil's leading exports (Argentina, Belgium, Canada, China, France, Germany, India, the Netherlands, Spain and the United States). Data for road density refers to 2011.
Source: WDI (2013), *World Development Indicators Database,* http://data.worldbank.org/data-catalog/world-development-indicators.

StatLink http://dx.doi.org/10.1787/888933242518

Figure 5.2. Global Competitiveness Index: Quality of transport infrastructure, 2013-14

Scale 1 to 7 (best)



Indices for BRIICS and OECD represent simple averages of member country indices.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva 2013. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

StatLink http://dx.doi.org/10.1787/888933242524

Underdevelopment of the Brazilian infrastructure is recognised by the government. Since the mid-1990s, it has undertaken important institutional and regulatory reforms in the infrastructure sectors, and in the mid-2000s public investment in infrastructure was significantly increased through various federal and state programmes. Governments at the federal and state levels also introduced various tax and credit incentives to increase private investment in infrastructure (Box 5.1).

The overall national policy on infrastructure development has important implications for the agro-food system. Several projects implemented by the Ministry of Transport and the Secretariat of Sea Ports are not specific to agriculture but have high potential to improve the capacity and the time involved in the handling and transport of agricultural commodities. This includes projects such as "Intelligent Logistic Chain," "Port without Paper," "Port 24 Hours," and projects to improve port perimeter zones. Additional investments are foreseen as of 2013 to develop railroad and road networks; these projects will increase the flow of agricultural commodities because they enable better connectivity between producing and consuming regions and with neighbouring export markets. Other activities include the development of electronic systems to facilitate the control of shipments in ports and other border points. As of 2013, the National Rural Credit System provides a reduced-cost credit for the construction of private storage. It is also foreseen to invest BRL 1 billion (USD 463 million) annually between 2013 and 2017 in the construction of public storage (Government of Brazil, 2013).

Box 5.1. Reforms and investment in Brazil's infrastructure sectors

The neglect of infrastructure investment over the decades of economic instability led to the emergence of bottlenecks in almost all infrastructure areas. The Brazilian railway sector is underdeveloped and underexploited. Tight control by the federal government over tariffs up until the late 1980s resulted in severe underinvestment and low maintenance spending and even led to shrinkage of the railway network. The current need is to expand the network and improve its connectivity given the significant positive social and environmental externalities of railway transport. The road system is also inadequate to the country's needs. Although this network is one of the largest in the world, the share of paved roads is small. In 2010, it was estimated to be only 14%, compared to 23% in Chile and over 50% in China, India and Indonesia (WDI, 2013). Ports represent another constraint, with many suffering underinvestment, inefficient management of public operators and rigid rules for hiring temporary port labour. The backlog is particularly high in the areas of water and sanitation: only 47% of the population benefit from sewage collection and approximately 20% of collected sewage is treated. For the electricity sector, the most important challenge is to raise generation capacity to meet the demands of economic development and an increasing population. According to Morgan Stanley (2010), Brazil would need to invest around 4% of GDP annually into infrastructure over 20 years in order to catch up with the infrastructure levels of Chile, the best performer in Latin America.

Regulatory reforms in infrastructure sectors included the creation of administratively and financially independent sectoral federal regulatory agencies, as well as the strengthening of public decision-making and accountability processes. The scope for private participation in infrastructure projects has been broadened. Concession agreements were launched in the road sector and more recently, in the airport sector, and a significant expansion of concession contracts is foreseen. Another regulatory step to enhance investments in infrastructure projects was the introduction of a new regulatory framework for Public Private Partnerships in 2004. FDI related to some transport activities were liberalised.

State involvement in the infrastructure sectors was also changed, although to different degrees in different sectors. Railway transportation was privatised in the mid-1990s. In the electricity sector, however, initial privatisation efforts were curtailed in the aftermath of a major supply crisis. The state is currently a major shareholder, concentrating 80% of assets in power generation and around two-thirds of the electricity distribution assets. A regulated electricity market operates on a wholesale power pool which is allocated through competitive auctions between generators and distribution companies based on long-term contracts. There is also a small free market for large consumers who can deal directly with electricity generators. The telecommunications sector underwent considerable deregulation with the dismantling of the state-owned company *Telebrás*, and the creation of regional operators and expansion of the existing network to fulfil newly specified universal service obligations. The telecommunications market is separated today into two regimes. The fixed-line segment is subjected to a "public" regime and suffers from a lack of competition. The firms under this regime must achieve universal service targets, comply with price caps and service obligations. Firms operating under the "private" regime face minimum government intervention, free pricing, and no restrictions on FDI.

In 2005, a pilot infrastructure development project was launched. In 2007 it was replaced by a longer-term programme, the Accelerated Growth Pact (*Programa de Aceleração do Crescimento*, PAC). PAC's aim is to increase both private and public infrastructure investments, improve regulatory base and co-ordination of bodies involved in infrastructure policies. It is currently in its second phase. During the first phase (2007-10), BRL 657 billion (USD 352 billion) were spent and for the second phase (2011-14) the budget has been increased to BRL 989 billion (USD 512 billion). PAC's coverage is wide, with almost 48% of total planned expenditures for the second phase going to the energy sector, 29% to the housing, 11% to the transport sector, and the remaining 12% is destined for urban development, water and light infrastructure. Other federal investments are made within infrastructure programmes that are not included in the PAC.

Source: OECD (2011 and 2013), *OECD Economic Surveys: Brazil.*

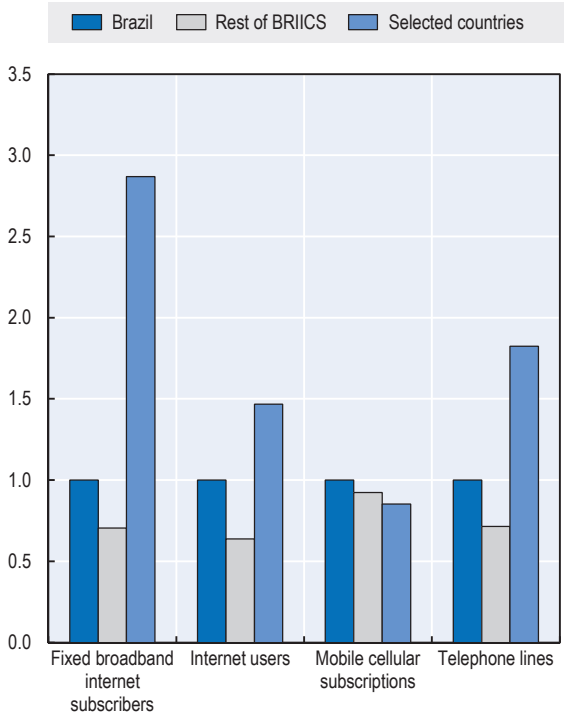
Information and communication technologies (ICT) have a distinct role in increasing innovation by speeding up the diffusion of information, facilitating networking, reducing geographic limitations and improving efficiency in communication. OECD analysis at the firm level shows that the probability to innovate increases with the intensity of ICT use. This is true for both manufacturing and service firms and for different types of innovation. Today, high-speed broadband networks support innovation as much as electricity and transport networks spurred innovation in the past; they dramatically change practices, extend innovation process beyond firms, government and researchers to consumers. Internet access is a prerequisite for using e-government services, and the data indicate a strong co-relation between penetration of the broadband infrastructure and the use of e-government services by citizens. The importance of ICT for innovation also comes from the fact that it improves basic competences of people and thus their capacity to create knowledge and uptake new products.

For example, OECD PISA results show that years of computer use is associated with higher student proficiency levels in science (OECD, 2010a).

Brazil has made impressive progress in ICT penetration, not least due to the considerable reforms undertaken in this sector. It is placed well ahead of the average for the rest of BRIICS by the share of internet and mobile telephone users and the density of internet and telephone networks (Figure 5.3). The gap with the average for selected OECD economies is much less than for the physical infrastructure and the spread of internet users Brazil even outperforms these selected economies. The perception of Brazilian businesses on the quality of electricity and telephony infrastructure are more favourable. They score it higher than the transport infrastructure, resulting in a higher international country ranking (4.57 points on a scale between 1 and 7 points), although there remains a significant quality gap with the best OECD performers (Figure 5.4).

Figure 5.3. Brazil's ICT penetration, international comparison, 2012

Per 100 people, normalised to 1 for the value of Brazil



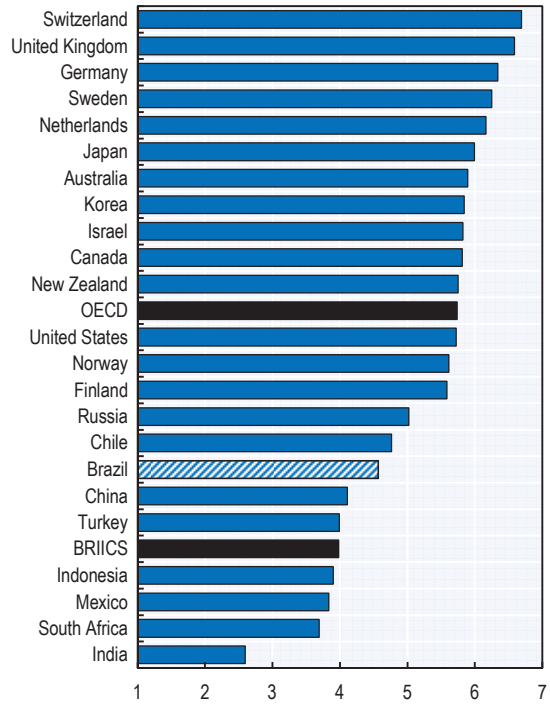
Selected countries are the 10 top commodity export competitors relative to Brazil's leading exports (Argentina, Belgium, Canada, China, France, Germany, India, the Netherlands, Spain and the United States).

Source: WDI (2013), World Development Indicators Database. World Bank, http://data.worldbank.org/data-catalog/world-development-indicators.

StatLink http://dx.doi.org/10.1787/888933242535

Figure 5.4. Quality index of Brazil's electricity and telephony infrastructure, international comparison, 2013-14

Scale 1 to 7 (best)



Indices for BRIICS and OECD represent simple averages of member-country indices.

Source: World Economic Forum (2013), *The Global*. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933242545

Labour market policy

Labour regulations affect the cost and conditions of employing labour and thus production choices by firms and their incentives to invest in new products and processes. Labour income played a key role in reducing poverty and income inequality in Brazil, helped by a steady decline in unemployment. Under Brazilian labour regulations, the minimum wage is subject to the automatic indexation rule based on past inflation and increases in overall GDP (as opposed to per capita GDP). This rule is scheduled for a review in 2015 and needs to be adjusted to better connect wages to

labour productivity, while protecting the purchasing power of the minimum wage (OECD, 2013b). Since the early 2000s, the minimum wage has almost doubled, also driving up average wage levels. The minimum wage indexation, a relatively high tax wedge on labour, and the policy focus on consumption stimulus have contributed to a fast rise in labour costs in Brazil over the past decade.

Brazilian labour regulations are viewed as rigid and complex, and generally constraining to employers. These regulations are set out in 900 legislative articles, with some formulated decades ago and inscribed into the national Constitution. Labour regulations focus on conditions of work and pay, and are quite detailed. The rigidity of regulations sometimes restricts the establishment of mutually beneficial labour agreements, resulting in a discrepancy between common practice and the law, thus posing legal risks to companies. It is not uncommon that the interpretation of labour regulations by labour courts is surrounded by uncertainties and some sources highlight the considerable difficulties that Brazilian businesses face in complying with labour laws (The Economist, 2011).

Beyond the cost of labour, labour regulations also affect innovation through their impact on labour mobility. Innovative firms are likely to be more dependent on adequate conditions for hiring and dismissing people, complemented by good systems of unemployment insurance and support for job placement, skills improvement and continuous learning. Policy on international mobility of human resources, particularly of skilled people, affects the creation, diffusion, and uptake of knowledge and, as such, becomes one of the policy drivers enabling innovation.

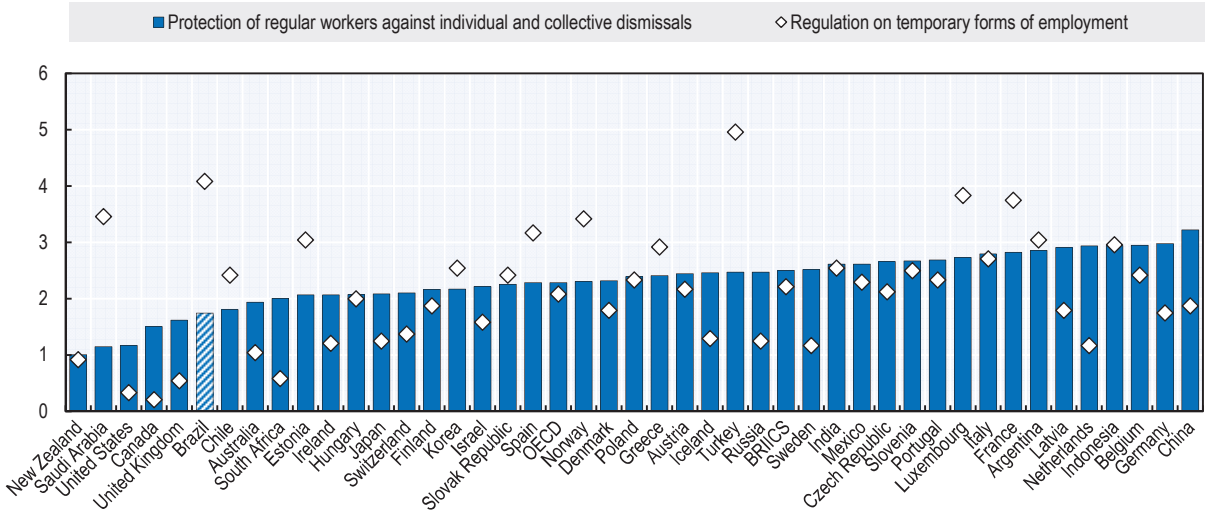
Employment protection regulations directly affect labour mobility. The OECD indicators of employment protection legislation measure the procedures and costs involved in dismissing individuals or groups of workers and the procedures involved in hiring workers on fixed-term or temporary work agency contracts (Figure 5.5). Overall, Brazil's labour system is less focussed on employment protection compared to conditions of work and rewards. Among the countries covered, Brazil is the one with relatively limited restrictions on hiring and dismissal of permanent workers. The regime for temporary employment is rigid, scoring second highest after Turkey. However, the practical relevance of this may be low as employment protection of regular contracts is not particularly strong (OECD, 2013b).

Well-functioning employment programmes targeting those who lost jobs or face such a risk facilitate labour mobility. In the context of innovation, a balance between passive measures that provide temporary financial support to the unemployed and active measures oriented towards job placement, training, job rotation and sharing, employment and start-up incentives is of particular relevance.

Since the 1990s, the Brazilian government has made efforts to diversify the functions of the National Employment System (Sistema Nacional de Emprego, SINE)[2] to include, beyond compensation-based programmes, programmes to insert and re-insert job seekers into the labour market. At present, Brazil's employment programmes cover four areas: unemployment insurance; job placement through intermediation of government agencies; vocational training; and employment and income generation. There has been progress in strengthening the focus on insertion of workers into the labour market. However, the system remains dominated by unemployment insurance, both in terms of the number of workers covered and resources involved. Labour market insertion measures supported by skills improvement programmes seem to be inadequate in terms of the resources involved and their performance, whereas these measures could play an important role in labour market adjustment to support the innovation process.

Figure 5.5. OECD indicators of employment protection legislation, 2013[1]

Scale from 0 (least) to 6 (most) restrictive



1. Data refer to 1 January 2013 for OECD countries and Latvia and 1 January 2012 for other countries.

Source: OECD (2013), *OECD Employment Protection Database*, www.oecd.org/employment/protection.

StatLink http://dx.doi.org/10.1787/888933242558

Box 5.2. Main components of Brazil's labour policies

Job placement activity, one of the active labour policy areas, has had a mixed performance, at least based on the information available as of the late 2000s: while the number of workers placed by the agencies of the National Employment System has been increasing, it did not keep pace with the rise in job vacancies, which may reflect the rapid expansion of the Brazilian economy during the 2000s. Vocational training, another active labour policy area, is implemented within the National Plan for Social and Vocational Training. This Plan aims not only to serve the workers who resort to the National Employment System, but to address the needs of self-managed enterprises and beneficiaries of welfare programmes. Between 2003 and 2008, training through the National Employment System had a small outreach due to limited availability of funding. The number of workers who completed courses did not exceed 150 000 per year, far below the requirements of the National Plan for Social and Vocational Training. It was foreseen to increase the outreach of the training programmes beyond 2008, however no updated information is available at the time of writing. In addition to the National Plan for Social and Vocational Training, an important part of the training is implemented within a PROJOVEM programme aimed at young people, who account for over 60% of the unemployed.

Employment policy in Brazil also includes measures for employment and income generation using FAT funds to provide credit for business activities. In 2008, FAT financed 17 credit programmes for various activities and sub-sectors, including four programmes related to rural business. Of these four, the most important is PRONAF (Programa Nacional de Fortalecimento da Agricultura Familiar) which supports the development of "family" (smallholder) agriculture. Another important programme for employment and income generation is PRONAMP (Programa Nacional de Apoio ao Médio Produtor Rural), which provides loans to medium size and small farmers not eligible for credit through PRONAF. The focus of PRONAF and PRONAMP, respectively, on small and medium-sized businesses implies that these programmes can be considered as important instruments that can potentially increase innovation by prioritising innovative businesses.

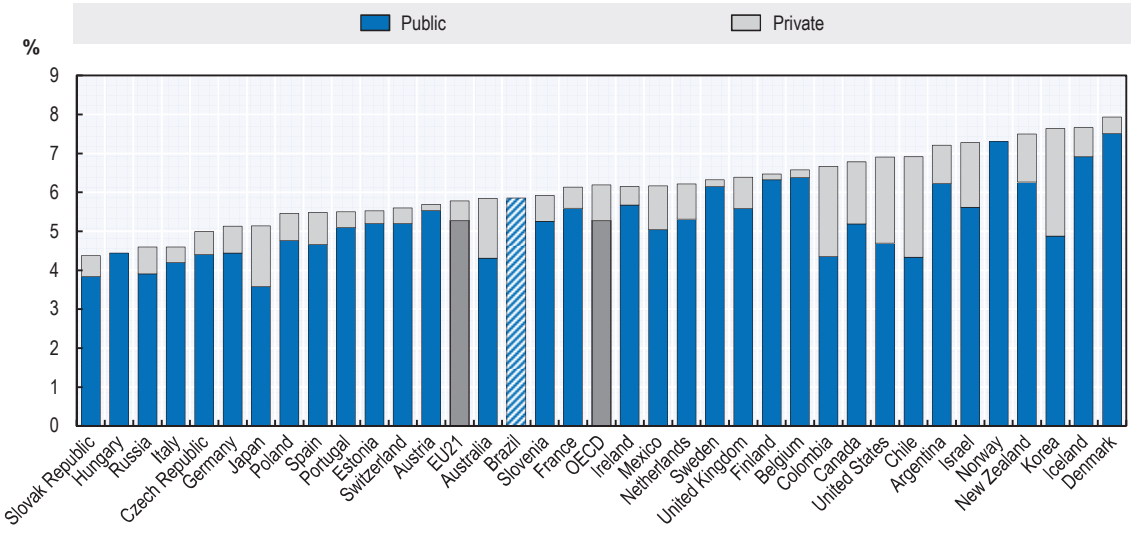
Source: Gonzales, R. H. (2010), "Employment Policies in Brazil: History, Scope and Limitations".

Education and skills policy

Education policy has strong and diverse links to innovation. A high level of general and scientific education facilitates acceptance of innovations by society at large. Effective innovation systems require well-educated researchers, teachers, extension officers and business, and producers with a good general, technical and business education would generally be more willing and better skilled at adopting innovations.

Nation's education improvement became a policy priority in Brazil in the 1980s, and was seen as a prerequisite to achieving social progress as well as an investment in future development. Between 2000 and 2011, the increase in public expenditures on education outpaced those in almost all OECD countries. Per student spending in primary and secondary education was more than doubled over this period, and was also increased for tertiary education but only slightly as expenditures were allocated across a nearly doubling of student numbers. By the share of national wealth directed towards education, Brazil has been rapidly catching up with OECD countries; between 2000 and 2011, expenditure on education increased from 3.5% to 5.9% of GDP compared to OECD average of 6.1% (Figure 5.6).

Figure 5.6. Public and private expenditure on educational institutions as a percentage of GDP, 2011



Public expenditure includes public subsidies to households attributable for educational institutions, and direct expenditure on educational institutions from international sources. Private expenditure is net of public subsidies attributable for educations institutions. Data for Canada refer to 2010; data for Chile refer to 2012.

Source: OECD (2014a), *Education at a Glance 2014: OECD Indicators*, http://dx.doi.org/10.1787/eag-2014-en.

StatLink http://dx.doi.org/10.1787/10.1787/888933242561

The focus since the mid-1990s was to ensure a mandated level of spending on education by establishing a per student spending floor for the entire country. Special funds were created to redistribute resources within the states so that all municipalities could reach the per student spending requirement. The municipalities that could not reach the national spending floor also received top-ups from the federal government. The efforts to increase financing for education were complemented by the establishment of incentives for good performance at the local level, supported by the introduction of uniform nation-wide tests to measure student attainments and school performance. The ability to monitor progress at the school level in a comparable manner was a major achievement and was very helpful in linking funding with performance improvements of the education system. Another important direction was the substantial increase in conditional cash transfer programme *Bolsa Familia* (initially, *Bolsa Escuola*) which created both incentives and the means for poor parents to send their children to school (De Mello and Hoppe, 2005; OECD, 2011).

Increasing options for vocational training through supply of shorter tertiary-education programmes with a more practical focus is an important goal, especially in the rural context. This has recently received much attention, with enrolment in vocational training more than doubling since the early 2000s. In 2011, a federal programme PRONATEC was launched and now covers 8 million students. Its objective is to expand the federal network of technical schools, with a particular focus on providing opportunities to students from poor backgrounds through free training places, loans and

bursaries (OECD, 2013b). Since 2013, it includes a component targeted to rural youngsters: PRONATEC Countryside.

Agricultural education has seen a particular expansion during the agricultural boom in Brazil which increased demand for qualified professionals in the public sector, enterprises, and a number of young farmers wishing to improve the technological level of their business. For example, in university education, the number of agricultural courses for bachelor degrees reached 830 in 2011, a six-fold increase over 1991, which covers only full-time studies, and does not include distance courses or MBAs (Table 5.1). The number of graduates nearly quadrupled, with the strongest increases occurring in the 2000s. General crop and livestock production disciplines concentrated the largest proportion of courses and students, followed by veterinary. The forest engineering and fishing disciplines are gaining in importance.

Table 5.1. Number of university courses and graduates in agricultural sciences[1]

Disciplines	Number of courses			Number of graduates, '000s		
	1991	2000	2011	1991	2000	2011
Forest engineering and silviculture	16	21	65	0.2	0.3	1.5
Horticulture	-	2	6	-	-	0.016
Crop and livestock production	86	156	542	3.4	4.0	10.9
Fishing resources	4	7	39	0.032	0.056	1.9
Veterinary	33	90	178	1.4	2.8	6.7
Total agriculture and veterinary	**139**	**276**	**830**	**5.1**	**7.2**	**19.5**

All data refer to bachelor degree studies.

Source: MEC/INEP (2013), *Cursos em ciências agrárias 2000-2011*.

Supply of agricultural education has become more evenly distributed across country regions, but it is still concentrated in the Centre-South. For example, the State of São Paulo hosts four prominent universities in Agricultural Sciences: Universidade de São Paulo (USP), Universidade Federal de São Carlos (UFSCar), Universidade Estadual Paulista "Julio Mesquita Filho" (Unesp) and Universidade Estadual de Campinas (Unicamp). The supply of courses in general has been following market needs, but requires continuous adaptation to industry demand (Contini and Dias Avila, 2014).

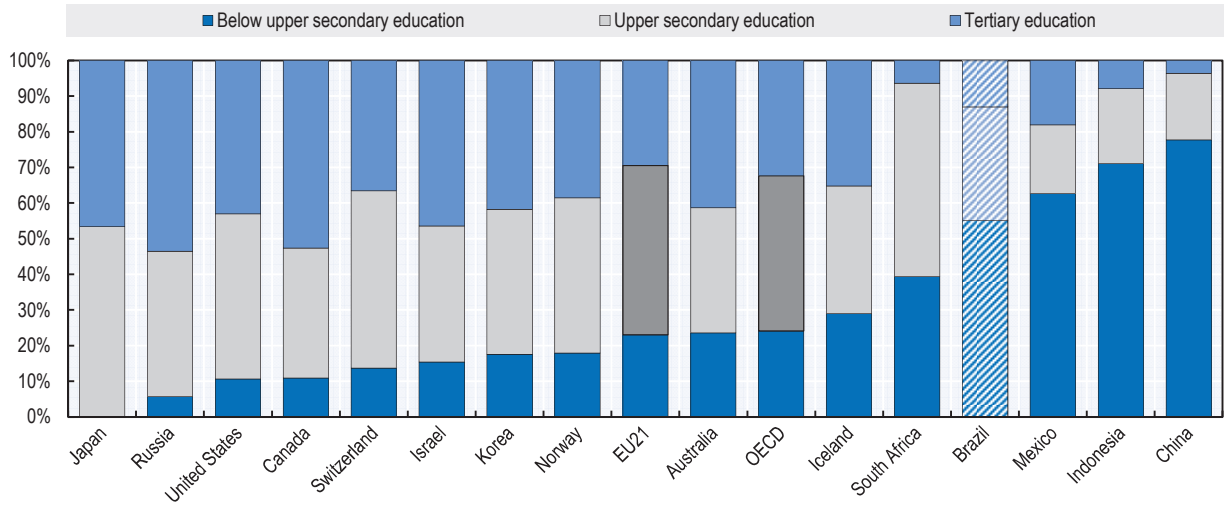
Brazil's active education policies enabled impressive progress in access to education, particularly for poor people, improved population's education attainments, and student performance. Still, there is yet a considerable gap to fill. As illustrated in Figure 5.7, the share of the country's 25-to 64-year-olds who attained at least an upper secondary or tertiary education is notably smaller than in the majority of OECD countries (45% compared to an OECD average of 76%) and some BRIICS (Russia and South Africa). Of those who received an education below the upper secondary level, nearly three-quarters have only pre-primary or primary education.

The OECD Programme for International Student Assessment (PISA) registers significant advancement in performance by Brazilian 15-year old students since 2003. This progress is particularly important in mathematics, where the country has shown the largest gains among the 65 countries and economies covered by the survey; significant progress is also found in reading and science. Depending on the area, the advancement can either largely or entirely be explained by improvements in the economic, social and cultural status of the student population. However, student performance in Brazil still lags far behind the average of OECD and BRIICS countries, with the gap being more significant for rural students (Figure 5.8). The average scores for Brazilian 15-year old students in all three areas of knowledge – mathematics, reading, and science – lagging behind their peers in OECD countries by one proficiency level. The share of top-performing students in mathematics is 0.8% for Brazil, compared to an OECD average of 12.6%.

An additional perspective of Brazil's education performance can be obtained from business perceptions on its various dimensions, measured by the WEF's Global Competitiveness Index as it pertains to education and training. This Index ranks the country below the majority of OECD countries and some of the BRIICS countries (Figure 5.9.A). This overall low score reflects the low appreciation of the quality of Brazil's education by the Brazilian business community. It, however, considers that the availability of education and on-job training, above the average levels of the rest of the BRIICS and somewhat closer to the average OECD levels (Figure 5.9.B).

Figure 5.7. Education attainments of Brazil's population, international comparison, 2012

Percentage distribution of population between 25 and 65 years of age



Countries are ranked by the percentage of population with education below upper secondary level. Data for Indonesia represent 2011 and for China represent 2010. EU21 refers to EU countries member to the OECD.

Source: OECD (2014a), *Education at a Glance 2014: OECD Indicators*, http://dx.doi.org/10.1787/eag-2014-en.

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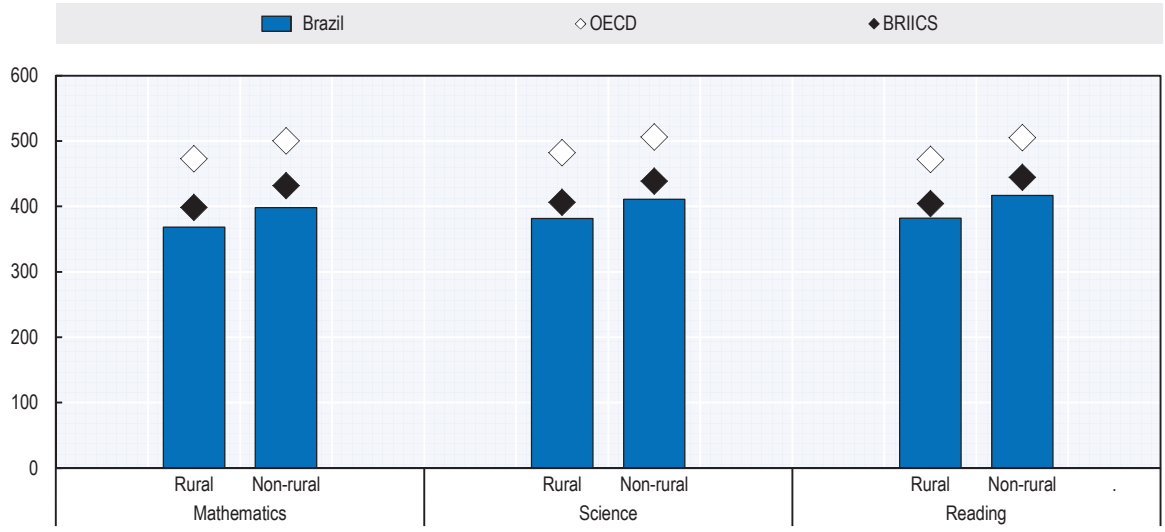
Figure 5.8. PISA assessment of 15-year old students' performance in mathematics, reading and science, 2012

Mean performance scores



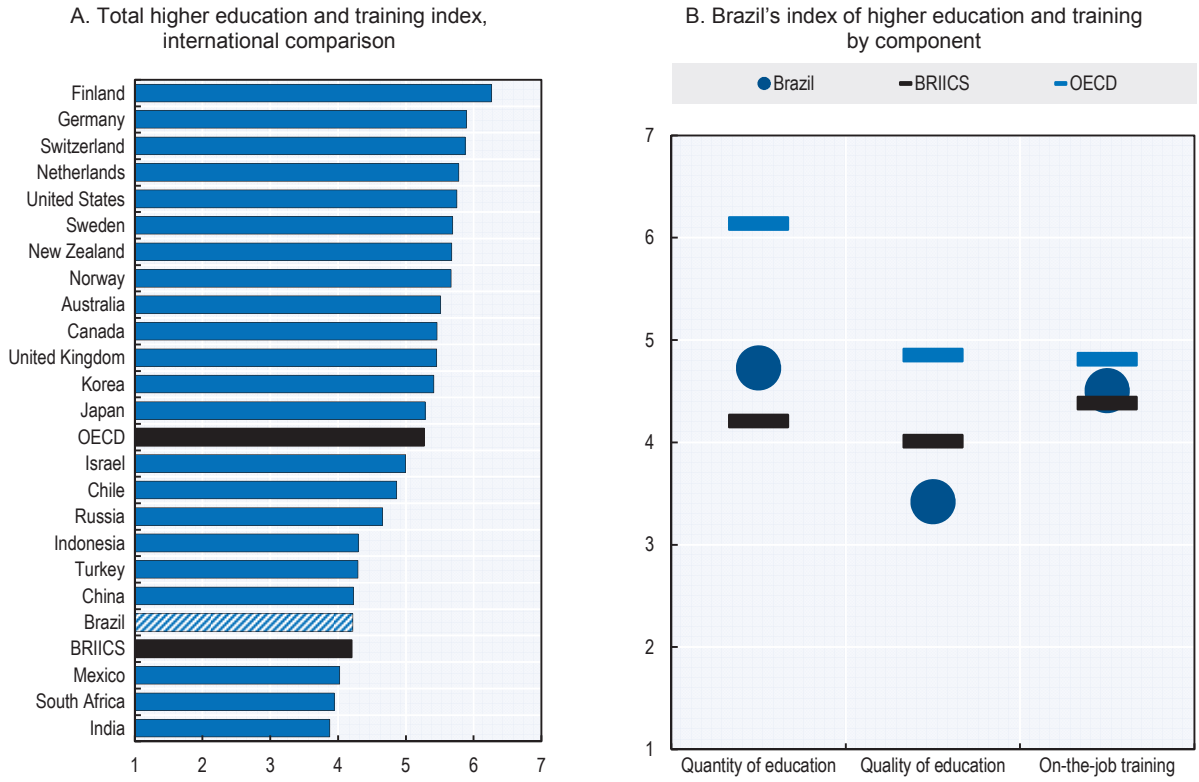
Rural includes villages and small towns.

Source: OECD (2014b), *OECD Programme for International Student Assessment* (PISA) database http://www.oecd.org/pisa/.

StatLink http://dx.doi.org/10.1787/888933242587

Figure 5.9. Global Competitiveness Index: higher education and training, 2013-14

Scale 1 to 7 (best)



Indices for BRIICS and OECD represent simple averages of member-country indices.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014*. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

StatLink http://dx.doi.org/10.1787/888933242597

Two recent OECD *Economic Surveys for Brazil* (OECD, 2011; OECD, 2013b) distinguished the advancement in education among the priorities for growth in Brazil, and highlighted that policy should focus on improving the quality of education. The challenge facing Brazil in this area is largely rooted in the fact the quality of instruction and teachers lagged behind the growing number of students involving large teachers' hiring over a relatively short period of time. The policies should be oriented at setting uniform standards for teachers, funding of teachers' training and learning materials, linking teachers' pay with performance more strongly rather than with the seniority status. Other issues concern reducing grade repetition (e.g. one of the highest for the 15-year olds across 2012 PISA survey) and the drop-out rates in the secondary education.

Notes

1. This section draws on Chapter 3, "Promoting infrastructure development" of *OECD Economic Surveys: Brazil* (OECD, 2011).
2. Brazil's National Employment System is financed from the Fund for Worker's Support (*Fundo de Amparo ao Trabalhador,* FAT), accumulating various turnover and revenue taxes and payroll contributions. As noted in Section 3.4 on financial policy, FAT funds are also used to capitalise the National Bank for Economic and Social Development. Thus, as of late 2000s, only around one half of FAT's revenue from tax and payroll collections was directed to the National Employment System (Gonzales, 2010).

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Chapter 6

Brazilian agricultural policy: Structural change, sustainability and innovation

This chapter provides an overview of domestic and trade agricultural measures, outlining those that support credit and environmental practices, and the development of bio-products. It also reports trends on the level and composition of support, and discusses the likely impact of agricultural policy measures on structural change, environmental performance and innovation in the sector.

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.

Agricultural policy includes measures that are specifically designed for and applied to the agricultural sector. This distinguishes agricultural policy from general policies reviewed in the previous chapters which concern agriculture and other sectors as parts of the overall economy. This section first discusses the objectives of Brazil's agricultural policy, it then looks at domestic price policies, payments based on various parameters of agricultural production or on other parameters inherent to agriculture, such as environmental condition of land and water. Next, trade policy measures associated with domestic agricultural policies are examined. Finally, the extent to which Brazil's agricultural policy is oriented to the support of agriculture's long-term productivity is evaluated based on OECD support indicators.

Agricultural policy objectives and instruments[1]

Agricultural policy rationale, objectives and programmes differ for commercial agriculture, represented by large and medium-size farms, and small-scale family farming, with the policy implementation institutionally separated between two ministries. Policy objectives related to the commercial segment consist of boosting production in this sector, while making it more technologically advanced and sustainable. More specific priorities are articulated in Annual Crop and Livestock Plans and include: increasing output of grains, oilseed and fibre crops to ensure food security; supporting access of producers to finance; assisting producers in managing price and climatic risks; enhancing biofuel and organic production; increasing the use of improved agricultural and livestock practices. Since 2012/13, priorities also include the development of storage and irrigation infrastructure, soil conservation and recovery and investments in technological innovation in agriculture, this new focus led to the introduction of several new investment credit programmes.

Policy objectives related to family farming have an equity rationale and consist of empowering rural poor to generate better incomes. Small farmer policy is focussed on providing rural poor access to agricultural land, financial resources, and knowledge and skills necessary to undertake farming or other rural activities.

Brazilian agricultural policy uses three main instruments: price support, concessional credit and insurance support. These instruments are applied along with the regulations on land use, agricultural zoning requirements, regulations on biofuel use and organic production. Brazil also directs important public funds into land reform and development of general services for agriculture and agro-industry system as a whole, such as research, education, and infrastructure (OECD, 2012).

Domestic agricultural policy

Price support policies

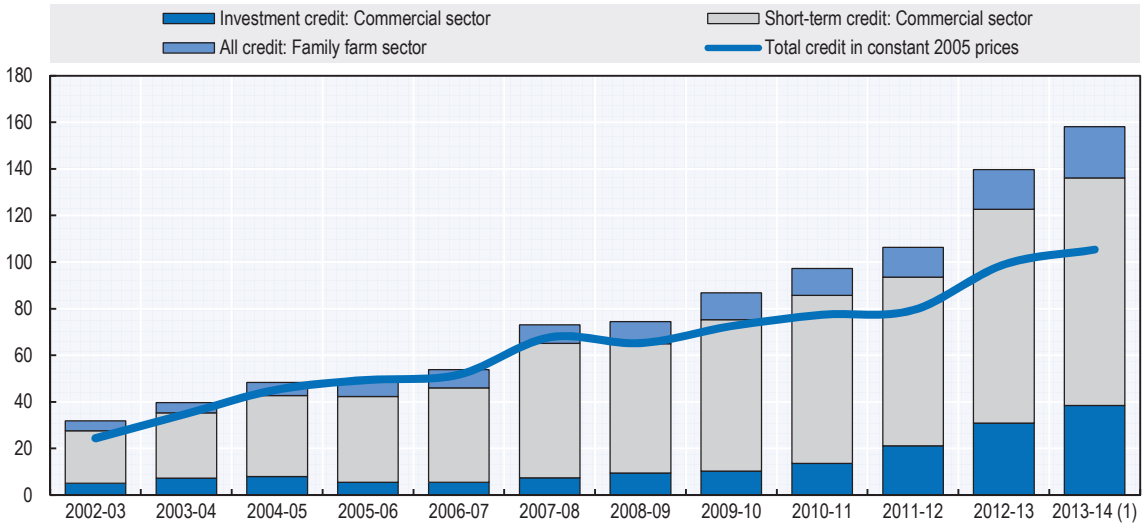
Brazil is a large and competitive agricultural exporter with prices for many agricultural commodities determined beyond the country borders. Nevertheless, a range of measures are applied to regulate domestic prices. The basic element of price policy consists of regionally announced minimum guaranteed prices which cover a broad range of crops and a few livestock products. Given these minimum guaranteed prices, the government implements several price support mechanisms, including direct government purchases; premiums to commercial buyers who pay minimum prices to supply producers; and public and private options contracts backed by private risk premium option. In addition to these programmes, producers receive various reduced-interest marketing loans which enable them to withhold the sale of a product in anticipation of a higher market price. Price guarantees are generally used to support production in nascent areas to help them become profitable, as well as to smooth prices over time to ensure stable farm income and provide support to poor farmers. Despite the variety of price support programmes, however, prices received by agricultural producers in Brazil are more or less aligned with international levels. Distortions are contained by the limitations on the amount of production eligible and by targeting price support to certain regions, usually less developed.

Credit support

Credit support is the principal component of support to agriculture in Brazil (Box 6.1). Annual allocations of concessional credit have increased considerably since the early 2000s. Around 87% of these allocations between 2011/12 and 2013/14 were provided to large and medium commercial producers. The remaining concessional credit allocations (13%) were directed to the small family farm sector within a broad range of credit programmes to support their current expenditures and investment. Around three-quarters of allocations to large and medium commercial producers represent short-term loans to finance their in working capital needs and marketing loans, with the major part going to working capital (Figure 6.1).

Figure 6.1. Annual allocations of concessional credit through the National Rural Credit System 2002/03-2013/14

BRL billion



1. Budgeted allocations.

Source: MAPA (2013), *Agriculture and Livestock Plan 2013/2014*. Brazilian Ministry of Agriculture, Livestock and Food. http://www.agricultura.gov.br/arq_editor/file/PAP%202013%202014/FINAL_Apresentacao%20Baixa%202.pdf.

StatLink http://dx.doi.org/10.1787/888933242605

Investment credit is a possible source of long-term finance for innovation. Support to investment credit may also act as an instrument to steer investment by businesses towards innovative technologies, new business practices and environmental improvements, e.g. by establishing specific eligibility conditions. In recent years, the share of investment credit in total allocations of concessional credit rose from 16% to 25% between 2010/11 and 2013/14. This shift was in line with the general policy of increasing the share of investments in GDP to achieve economic growth targets.

State-supported investment credit programmes involve substantial interest concessions (Figure 6.3). The majority of rural investment credit is provided at or below the TJLP rate (Taxa de Juros de Longo Prazo) set quarterly by the National Monetary Council for BNDES and applied by the bank for most of its programmes. The TJLP is currently set at 5%, or 675 basis points below SELIC rate at which the government typically borrows, which implies substantial state support to investment credit (OECD, 2013b).

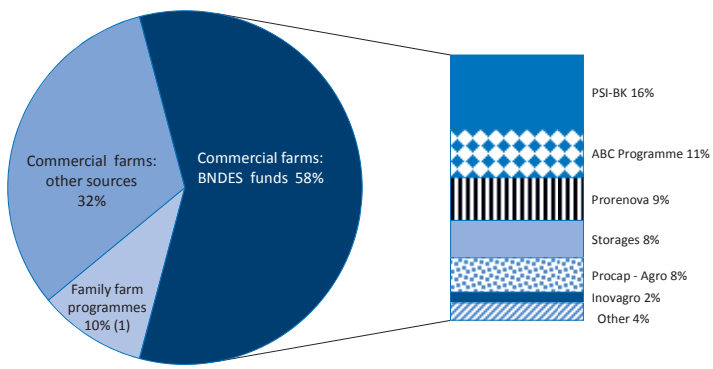
Box 6.1. Brazilian rural credit system

Concessional rural credit dates from the 1960s and continued during the years of macro-economic instability in the 1980s and 1990s. It is operated through the National Rural Credit System (*Sistema Nacional do Credito Rural*, SNCR), which serves agricultural producers and their co-operatives and, to a lesser extent, the agro-processing sector. Preferential rural credit draws on several sources. First, commercial banks are required to direct mandatory resources from their sight deposits and from rural savings to borrowers of the system at interest rates fixed by the government. Other sources are special federal funds – Unemployment Insurance Fund (*Fundo de Amparo ao Trabalhador*), Constitutional State Funds (*Fundos Constitucionais*), the Brazilian Coffee Fund, and free resources from commercial, federal public banks and co-operative banks.

Concessional credit covers both short-term (marketing and working capital loans) and investment loans, with specific sets of programmes offered to (i) commercial producers and their co-operatives, and to (ii) smallholder farmers and specific rural groups (e.g. rural youth and women). Commercial producers receive the bulk of total lending, with a relatively small portion going to small producers.

Short-term concessional loans are allocated through many banks, but the dominant provider of investment credit is the National Economic Development Bank (BNDES) (Figure 6.2). As highlighted in Chapter 4, BNDES' core mandate is to finance projects on development, innovation and environmental sustainability. The Bank offers a whole cluster of credit products for the agricultural and agro-processing sectors to finance investments in enterprise creation, expansion and modernisation. A range of investment programmes operates for the agrarian reform settlers to undertake land improvement, construction of production facilities and infrastructure, acquisition of livestock, and other assets necessary for productive exploitation of lands. Established family farms also benefit from a range of investment loans for technical modernisation, development of integrated agriculture, and value-adding activities.

Figure 6.2. Investment credit by programmes, allocations planned for 2013-14



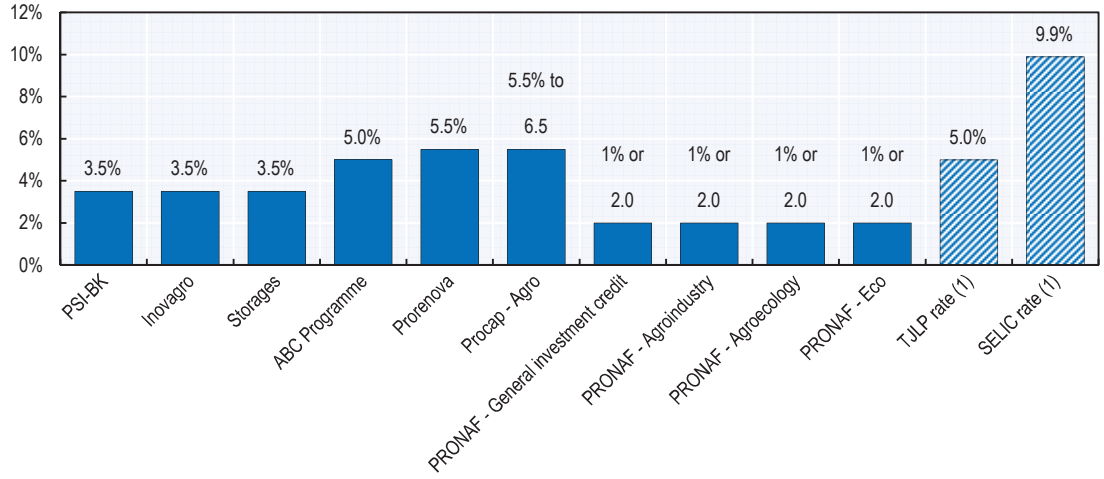
1. Estimated share.

Source: MAPA's on-line statistical database, http://www.agricultura.gov.br/.

StatLink http://dx.doi.org/10.1787/888933242610

Concessional investment credit in Brazil has traditionally been directed to increase mechanisation of agriculture, as for example, Rural PSI Programme, Moderagro and Moderinfra programmes (Annex 6.A1). Since the mid-2000s, greater focus has been placed on the adoption of new technologies and sustainable agricultural practices. The ABC Programme was introduced in 2011 as part of the National Plan on Climate Change. This programme consolidates a range of the pre-existing ones that supported low carbon agriculture. Other new programmes are Inovagro, PCA and PSI "Cerealistas" (grain traders). Inovagro aims to support the adoption of technological innovations and good agricultural and farm management practices with a broad range of investments and services related to innovations eligible for support. PCA aims to support investments in the construction of storages for primary agricultural producers and PSI (Cerealistas) for grain wholesalers.

Figure 6.3. Annual interest rates applied in selected investment credit programmes for agriculture, 2013-14



1. TJLP and SELIC rate as of December 2014.

Source: MAPA's on-line statistical database, http://www.agricultura.gov.br/.

StatLink http://dx.doi.org/10.1787/888933242628

The rationale of rural credit policy has been to reduce the high cost of domestic borrowing to the agriculture and the agro-processing sectors and to address market failure in rural credit finance, while credit assistance to small producers has an additional equity rationale. The issue of failure of credit markets to cater to the needs of the rural sector is probably most relevant for long-term finance. According to BNDES, the Brazilian banking industry generally favours short-term operations that yield high returns. There is little interest in engaging in long-term credit for the agricultural sector due to insufficient knowledge of specific risks, such as climate, disease and other. There is also a lack of adequate regulation and practices enabling easy collateral procedures with agricultural borrowers. Importantly, agriculture also faces high competition from other sectors for scarce private long-term finance. All this implies that there are fundamental macro-economic and structural factors beyond agricultural policy that perpetuate the current rural credit system. On the other hand, state-directed lending produces a crowding-out effects: the availability of subsidised credit reduces the opportunities for the provision of credit on market terms by lenders and the incentives to take up such loans for borrowers. This crowding-out effect is likely to be occurring, in particular, in the long-term credit segment where one state bank provider dominates. Phased steps to create a level playing field for state and private providers could help attract more private resources to the sector and improve allocation of long-term credit (as discussed in Box 3.2 in the section on finance policy).

Beyond reducing the broad structural impediments to the expansion of investment credit, a re-orientation of the rural credit system itself presents an important opportunity to better target policy to innovation and productivity improvements. Rural lending continues to be concentrated on working capital loans to commercial producers. The focus on subsidising current costs of producers through reduced-interest working capital loans may have short-term effects of increasing the output but does not stimulate producers to become more efficient. Producers are less responsive to market conditions and have weaker incentives to adopt cost-reducing strategies. They also have perverse incentives to build-up debt. In fact, farm debt to the rural credit system underwent major rescheduling in the late 1990s and 2000s, and was further re-negotiated on several occasions. The government should consider a gradual downsizing of working capital loans to commercial producers. The on-going efforts to simplify procedures for access to bank credit by rural borrowers, to expand agricultural insurance, and to promote non-bank financial instruments would facilitate such a move (see below). Credit resources could be re-directed to support long-term investment and be allocated to well-specified innovation, environmental, and infrastructure projects.

Easing access to rural credit by simplifying regulations and procedures could reduce the implicit costs for borrowers and facilitate their recourse to borrowing on market terms. Over its long life, the rural credit system has seen a multiplication of public sources of funding, and differentiation of subsidy levels and credit programmes. The regulations governing the provision of concessional loans are complex and numerous, and apply to lending both on concessional and market terms. A draft law has been prepared recently to consolidate rural credit legislation. In addition, there are proposals by producer groups to undertake a broader review of the rural credit system to simplify regulations and reduce related access costs. Pursuing these initiatives would be a move in the right direction.

Promotion of private financing instruments

Brazil has been increasingly promoting "rural securities", i.e. private financing instruments. These efforts to create additional sources of financing have been driven by the desire to reduce the budgetary burden of governments support to bank lending. Rural securities could be used by agricultural producers and their cooperatives as promissory notes to leverage credit from up- and down-stream agents, as well as banks or agro-processors. The government's role in this case is more of a regulatory nature, consisting of setting appropriate rules and guarantees, easing procedures for such financing and for tax incentives, and ensuring the acceptance of rural securities. Several types of "rural securities" are currently in use in Brazil, involving different finance mechanisms and different groups of borrowers and creditors.[2] To the extent these arrangements broaden access to finance for agricultural and agro-industry businesses, this improves the capacity of business to invest and innovate.

Support to agricultural insurance

Support to agricultural insurance is aimed to mitigate fluctuations in farmers' incomes. Four government-supported programmes operate for both commercial and family farmers. In general terms, they provide support either in the form of insurance premium subsidies or by compensating farmers for production losses due to natural disasters.

The PSR programme (Programa de Subvenção ao Prêmio do Seguro Rural) grants insurance premium subsidies to commercial producers who establish contracts with insurance companies listed by the government. It covers all agricultural and livestock activities, as well as forestry and aquaculture. This programme alone covered 5.24 Mha of major crops in 2012. PROAGRO is another insurance programme for commercial agriculture in place since the 1970s. It offers eligible framers partial compensation of the bank debt on working capital loans used in production of the damaged crop and provides indemnity on loss of own resources invested in production. Most of the resources allocated by this programme are directed to the southern region and to grain crops, mainly soybeans, covering an area of 5.58 Mha in 2011 and involving 40 109 producers (Government of Brazil, 2013). For the last seven years, this programme has reduced its payments due to an increase of indemnities paid under PROAGRO-Mais for small-scale farms, which grew to more than a double its counterpart PROAGRO. Garantía Safra is available to family farms enrolled in PRONAF who are located in arid areas (Northeast part of the country) and are producing non-irrigated crops.

Biofuel support

Development of biofuels has been a long-standing strategy of Brazilian government, initially emerging as a component of the energy independence policy and more recently also becoming a part of the policy on climate change. Thus, according to the National Plan for Climate Change, ethanol from sugar cane is estimated to prevent the emission of 508 million tonnes of CO_2 between 2008 and 2017, which would otherwise be released if fossil fuels were used (Government of Brazil, 2008).[3] Varied instruments are applied to support production and consumption of biofuels, on one side, and to prevent negative environmental and social impacts of biofuel expansion, on the other. Agricultural policy acts on both these dimensions of policy. Production incentives are provided to growers of sugar cane and oilseeds through concessional credit programmes enabling them to obtain liquidity

for the marketing period (marketing loans) and a working capital. Growers of biofuel crops and biofuel processors can also benefit from investment credit for rehabilitation and establishment of sugar plantations and construction of ethanol storages (Moderinfra). A special line of credit Prorenova (Annex 6.A1) was opened in 2012/13 and continued for the next season to help overcome sugar cane shortage in the ethanol sector.[4] Sugar cane is one of the crops covered by agricultural zoning, which can be regarded as one of the instruments to balance between boosting production and the environmental objectives of the biofuel policy. In addition to zoning the sugar cane growing area, it is foreseen to gradually eliminate the practice of burning to clear sugar cane fields. In 2008, burning was still used in at least 25% of units growing sugar cane (Government of Brazil, 2008).[5] This commitment and the zoning of the sugar cane are among the actions included in Brazil's National Plan for Climate Change.

Measures to support the production of biofuels are combined with strong consumption stimulus. Tax incentives are provided to users of flex-fuel cars which can run on any combination of ethanol and gasoline. These are combined with mandatory blending ratios for both gasoline and diesel: the 25% blending ratio of ethanol with gasoline and 5% of biodiesel with diesel. Biofuel production in Brazil has received a considerable boost through state support to R&D, and the liberalisation of the FDI regime enabling significant foreign investment in technology development and its application.

Agri-environmental policies

Agricultural policy has increasingly focussed on sustainable agricultural development. Agricultural zoning represents an important instrument linking agricultural support to environmental sustainability of farming activity. Respect of zoning rules is used as a condition of producers' eligibility for concessional credit and subsidised insurance programmes. Compliance with zoning applies to all concessional credit and all insurance premium subsidies for any product covered by the zoning). Furthermore, since 2008 access to subsidised credit for agricultural production in the Amazon biome is conditional on the registration of agricultural producers and ranchers in the Rural Environmental Cadastre and the provision of information on compliance with environmental regulations, in particular land use regulations set out in the Forestry Code.

Beyond linking the provision of support with environmental compliance, a number of programmes offering targeted support for environmentally beneficial practices have recently been launched (Table 6.A1.1). Such programmes are designed for both the commercial and family farm segments. The ABC programme mentioned above provides investment loans for the introduction of no-till cultivation, restoration of degraded pastures and development of integrated farming systems. Several credit programmes for the family farm segment have an environmental focus. Thus, PRONAF's Agroecology programme provides investment credit for the introduction of environmentally sustainable agricultural systems and organic production. PRONAF's Eco programme finances the construction of mini biofuel plants, energy generation from renewable sources and conservation, and improvement and restoration of soils. Non-reimbursable financing is also available from the recently created Amazon Fund. Although it is not destined exclusively for agriculture, it may finance a broad range of agriculture-related environmental activities, such as the integration of forestry, crop farming and cattle-raising, and the preservation of biodiversity. The Programme for Promotion of Social-Biodiversity Products and the *Bolsa Verde* programme integrate environmental objectives into programmes designed to combat poverty. Sustainable farming practices, for example, related to reducing water pollution and a variety of other environmental issues, are also supported through state-level and municipal projects.

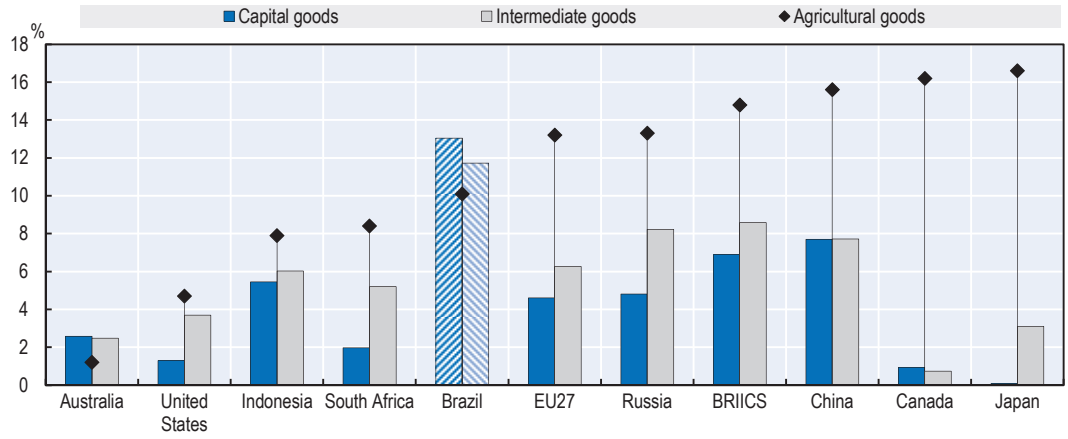
Agri-environmental measures in Brazil are inscribed into broader national strategies, such as the development of economic instruments for remuneration of environmental services; incentives for recycling and re-utilisation of materials and incentives for preservation of ecological corridors and pollination.

Agricultural trade policy

Brazil's trade regime is subject to WTO disciplines and free trade agreements with almost all South American countries. Mercosur is the main regional trade framework, providing for a customs union between its member states[6] with a common external tariff. The Mercosur Common External Tariff (CET) constitutes the core of Brazil's import tariff protection, which in its agricultural part, is significantly below Brazil's WTO bindings. However, each Mercosur party has a list of tariffs exceptions that includes 100 products and a temporary list of 100 additional products is currently in effect until 2014. The exceptions may result in applied tariffs above or below the CET, but they are not allowed to break WTO bindings.

A simple average applied MFN tariff for agricultural goods was 10% in 2012 (compared to the final WTO bound tariff of 35%). The level of agricultural protection is somewhat below that for the rest of trade, with a simple average non-agricultural MFN tariff amounting to 14.1% (WTO, 2013). Brazil's position as a large net agro-food exporter implies that its own import tariff regime has limited importance for most parts of the agricultural and agro-processing sectors. From this perspective, the potential size of foreign markets matters and, therefore, tariff and non-tariff barriers faced by Brazilian exporters in third countries. Brazil's key export markets are protected by Tariff Rate Quotas (TRQ) and exporters also face various SPS restrictions.

Figure 6.4. Import tariffs for industrial and agricultural goods[1], 2012 or latest available year



1. Simple average MFN tariffs, specific duties in *ad valorem* equivalents included.

Source: WITS (2013), *World Integrated Trade Solution database*, http://wits.worldbank.org/wits/.

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Tariff and non-tariff protection for capital and intermediate goods is particularly relevant in the context of innovation as it increases investment costs into advanced technologies, equipment and of the technology transfer. Average tariff levels on capital and intermediate goods are high in Brazil compared to some other countries; they also exceed agricultural tariffs, particularly for capital goods, suggesting industrial bias in trade protection (Figure 6.4). There are no preferential tariff provisions for technological imports destined for the agricultural and agro-processing sectors. It should be noted, however, that the free trade agreements with South American countries foresee tariff preferences for capital and intermediate goods. Industrial tariffs have been rising since 2008, with the most recent tariff increases taking place in 2012 (some of which expired by end 2013). In addition to protection at the border, Brazil uses local content provisions in publicly financed projects, while the BNDES bank attaches local content conditions to loans for capital goods (OECD, 2013b), including for the agro-food and agro-processing sectors.

Level and composition of agricultural support from the perspective of innovation

Domestic agricultural and associated trade measures affect farm investments and practices through a variety of instruments, with different impacts on innovation and sustainability. Several dimensions of agricultural policies are important in this context: (i) the extent to which market-distorting instruments are used to support producers; (ii) the extent to which policies provide support to general services for the sector as opposed to support to individual producers; and (iii) the extent to which policies provide targeted support to innovation and sustainability activity by producers.

Support agricultural producers: Use of most distorting support

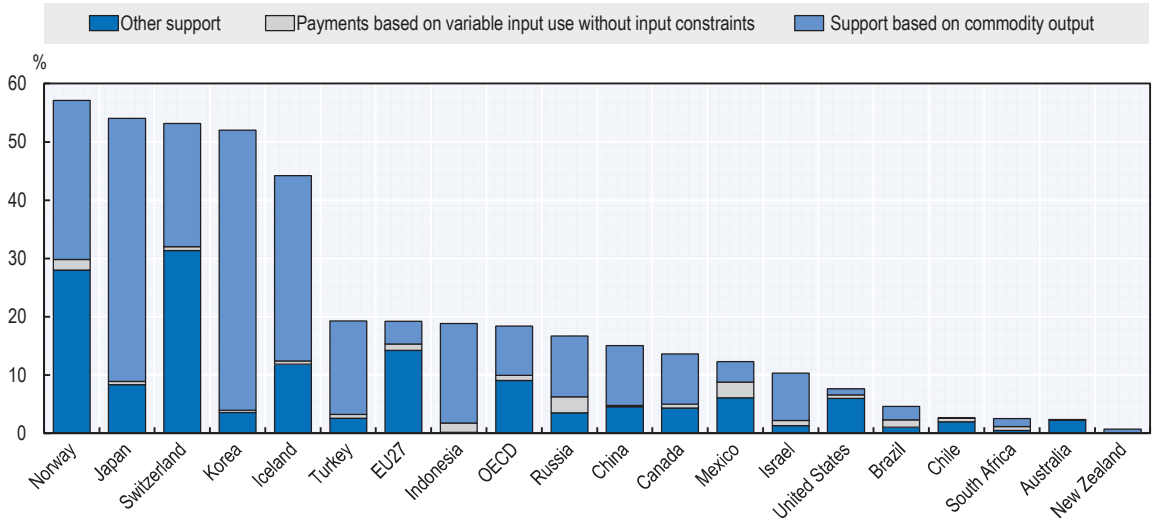
A key characteristic of agricultural policy from the perspective of innovation is the extent to which producer support relies on measures that distort agricultural output and input markets. OECD analysis on production, trade and income effects of agricultural support has shown that border protection, supply controls, output-based payments and variable input subsidies are potentially the most distorting. As such, these policies strongly diminish producer incentives to employ production factors more efficiently and to innovate so as to become more competitive. Distorting policies dampen incentives for innovation not only because they shield producers from competition, but also because they perform weakly in terms of generating income for long-term investment. It has been shown that most of the support provided through price interventions and variable input subsidies is captured in land rents by input suppliers and is lost as deadweight (Martini, 2011). Most distorting measures are not likely to be advantageous for investment also because they encourage riskier behaviour by producers, making them more exposed to market and natural risks (OECD, 2011). On the other hand, broad-based income support decoupled from commodity production is more effective in transferring income to producers and thus increasing their capacity to invest and innovate. It also leaves more flexibility to producers to undertake new activities and switch to new products. If conditional on the adoption of environmentally-friendly practices, this support may help more sustainable resource use. However, even if decoupled from production choices, income support still slows structural adjustment needed to facilitate economies of scale, attract new entrants, and thus foster innovation and productivity growth.

Brazil's level of support to agricultural producers is relatively low compared to the overall size of agricultural output, with the PSE amounting to 5% of gross farm receipts in 2010-13. This implies that agricultural policies in Brazil overall create small distortions to producer incentives. Brazil is placed among the monitored countries with the lowest level of support, such as Australia, New Zealand, South Africa and Chile (Figure 6.5).

As measured by the Nominal Protection Coefficient (NPC), domestic agricultural prices in Brazil are on aggregate only 2% above those observed in world markets. Nevertheless, cross-commodity distortions are non-negligible. Some products receive significant price protection, such as cotton with the NPC at 1.22, milk with the NPC at 1.17 and rice with the NPC at 1.16 (OECD, 2013a). Tariff protection is the main source of disparities in support levels for individual commodities (Figure 6.6). A relatively limited amount of support is based on output or variable input use, both types of support arising from the concessional credit programmes. Commodity-specific transfers constituted nearly 70% of Brazilian PSE in 2010-12. Although support level in Brazil is relatively low, it is generated predominantly by the most distorting measures. Market price support, payments based on output, and payments based on input use accounted for 78% of Brazil's PSE in 2010-12.

Figure 6.5. Composition of Producer Support Estimate (PSE) by country, 2011-13 average

As a percentage of gross farm receipts



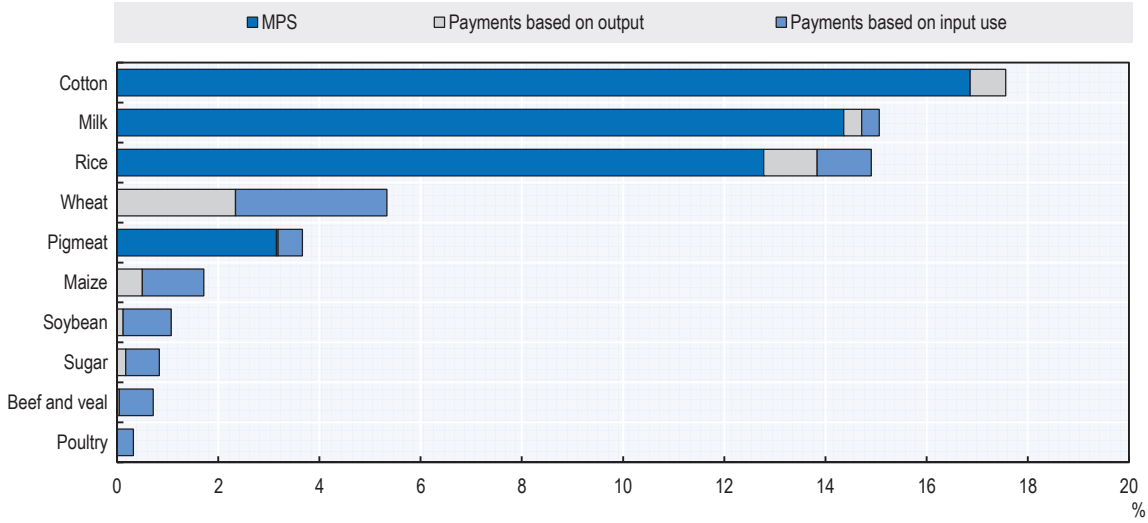
Data from Brazil, China, Indonesia, Russian Federation and South Africa are for 2010-12.

Source: OECD (2013 and 2014) "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database. www.oecd.org/agriculture/PSE.

StatLink http://dx.doi.org/10.1787/888933242648

Figure 6.6. Support to specific commodities in Brazil (Single Commodity Transfers), 2010-12 average

As a percentage of gross farm receipts for each commodity



Source: OECD (2013 and 2014) "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database. www.oecd.org/agriculture/PSE.

StatLink http://dx.doi.org/10.1787/888933242652

Total support to the agricultural sector: Focus on innovation and productivity enhancement

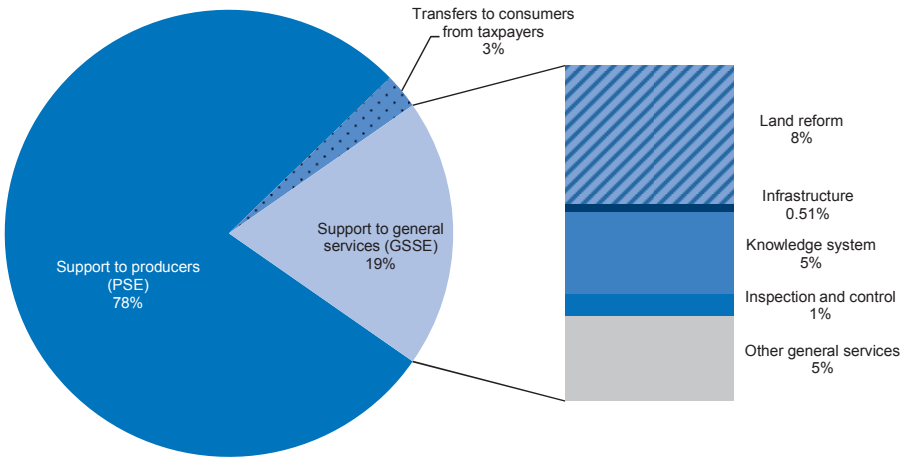
Another key feature of agricultural policy from the perspective of innovation is the extent to which it is oriented towards supporting long-term productivity improvements. Such policy orientation can be revealed by the importance in the overall support of investments in development of knowledge systems, infrastructure and institutions. These investments differ from assistance to individual producers (as measured by the PSE) in that they support systems essential for the efficient functioning of the entire agro-food system and which provide services with broadly spread benefits.

Total support to agriculture in Brazil is dominated by transfers to individual producers in various forms of subsidy. These transfers accounted for nearly 80% of total support to agriculture in 2010-12 in Brazil as measured by the Producer Support Estimate (PSE) (Figure 6.7). Financing of general services to agriculture (the General Services Support Estimate, GSSE) constituted 19% of total support to the agricultural sector during the same period, with the remaining 3% directed to consumers of agricultural products in the form of budgetary subsidies.

The GSSE indicator includes the financing of knowledge-related activities, such as agricultural research and education, as well as investments in infrastructure, land reform, inspection and control systems, activities on promotion and marketing of agricultural products, and the costs of maintenance of public stockholding systems. Within this broad range, activities supporting knowledge systems, infrastructure development and inspection and control systems contribute directly to fostering innovation and productivity in the agricultural sector. Financing these activities constitutes only slightly more than one-third of overall support to general services in Brazil (Figure 6.8). The main part of the Brazilian GSSE is represented by agrarian reform spending, which includes government purchase of lands for settlement by the beneficiaries of the reform and investment in infrastructure and basic communal services for those settled areas. Over the longer term, the share of support directed to general services in the overall agricultural support tended to decline, as did the share of expenditures for innovation and productivity-enhancing services.

The dominance of support to individual producers over support to general services in Brazil is similar to the situation in the majority of countries covered by OECD agricultural policy monitoring. With the exception of few countries, such as New Zealand, Chile and Australia, where the low shares of producer support in total support reflect explicit policy orientation towards the provision of public goods, this share reaches from over 60% to over 90% in other countries (Figure 6.9.A). The degree to which countries prioritise innovation and productivity-enhancing areas in their support to general services also varies widely. Form this standpoint, Brazil is among those few where this share is relatively low (below 40%), compared to over 70% in the majority of the monitored countries (Figure 6.9.B).

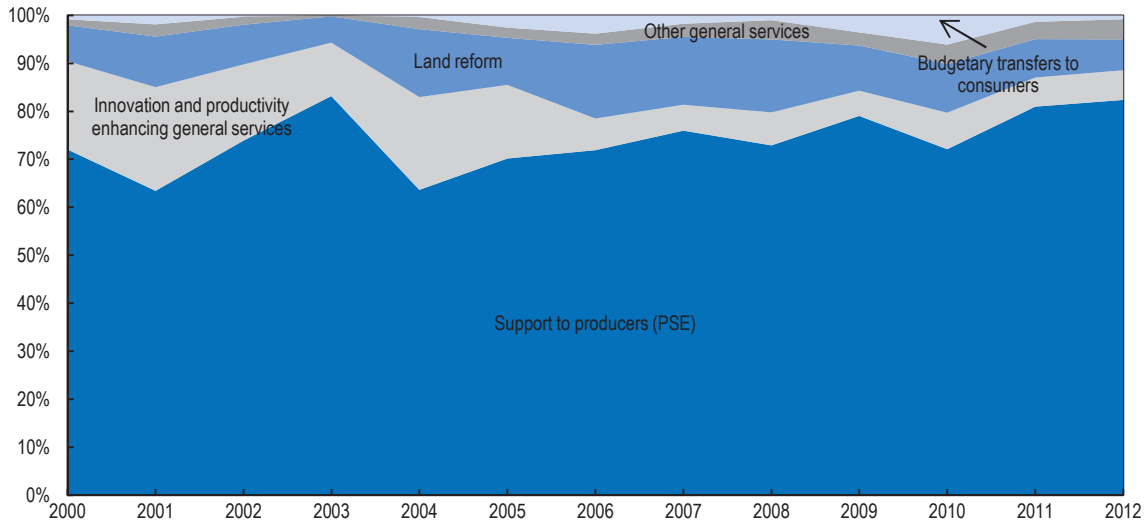
Figure 6.7. Composition of Total Support Estimate (TSE) in Brazil, 2010-12 average



Innovation and productivity enhancing GSSE includes financing of knowledge and innovation systems, infrastructure and inspection and control systems. Other general services include financing of marketing and promotion activities and costs of public stockholding costs.
Source: OECD (2013 and 2014) "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database. www.oecd.org/agriculture/PSE.

StatLink http://dx.doi.org/10.1787/888933242661

Figure 6.8. Evolution of Total Support Estimate (TSE) in Brazil, 2000-2012[1]

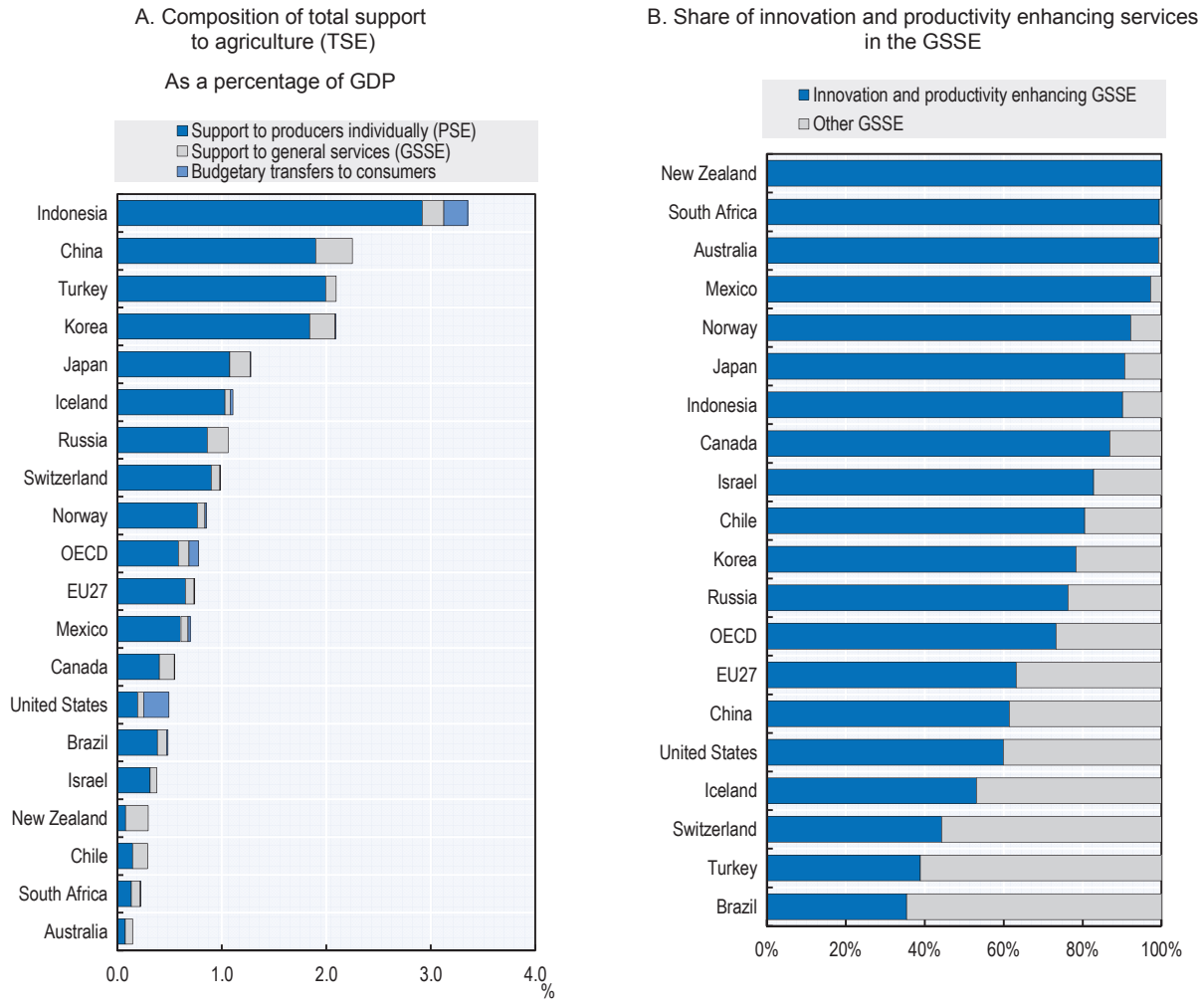


1. Innovation and productivity enhancing GSSE includes financing of knowledge and innovation systems, infrastructure and inspection and control systems. Other general services include financing of marketing and promotion activities and costs of public stockholding costs.

Source: OECD (2013), *OECD PSE/CSE database*, www.oecd.org/agriculture/PSE.

StatLink http://dx.doi.org/10.1787/888933242670

Figure 6.9. Total support to agriculture (TSE) and general services (GSSE), international comparison, 2010-12 average



Data for Brazil, China, Indonesia, Russian Federation and South Africa represent 2010-12.
Source: OECD (2013 and 2014) "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database. www.oecd.org/agriculture/PSE.

StatLink http://dx.doi.org/10.1787/888933242680

Notes

1. A comprehensive description of Brazil's agricultural policy is contained in OECD (2005), with updates in OECD (2007), OECD (2009), OECD (2011a) and OECD (2013a).
2. Rural Product Bill (Cédula do Produto Rural, CRP); Rural Promissory Note (Nota Promissória Rural, NPR) and Rural Duplicate (Duplicata Rural, DR); Agribusiness Credit Bill (Letra de Crédito do Agronegócio, LCA); Certificate of Agribusiness Credit Rights (Certificado de Direitos Creditórios do Agronegócio, CDCA); Certificate of Agribusiness Receivables (Certificado de Recebíveis do Agronegócio, CRA), Certificate of Agricultural Deposit (Certificado de Depósito Agropecuário , CDA) and Agribusiness Warrant (Warrant Agropecuário, WA).
3. A joint study by Brazilian and international organisations indicated that the use of sugar bioethanol may result in 72% reductions of CO2 emissions compared to gaz (*Sugarcane-Based Bioethanol: Energy for sustainable development* / coordinated by BNDES and GEE, Rio de Janeiro: BNDES, 2008); while a recent report by the Brazilian Ministry of Agriculture highlights significant effects of biodiesel use in terms of reduction of GHG emissions and other harmful substances (*Benefícios Ambientais da Produção e do Uso do Biodiesel – 1ª Edição*, MAPA, Brasilia, October 2013).
4. Due to a poor sugar cane harvest, the cost of raw materials soared significantly, occurring also amid a rise in sugar prices on international markets. Ethanol plants worked at below normal capacity and faced financial difficulties, leading to a build-up of their credit debt. Under these conditions, many ethanol processors were unable to undertake new investment to renew sugar plantations, which further aggravated the raw material supply problems (FGV, 2013).
5. In São Paulo state, a voluntary agreement was reached between São Paulo State Government, the sugarcane industry (UNICA) and cane suppliers (ORPLANA) on the termination of sugarcane burning: in areas that can be mechanized over the period between 2014 and 2021 and in other areas between 2017 and 2031. This agreement also includes other conservation measures. One hundred and seventy-three mills and 29 associations of sugarcane suppliers, representing 90% of the São Paulo state production and 50% of the national production participate in this initiative.
6. Argentina, Brazil, Paraguay, Uruguay, and Venezuela, with Bolivia having the status of an acceding member.

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Annex 6.A1

Brazil's main investment credit programmes in agriculture

Investment credit for large and medium-size farms and agricultural cooperatives is provided under the following programmes:

- Rural PSI (*Programa de Sustentação do Investimento Agrícola*) finances the acquisition of new domestically produced machinery and agricultural equipment. It is currently under review to allow the financing of projects on technological innovation, infrastructure and logistics.
- Low Carbon Agriculture-ABC Programme (*Agricultura de Baixo Carbono*) provides credit for adoption of farming practices that contribute to reducing emissions of greenhouse gases (Table 6.A1.1).
- Storages Programme-PCA (*Construção e Ampliação de Armazens*) and PSI-Grain Traders (*Programa de Incentivo à Armazenagem para Empresas e Cooperativas Cerealistas Nacionais*) finance construction of private storages for primary producers and grain traders respectively.
- Pronamp-Investment (*Programa Nacional de Apoio ao Médio Produtor Rural-Investimento*) is targeted only to medium-size agricultural producers and supports various investments in agricultural enterprise with the criteria that they increase productivity and reduce production costs of the enterprise. When loans are used to purchase of machinery and equipment, they are granted only for domestically produced items.
- Procap Agro (*Programa de Capitalização de Cooperativas Agropecuárias*) supports capitalisation and equity restructuring of agricultural, agro-processing, aquaculture and fishing cooperatives by providing resources required to finance cooperative's share payments and working capital. However, most of the funds within this programme are provided for working capital.
- Inovagro (*Programa de Incentivo à Inovação Tecnológica na Produção Agropecuária*) aims to support the adoption of technological innovations and good agricultural and management practices. A broad range of investments and services related to innovations can benefit from support, among others, precision agriculture, acquisition of genetic material and pedigree animals, automation of poultry, swine and dairy farming, computer software for management, monitoring and automation of processes on farms, related technical assistance and training. The Programme also finances products developed in the framework of another technological innovation programme focussing on pioneer technologies (Inova-Empresa), and activities or products that comply with the Systems of Integrated Agricultural Production PI-Brazil and Animal Welfare; Good Agricultural Practices in Milk and Meat Cattle Raising; and with the sector-specific Food Security Programmes.
- Prorenova (*Programa de Apoio à Renovação e Implantação de Novos Canaviais*) applied between 2012 and 2013, supported the rehabilitation and establishment of new sugar

plantations with the aim to expand sugar and ethanol production (see also section on biofuel support below).

- Moderagro (*Programa de Modernização da Agricultura e Conservação de Recursos Naturais*) is a programme that absorbed many previously existing smaller credit programmes targeted to specific sectors and activities; it therefore has a broad scope in terms of beneficiaries (from farming to downstream businesses), product sectors and types of activities financed. The support is provided in three main areas: (i) various enterprise investments in modernisation and business expansion; (ii) animal health activities, including within the framework of the National Programme for Control and Eradication of Brucellosis and Tuberculosis, and the implementation of animal traceability system; (iii) purchase, transportation and application of soil improvement materials for soil recovery.

Other currently applied programmes, such as the three presented below, were once relatively important but have declined substantially as resources were shifted to the PSI program created in 2009.

- Moderinfra (*Programa de Incentivo à Irrigação e à Armazenagem*) supports the development of sustainable irrigated agriculture; it also finances the expansion of on-farm storage capacities for agricultural products and structures for storage of farm machinery and agricultural inputs.
- Moderfrota (*Programa de Modernização da Frota de Tratores Agrícolas e Implementos Associados e Colheitadeiras*) finances acquisitions of new tractors, combine harvesters and other agricultural machinery and equipment.

Investment credit for family farms covers a broad range of investment credit lines for family farms are available mainly under the umbrella of the National Programme for Strengthening Family Agriculture (*Programa Nacional de Fortalecimento da Agricultura Familiar*, PRONAF), such as general investment credit; Agroindustry; Flower Growing; Semiarid Areas; Women Farmers; Young farmers; Agroecology; Eco and other.

Source: BNDES; MAPA, MDA.

Table 6.A1.1. Main programmes incorporating payments for agri-environmental practices in Brazil

Activity	Environmental objectives	Content	Policy instruments[1]	Start year
Low Carbon Agriculture	• Soil quality / protection • Resilience to adverse events • Carbon emissions reduction • Sustainable resource use	Provides concessional loans to commercial farms for adoption of farming practices that contribute to reducing emissions of greenhouse gases; activities of research and education, technical assistance and extension. Six activities are supported: (i) no-till technologies; (ii) restoration of degraded pastures; (iii) integrated crop-livestock-forestry farming; (iv) planting for commercial forestry; (v) biological nitrogen fixation; (vi) animal waste treatment.	• Investment support • Payments based on farming practices • Technical assistance / extension • Community based measures • Research / education	2010
PRONAF Agroecologia	• Sustainable resource use • Organic farming	Provides concessional investment loans to family farms for adoption of agri-ecological production systems and organic production.	• Investment support	2005
PRONAF Eco	• Sustainable resource use	Provides concessional investment loans to family farms for small-scale bioenergy and hydro-energy production facilities, energy management, adoption of ecologically friendly technologies, sustainable forestry; conservation, improvement and restoration of soils.	• Investment support	2007
Promotion of Socio-Biodiversity Products	• Biodiversity • Sustainable resource use	Includes a broad range of actions to strengthen value chains for products associated with Brazilian socio-biodiversity, such as Brazilian nuts, rubber, and other nine typical natural products. Beneficiaries are mainly rural populations involved in extractive practices, family farmers, quilombolas, and indigenous communities. Among other types of support, they may receive credit support and minimum guaranteed prices for socio-biodiversity products.	• Payments based on farming practices • Investment support • Payments based on output • Technical assistance / extension	2007
Bolsa Verda Programme	• Generic / broad spectrum • Sustainable resource use	Targeted support to families in extreme poverty that leave on lands requiring conservation. These families may receive additional social payments if they introduce specified land conservation practices.	• Payments based on farming practices • Technical assistance / extension	2011
Amazon Fund	• Prevention of deforestation • Generic / broad spectrum • Biodiversity • Reduction of carbon emissions	Provides non-reimbursable financing for projects directly or indirectly contributing to reduction of deforestation of the Amazon Forest. Up to 20% of the Fund's disbursements may support the development of systems for monitoring and control of deforestation in other Brazilian biomes and in biomes of other tropical countries. A broad range of activities is financed, such as integration of forestry, farming and cattle-raising; ecological and economic zoning and agricultural arrangement and regulation; agricultural management systems; renewable energy; and biodiversity preservation.	• Investment support • Research / education • Technical assistance / extension • Community based measures	2009

Table 6.A1.1. Main programmes incorporating payments for agri-environmental practices in Brazil (*cont.*)

Activity	Environmental objectives	Content	Policy instruments[1]	Start year
Environmental services projects	• Water resources / pollution • Biodiversity • Carbon emissions reduction	A variety of local projects supporting farmers for land retirement and for performing certain environmentally-friendly agricultural practices that secure or support the provision of environmental services	• Payments based on land retirement and on farming practices • Investment support • Technical assistance / extension • Community based measures	2000's
Micro watersheds programmes	• Generic / broad spectrum • Water resources / pollution • Soil quality / protection	Sub-national programmes implemented in southern and south-eastern regions of Brazil, often supported by financing from the World Bank and Inter-American Development Bank. Focus on sustainable natural resources use, water erosion control, land use planning and general environmental conservation. Besides community-based measures include technical assistance, information dissemination and rural extension activities	• Research / education • Technical assistance / extension • Community based measures	1980-90s

Source: Zanella and Cardoso, 2011; the Amazon Fund; on-line information from MAPA and MDA.

Chapter 7

The Brazilian Agricultural Innovation System

This chapter analyses the functioning of the Brazilian agricultural innovation system. It discusses the role of the different actors and describes governance mechanisms to define priorities and evaluate performance. It analyses trends in agricultural R&D expenditure and sources of funding, the role of intellectual property protection in fostering knowledge markets, and outlines mechanisms used to facilitate knowledge transfers, including collaboration at the national level and the adoption of innovation at the farm or firm level. It also outlines efforts to strengthen international R&D co-operation. Finally, it provides evidence on the performance of the agricultural innovation system, including R&D outputs and adoption rates.

General innovation profile[1]

Agriculture innovation is increasingly dependent on general innovation through developments in Information and Communication Technology (ICT), biotechnology and nanotechnology, but also marketing innovation. A thriving innovation profile will ensure that general knowledge and specific knowledge in other fields, which are needed to develop and implement agriculture innovation, are available, and that economic actors and society in general share an innovation culture.

Brazil's **overall Science, Technology and Innovation (STI) strategy** is laid out in the National Strategy in Science, Technology and Innovation (ENCTI)[2] for 2012-15, which was designed to: i) close the technological gap with developed economies; ii) support Brazil's leadership in the nature-related knowledge economy (including green innovation, agribusiness and other natural-resource-based activities); iii) strengthen the internationalisation of the national research system;[3] iv) foster the development of a green economy; and v) address social and regional inequalities. Funding for this strategy is BRL 75 billion over 2012-15, compared to BRL 41.2 billion for the previous plan covering 2007-11. The STI strategy is integrated into the Greater Brazil Plan 2011-14, adopted in 2011, which gives innovation a central role and includes proposals for significant changes in legal frameworks (OECD, 2012).

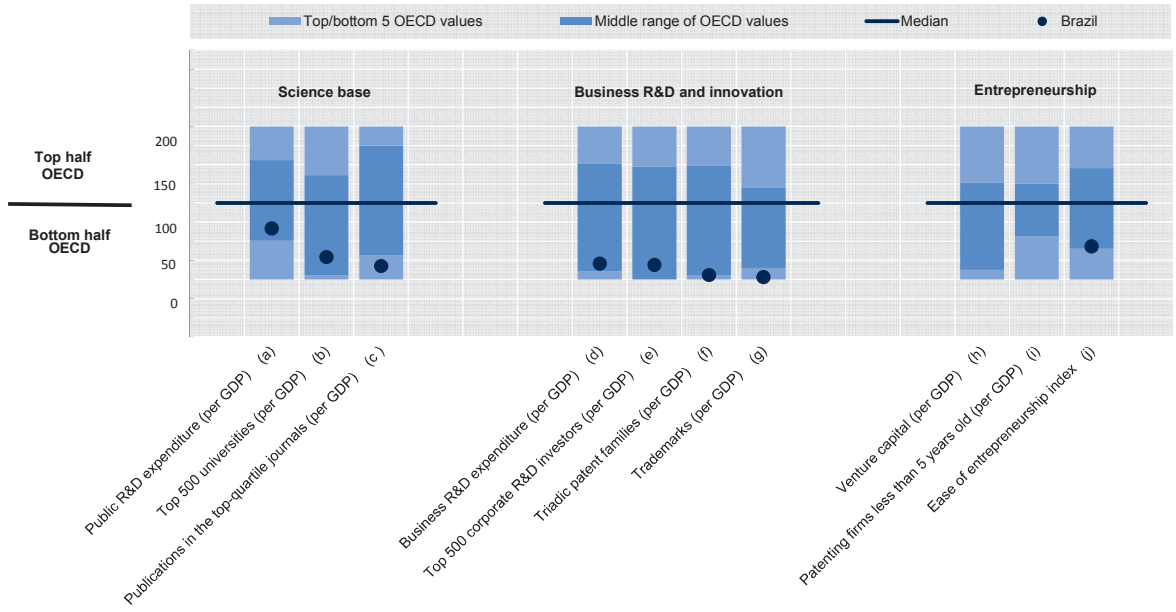
There have been no recent major changes to Brazil's **STI policy governance**. However, several measures aim to improve co-ordination between institutions at the federal level and between federal and state bodies. The National Council for Industrial Development was redesigned in August 2011. It includes ministries, the president of the National Bank for Economic and Social Development (BNDES), private businesses, and industry and labour union representatives, among others, and aims at better co-ordination and greater involvement of stakeholders (OECD, 2012).

Using a set of indicators of STI efforts and outcomes, the *OECD Science, Technology and Industry Outlook 2012* (OECD, 2012) finds that the performance of Brazil's innovation system is unequal across sectors, with leading innovative firms in some sectors, e.g. deep water oil extraction, but weak innovation in small and medium-sized enterprises (SMEs). The relatively weak STI performance of the Brazilian economy can be related to challenging framework conditions, particularly in terms of human resources.

Government expenditure on agricultural R&D (1.08% of agricultural GDP in 2008) is below the OECD average but above other major Latin American countries such as Argentina, Chile or Mexico. Business expenditure on R&D is relatively weak despite government incentives, in particular through tax exemptions, which were modified in 2007 to link them to the use of Intellectual Property Rights (IPRs). Support is also available for start-ups and for the commercialisation of innovation. According to Cavalcante (2011), there were approximately 87 143 scientific researchers in the general innovation system in 2007, which in relative terms represented 40.1 researchers for 100 000 residents in Brazil.

Research outputs are very low compared to the OECD average, in terms of both number of articles published in top journals and number of patents and trademarks (Figure 7.1). The share of research outputs originating from international cooperation is relatively low, as is often the case with large countries. Revealed technology advantage based on PCT patent applications is slightly above the OECD median for bio- and nanotechnologies, and environment related technologies, but it is much below the OECD median and BRIICS average in ICT (OECD, 2012).

Figure 7.1. Science and innovation profile of Brazil



Source: OECD (2012), *OECD Science, Technology and Industry Outlook 2012*, OECD Publishing, Paris.
DOI: http://dx.doi.org/10.1787/sti_outlook-2012-en.

StatLink http://dx.doi.org/10.1787/888933242696

Overview of agricultural innovation system's actors and respective roles

Agricultural innovation systems involve a wide range of actors who enable, guide, fund, perform, implement, inform and facilitate innovation.

The Brazilian agricultural innovation system, due the continental dimension of the country and diversity of the agricultural sector, involves a complex network of actors, including farmers, researchers, extension officers, policymakers, private-sector companies, entrepreneurs, processor agro industries, nongovernmental agencies, and other intermediary organisations (Asenso-Okyere and Davis, 2009).

The Brazilian Corporation for Agricultural Research, Embrapa, is the main public R&D organisation in Brazil and a leader in agricultural innovation.[4] It was established in 1973 as a semiautonomous federal agency administered by the Ministry of Agriculture, Livestock and Food Supply (MAPA) with "the mission to provide feasible solutions for the development of Brazilian agribusiness through knowledge and technology generation and transfer." (Correa and Schmidt, 2014).

Embrapa is organised as a large network, composed of 47 decentralized centres distributed among the several regions of Brazil (Figure 7.5).[5] There are three types of centres: by commodity (e.g. rice and beans, wheat, soybeans, tropical fruits, beef cattle, or dairy cattle), eco-regional (e.g. semi-arid, amazon, or savannahs) and thematic (e.g. soil, biotechnology, or environment).

Embrapa research focuses on primary agriculture, including production systems, natural resources, pest and disease controls, agricultural practices, genetic resources and breeding, environmental issues, and other activities to improve the productivity and the quality of agricultural and livestock production. Embrapa also carries out research on post-harvest, food processing, machines and equipment for small famers and agricultural instruments (electronic equipment).

While all commodity centres of Embrapa work on post-harvest issues, there are two centres specialised in food processing: one in the state of Rio de Janeiro and other in Fortaleza, state of Ceará. Work by Embrapa on the development of machines and equipment is limited given that this area is dominated by the private sector.

Brazilian agricultural R&D focuses on applied innovations. At Embrapa, and some state organisations, some basic research has been developed but the main role is led by universities and some research institutes linked to the Ministry of Science and Technology.

Brazilian universities provide a high level of education in fields related to the agricultural sector (agronomist, veterinary, forest engineering, environmental technician, etc.) and in basic research. The federal and state universities are also involved in applied research in agrarian sciences, especially those linked to the agricultural sciences. The main ones are located in the states of São Paulo, Minas Gerais, Rio de Janeiro and Rio Grande do Sul.

At state level, there are agricultural research organisations (Oepas) and rural extension agencies (EMATER). To improve the rural extension support, especially to those farmers still not linked to the ATER system, the Federal Government created a National Agency for Technical Assistance and Rural Extension (ANATER) in 2013.

The role of the private sector in Brazilian agricultural innovation system has been growing in the last two decades due the boom of agribusiness, especially in the Cerrado region in the centre of the country. Its role is more oriented to the supply of inputs and technical assistance to the farmers but agricultural research in the private sector is also growing (seeds, equipment, machines, feed, agrochemicals, etc.).

Non-profit organisations acting in agricultural research have also been present in Brazil for the last 30 years. Among these organisations it is important to highlight those linked to the grain sector like FUNDACEP in Rio Grande do Sul state and COODETEC in Paraná state, and those linked to the citrus and sugarcane sectors: Fundecitrus and Sugarcane Technology Centre (CTC)[6] in São Paulo state.

A survey developed by Beintema, Avila and Pardey (2001), involving the main institutions (68) doing agricultural research (federal and state organisations, universities, non-profit organisations and seed companies) showed that in 1996 there were around 5 000 full time equivalent (FTE) agricultural researchers in Brazil. A new survey developed by Beintema, Avila and Fachini (2010) showed a modest growth at the Brazilian agricultural R&D sector in 2006. The total research staff was estimated at 5 373 FTE, a growth rate of 6% over a ten-year period. A new national R&D survey is currently in progress. In spite of the recent expansion of the higher education sector in areas related to agrarian sciences, an important growth of agricultural R&D staff is not expected.

Agricultural innovation system governance structure and integration

Governance ensures that government priorities are coordinated and communicated clearly, that progress is monitored and that policy outcomes and impacts are evaluated against objectives. The integration of agricultural innovation system in the governance of general innovation ensures better use of public funds, and increased efficiency of innovation systems through the pooling of different expertise.

The Ministry of Agriculture, Livestock and Food Supply (MAPA) and the Ministry of Agrarian Development (MDA) have the most important governance-related roles of coordinating and/or promoting policies, and actions for its organisation and modernisation. The MAPA is responsible for the coordination of agricultural research through Embrapa. Embrapa coordinates the National Agricultural Research System (SNPA), which acts together with the CONSEPA, the national council of state agricultural research organisations (Beaulieu, 2013). The MDA coordinates the rural

extension system. This kind of public coordination also exists at state level and is led by the state government agencies.

The agricultural innovation system is largely funded by the government (federal and states) who have their own monitoring and evaluation systems. For the Brazilian agricultural innovation system as a whole there is no formal governance structure but Embrapa, in general, is always involved in the main decisions related to agricultural R&D (Salles Filho, 2000).

The agricultural innovation system is closely linked to the general innovation system due to the strong relationship with the Ministry of Science and Technology (MCT), the leader through the National Council for Scientific and Technological Development (CNPq). The Ministry of Environment (MMA), the leader for environmental questions, and the Ministry of Education, linked with the universities, also play important roles in the general innovation system.

Agricultural innovation priorities and coordination mechanisms

The most important roles in the establishment of innovation priorities and coordination mechanisms are performed by MAPA and MDA, but the MCT also has a strong role, especially at the R&D at the university level, as the main source of funding for universities is the National Fund of Scientific and Technological Development (FNDCT),[7] which is under the MCT. At the national level, the priorities for R&D are established by government through the different ministries involved in innovation, led by the Ministry of Science and Technology. The main agency of the MCT to support agricultural research is the National Council of Scientific and Technological Development (CNPq).

The CNPq is a promotion agency, which supports research programmes in all areas of knowledge including agricultural sciences. It delivers grants and project funding, through competitive public calls. Beneficiaries are researchers in public or not-for-profit private high education institutions and R&D institutions and centres, and public companies with science, technology or innovation research activities. A large part of funds delivered by CNPq to support specific themes come from other ministry resources. In the case of agricultural sciences, funds come mainly from the MCTI, the MAPA and the MDA and reflect their respective priorities. Another significant source of funding is the FNDCT, which through the sectoral fund for agroindustry (CT agro), supports research in agricultural sciences in priority areas defined by the management committee. The MCTI coordinates sectoral funds.

In MAPA, there are more than 30 sectorial councils, responsible for the identification of the main technological and infrastructure demands of the most important agricultural chains in Brazil. This system, which involves all public and private innovation actors, identifies market and system failures. Periodically, MAPA councils forward the main technological demands, which become R&D projects to be implemented, to the federal agricultural innovation actors, led by Embrapa.

Embrapa and state organisations have their own strategic planning system to identify R&D priorities. Embrapa's current strategic plan covers the period 2008-23 and defines five broad priorities (see next section). Each Embrapa centre also elaborates a strategic plan linked to the corporate strategic plan of Embrapa, in co-ordination with Headquarters under the supervision of the Board of Trustees and the executive directors. The Board includes representatives of small and large farmers, researchers, agribusiness and universities.

To avoid duplication among these centres, there is a general co-ordination at the Headquarters at the strategic planning level and for the R&D programing process. The R&D Department coordinates the preparation and analysis of the R&D proposals, and monitors and evaluates the results obtained.

Embrapa is currently carrying out strategic studies to design a new research vision to orient its research for the next 20 years. These studies are coordinated through the ***Agropensa***, an Embrapa initiative established in 2012 that operates through a networking approach. It is dedicated to interacting with relevant stake-holders, in Brazil and abroad, that aims to produce and disseminate

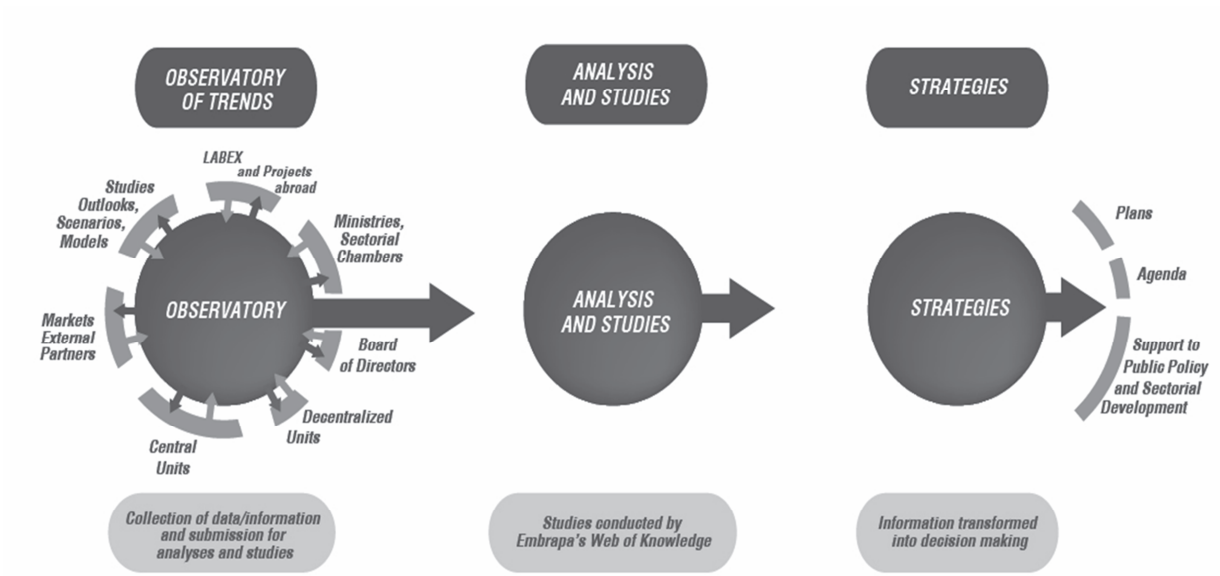
strategic knowledge on future technological challenges and opportunities for agriculture (there is a strong emphasis on partnership). An important step in Agropensa's success is the commitment and collaboration of Embrapa researchers, spread over 50 units, and of external experts in Brazil and other countries.

Figure 7.2 shows how Agropensa is organised. It is important to note the relationship between this project and other actors of the Brazilian agricultural innovation system, especially at the "Observatory" phase. This "think tank" will result in a better integration of Brazilian agencies that work in the field of agricultural research and will be nationally coordinated by Embrapa.

This Embrapa initiative serves as a model for the other Brazilian R&D organisations, particularly those located in the main states of the country and universities, to improve the competitiveness of the agricultural sector in the future.

Embrapa's strategic planning process has been strengthened in the last decades to better identify and prioritise technological demands. This was done through external consultancies by universities (São Paulo and Campinas, for example) and private companies such as Macroplan, from Rio de Janeiro. In addition, Embrapa has been training its staff on strategic planning methodologies, in some cases together with state R&D organisations. This strategic planning system is nationally coordinated at Embrapa by a central unit named Strategic Management Secretariat.

Figure 7.2. Embrapa Agropensa components and functioning



Source: Embrapa, *Agropensa*, https://www.embrapa.br/web/agropensa.

Private organisations also propose priorities to the Brazilian agricultural innovation system. According to the Brazilian National Confederation of Industry (CNI, 2013), the main areas for research are biotechnology, bioreactors, vegetal and animal assisted reproduction, forest biotechnology, germplasm collection and conservation, plant resistant to biotic and abiotic stresses, genetic modified organisms and bio-prospection.

At the agricultural innovation system level, there are no national and formal mechanisms to coordinate this process to capture innovation priorities in agriculture. This role is assumed by Embrapa in case of federal R&D demand for innovation. The same role is assumed at the state level by the R&D agricultural organisations. Both Embrapa and Oepas implement R&D projects considered most relevant.

In the case of rural extension, actors at the federal and state levels carry out a similar role. The federal role in rural extension is more focused on family agriculture and led by the Ministry of Agrarian Development (MDA).

Performance evaluation system

The evaluation systems for human resources, R&D projects and institutional performance exist at the level of each actor of the agricultural innovation system. In the case of public organisations these systems are closely linked to federal and state ministries or secretaries. These government agencies receive institutional reports periodically from these actors.

Embrapa uses a formal performance evaluation system and its results are used to prepare annual reports to the Government. All the reports prepared are available on the Embrapa website.[8]

The criteria used at Embrapa are based on efficacy (accomplishment of goals), efficiency (inputs versus outputs) and effectiveness (outcomes and impact), the traditional criteria to evaluate institutional performance. Embrapa evaluates each one of its agricultural research centres, and also monitors and evaluates R&D projects and personnel.

Embrapa has an internal evaluation system but it is based on ad hoc consultants and its results are compared periodically with those obtained by other R&D organisations. In general, the comparisons are made with the international agricultural research centres and national R&D institutes in Latin America and the Caribbean (LAC) and other world regions. Embrapa also uses external experts to do evaluations when necessary, especially in the case of impact assessment.

Similar systems for R&D projects and for personnel were implemented in state organisations. Individual performance evaluation is also used by other actors of the agricultural innovation system; rural extension agencies, private companies, non-profit organisation and producer organisations.

Impact evaluation at the agricultural innovation system

The economic impact of agricultural innovation is commonly evaluated and an important number of impact assessment studies have been developed by Embrapa, state organisations and universities over the last three decades.

Since 1997, Embrapa has implemented a monitoring and evaluation system to evaluate the outcomes and impacts of the main technologies developed. More than 100 technologies and 200 cultivars are evaluated annually in terms of their economic, social and environmental impact. The impact assessment results are published in Social Reports issued in April of each year (available on the Embrapa website).

The Embrapa system is unique in the world and is based on the economic surplus approach to measure economic impacts and farmer surveys to evaluate social and environmental impacts. The results of these evaluations are used as feed-back for future R&D projects and since 1997 are also published annually as part of its Social Report (Embrapa, 2013).[9] Some state organisations are now doing similar social reports with the support of Embrapa. The estimation of economic surplus is the most traditional method used to evaluate the impact of agricultural research organisations (Alston et al., 1995). It is based on the estimation of the additional economic benefit generated by the adoption of technological innovations compared with the traditional technology adopted by the farmers.

There is no formal impact assessment system for the whole Brazilian agricultural innovation system. Embrapa Impact Assessment teams undertake farmer surveys using randomised samples and annual private surveys such as the adoption cultivars survey, conducted by the Kleffmann Group, covering the main grains produced in Brazil.

Investing in innovation

The public sector continues to be the main source of funding for agriculture R&D, whether performed by public or private organisations. A wide variety of funding mechanisms are used from direct spending on research projects, including for Public-Private Partnerships (PPPs) and "pull mechanisms," to various forms of tax incentives. Business investment in R&D is normally driven by market demand, but governments also provide different kinds of incentives. Some, like R&D tax rebates, apply to the economy in general, while others are agriculture specific. In many countries, producer organisations and other non-governmental organisations also provide R&D funding. Knowledge infrastructure is a public good that can enable innovation; it includes ICT infrastructure and general purpose technologies, as well as specific knowledge infrastructure such as databases and institutions.

Investment in public R&D

Priorities for public R&D

According to the Strategic Plan of Embrapa for 2008-2023, elaborated in 2007/08, the priority areas for the next ten years are the following: a) ensure competitiveness and sustainability for Brazilian agriculture; b) achieve a new competitive technological level in bioenergy and biofuels;[10] c) enhance the development of technologies for sustainable use biomes (e.g. savannah and Amazon) and integration of Brazilian regions to the market; d) exploring biodiversity for development of differentiated and high value-added products to explore new action market segments; and e) contribute to advancing the frontier of knowledge and incorporating emerging technologies.

The preliminary results of the prospective studies coordinated through the Agropensa indicated that the Brazilian R&D organisations must concentrate their efforts over the next decades in eight macro themes: a) natural resources and climate change; b) new sciences: biotechnology, nanotechnology and geo-technology; c) automation, precision agriculture and ICT; d) zoo and phytosanitary security in the value chain; e) production systems; f) agroindustry and biomass technology and green chemistry; g) food safety, nutrition and health; and h) markets, policies and rural development.

Public expenditures on agricultural R&D and trends

The Brazilian agricultural innovation system is basically supported by the public sector (federal and state governments) and which is responsible for more than 80% of resources allocated to agricultural R&D (Embrapa, state organisations and universities). The private sector's share of Brazilian agricultural R&D expenditures is estimated at around 10%. Table 7.1 presents the composition of the public expenditures in 2006 (Beintema, Avila and Fachini, 2010).

Basic research in Brazil is developed by universities or brought in from other countries, and applied research is developed by Embrapa, state organisations, private sector and non-profit agencies. The share of basic versus applied research is not available.

According to Beintema, Avila and Fachini (2010) the trend of public expenditures on agricultural research in Brazil for 1976-2009 is positive for Embrapa and stable for APTA (the São Paulo state agricultural research organisation) and the other state organisations. Growth rates in real public expenditure on agricultural R&D have, however, decreased the mid-1990s, and the mid-2000s (Figure 7.3).

Public expenditure relative to agricultural value-added (research intensity) in Brazil has also decreased between the mid-1990s, and the mid-2000s, but at 1.5% research intensity was much higher than in other South American or emerging economies, with the exception of South Africa, and not far away from that in Australia or the United States. Lower research intensity may also reflect the large increase in agricultural GDP over the period. Research intensity should be higher in

the early 2010s, as Embrapa has received significant additional funding following its low level of the early 2000s (Figure 7.4) and now accounts for 80% of public expenditure on agricultural R&D (Cerrao and Schmidt, 2014).[11]

Additional funding for Embrapa is spent on agricultural R&D, updating its infrastructure, hiring of new researchers and technicians, and the construction of four new research centres to improve its technological support in the Cerrado and pre-Amazon biomes, a new agricultural production region.

Table 7.1. Institutional composition of public R&D in Brazil, 2006

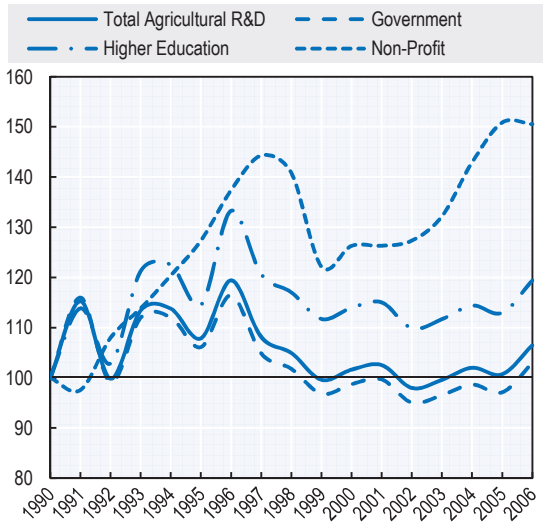
	Total spending			Total staffing	
	BRL	PPP USD	Share	Number	Share
	Million 2005 prices		%	FTEs	%
Embrapa (1)	1 013.2	746.8	57	2 215.0	41
APTA (7)	123.1	90.7	7	871.0	16
Other state governments (15)t	256.2	188.8	14	1 169.6	22
Other government and non-profit (6)	90.5	66.7	5	239.9	4
Higher education (estimated)	290.3	213.9	16	879.9	16
Total (estimated)	1 773.2	1 307.0	100	5 375.5	100

FTE: Full-Time Equivalent.

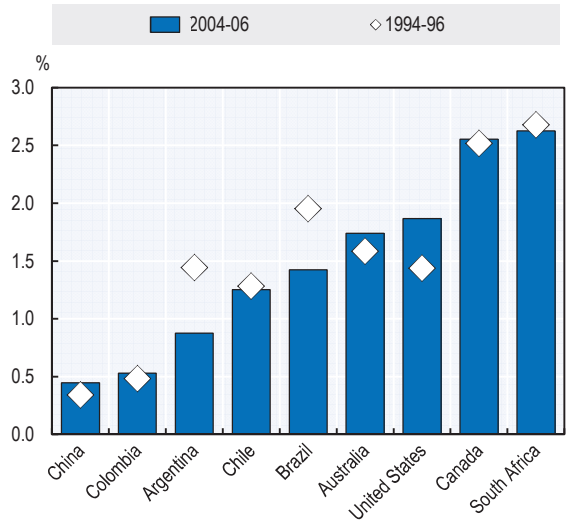
Source: Beintema, N., A.F.D. Avila and C. Fachini (2010), *Brasil – Inovações na Organização e Financiamento da Pesquisa Agropecuária Pública*, ASTI - IFPRI, Roma.

Figure 7.3. Government expenditures on agricultural R&D

A. Trends, 1990-2006
Index 1990=100, 2005 PPP



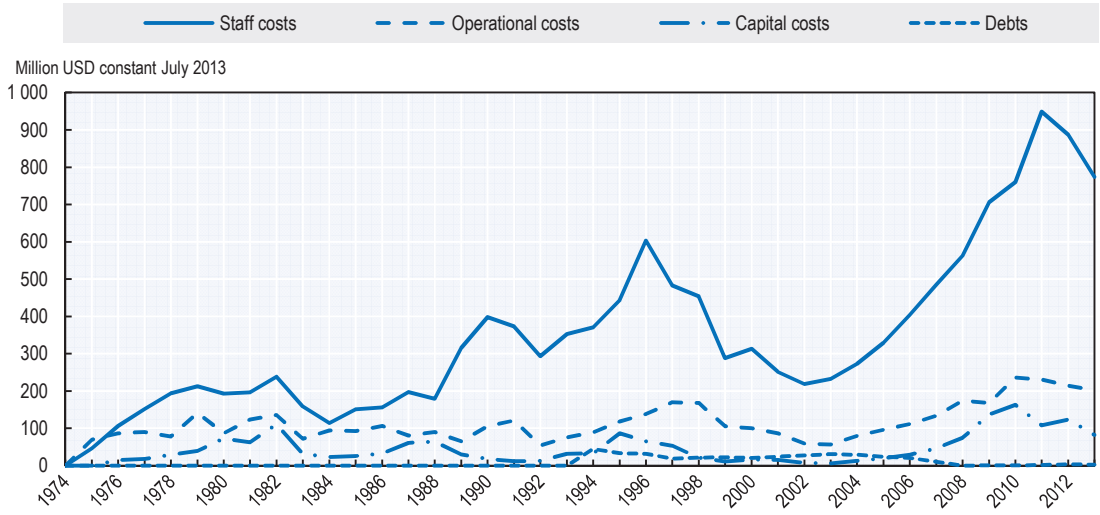
B. As a share of value-added, in selected countries, 1994-96 and 2004-06



Source: ASTI database (http://asti.cgiar.org/) for Brazil and other non-OECD countries; OECD Research and Development Statistics, 2014 (http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUBOECD or OECD.stat) for OECD countries.

StatLink http://dx.doi.org/10.1787/888933242709

Figure 7.4. Developments in Embrapa expenditure, 1974-2013



Source: Embrapa/DAF.

StatLink http://dx.doi.org/10.1787/888933242711

Public partnership with private R&D

The Brazilian legislation makes it difficult for public organisations to enter into relationships and contracts with the private sector. The main constraint is that public money needs to benefit society. Consequently, the result of research conducted with some public funding cannot be for the exclusive benefit of one company. As a result, the share of agricultural R&D projects funded by the public and private sectors together is probably below its potential (Contini and Andrade, 2014).

There are a few examples of R&D contracts involving public and private companies, like Monsanto, Basf, Abrazem, Dupont and Syngenta, who are carrying out research in biotechnology with Embrapa. There are also R&D contracts for seed production with non-profit organisations such as Unipasto and Sul Pasto, and with Foundations (Meridional, Triângulo, Cerrado, Bahia, and Goiás).

In 2012, Embrapa signed more than 300 contracts with the private sector, including agreement for technology transfer of material (in particular, seeds) and contracts for technical cooperation. The main seed contracts cover cotton, maize, soybeans, sorghum, wheat, and pastures.

According to Pray (2013), collaborative research between the public and private sectors is growing in Brazil, especially in the state of São Paulo, where FAPESP, the R&D state foundation is promoting the link between universities and private companies. One of the most successful R&D projects was in the area of biotechnology (sequencing of *xylella fastidiosa*, bacteria that causes citrus variegated chlorosis). The private-public R&D effort moved to sequencing bacteria causing citrus cankor and sequencing the sugarcane genome. Two other examples cited by Pray (2013) are: a) the collaborative research with the COOPERSUCAR Cooperative to develop virus-resistant sugar-cane varieties and identification of micro-satellite markers; and b) the Embrapa/Monsanto joint venture on transgenic soybeans.

Public incentives to investment in agricultural R&D and innovation

The majority of developed, developing and poor countries have instruments and provide incentives to finance scientific and technological development (Alston et al., 1998). In consideration of their condition and functional structures, these countries use mechanisms such as fiscal incentives, financing arrangements, investment plans, and specific legislation regulating partners' participation and preferential government purchases, available to those involved in the process.

The most important legal document with the objective to connect private and public research in Brazil is Law Nº10,973 (2004), which established appropriate measures to provide incentives for innovation in scientific and technological research in the production sector. It also addressed the achievement of qualifications and technological autonomy, and other activities directed at Brazilian industrial development. This law introduced new concepts, including stimulating and building a specialised and cooperative innovation environment, with minority participation by government institutions in the capital of the established corporations. It was also designed to provide incentives to build international networks for technological and research projects, as well as establish technological entrepreneurship and the creation of innovation areas, such as incubator companies and technological parks (Brunale, 2006).

The ***CT Agro*** (Science and technology Fund for the Agribusiness Sector) was created in 2001. It focuses on research in agronomy, veterinary, biotechnology, rural economics and sociology, and related areas. It also includes technological updates for the agroindustrial sector and invests in tropical biotechnology and technological transfers.

Recently the Brazilian government has set up new directives to support private R&D through loans with low interest rates and incentives to R&D by deducting federal and state tax. The organisations leading this process are *Financiadora de Estudos e Projetos* (FINEP) and *Banco Nacional de Desenvolvimento Econômico e Social* (BNDES). There are also state foundations, based on tax deductions at state level (1.5% on average), to support research projects in science and technology. These mechanisms are used in the agricultural sector, especially by universities and some of these research foundations finance R&D projects involving centres of excellence and private companies.

FINEP and BNDES support all the main steps of the scientific and technological development cycle, including basic research and improvement and development of products, services and processes. Support is available for private companies, scientific and technological institutions, ICTs and cooperation between companies.

In mid-2013, a new agricultural innovation programme supported directly by FINEP and BNDES was launched: ***Inova-Agro*** (technological innovation at agribusiness sector). It provides R&D funds to Brazilian companies to develop and strengthen input supply chains, machinery and equipment for agriculture and the development of food products and processes. Inova-Agro has become the main channel for BNDES to deliver R&D funds in the sector, and accounted for over 80% of a total of about USD 27 million). Over 80% of Inova-Agro funding is targeted to livestock, fisheries and aquaculture.

In the past, three large institutions in Brazil were supported by tax deductions on exports to carry out agricultural research on coffee, cocoa and sugar cane. Only coffee research is currently supported by tax deductions and Embrapa is managing a national consortium to use the coffee fund (FUNCAFE). This fund was created in 1986 based on a coffee export tax, replaced in 1989 by a tax based on government stock sales of coffee.

In the seed sector, the trend in private R&D is to focus on the main commodities grown in Brazil, such as soybeans, cotton and maize. However, the private sector will continue to work in partnership with public research for exchange of genetic material given the high relevance of the national germplasm bank, which is still a public institution.

The private sector will continue to dominate research on machineries and rural equipment as part of the modernisation and automation process of the Brazilian agribusiness. It will be also important in the development of agrochemical products, feed and vaccines. The Brazilian food processing sector and its technological development are dominated by large multinational companies such as Nestlé and Parmalat. However, new Brazilian companies are becoming very important on the international market, especially in the meat sector (BR Foods, Mafrig Group and JBS).

A large part of research and innovation in these areas will come from the headquarters of multinational companies, which are located abroad. In this regard, it should be highlighted that the national private sector in R&D is still weak when compared with the large multinational companies.

Knowledge infrastructure

Government support to institutions

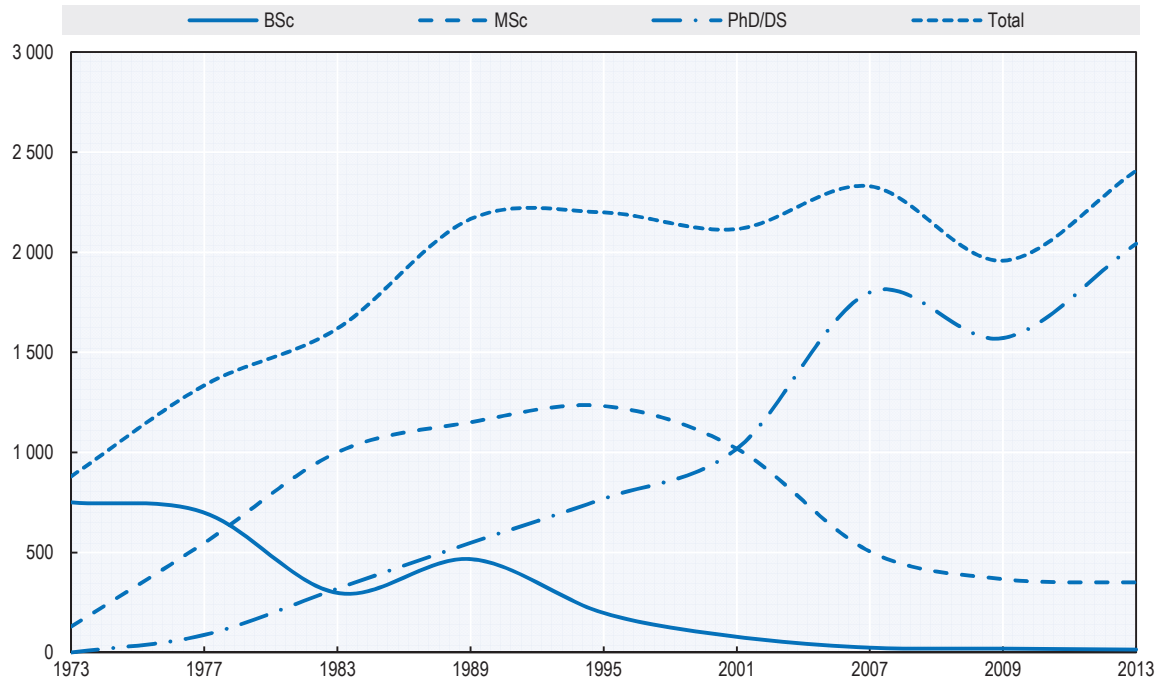
Embrapa has around 10 000 employees in 47 centres located in the main biomes, 2 430 researchers, and a budget of more than USD 1 billion (Figure 7.4).

At the state level, there are R&D organisations in 17 Brazilian states with 2 032 researchers, 239 experimental stations and a total budget of over USD 500 million. As Brazil has 27 states, the R&D needs in the other 10 states are covered by Embrapa.

In the academic sector, agricultural innovation is also well covered. In 2011, there were 830 graduate courses involving 153 400 students in agriculture and veterinarian sciences. In 2011, 19 500 students graduated.

According to the CNPq, the number of researchers in agrarian sciences in 2010 was 15 300, where 11 700 had a PhD degree. These numbers represent 12% of the total number of researchers in Brazil and 14% of doctors (Embrapa, 2014). Figure 7.5 shows the academic achievement of Embrapa researchers. When Embrapa was created in 1973, less than 10% of researchers held an MSc and/or a PhD, while in 2013 almost all had obtained this level of education. This is also observed in other Brazilian research organisations where the majority of the research staff holds an MSc and/or a PhD.

Figure 7.5. Academic qualification of Embrapa researchers, 1973/2013



Source: Embrapa-DGP.

StatLink http://dx.doi.org/10.1787/888933242722

Sharing of infrastructure

Embrapa is creating multiuser laboratories which share the existing infrastructure in its research centres to optimise the use of its laboratories. It is also negotiating with some Brazilian universities the establishment of R&D units where researchers of both institutions work together in strategic areas (Embrapa and University of Campinas, São Paulo state).

At the end of the 1990s, Embrapa developed strategic research overseas in partnership with international centres of excellence, named LABEX. Embrapa currently shares laboratories with agricultural R&D organisations in the United States, France, Germany, England, South Korea and China.

Embrapa also shares its infrastructure locally to develop research projects with international partners and to train foreign researchers, especially from Africa and South America (Embrapa, 2012).

Policy access to knowledge and databanks

Access to knowledge is open in public R&D organisations involved in agricultural research. All results generated by Embrapa, state organisations, and universities are publicly available but the users cannot commercialise it. Where products are patented (e.g. equipment) or protected (e.g. cultivars), commercial production requires a contract.

In general, all results generated by public R&D organisations are available on their websites or can be obtained through publications and other media (e.g. CD/DVD). In Brazil, it is also possible to obtain information about R&D results and related information on the website of the Ministries of Science and Technology or other ministry or state secretary where the R&D organisation is linked.

Embrapa has a strong agricultural research network involving a diverse set of international organisations, such as those linked to the CGIAR Consortium (CIAT, IRRI, IFPRI, etc.) or members of regional cooperation programmes on agricultural research (PROCISUR, PROCITROPICOS, etc.) that allow an intense sharing of knowledge. This is also the case for Brazilian universities and to a lesser degree for state organisations.

Fostering knowledge flows: The role of networks and markets

Intellectual property rights (IPRs), knowledge networks, and knowledge markets are of growing importance in fostering innovation, which increasingly requires collaboration and exchanges.

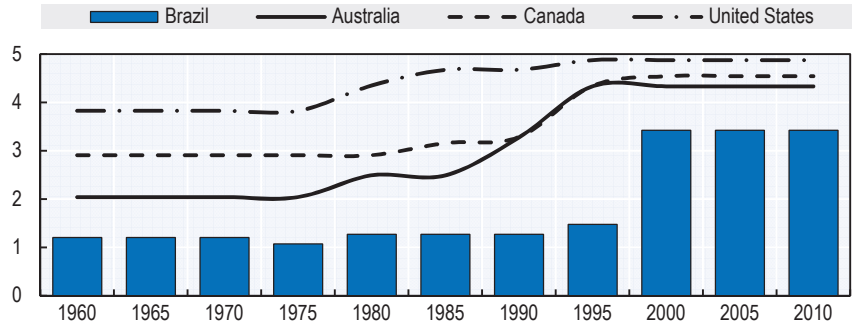
Intellectual property

All Brazilian agricultural R&D organisations must follow the IPR and patents rules established by the Government. These rules are established for each organisation according to its own needs. The sharing of results protected by these rules is implemented by contracts. The public organisations adopt these rules to register and commercialise their results.

The private sector uses the IPR and patents rules. Cultivars are protected by the Ministry of Agriculture, Livestock and Food Supply following the standards of International Convention for the Protection of New Varieties of Plants (UPOV)-78 rules. The patents are registered at the National Institute for Intellectual Property (INPI). This system was reformulated in 1996 creating the Industrial Property Law (Law No. 9.456/1996) which regulates the rights and obligations related to industrial property in Brazil. This law has satisfied the new requirements of the WTO's TRIPS agreement (Trade Related Aspects to Intellectual Property Rights), leaving open the patenting of plants but allowing the patenting of microorganisms, genes and processes, complementing the Biosafety Law.

Figure 7.6. Intellectual Property Protection

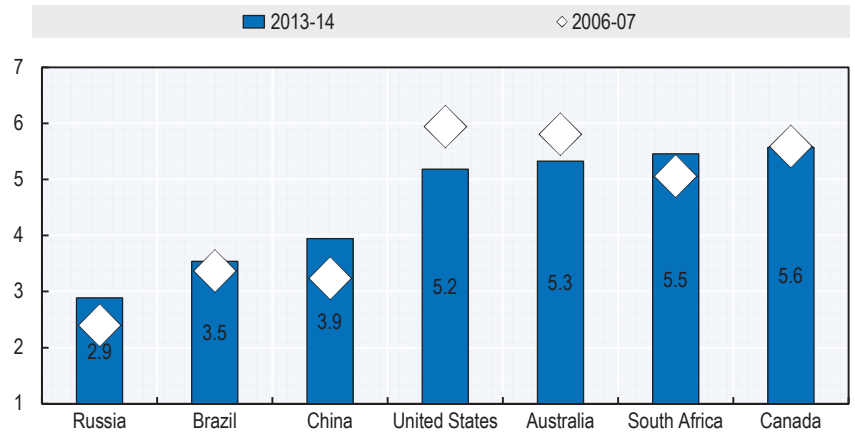
A. Patent Protection Index, 1960-2010
Score 1-5 (best)



Sum of indices for duration, enforcement, loss of rights, membership and coverage.

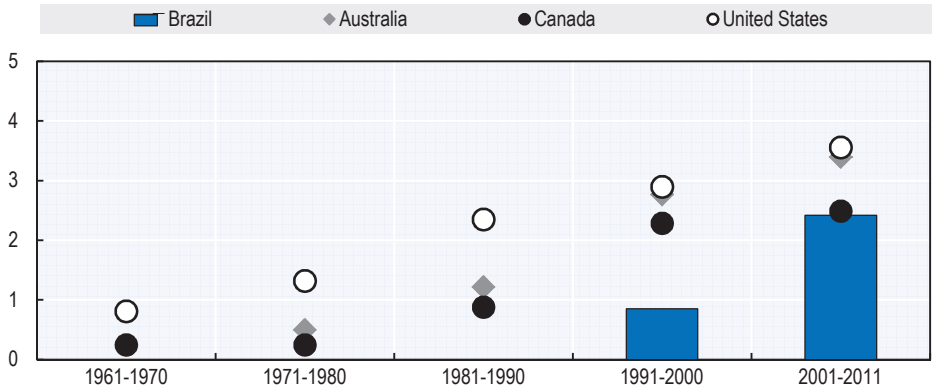
Source: Unpublished update to the series from Park, W.G. (2008), "International Patent Protection: 1960-2005", http://www.sciencedirect.com/science/journal/00487333/37.

B. WEF Intellectual Property Protection Index
Score 1-7 (best)



Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

C. Plant Variety Protection Index
Score 1-5 (best)



Source: Campi, Mercedes; Nuvolari, Alessandro (2013), Intellectual property protection in plan varieties: A new worldwide index (1961-2011), http://hdl.handle.net/10419/89567.

StatLink http://dx.doi.org/10.1787/888933242732

According to the Biotech Information Centre (CIB, 2014), the Brazilian regulatory process is acknowledged internationally as one of the strictest and most complete in the world. The country has had biosafety legislation in place since 1995 focused on genetic manipulation but with strong influence in the vegetal area (Vieira and Buainain, 2011).

The Government in 1997 approved the Cultivars Protection Law creating mechanisms and incentives to the private sector to develop new cultivars. In the past, this activity was almost exclusively developed by the public organisations. Vieira and Buainain (2011) have recently analysed the effects of this law at the private sector level and concluded that it has allowed a strong expansion of the private companies in the developing of new varieties and seed production, giving the possibility to appropriate economic gains in this area.

In 2005, the Biosafety Law was replaced by a new normative rule, which established the terms of regulation of all types of handling and use of genetically modified organisms (GMOs) in Brazil, including research in containment, field trials, transportation, importation, production, storage and marketing. The new Biosafety Law No. 11.105/05 currently regulates the use of biotechnology. It establishes a number of control mechanisms ranging from product development to market monitoring. This includes: the requirement that all research institutions must have an Internal Biosafety Commission (CIBio) responsible for ensuring the safe handling of GMOs; the need for prior authorisation and registration of facilities and skilled professionals for research activities, by means of the Biosafety Quality Certificate (CQB) issued by CTNBio; and a case-by-case examination of applications for commercial release.

The National Institute for Intellectual Property (INPI) is another agency playing an important role in agricultural innovation in Brazil being responsible for the registration and protection of the results submitted to any IP provision. The sharing of these results with other countries or institutions needs to be protected by the INPI and is implemented through agreement or contracts, on a case by case basis.

According to the World Economic Forum's index of Intellectual Property Protection, intellectual property is less protected in Brazil than in OECD countries such as Australia, Canada and the United States, and in emerging economies like China and South Africa (Figure 7.6). Patent protection has been strengthened since 2000, but remains below that of Australia, Canada and the United States. Plant variety protection increased with the signature of the UPOV-78 in 1999, but Brazil, like Canada, did not sign the 1991 convention, plant variety protection remains lower in these two countries.

In the agricultural sector, the Brazilian government pursued an open innovation system and IPR policy, which facilitated technology transfer, diffusion of new cultivars and the filing of international patents. This policy allowed new technology to be distributed at production costs only (Correa and Schmidt, 2014). Nowadays, Embrapa diversifies its IPR strategy by project to facilitate collaboration with other research institutes and the private sector.

Facilitating knowledge flows and linkages

Reinforcing linkages across participants in the agricultural innovation system (researchers, educators, extension services, farmers, industry, NGOs, consumers and others) can help match the supply of research to demand, facilitate technology transfer, and increase the impact of public and private investments. Partnerships can also facilitate multi-disciplinary approaches that can generate innovative solutions to some problems.

In addition to agricultural education discussed in Section 5.3 and investment support discussed in Section 5.1, extension is an important channel to bring agricultural innovation to the farm.

Private companies are fundamental actors in the provision of technical assistance and rural extension. National and multinationals linked to the agricultural input sector (fertilisers, seeds,

agrochemicals, machines, equipment and marketing) provide technical assistance to medium and large farm operators.

An important player in the support of Brazilian farmers is the agricultural cooperatives, mainly in the south and southeast of the country. There are 1 561 agricultural cooperatives with more than one million members, responsible for 48% of the Brazilian production. In these cooperatives there are 164 000 employees, at least 10% of them dedicated to providing free technical assistance to the associate farmers.

In view of the recent boom of Brazilian agriculture and growing volume of agricultural exports, private rural extension is taking a significant role. This service is paid for by farmers using various mechanisms (permanent job, consultancy, and percentage of the production).

The public extension service is aimed at family producers and those without the means to pay for technical assistance. Public extension is provided by specialised state agencies (EMATERs) which exist in all 27 Brazilian states. This service is under the Secretary of Agriculture in each state, which also coordinates the agricultural research organisation. This ensures the necessary link between research and technical assistance.

Technical support to state rural organisations is reinforced by the Federal Government through the Ministries of Agriculture and Agrarian Development. At the agricultural research level, Embrapa plays an important role in this process lead by the Executive Director of Technology Transfer and its research and services units spread throughout the country.

Producers accessing those services also receive government credit subsidies, which include funding for technical assistance, corresponding to 2% of the loan, and up to 4% in the new Inovagro programme, which aims to support the adoption of technological innovations and good agricultural and farm management practices.

The quality and coverage of public extension service has been criticised, in spite of the good spatial distribution and links with the federal and state agricultural research organisations. This service does not have the capacity to respond to a growing demand for advice covering a wider range of issues (e.g. agroecology). This weakness was highlighted by Alves et al. (2013) in their analysis of the contribution of agricultural research to the development of the agricultural sector in Brazil that shows that more than half of the 5.2 million farmers are poor. The authors strongly recommended the improvement of rural extension services for these farmers.

Following the recommendation of this report, the Brazilian government created the National Agency for Technical Assistance and Rural Extension (ANATER) in 2013. The legislation relative to this agency is currently being developed. The plan is to increase financial resources and provide subsidies to poor farmers, giving them access to private extension services according to their needs. This is expected to stimulate the provision of services, e.g. from consultants or universities, improve the integration of the diverse providers. This should strengthen the capacity of the system, and increase access of poor farmers to extension services. The aim is to increase the productivity and environmental sustainability of those farms and improve their access to markets.

International cooperation on agricultural innovation

International co-operation on agricultural research and development offers universal benefits. While this is generally true given the public good nature of many innovations in agriculture, it is particularly the case where global challenges are being confronted (as in the case of responding to climate change) and when initial investments are exceptionally high. The benefits of international co-operation for national systems stem from the specialisation it allows and from international spill-overs. In countries with limited research capacity, scarce resources could then focus on better taking into account local specificities.

Encouragement of international collaboration

Traditionally, Brazil collaborates widely in agricultural R&D with countries located in tropical areas, mainly Latin America, the Caribbean and Africa. Embrapa is a member of PROCISUR (Regional Collaboration Program for the Southern Cone of Latin America), PROCITROPICOS (Regional Collaboration Program for the Latin America Tropics), and has bilateral programmes with the majority of Latin American countries (Argentina, Chile, Colombia, Uruguay, etc.).

More recently Embrapa established offices in Venezuela and Panama to strengthen the relationship in agricultural research, especially in tropical agriculture. Offices were also created in Ghana, Mozambique, Senegal and Mali to support the Brazilian collaboration in agricultural research in Africa.

In 2011, Embrapa had 78 bilateral agreements with 89 institutions in 56 countries. It had multilateral agreements with 20 international organisations (Lopes, 2011).

To encourage international collaboration, Labex (Virtual Laboratories Program) was created to promote opportunities for institutional cooperation in agricultural research and to monitor scientific advances, trends, and activities of interest to agribusiness in partner countries. Embrapa selects and sends senior researchers to develop strategic research for Brazil in partnership with R&D centres of excellence in agricultural research.

Embrapa opened virtual laboratories in the United States, Europe (France, England, the Netherlands and Germany), South Korea, China and Japan. The first one was installed in April 1998, with a technical agreement between Embrapa and USDA–ARS (the Agricultural Research Service of the United States Department of Agriculture). The positive results stimulated Embrapa to initiate a similar programme in Europe. In January 2002, through an agreement with Agropolis International, a second laboratory was opened in Montpellier, France. Through the cooperation with Agropolis, more than 200 research centres, as well as all partners in the Languedoc-Roussillon region of France, and other institutions and companies in other parts of Europe, have been involved in research projects of Brazilian interest (Agropolis, 2012).

According to Brunale (2006), since the concept of the virtual laboratory was established, in which the host country's operational and laboratory facilities were made available to foreign partner scientists, Labex has had the potential to be a powerful mechanism for the development and enhancement of international cooperation among developing and developed countries. It is also a way to promote potential international agricultural research networks.

Policies for exchange of staff

Since the 1970s, Embrapa and other Brazilian R&D institutions have been sending people abroad to exchange experience and training. In the beginning this was more concentrated in MSc and PhD training but is now more oriented to post-doctoral and sabbatical license, given the high degree of academic training of Brazilian researchers (more than 80% with PhDs).

Table 7.2 shows the number of agricultural research staff trained abroad from 1973 to 2013 involving Embrapa and state organisations (Oepas). A total of 1 479 researchers were trained in the main universities around the world.

Another recent strategy is to receive people from other countries for training in Brazil. There is a strong interest in tropical agricultural given the Brazilian competitive advantage in the area.

Table 7.2. Brazilian agricultural research staff trained abroad, 1973-2013

	Embrapa	Oepas	Total
MSc	262	135	397
PhD	576	133	709
Post-Doctoral	373		373
Total	**1 211**	**268**	**1 479**

Source: Embrapa – DGP 2014.

Barriers to the international flow of knowledge

In general, there is strong communication and interaction among researchers today and there is a large international flow of knowledge in agricultural R&D involving public and private actors. This flow is complex in certain areas and regions of the world given the barriers established for diverse reasons.

In the 21st century, knowledge accumulation and application will drive development processes and create unprecedented opportunities for growth and poverty reduction (Asenso-Okyere and Davis, 2009). Knowledge must therefore be created, accumulated, and managed if it is to be useful for innovation. In an era of globalisation and rapid change, decision-makers should promote innovation in organisations, institutions, and policies to bring about outcomes where knowledge can be taken up, adapted, and implemented to promote development.

Given these barriers some initiatives have been created to facilitate this flow. The CIARD (Coherence in Information for Agricultural Research for Development), for example, is one of them.[12] This is a global movement working to make agricultural research information publicly available and more accessible. The CIARD partners coordinate their efforts, promote common formats for information sharing and exchange, and adopt open information systems approaches. Creating a global network of truly accessible outputs of research and innovation greatly increases the chance they can be put to use locally, nationally and globally.

The impact of public knowledge and research on agricultural and rural development and natural resources management is limited because most of these outputs are not easily or widely accessible. But this does not have to be the case – partly because new information and communication technologies provide many opportunities for information to be handled and presented differently and more cheaply. The CIARD mission includes building and improving information systems, empowering the institutions and people using them with a framework and a set of tools that open access to their content resources.

In Brazil, there is currently a large effort to facilitate the flow of knowledge developed by public organisations at the national level. The Government is promoting policies to encourage the public institutions to open access to the information generated by them. However, this policy is domestic with little effect on the international flow of knowledge.

The international openness of Brazilian organisations working in agricultural R&D has been limited in the past. In this regard is important to highlight the release in the last decades of Government policies that stimulate cooperation between Brazilian R&D institutions and international partners. Federal institutions, Embrapa, and universities are directly involved in this national policy. The opening of Embrapa to the international area was influenced by these policies as well by the expansion of its technical cooperation with Africa and Latin America.

Recent efforts need to continue. Brazilian R&D institutions are still publishing the large majority of its scientific production in Portuguese journals. This is the main barrier to the international flow of agricultural knowledge generated, especially in tropical agriculture.

International and regional networks

In agricultural research, Brazil is participating in the GFAR and has a close relationship with the international agricultural research centres linked to the CGIAR Consortium.

Embrapa has a large number of technical cooperation projects (TCP) in partnership with international organisations on agricultural R&D. In order to operate each one of these projects, Embrapa, has in operation more than 100 international agreements. Figure 7.7 shows the TCP in progress in Africa, Latin America and the Caribbean, and Asia in 2013.

Figure 7.7. Technical cooperation projects of Embrapa with others countries, 2013

Country	Projects	
	Africa	
	Execution	**Negotiation**
Burkina Faso	1	
Cap Verde	1	
Congo		1
Ghana	1	
Guine-Bissau	1	
Ivory Coast		1
Nigeria	2	
Tanzania	3	
Togo	1	
Tunisia		1
Total	10	
Central America and Caribbean		
Belize	4	
Costa Rica	1	
El Salvador	2	
Guatamala	1	
Honduras	1	
Jamaica	1	
Nicaragua	1	
Panama	8	
Cuba	6	
Haiti	1	5
Total	26	5

Country	Projects	
	South America	
	Execution	**Negotiation**
Argentina	1	
Bolivia	2	
Chile		1
Colombia	2	1
Ecuador	3	
Guyana		1
Paraguay	2	
Peru	4	2
Suriname		1
Venezuela	3	
Total	17	7
Asia		
Afghanistan	1	
East Timor	1	
Total	2	

Source: Embrapa – SRI. 2013.

StatLink http://dx.doi.org/10.1787/888933242811

Embrapa is a founding and central member of the agricultural innovation ***MKTPlace***,[13] an international initiative supported by different partners aiming to link Brazilian, African and Latin American and Caribbean (LAC) experts and institutions to develop cooperative research projects for development and support policy dialogue. It aims to finance collaborative projects in: 1) Productivity Enhancing Technologies; 2) Natural resource management improvement; 3) Policy, institutional and market strengthening and knowledge management; and 4) Smallholder and poverty-alleviation targeted technologies.

Mechanisms to encourage cooperation at national level

In the agricultural research system there is a close relationship with Embrapa who coordinates the National System on Agricultural Research (SNPA) involving all the state organisations. At the state organisations level, the Consepa, the National Council of the State Organizations is responsible for encouraging co-operation among these institutions and with other agricultural R&D institutions.

Universities also play an important role in linking research and education. At this level, the Brazilian Association of Agricultural Higher Education (ABEAS) coordinates the projects in agrarian sciences and training.

Nevertheless, participation of foreign staff in the national R&D system is insignificant. This situation intensified due to restrictions placed on public institutions in hiring foreign personnel. Furthermore, Brazilian researchers working abroad are in the majority involved in training programmes and not in research.

Overall outputs of agricultural innovation system

The performance of Brazilian agribusiness is closely related to the strength of the agricultural innovation system. According to Barros (2012), significant contributions of the Brazilian agricultural innovation system include higher production, lower prices, and large volumes of foreign currency earnings for the country.

Cultivars protected in Brazil

Table 7.3 shows the total number of cultivars protected by the National Service of Cultivars Protection (SNPC) from 1998 to 2012. Embrapa protected, on average, 24% of the 1 708 cultivars included in the Brazilian SNPC in the period.

The private sector's participation in the National Service of Cultivars over the1998-2012 period is important for soybeans, maize, sugar-cane and cotton. According to Vieira-Filho and Vieira (2013), around 60% of cultivars for soybeans, sugar cane and cotton come from the private sector. The Embrapa royalties received during the 2009-12 period were around BRL 10 million. The annual amount received from cultivars royalties is around USD 5 million, which is very small when compared with the Embrapa total budget, currently around USD 1 billion.

In spite of its modest revenue Embrapa is an important participant in the seed market. Table 7.4 shows the adoption of Embrapa cultivars at farm level according to the national survey conducted by the Kleffmann Group and published in the 2012 Social Report (Embrapa, 2013).

Table 7.3. Total of cultivars protected at SNPC, 1998-2012

Products	1998	2001	2004	2007	2010	2012
Soybeans	39	94	179	302	442	539
Sugar cane	6	32	51	71	90	110
Maize	0	17	28	32	49	51
Coffee	0	0	0	6	7	8
Cotton	1	11	30	48	56	60
Others	5	55	169	352	673	940
Total	**51**	**209**	**457**	**811**	**1 317**	**1 708**

Source: Vieira-Filho and Vieira (2013).

Table 7.4. Adoption of Embrapa cultivars in 2011/12 in the main Brazilian products

Products	Cultivated area 2011/12 (1 000 ha)	Adoption Embrapa cultivars (%)
Rice		
Upland	1 374	49
Irrigated	1 053	0.4
Cotton	1 393	0.2
Soybeans	25 042	6
Maize		
1st season	7 559	0.4
2nd season	7 62	2
Beans	3 262	42
Sorghum	787	14
Wheat	2 166	13

Source: Embrapa (2013).

Scientific outputs and patents

In the last 40 years, Brazilian scientific production increased considerably (Figure 7.8). This development has been particularly fast for publication in agrarian sciences, which accounted for 47% of all scientific publications from Brazilian authors in 2013 compared to 38% in 1976. Between 1996 and 2012, the percentage of publications from Brazilian authors in agricultural sciences in the world's total increased from 1.5% to over 5% (Figure 7.9). Since the mid-2000s, it more than doubled, and Brazil is now the fourth contributor behind the United States, China, and the United Kingdom (Figure 7.A1.3). By comparison, scientific production in all areas accounts for less than 2.5% of the world's total publications (Sales Filho, 2012).

During the last 20 years, Embrapa's contribution to the Brazilian scientific production in agrarian sciences has been relatively constant around 4-5%.

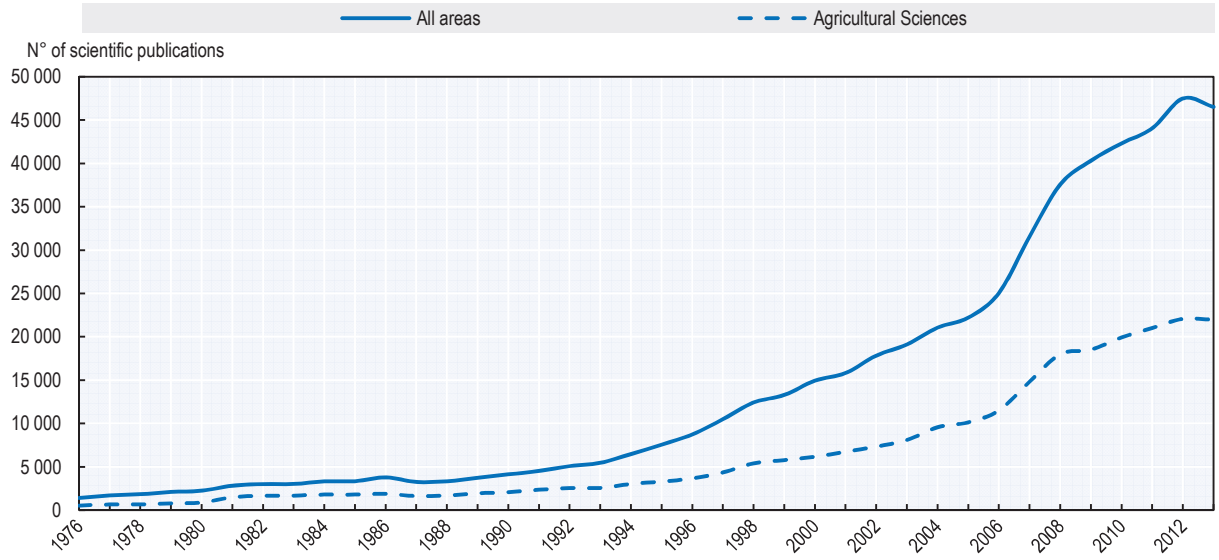
The Brazilian participation in the total of patents filed at USPTO grew from 0.05% to 0.095% during the 1998-2011 period, but is still very small (Salles-Filho, 2012). The share of Brazilian patents in the agricultural area as a percentage of world's total filed under the Patent Cooperation Treaty is slightly higher at 0.2%, but still lower than the BRIICS average, and less than a third of the OECD average (Figure 7.A1.1).

The total number of patents registered by Embrapa during its 40 years at the National Institute for Intellectual Property (INPI) is 380, around 10% of which are actually licensed.

Compared to other countries, Brazil's R&D outcome is highly specialised in agriculture. About 20% of academic publications by Brazilian authors and 11% of patents are in agriculture-related areas (Table 7.5). The specialisation in agricultural publications is the highest of all the OECD and emerging economies reported in Figure 7.A1.3. This specialisation reflects the importance of this sector in the economy and in particular its contribution to exports (Table 1.2).

International cooperation, as measured as the share of patents or publications with foreign co-authorship is relatively high for patents, but low for publications (Table 7.6, Figures 7.A1.2 and 7.A1.5). This may reflect a language issue or the specialisation of Brazilian research.

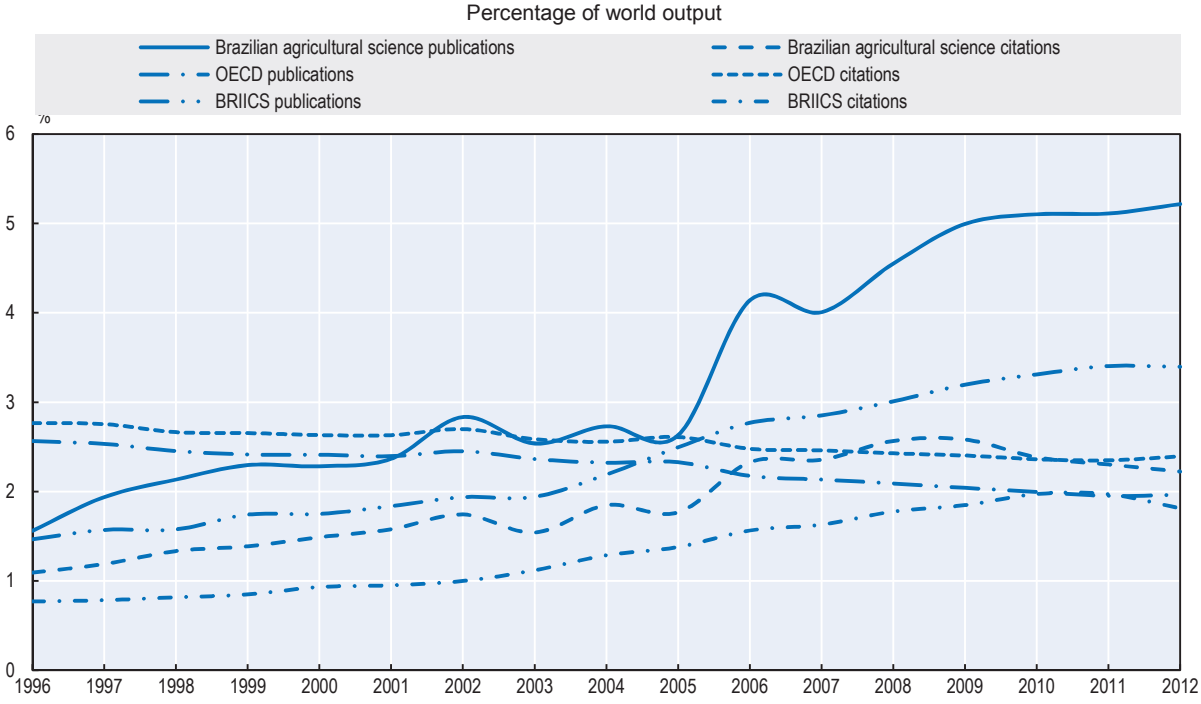
Figure 7.8. Brazilian scientific production in total and agrarian sciences, 1976-2013



Source: Web of Science 2014 (http://thomsonreuters.com/thomson-reuters-web-of-science/).

StatLink http://dx.doi.org/10.1787/888933242748

Figure 7.9. Evolution of scientific output and impact in agricultural sciences, 1996-2012



Agricultural science include Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behavior systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

Source: SCImago. (2007), SJR — SCImago Journal and Country Rank, http://www.scimagojr.com.

StatLink http://dx.doi.org/10.1787/888933242758

Table 7.5. R&D outcomes, 2006-11

	Australia	Brazil	Canada	United States	OECD average	OECD total
Agri-food specialisation: Agri-food as a share of the country's total (%)						
Patents	7.4	11.0	6.0	6.8	5.6	
Publications	10.6	19.4	8.7	6.7	9.4	
Citations	10.8	15.5	8.3	6.3	11.9	
Country's contribution to world agri-food output (%)						
Patents	0.5	0.2	0.6	10.8	0.7	27.9
Publications	3.3	4.7	3.7	18.3	2.0	68.9
Citations	2.9	1.2	4.1	27.2	..	48.4

Source: OECD Patent Database, January 2014; SCImago. (2007), SJR — SCImago Journal & Country Rank. http://www.scimagojr.com.

Table 7.6. R&D co-operation, 2006-11

Agri-food outputs with co-authors as a share of total agri-food outputs (%)

	Australia	Brazil	Canada	United States	OECD average
Patents	23.1	29.7	29.7	14.3	11.8
Publications	47.3	22.3	48.9	36.4	50.8

Source: OECD Patent Database, January 2014; SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved 19 March 2014, from http://www.scimagojr.com.

Notes

1. This chapter is based on a report prepared for the OECD by two Embrapa researchers, Elisio Contini and Antonio Flavio Dias Avila.
2. This strategy is available at: http://www.mct.gov.br/upd_blob/0218/218981.pdf.
3. For example, a Canada-Brazil Framework Agreement for Cooperation in Science, Technology and Innovation was signed in São Paulo, in November 2008 and ratified in Spring 2010 http://www.oceansadvance.net/sites/default/files/Brazil%20workshop%20de-brief%20May%202012.pdf.
4. For more information on the establishment and development of Embrapa, see J.G. Martha, E. Contini and E. Alves (2012), "Embrapa: its origins and change", in Baer, W. (Ed.), *The Regional impact of national policies: The case of Brazil*, Edgar Elgar, Northampton, pp. 204-226.
5. The list of Embrapa Centres and their specific websites are available at: http://www.embrapa.br/english/embrapa/unidades_de_pesquisa/.
6. See CTC website: http://www.ctcanavieira.com.br/.
7. Another linkage between the agricultural and general innovation systems is that Embrapa is part of the FNDCT.
8. See Embrapa website at: http://www.embrapa.br/english.
9. *Embrapa – Balanço Social 2012. Embrapa Secretaria de Gestão Estratégica*, Secretaria de Comunicação. Brasília 2013.

10. In 2006, the Ministry of Agriculture, Livestock and Supply (MAPA), launched the National Plan of Agroenergy, which established the requirements for public and private actions to generate knowledge and technologies that contribute to the sustainable production of energy and agriculture for the rational use of this renewable energy. To meet the guidelines set forth in that Plan, Embrapa created the National Center for Research on Agroenergy (CNPAE).
11. In the ASTI database, data series of expenditure on agricultural R&D and number of staff stop in 2006 for Brazil. They are currently being updated and estimates up to 2013 will be available in 2015 at: http://asti.cgiar.org/.
12. CIARD (Movement Coherence in Information for Agricultural Research for Development). http://www.ciard.net/. Accessed on 3 March 2014.
13. MKTPlace: http://www.mktplace.org/site/.

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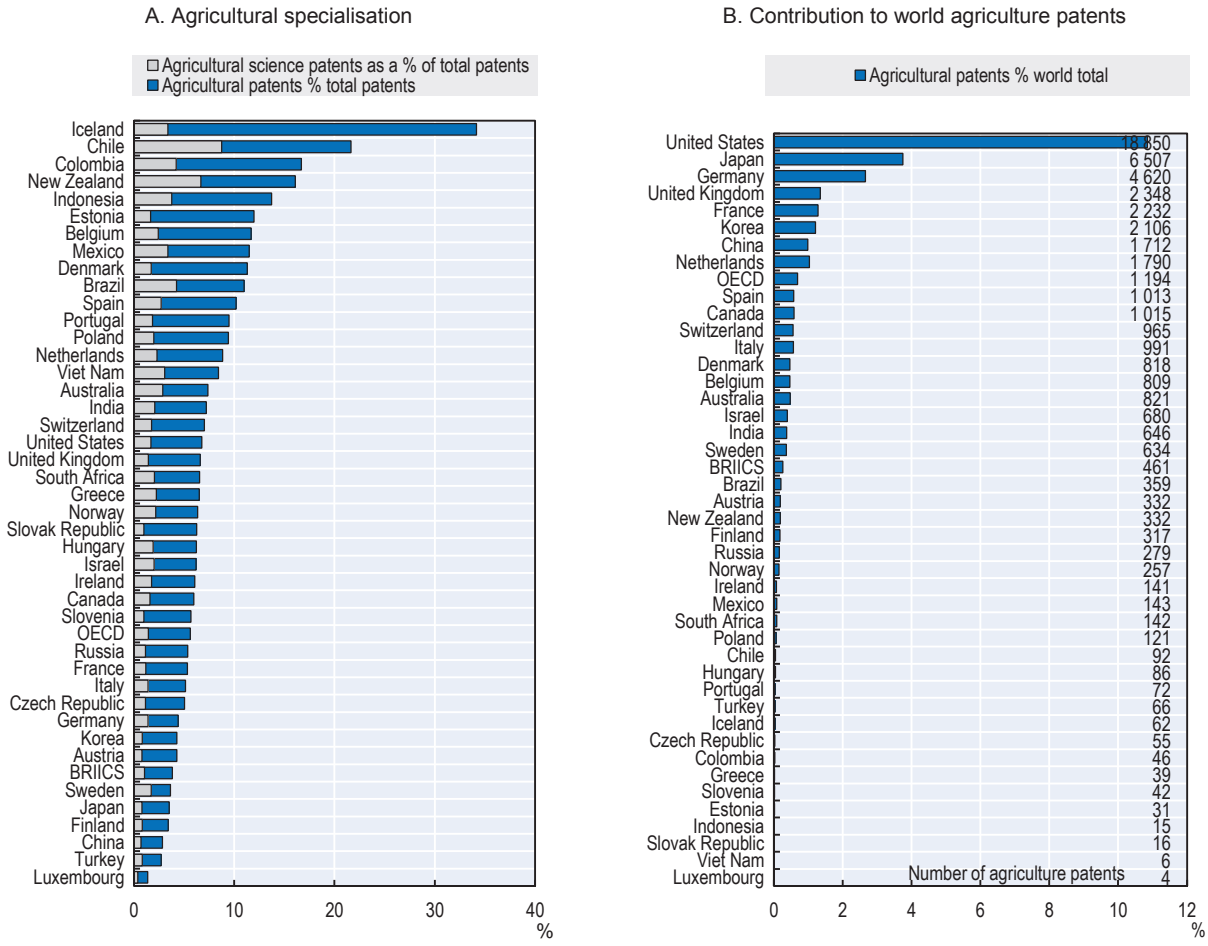
Annex 7.A1

Background indicators of R&D outcomes

Figure 7.A1.1. Agriculture patents applications filed under the Patent Co-operation Treaty (PCT), 2006-11



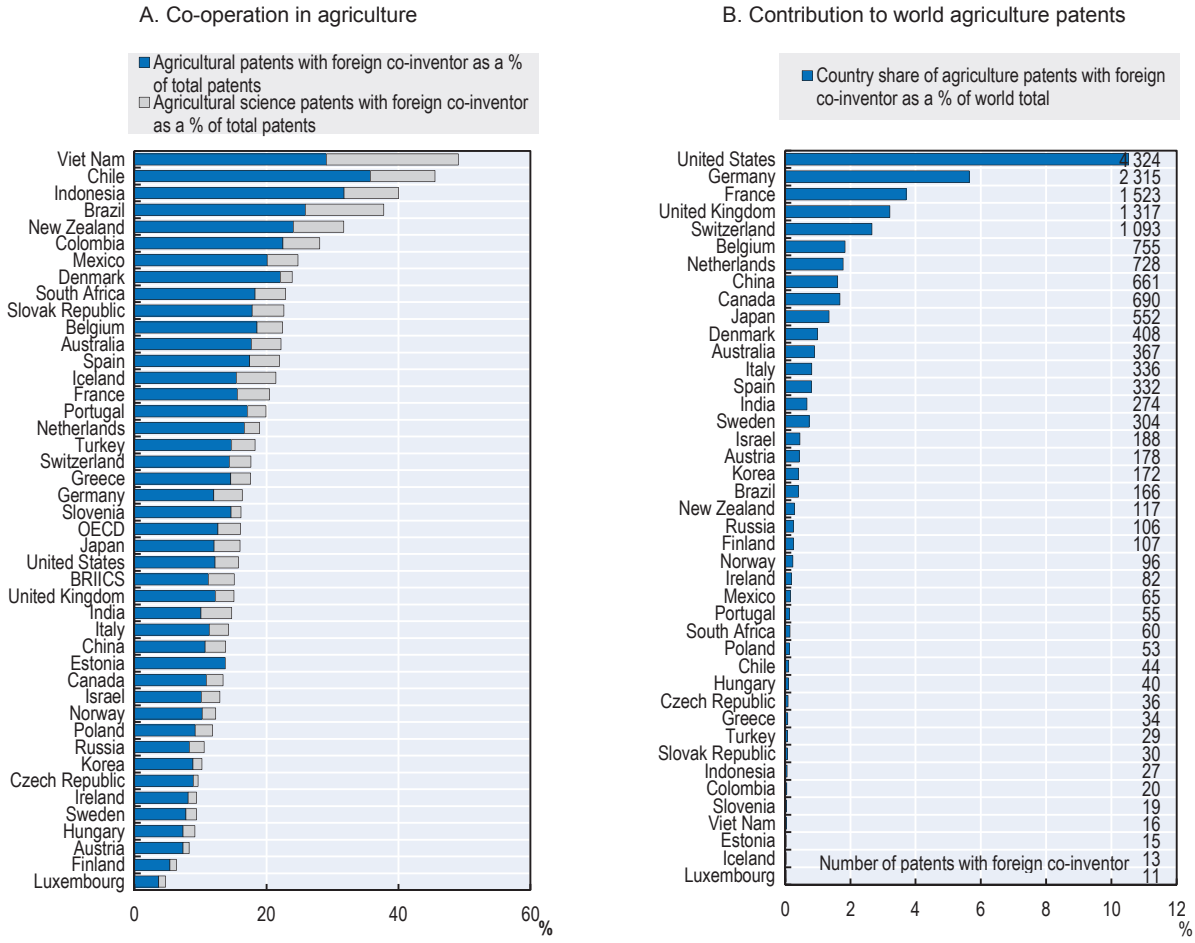
Agriculture includes patents from IPC classes A01, A21, A22, A23, A24, B21H 7/00, B21K 19/00, B62C, B65B 25/02, B66C 23/44, C08b, C11, C12, C13, C09K 101/00, A02B 11/00, A04H 5/08, A04H 7/22, G06Q 50/02.

Patent counts are based on the priority date (first filing of the patent worldwide), the inventors country of residence, using fractional counts.

Source: OACD Patent Database, January 2014.

StatLink http://dx.doi.org/10.1787/888933242766

Figure 7.A1.2. Agriculture patents with a foreign co-inventor filed under the Patent Co-operation Treaty (PCT), 2006-11



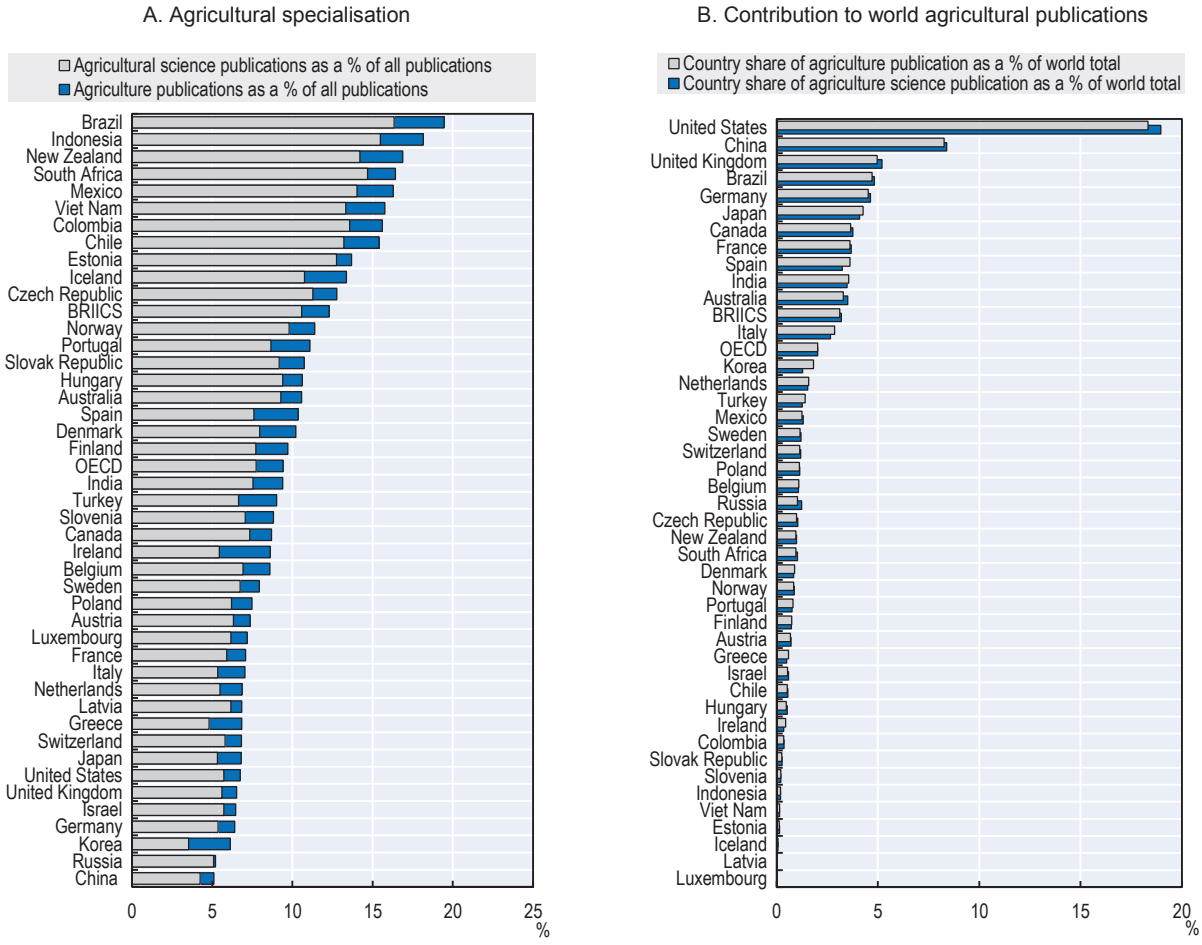
Agriculture includes patents from IPC classes A01, A21, A22, A23, A24, B21H 7/00, B21K 19/00, B62C, B65B 25/02, B66C 23/44, C08b, C11, C12, C13, C09K 101/00, A02B 11/00, A04H 5/08, A04H 7/22, G06Q 50/02.

Patent counts are based on the priority date (first filing of the patent worldwide), the inventors country of residence, using fractional counts. AU28 and BRIICS totals exclude intra-zone co-operations.

Source: OACD Patent Database, January 2014.

StatLink http://dx.doi.org/10.1787/888933242777

Figure 7.A1.3. Agriculture publications, 2007-12



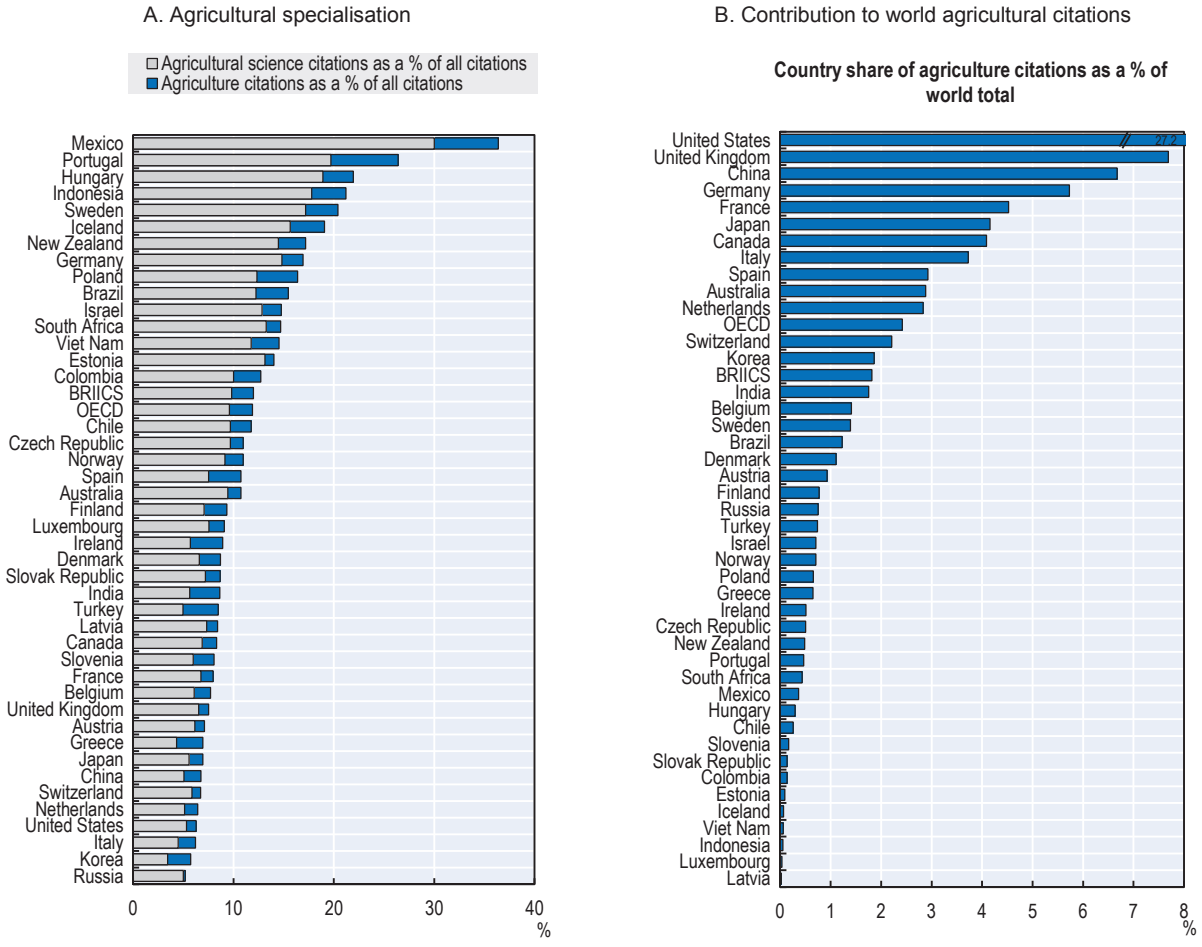
Agricultural sciences include Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behaviour systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

Agriculture publications include food sciences.

Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved March 2014, from http://www.scimagojr.com.

StatLink http://dx.doi.org/10.1787/888933242782

Figure 7.A1.4. Agriculture citations, 2007-12



Agricultural sciences include Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behaviour systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

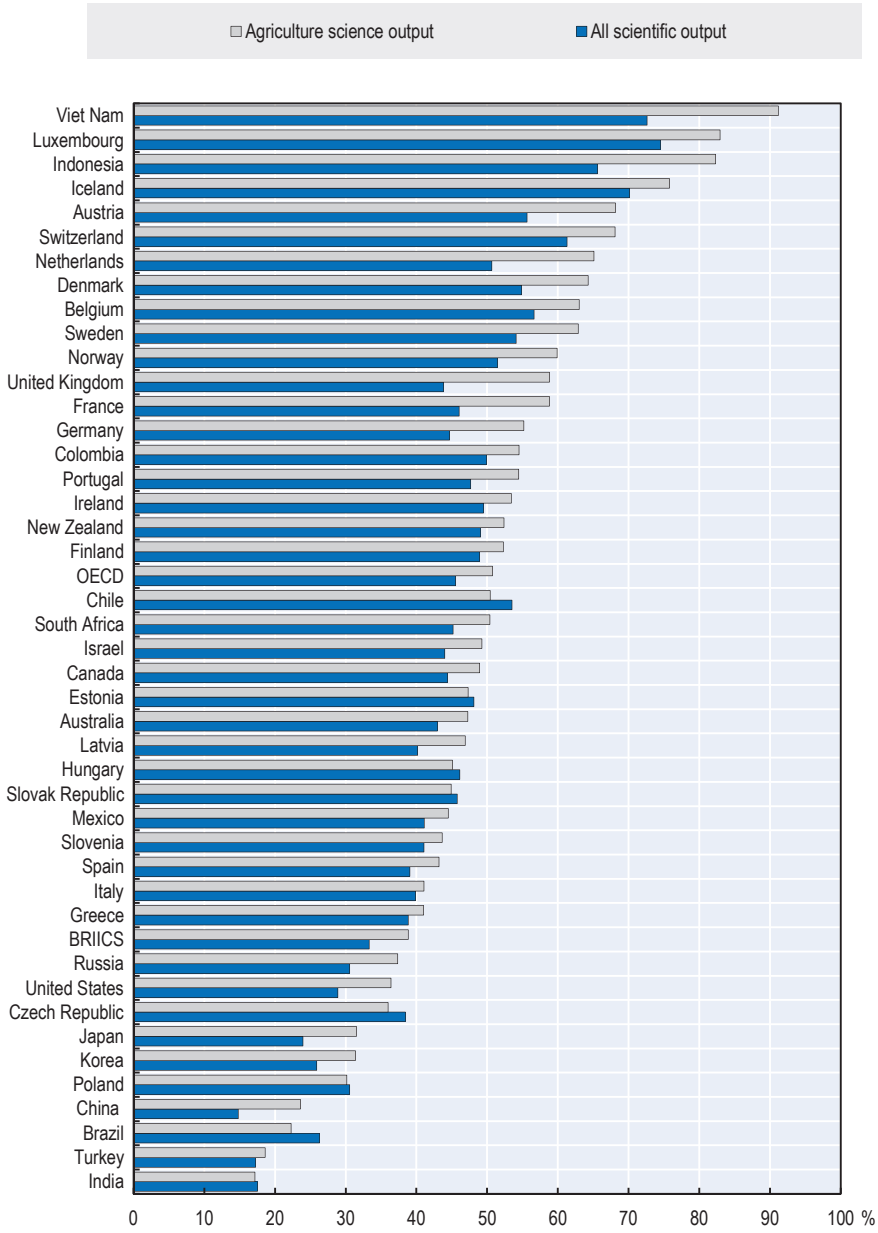
Agriculture citations include food sciences.

Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved March 2014, from http://www.scimagojr.com.

StatLink http://dx.doi.org/10.1787/888933242798

Figure 7.A1.5. International collaboration, 2007-12

Percentage of documents with collaborating authors in foreign country



Agricultural sciences include Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behaviour systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved March 2014, from http://www.scimagojr.com.

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