

COLLABORATE TO INNOVATE

KNOWLEDGE AND INNOVATION COOPERATION BETWEEN BRAZIL AND THE NETHERLANDS



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Sumário executivo - Português

Este estudo descreve aspetos do sistema de conhecimento e inovação do Brasil que afeta a cooperação holandesa-brasileira nos campos da pesquisa, tecnologia e inovação. Atenção extra é dada à cooperação brasileira-holandesa nos setores: agricultura, biomassa; água, ciências da vida (saúde) e aeronáutica. Esta seleção não é de todo uma visão geral completa mas antes uma primeira impressão das possibilidades para a cooperação holandesa-brasileira.

Conhecimento e inovação no Brasil

O Brasil tem 2.377 universidades e faculdades. A Universidade de São Paulo (USP) está na 51ª posição no ranking mundial, similar à Universidade de Amsterdão (UvA) no número 50. A produção acadêmica do Brasil tem aumentado significativamente nos últimos anos, incluindo colaborações acadêmicas internacionais. O Brasil forma um nó importante na rede de coautoria global, conectando os EUA e a UE à América Central e do Sul.

Para incentivar uma maior cooperação internacional no domínio do ensino superior, o governo brasileiro introduziu um programa de bolsas popular, Ciência sem Fronteiras (SwB): Em 2015, 394 estudantes receberam uma bolsa de estudos para estudar na Holanda. O top três dos destinos dos holandeses são a Universidade de Radboud Nijmegen, Universidade de Amsterdão e Universidade de Groningen. A Ciência sem Fronteiras - Holanda é facilitada pela Nuffic-Neso, a organização holandesa responsável pela internacionalização do ensino superior holandês.

Em relação à Ciência, Tecnologia e Inovação (CTI), a política do governo mudou do apoio à ciência nas universidades para o aumento do apoio à 'Research & Development' (R&D) e colaborações entre universidade-indústria. Para além do apoio financeiro do governo federal, os estados brasileiros têm as suas próprias políticas, com agências de financiamento e institutos de pesquisa chamados FAPs (*Fundação de Amparo a Pesquisa*). A Fundação de Pesquisa de São Paulo - FAPESP - é a maior.

O Brasil tem vários pontos de inovação, incluindo um foco em biomassa em Campinas com a universidade UNICAMP e a cooperação holandesa-brasileira BE-Basic. Também existem vários institutos de investigação (semi) privados que são muito influentes na paisagem CTI do Brasil, como o IPT (um laboratório de investigação tecnológica) e Embrapa (agricultura).

Atualmente, o principal desafio para o Brasil é ir para além dessas bolsas de inovação em setores específicos (por exemplo, agricultura, petróleo e gás) para a restante

economia, onde empresas em R&D continuam a ser relativamente poucas, por várias razões. Também o passo de geração de conhecimento (ainda maioritariamente nas universidades) para a inovação continua a ser grande no Brasil. Por exemplo, o país produz um número muito modesto de patentes internacionais, comparado com outros países. Na verdade, as universidades brasileiras estão produzindo mais patentes (embora poucas são licenciadas) do que o setor industrial. Apesar dos investimentos do governo na educação na década passada, o capital humano continua sendo um sério problema no Brasil.

Cooperação brasileira - holandesa em Ciência, Tecnologia e Inovação (STI)

A Holanda e o Brasil assinaram vários acordos (governamentais) com a intenção de estimular a cooperação no domínio do conhecimento e da inovação. O acordo principal é um Memorando de Entendimento sobre Ciência, Tecnologia e Inovação, assinado em 2012. A Comissão Conjunta identificou como temas de interesse mútuo: cidades sustentáveis, bio-economia, mudanças climáticas, astronomia, alimentos e tecnologia de agricultura, recursos hídricos, a comunicação científica e energia renovável. A pesquisa para este relatório mostra que existe de ambos os lados uma grande vontade de desenvolver ainda mais essa cooperação, que exige o reconhecimento pelos participantes holandeses do importante papel do Memorando de Entendimento e outros tipos de acordos como um ponto de partida para a construção de relacionamentos (em vez do início da implementação), necessitando de investimentos em tempo, recursos e relacionamentos.

O Brasil e a Holanda foram muito bem-sucedidos em conjunto no campo da ciência. A participação da colaboração do Brasil - Holanda pode ser apenas de 4% da colaboração internacional do Brasil, no entanto, esta colaboração é de elevada qualidade, com um impacto superior a três vezes a média mundial. Não há qualquer surpresa que esta cooperação tenha crescido (19% desde 2010), inclusive através de chamadas holandesas-brasileiras conjuntas (ex. NWO-FAPESP). Todas as 13 universidades na Holanda (e várias faculdades) têm algum tipo de presença no Brasil, embora com diferentes níveis de atividade.

Também a Holanda é uma grande investidora no Brasil, e várias das empresas holandesas no país são ativas no campo da tecnologia e da inovação. Há um interesse tanto da Holanda como do Brasil em se adaptar à experiência holandesa com modelos do chamado "Triple Helix" para o contexto brasileiro, permitindo que o governo, setor privado e academia unam forças. Várias destas parcerias estão atualmente a ser desenvolvidas, como por exemplo, BE-Basic e Living Lab Bio-Economy.

Para promover a cooperação CTI brasileira-holandesa, o governo holandês investiu numa rede de consultores de inovação, como parte de uma rede econômica mais ampla

no Brasil. O seu apoio, conhecimento e compreensão são considerados muito úteis para ambas as empresas brasileiras e holandesas, institutos de investigação e outros interessados.

Oportunidades para uma maior cooperação CTI

O Brasil é um país tão grande, com tantas oportunidades que as pessoas entrevistadas para este relatório encontram dificuldade em definir prioridades de R&D nos setores selecionados. O Brasil tem interesse tanto nas tecnologias básicas para resolver problemas atuais (p. ex. no tratamento de esgotos, prevenção de inundações), bem como em tecnologias avançadas para os desafios do futuro (p. ex. envelhecimento saudável, biocombustível de aviação, biomateriais avançados, materiais aeroespaciais compostos). A Holanda tem muito a contribuir em todas as áreas, mas pode beneficiar ao apresentar a sua capacidade de forma mais ativa em áreas selecionadas com maior potencial para benefício mútuo.

Embora ambos os países possam beneficiar da cooperação estratégica focada nos futuros desafios e oportunidades, inovando juntos, é necessária alguma gestão da expectativa. Segundo os entrevistados, os participantes holandeses que operam e investem no Brasil estão satisfeitos com os resultados, mesmo que estes estejam muitas vezes abaixo das expectativas iniciais. O ambiente de negócio brasileiro permanece complicado e nem sempre favorável à inovação e à cooperação internacional, que tem implicações na velocidade que os resultados podem ser agendados. Além disso, obviamente, a abordagem e soluções holandesas necessitam de adaptação para o contexto brasileiro.

Algumas recomendações para a Holanda

Empresas:

- ▶ Embora o setor privado de R&D ainda seja relativamente baixo no Brasil, o país tem um grande potencial para a captação de materiais inovadores, tecnologia ou serviços.
- ▶ Empresas e institutos holandeses parecem ter uma melhor hipótese de mercado como fornecedores de conhecimentos e tecnologia em consórcios com grandes parceiros brasileiros.
- ▶ Empresas holandesas, com produtos atraentes e inovadores que têm de ser adaptadas ao contexto brasileiro, poderiam procurar a cooperação com instituições públicas CTI como o IPT, ITA e EMBRAPA. Também as empresas podem se ligar ativamente a universidades brasileiras p. ex. para disseminar conhecimentos e cooperar em matéria de S,T&I).

Universidades:

- ▶ Muitos acordos foram assinados entre universidades. Contudo, precisam de investimento. As boas relações pessoais e institucionais são um pré-requisito e precisam ser construídas ao longo do tempo. Também a aplicação dos acordos exigem investimentos financeiros (p. ex. capital inicial para oficinas e intercâmbios conjuntos).
- ▶ O intercâmbio de alunos (Mestrado, Ph.D.) é um bom ponto de partida para a construção de relações, no entanto, em breve para ser seguido de projetos conjuntos e, finalmente, de relações institucionais mais fortes. A(s) rede(s) Alumni pode(m) ser desenvolvida(s) e melhorada(s).
- ▶ As universidades brasileiras ainda se focam em investigação fundamental, embora sua atividade em tecnologia e inovação esteja a crescer (p. ex. UNICAMP-INOVA). Com base na experiência na Holanda, as universidades holandesas podem trabalhar com os seus parceiros brasileiros para promover uma cultura de arranque e melhorar as ligações entre universidades e empresas.
- ▶ Os investimentos relativamente limitados de R&D das empresas brasileiras também significam que para as universidades holandesas a cooperação com as universidades brasileiras é o ponto de entrada mais óbvia para a colaboração com o setor privado brasileiro.
- ▶ Colaborações acadêmicas entre a Holanda e o Brasil, como o Living Lab sobre a Bio economia, poderiam ser desenvolvidas com a cooperação do setor privado, tanto brasileiro como holandês.

Governo holandês:

- ▶ O Memorando de Entendimento sobre a CTI desempenha um papel crucial no relacionamento entre os dois países (bem como os acordos semelhantes com os governos estaduais e universidades). Tais acordos podem ser tratados como a alçada para atividades diferentes. Também os acordos requerem financiamento para a sua implementação (p. ex. Nuffic-Neso não tem financiamento, ao contrário da sua parceira brasileira CAPES). A iniciação de projetos concretos pode ser o início de uma cooperação a longo prazo. Poderão haver possibilidades de cooperação com outros Estados membros da UE com competências complementares.
- ▶ A rede de inovação pública holandesa com adido e consultores desempenha um papel importante na promoção da cooperação entre os dois países. No entanto, a partir das entrevistas realizadas para este relatório, torna-se claro que o governo holandês vai poder continuar a trabalhar o seu perfil no Brasil para ir além das visões tradicionais (vacas, verde...) para reconhecer a Holanda como um país altamente tecnológico e criativo.
- ▶ Como o sistema brasileiro é baseado, sobretudo, na oferta, é importante articular claramente o 'abastecimento' de alto nível dos holandeses, ou seja, exatamente

o que o país tem para oferecer e como é que isso poderia beneficiar os participantes específicos no Brasil (foco).

- ▶ O Brasil está muito interessado no modelo holandês de cooperação entre governo, empresas e universidades (“Triple Helix”). O governo holandês poderia promover este modelo. Apresentações em feiras existentes de Parceiros público-privadas (PPP) entre Brasil e Holanda podem ser uma forma de aumentar a percepção e o interesse brasileiro.

Samenvatting - Nederlands

Deze studie beschrijft aspecten van het Braziliaanse Kennis en Innovatiesysteem die van invloed zijn op de Nederlands-Braziliaanse samenwerking op het gebied van onderzoek, technologie en innovatie. Speciale aandacht gaat uit naar samenwerking in enkele sectoren: landbouw, biomassa, water, gezondheidszorg en aeronautica. Deze selectie geeft zeker geen compleet overzicht, maar is bedoeld als een eerste impressie van de mogelijkheden voor Braziliaans-Nederlandse samenwerking.

Kennis en innovatie in Brazilië

Er zijn in Brazilië 2.377 universiteiten en *colleges*. De Universiteit van São Paulo (USP) staat op nummer 51 in de wereldranglijsten, nagenoeg op dezelfde plaats als de Universiteit van Amsterdam (UvA), die op nummer 50 staat. De academische productie van Brazilië is sterk gestegen in de afgelopen jaren, waaronder de internationale wetenschappelijke samenwerking. Brazilië verbindt de Verenigde Staten en Europa met Midden- en Zuid-Amerika.

Om internationale samenwerking op het gebied van hoger onderwijs te stimuleren, introduceerde de Braziliaanse overheid een succesvol beurzenprogramma, *Ciencias sin Fronteras* (Science without Borders, SwB). In 2015 kregen 394 studenten een beurs voor Nederland. De meest geliefde bestemmingen zijn Radboud Universiteit Nijmegen, VU Amsterdam en de Universiteit van Groningen. Voor Nederland wordt dit programma gefaciliteerd door Nuffic-Neso, verantwoordelijk voor de internationalisering van het Nederlandse hoger onderwijs.

Wat betreft wetenschap, technologie en innovatie is het Braziliaanse overheidsbeleid verschoven van ondersteuning van wetenschap in universiteiten naar het stimuleren van samenwerking tussen universiteiten en bedrijven en ondersteuning São Paulo van R&D door bedrijven. Naast financiële steun vanuit de federale overheid voeren de Braziliaanse staten ook elk een eigen beleid uit, met eigen fondsen en onderzoeksinstituten, FAPs genaamd (de grootste is de *Fundação de Amparo a Pesquisa* van São Paulo, FAPESP).

Er zijn verschillende innovatiehotspots in Brazilië waaronder een voor biomassa in Campinas met de universiteit UNICAMP en de Braziliaans-Nederlands samenwerking Be-basic. Daarnaast kent het land ook verschillende invloedrijke (semi)private onderzoeksinstituten zoals IPT (technologie onderzoek laboratorium) en Embrapa (landbouwonderzoek).

De uitdaging in Brazilië is nu om verder te gaan en dergelijke innovatie (bijvoorbeeld in de landbouw en de olie & gas sector) breder te verspreiden binnen de rest van de economie, waar private R&D om verschillende redenen beperkt is gebleven. Ook de stap van kennisontwikkeling (vooral in universiteiten) naar innovatie blijkt nog groot in Brazilië. Bijvoorbeeld, het land produceert relatief weinig internationale patenten en de meeste daarvan worden verkregen in universiteiten. Daarnaast blijft de beschikbaarheid van geschoold menselijk kapitaal een knelpunt, ondanks de toegenomen publieke investeringen van de afgelopen jaren op dit gebied.

Braziliaans-Nederlandse samenwerking op het gebied van Onderzoek, Technologie en Innovatie (ST&I)

Nederland en Brazilië hebben verschillende (gouvernementele) overeenkomsten getekend met als doel het stimuleren van samenwerking in kennis en innovatie. De kern is de Memorandum of Understanding Science, Technology and Innovation (MoU), die op 29 november 2011 ondertekend werd. Het daaraan verbonden Joint Committee identificeerde als gemeenschappelijke interesses: duurzame steden, bio-economie, klimaatverandering, astronomie, voedsel en landbouwtechnologie, watermanagement, wetenschaps-communicatie en hernieuwbare energie. Uit het onderzoek voor deze studie bleek dat er aan beide kanten grote bereidheid is om deze samenwerking verder te ontwikkelen. Dit vergt onder andere een beter begrip van de belangrijke rol die overeenkomsten als de MoU's spelen in Brazilië als uitgangspunt voor het ontwikkelen van *bilateral cooperation* (meer als het startpunt voor uitvoering), met bijbehorende investeringen in tijd, middelen en relaties.

Brazilië en Nederland zijn samen succesvol geweest in de wetenschap. Het aantal wetenschappelijke artikelen dat het resultaat is van Braziliaans-Nederlandse samenwerking is klein, namelijk 4% van alle artikelen die Braziliaanse wetenschappers publiceren in samenwerking met een of meer buitenlandse collega's. De kwaliteit is echter hoog, getuige de impact-score die drie keer hoger is dan die van artikelen die samen met wetenschappers uit andere landen zijn gepubliceerd. Het is dan ook begrijpelijk dat de samenwerking gegroeid is (19% sinds 2010), onder andere middels gemeenschappelijke *Calls for Proposals* (bijvoorbeeld van NWO-FAPESP). Alle dertien universiteiten in Nederland, maar ook verschillende hogescholen, zijn actief in Brazilië (met wisselende intensiteit).

Nederland is ook een belangrijke investeerder in Brazilië en verschillende Nederlandse bedrijven zijn in Brazilië actief op het gebied van technologie en innovatie. Er is in zowel Nederland als Brazilië interesse in het gebruik van de Nederlandse ervaringen met het zogenoemde 'Triple Helix' model voor samenwerking tussen overheden, het bedrijfsleven en de wetenschap, weliswaar aangepast aan de Braziliaanse context.

Vershillende van dit soort partnerschappen worden op dit moment ontwikkeld, waaronder BE-Basic en Living Lab Bio-Economy.

Om de Braziliaans-Nederlandse ST&I samenwerking te bevorderen heeft de Nederlandse overheid geïnvesteerd in een netwerk van innovatie adviseurs, als onderdeel van een breder economisch netwerk in Brazilië. Zijn ondersteuning, kennis en begrip worden als zeer nuttig ervaren voor zowel de Braziliaanse als de Nederlandse bedrijven, onderzoeksinstituten en andere geïnteresseerden.

Mogelijkheden voor verdere ST&I samenwerking

Brazilië is een groot land met zo veel verschillende kansen dat de geïnterviewden voor deze studie het moeilijk vonden om de R&D prioriteiten aan te geven in de geselecteerde sectoren. Brazilië is geïnteresseerd in zowel de technologieën om acute problemen op te lossen (bijvoorbeeld, het behandelen van rioolwater, voorkomen van overstromingen) als in geavanceerde technologieën om toekomstige uitdagingen aan te pakken (bijvoorbeeld gezond ouder worden, bio-vliegtuigbrandstof, geavanceerde bio-materialen en aerospace materialen). Nederland heeft veel bij te dragen in al deze gebieden, maar zou er baat bij kunnen hebben om die capaciteit actiever te promoten in een selectie van gebieden met het meeste potentieel voor gemeenschappelijke baten.

Terwijl beide landen overduidelijk baat zouden hebben bij strategische samenwerking voor het aanpakken van toekomstige uitdagingen en kansen, is enig verwachtingsmanagement gepast. Volgens de interviews voor deze studie, zijn de Nederlandse actoren die werken en investeren in Brazilië tevreden met de resultaten al voldeden die vaak niet aan de initiële verwachtingen. De Braziliaanse economie is nog steeds niet makkelijk te betreden en niet altijd even bevorderlijk voor innovatie en internationale samenwerking, wat implicaties heeft voor de snelheid waarmee resultaten geboekt kunnen worden. Daarnaast is het uiteraard van belang dat de Nederlandse aanpak en oplossingen aangepast worden aan de Braziliaanse context.

Aanbevelingen voor Nederland

Bedrijven:

- ▶ Hoewel R&D investeringen door bedrijven nog relatief laag zijn in Brazilië heeft het land een groot potentieel voor de opname en integratie van innovatieve materialen, technologie en diensten.
- ▶ Nederlandse bedrijven en instituten lijken betere marktkansen te hebben als toeleveranciers van kennis en technologie in consortia met grote Braziliaanse partners.
- ▶ Nederlandse bedrijven met aantrekkelijke en innovatieve producten die aangepast moeten worden aan de Braziliaanse context kunnen samenwerking zoeken met

Braziliaanse publieke instituten zoals IPT, ITA en EMBRAPA. Bovendien kunnen bedrijven actief samenwerken met Braziliaanse universiteiten (bijvoorbeeld voor verspreiding van expertise en samenwerking in wetenschap, technologie en innovatie).

Universiteiten:

- ▶ Er zijn veel overeenkomsten getekend tussen universiteiten. Deze vergen echter ook investeringen. Goede persoonlijke relaties zijn een voorwaarde en dienen over een langere tijd te worden opgebouwd. Bovendien zijn voor de uitvoering van de overeenkomsten ook financiële investeringen nodig (bijvoorbeeld geld voor gezamenlijke workshops en uitwisseling).
- ▶ De uitwisseling van studenten (Master, PhD) is een goed startpunt voor de opbouw van relaties. Dit dient snel opgevolgd te worden door gezamenlijke projecten, die uiteindelijk kunnen uitmonden in sterke institutionele relaties. Alumni netwerken zouden kunnen worden opgezet of versterkt.
- ▶ Braziliaanse universiteiten zijn nog sterk gefocust op fundamenteel onderzoek hoewel hun activiteiten in technologie en innovatie groeiende is (bijvoorbeeld UNICAMP-INOVA). Gebaseerd op hun ervaringen in Nederland kunnen Nederlandse universiteiten met hun Braziliaanse partners samenwerken op het verder versterken van een start-up cultuur en het verbeteren van de banden tussen bedrijven en universiteiten.
- ▶ De relatief beperkte R&D investeringen van Braziliaanse bedrijven betekenen ook dat voor Nederlandse universiteiten een samenwerking met een Braziliaanse universiteit een goed startpunt is voor samenwerking met Braziliaanse bedrijven.
- ▶ Nederlands-Braziliaanse academische samenwerking, zoals het Living Lab on Bioeconomy, kan verder worden ontwikkeld in samenwerking met het bedrijfsleven, zowel Nederlands als Braziliaans.

Nederlandse overheid:

- ▶ De overeenkomst (MoU) op het gebied van wetenschap, technologie en innovatie speelt een belangrijke rol in de relaties tussen beide landen (net zoals vergelijkbare overeenkomsten tussen deelstaat overheden en universiteiten). Dergelijke overeenkomsten kunnen gebruikt worden als kapstok en paraplu voor verschillende activiteiten. Deze overeenkomsten hebben fondsen nodig voor uitvoering (bijvoorbeeld Nuffic-Neso heeft geen specifieke fondsen hiervoor terwijl hun partner CAPES dat wel heeft). Het initiëren van concrete projecten kan de start zijn van langetermijnsamenwerking. Er zijn waarschijnlijk mogelijkheden om samen te werken met andere EU lidstaten met complementaire expertise.
- ▶ Het Nederlandse publieke innovatienetwerk met de attaché en adviseurs spelen een belangrijke rol in het versterken van de samenwerking tussen beide landen. Uit de interviews blijkt echter dat de Nederlandse overheid meer kan doen voor het

profileren van Nederland in Brazilië om het traditionele beeld over Nederland (koeien, water, ...) bij te stellen naar high-tech en creatieve industrie.

- ▶ Omdat het Braziliaanse systeem nogal aanbod gedreven is, is het belangrijk om goed duidelijk te maken wat het Nederlandse top 'aanbod' is, oftewel wat Nederland te bieden heeft en hoe specifieke actoren in Brazilië hiervan kunnen profiteren.
- ▶ Brazilië is zeer geïnteresseerd in het Nederlandse model van samenwerking tussen overheid, bedrijven en universiteiten (Triple Helix). De Nederlandse overheid kan dit model verder stimuleren in haar benadering van Brazilië. Presentaties bij handelsbeurzen van bestaande Braziliaanse-Nederlandse PPPs zou een manier kunnen zijn om de Braziliaanse kennis en interesse te vergroten.



Executive summary - English

This study describes aspects of Brazil's knowledge and innovation system that affect Dutch-Brazilian cooperation in the field of research, technology and innovation. Extra attention is given to Brazilian-Dutch cooperation in the sectors: agriculture, biomass; water, life sciences (health care) and aeronautics. This selection is by no means a complete overview but rather intended as a first impression of the possibilities for Dutch-Brazilian cooperation.

Knowledge and innovation in Brazil

Brazil has 2,377 universities and colleges. The University of São Paulo (USP) ranks number 51 in the world, similar to the University of Amsterdam (UvA) at number 50. Brazil's academic output has increased significantly over the past years, including international academic collaborations. Brazil forms an important node in the global co-authorship network, connecting the US and EU to Middle- and South-America.

In order to further encourage international cooperation in the area of higher education, the Brazilian government introduced a popular scholarship program, Science without Borders (SwB). In 2015, 394 students received a scholarship to study in the Netherlands. The top three Dutch destinations are Radboud University Nijmegen, VU Amsterdam and University of Groningen. Science without Borders - Holland is facilitated by Nuffic-Neso, the Dutch organisation that is responsible for internationalisation of Dutch higher education.

With regard to Science, Technology and Innovation, government policy has shifted from support to science in universities to increased support for business R&D and university-industry collaborations. Besides financial support from the federal government, Brazilian states have their own policies, with funding agencies and research institutes called FAPs (*Fundação de Amparo a Pesquisa*). The São Paulo Research Foundation – FAPESP – is the largest.

Brazil has several innovation hotspots including one focusing on biomass in Campinas with the university UNICAMP and the Dutch-Brazilian cooperation BE-Basic. Moreover, there are various (semi)private research institutes that are very influential in Brazil's STI landscape, such as IPT (a technological research laboratory) and Embrapa (agriculture).

Currently, the main challenge for Brazil is to move beyond such pockets of innovation in specific sectors (e.g. agriculture, oil & gas) to the rest of the economy, where business R&D remains relatively low for various reasons. Moreover, the step from knowledge generation (still mainly in universities) to innovation remains large in Brazil.

For example, the country produces a very modest number of international patents compared to other countries. In fact, Brazilian universities are producing more patents (though few are licensed) than the industrial sector. Moreover, despite the government's investments in education of the past decade, human capital remains a serious bottleneck in Brazil.

Brazilian-Dutch cooperation in Science, Technology and Innovation (ST&I)

The Netherlands and Brazil have signed several (governmental) agreements with the intention of stimulating cooperation in the field of knowledge and innovation. The main agreement is a Memorandum of Understanding on Science, Technology and Innovation, signed in 2012. A Joint Committee identified as topics of mutual interest: sustainable cities, bio-economy, climate change, astronomy, food and agriculture technology, water resources, science communication, and renewable energy. The research for this report shows that there is on both sides a great willingness to further develop this cooperation, which a/o requires acknowledgment by the Dutch actors of the important role of MoUs and other kinds of agreements as a starting point for building relationships (rather than the start of implementation), needing investments in time, resources and relationships.

Brazil and the Netherlands have been very successful together in the field of science. The share of Brazil – Netherlands collaboration might only be 4% of Brazil's international collaboration, however, this collaboration is of very high quality with an impact of more than three times the world average. It is then no surprise that this cooperation has been growing (19% since 2010), including through joint Dutch-Brazilian calls (e.g. NWO-FAPESP). All thirteen universities in the Netherlands (and several colleges) have some sort of presence in Brazil, though with varying levels of activity.

Furthermore, the Netherlands is a large investor in Brazil, and several of the Dutch companies in the country are active in the field of technology and innovation. There is an interest of both the Netherlands and Brazil in adapting the Dutch experience with the so-called 'Triple Helix' models to the Brazilian context, allowing government, private sector and academia to join forces. Several of such partnerships are currently being developed, e.g. BE-Basic and Living Lab Bio-Economy.

In order to further the Brazilian-Dutch STI cooperation, the Dutch government has invested in a network of innovation advisors, as part of a broader economic network in Brazil. Their support, knowledge and understanding are considered very helpful for both Brazilian and Dutch companies, research institutes and others interested.

Opportunities for further STI cooperation

Brazil is such a large country with so many opportunities that people interviewed for this report find it difficult to define R&D priorities in the selected sectors.

Brazil is interested in both basic technologies to solve current problems (e.g. in sewage treatment, flood prevention) as well as advanced technologies for future challenges (e.g. healthy aging, bio jet fuel, advanced bio-materials, aerospace composite materials). The Netherlands has a lot to contribute in all those areas, but might benefit from presenting its capacity more actively in selected areas with most potential for mutual benefit.

While both countries could benefit from strategic cooperation focused on future challenges and opportunities, innovating together, some expectation management is required. According to those interviewed, Dutch actors operating and investing in Brazil are satisfied with the results, even though these are often actually below initial expectations. The Brazilian business environment remains cumbersome and not always conducive to innovation and international cooperation, which has implications for the speed at which results can be booked. Moreover, obviously the Dutch approach and solutions need adaptation to the Brazilian context.

Some recommendations for the Netherlands

Companies:

- ▶ Though private sector R&D is still relatively low in Brazil, the country has great potential for the uptake of innovative materials, technology or services.
- ▶ Dutch companies and institutes seem to have a better market chance as suppliers of knowledge and technology within consortia with large Brazilian partners.
- ▶ Dutch companies with attractive and innovative products that have to be adapted to the Brazilian context could seek cooperation with public ST&I institutions such as IPT, ITA and EMBRAPA. Moreover, companies can actively connect with Brazilian universities (e.g. to disseminate expertise and cooperate in the field of S,T&I).

Universities:

- ▶ Many agreements have been signed between universities. However, they require investment. Good personal and institutional relations are a prerequisite and need to be built over time. Moreover, the implementation of the agreements also require financial investments (e.g. seed money for joint workshops and exchanges).
- ▶ The exchange of students (Masters, PhD) is good starting point for building relations, however, soon to be followed by joint projects and ultimately stronger institutional relations. Alumni network(s) could be developed or strengthened.
- ▶ Brazilian universities still focus on fundamental research, though their activity in technology and innovation is growing (e.g. UNICAMP-INOVA). Based on experience in the Netherlands, Dutch universities can work with their Brazilian partners to further a start-up culture and improve university-business linkages.

- ▶ The relatively limited R&D investments of Brazilian companies also means that for Dutch universities cooperation with Brazilian universities is the most obvious entry point for collaboration with Brazilian private sector.
- ▶ Dutch-Brazilian academic collaborations, such as the Living Lab on Bio economy, could be developed further with the cooperation of the private sector, both Brazilian and Dutch.

Dutch Government:

- ▶ The MoU on STI plays a crucial role in the relationship between both countries (as well as similar agreements with state governments and universities). Such agreements should be treated as the umbrella for different activities. Moreover, agreements require funding for their implementation (e.g. Nuffic-Neso has no funds while its Brazilian partner CAPES does). Initiation of concrete projects can be the start of longer term cooperation. There might be possibilities of cooperating with other EU member states with complementary expertise.
- ▶ The Dutch public innovation network with attaché and advisors plays an important role in furthering cooperation between the two countries. However, from the interviews conducted for this report, it becomes clear that the Dutch government could continue to work on its profiling in Brazil to move beyond traditional views (cows, green, ...) to acknowledge the Netherlands as a high-tech and creative country.
- ▶ As the Brazilian system is rather supply-driven, it is important to clearly articulate the Dutch top-notch 'supply', i.e. what exactly the country has to offer and how this could benefit specific actors in Brazil (focus).
- ▶ Brazil is very interested in the Dutch model of cooperation between government, business and universities (Triple Helix). The Dutch government could further this model in its approach towards Brazil. Presentations at trade fairs of existing Brazilian-Dutch PPPs might be one way to raise Brazilian insight and interest.

Introduction

The Advisory Council for Science, Technology and Innovation (AWTI) advises the Dutch government and parliament on policy in the areas of scientific research, technological development and innovation. The AWTI has conducted several country studies (China, Germany, United Kingdom) to identify opportunities for cooperation in the field of science, technology and innovation.

This report focuses on Brazil. According to the terms of reference (April 30th 2015), the purpose, focus and target audience areas are as follows:

Purpose

The purpose of this country study is to provide general insight into how the knowledge and innovation system of Brazil is organized, to identify opportunities for cooperation between Dutch and Brazilian universities, knowledge institutes and companies, and to provide recommendations to enhance this cooperation and inspire similar forms of cooperation in other sectors.

Audience

The audience is both Dutch and Brazilian public sector, universities and knowledge institutes, and interested parties in the private sector.

Focus

The report provides an introduction to the Brazilian knowledge and innovation system (i.e. Brazil's higher education and research system and innovation policies), focusing on aspects that affect Dutch-Brazilian cooperation in the field of research, technology and innovation.

As an illustration of possible Brazilian-Dutch cooperation, the study collates information on a selection of sectors: agriculture, biomass; water, life sciences (health care) and aeronautics. This list is by no means exhaustive. References are provided to more in-depth sector studies and other information sources.

Overview of the Brazilian Knowledge and Innovation System

2.1 Brief overview of relevant government policies

Historically, Brazil's economic policies pursued strong industrial sectors through inward looking strategies (e.g. government support for domestic industry and import substitution). The agricultural sector, for example, became one of the most efficient and competitive in the world. Well-known companies as Petrobras (oil & gas) and Vale (mining) have their origins as statist monopolies.

Research and Development (R&D) investments were indirectly supported through public universities and infrastructure investments deemed important for industrial growth.¹ Though since the 1990s markets were increasingly opened up, this rather protective economic model continued to be supported across different governments, with allies in both the public and private sector. It obviously also affects the environment for Science, Technology and Innovation (ST&I).²

A full-fledged description of the Knowledge and Innovation System (KIS) in Brazil would require a much longer report. Therefore the focus of this report is on a few key developments, with relevance for Brazilian-Dutch cooperation.

FINEP and Sectoral Funds

Between 1995-2002, the then President Cardoso introduced far-reaching economic, fiscal, market and social reforms. Foreign Direct Investment – especially from EU countries – increased significantly due to liberalisation of the economy. In the field of innovation, several interesting initiatives arose.

For example, in 1999 Brazil installed the so-called Sectoral Funds, which still provide the majority of the funding for FINEP (*Financiadora de Estudos e Projetos*), Brazil's innovation agency since 1967. Sectoral Funds are expected to bind resources from the strategic sectors to innovation in those same sectors (starting in 1999 with oil and gas and now up to 15 sectors). The Funds accrue from special taxation on a.o. electricity, telecommunication and oil explorations, in order to make government R&D investments in these strategic sectors independent from the national budget and administrations.

¹ Rodriguez, Dahlman, Salmi 2008.

² See for a more elaborate description of innovation policies of Brazil, among others, analysis by CINDES Motta Veiga and Rios, 2011, *Inovação: política e desempenho das Empresas*. Breves Cindes 52.

The Sectoral Funds are used to subsidise loans and provide grants for innovations, and stimulate university-company partnerships. Firms and research institutes respond to calls for proposals, which are assessed by committees of academics, government officials and entrepreneurs.

Plano Brasil Maior and the ENCTI

President Luiz Inacio Lula da Silva (2003-2010) introduced new social policies and programmes but also continued many of the existing liberal economic policies. This is thought to have enhanced macro-economic stability, repaid Brazil's international debt and reduced poverty. Since 2010, President Dilma Rousseff (now in her second term) has given extra attention to business development and education. Her government's *Plano Brasil Maior* 2011-2014 (Plan Greater Brazil) gives innovation a central role.

The National Strategy for Science, Technology and Innovation (ENCTI) 2012-2015 focuses on:

- ▶ Closing the technology gap with developed economies.
- ▶ Leadership in the areas of the knowledge economy linked to the country's natural resources, such as green innovation, agro-business and other resource-based activities.
- ▶ Strengthening the internationalisation of the national research system.
- ▶ Development of a green economy (environmental technologies, bio- and nanotechnologies to be supported by sectoral funds and a Climate Fund).
- ▶ Addressing social and regional inequalities through
 - ▶ support for the development of low-cost, user-friendly innovations that address social challenges (e.g. housing technology),³
 - ▶ support to SME and start-ups (e.g. *Primeira Empresa Inovadora* grants programme),
 - ▶ FINEP's *Inovacred* programme for decentralised funding.

³ E.g. HABITARE, an initiative of some USD 14 million, supports innovations in housing technology, including for social housing.

Table 1 Focus areas of Ministry of Science, Technology and Innovation (MCTI):⁴

Competitiveness	Natural resources	Social Development
Aerospace	Antarctica	Digital inclusion
Agriculture & cattle ranching	Biodiversity	Social inclusion &
Biotechnology	Marine biotechnology	population productivity of
Defence	Natural disasters	ST&I and improvement of
Energy	Meteorology,	science education
Pharmaceuticals and Health	Climatology &	Social and assistive
Nanotechnology	Hydrology	technologies
Nuclear	Climate change	
Oil and gas	Oceans and Coastal Zones	
Information &	Water resources	
Communication Technologies	Mineral resources	

It is interesting to note that the social-oriented governments of the last decade have been aware of the potential negative as well as positive impacts of innovation or new technologies on labour and employment. Waste collection and treatment was mentioned as an example where innovation is hampered, because of the worry that many garbage collectors (*catadores*) will lose their job.⁵ In contrast, mechanisation in the sugar cane accelerated because it also had significant labour benefits: (1) field work is hard and mechanisation leads to better labour conditions; (2) the sugar cane is highly competitive so labour productivity is important; (3) the surplus of labour was absorbed by the strong economy (e.g. construction).

Innovation Laws

Public funding for innovation, science & technology was initially geared towards universities and research institutes, with little attention to R&D by the private sector. Brazilian companies invested relatively little in innovation (illustrated by the shortage of scientists and engineers employed in the private sector and low rates of patent applications by Brazilians). This is often linked to their traditionally inward focus, a result of a history of protectionist government policies and the large internal and regional market.⁶ However, in the past ten years government policy has shifted its focus and upped the support for business R&D and university-industry collaborations.

⁴ <http://www.mcti.gov.br/inicio>

⁵ Interviews June 2015 Brazil.

⁶ Interviews June 2015 Brazil.

Such support includes, among others, the following policy initiatives:⁷

- ▶ **Innovation law** (*Lei da Inovacao*, 2004) provides the institutional framework to direct public funds for use by the private sector. The law allows for subsidising salaries of post-doc researchers in private companies (for the first few years), as well as offering companies incubation services in public S&T institutes.
- ▶ **Good law** (*Lei do Bem*, 2005) includes different kinds of tax deductions for R&D expenditures (with further modifications in 2007).
- ▶ **Pró-Inova programme** (2008) provides information about tools, facilities etc. in the field of ST&I.
- ▶ **Plano Inova Empresa** (2013) provides credit, grants and equity financing, and includes measures to decentralise policy implementation in order to better reach small-medium enterprises (SME) and reduce administrative bureaucracy.

State funding

Not only the Federal government is important for knowledge development and innovation. On the level of the states, State Secretariats are grouped in the “National Council of State Secretaries for Scientific and Technology and Innovation Affairs” (CONSECTI). The states have their own policies, with research institutes and funding agencies called FAPs (*Fundação de Amparo a Pesquisa*).⁸ A FAP receives funding from the state’s tax revenue and disperse funds for research, scholarships, small business and special programmes for technological innovation.⁹ For example, the São Paulo Research Foundation (*Fundação de Amparo a Pesquisa do Estado de São Paulo*, FAPESP) is one of the largest funding agencies in Brazil.¹⁰ The FAPs are grouped in the “National Council of State Research Support Foundations” (CONFAP).

Even though São Paulo is the largest recipient of federal funds, about two thirds of public funding for R&D comes from state sources (mainly FAPESP). Across states, however, the expenditures on S&T vary significantly. After São Paulo (R\$ 8.786 million in 2013), the next biggest public investments on R&D are by Rio de Janeiro State (R\$ 960 million in 2013) and Parana State (R\$ 772 million in 2013). Next in the ranking of 2013 are Minas Gerais (R\$ 701 million), Bahia (R\$ 538 million) and Santa Catarina (R\$ 483 million). The Federal government spent R\$ 26.395 million on S&T in 2012, compared to R\$ 13.651 by the states.¹¹

⁷ 10.1787/sti_outlook-2014-39-en

⁸ Federal expenditure Science & Technology, 2012, 26.394 mill R\$ (of which R 8.006 mill R\$ on post-graduate positions as a proxy for R&D by institutions for higher education) http://www.mct.gov.br/index.php/content/view/5013/Brasil_Dispendios_do_governo_federal_em_ciencia_e_tecnologia_C_T_sup_1_sup_por_atividade.html

⁹ www.fapesp.br

¹⁰ http://agencia.fapesp.br/fapesps_scientific_director_speaks_in_washington_about_science_in_sao_paulo_brazil/21222/

¹¹ http://www.mct.gov.br/index.php/content/view/2064/Governo_federal.html

2.2 Overview of Brazilian KIS

As figure 1 illustrates, the Brazilian system is rather complex, covering different policy areas: science and technology, trade and commerce, and public research centres associated with different social sectors (e.g. agriculture, health, defence, ...).

Figure 1 Overview Brazilian KIS¹²

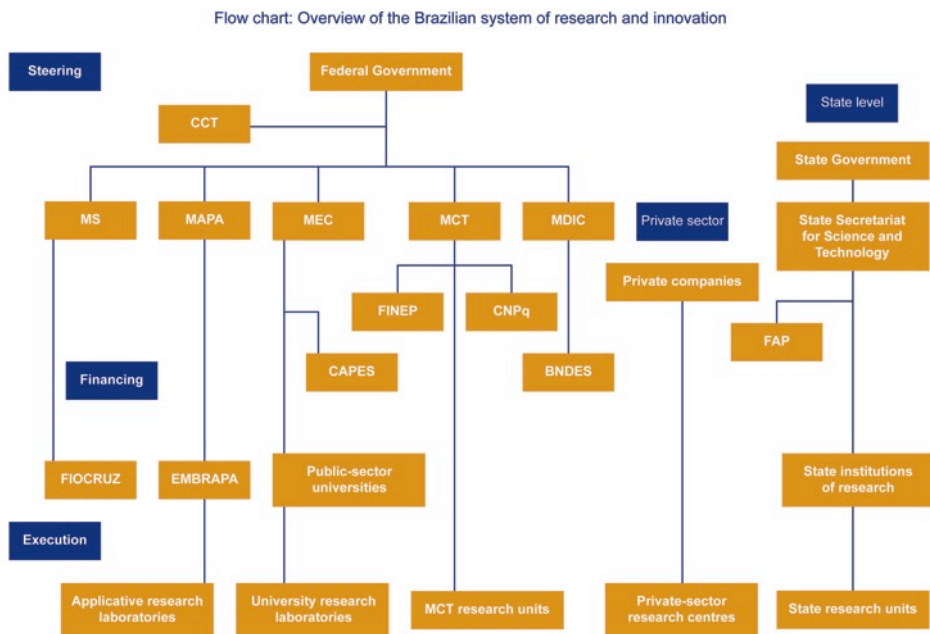


Table 4 provides an overview of some of the key federal public actors in the Brazilian KIS, though this is still by no means a complete list. For example, as will be described below, the water sector has several public institutes that deal with sector-specific knowledge and innovation, as does the defence sector). To this list should moreover be added the different research institutes of the states of Brazil as well as some private-law companies that were originally government owned (e.g. CPqD)¹³.

¹² Source: <http://www.access4.eu/brazil/330.php>

¹³ <https://www.cpqd.com.br/en/about-cpqd/historical-background/>

Table 2 Overview actors KIS

Science & Technology			
National Council on S&T	Centro Científico Tecnológico	CCT	Defines priorities and coordinates policies
Ministry of Science, Technology and Innovation	Ministério da Ciência, Tecnologia e Inovação	MCT(I)	Implements policies
National S&T Development Council	Conselho Nacional de Desenvolvimento Científico e Tecnológico	CNPq	Funds (post)graduate programmes and scholarships ¹⁴
Studies and Projects Financing Agency	Financiadora de Estudos e Projectos	FINEP	Funds basic research (a/o Sectoral Funds)
Post-Graduate Development Agency / Ministry of Education (MEC)	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior	CAPES	Coordinates (post)graduate scholarships
Industry and Commerce			
National Industrial Development Council	Conselho Nacional de Desenvolvimento Industrial	CNDI	Industrial development priorities and coordinates policies
Ministry of Development, Industry and Foreign Trade	Ministerio de Desenvolvimento Industria e Comercio Exterior	MDIC	Policy development and implementation

¹⁴ The CNPq also has several research institutes: those in Rio de Janeiro include a/o the Brazilian Center for Physics Research (Centro Brasileiro de Pesquisas Físicas--CBPF), the Mineral Technology Center (Centro de Tecnologia Mineral--Cetem), the National Observatory (Observatório Nacional--ON), the Brazilian Institute of Scientific and Technological Information (Instituto Brasileiro de Informação em Ciência e Tecnologia--IBICT) in Brasília, the National Astrophysics Laboratory (Laboratório Nacional de Astrofísica--LNA) in Itajuba (Minas Gerais), and the National Synchrotron Light Laboratory (Laboratório Nacional de Luz Síncrotron--LNLS) in Campinas. These institutes vary in quality and size, and many of them have their own graduate education programs.

National Bank for Economic and Social Development	Banco Nacional de Desenvolvimento Economico e Social	BNDES	R&D funding for private sector
Brazilian Industrial Development Agency	Agencia Brasileira de Desenvolvimento Industrial	ABDI	Services to industry
National Institute of Intellectual Property	Instituto Nacional de Propriedade Industrial	INPO	Manages intellectual property rights
Public Research Institutes			
Oswaldo Cruz Foundation / Ministry of Health (MS)	Fundação Oswaldo Cruz	FIOCRUZ	Health research
Agricultural Research Corporation / Ministry of Agriculture (MAPA)		Embrapa	Agricultural research and technology transfer to regional centres
Centre for Management and Strategic Studies / Ministry of Science, Technology and Innovation	Centro de Gestão e Estudos Estrategicos	CGEE	Research and policy advice for Ministry
IBAMA/ Ministry of Environment		IBAMA	Knowledge in the area of environment and biodiversity
National Institute of Space Research / Ministry of Defence		INPE	
Aeronautical Technology Institute	Instituto Tecnológico de Aeronáutica	ITA	

Knowledge and Innovation in Brazil

3.1 Higher education and knowledge

Stimulated by the government, school and university enrolment rates in Brazil sharply increased between 2005-2012, from 37% to 61%. In 2014, there were 6.4 million undergraduate enrolments and 180,000 graduate students 40,000 students concluded their Masters and 12,000 a PhD.¹⁵ Brazilian universities receive 59% of the government expenditure on education. In 2011, Brazil spent 5.8% of its GDP on education.¹⁶

While the best secondary education is provided by private schools, the best tertiary high-level education is considered to be provided by public universities. However, the quality of the 2,377 universities and colleges varies widely with the top universities in the south and southeast, most affluent, regions of the country (though also good universities can be found in regions such as Brasilia, Pernambuco and Bahia). The top five Brazilian universities, which are included in the top 50 for Latin America and BRICS rankings, are:

Table 3 Top five universities (2014)¹⁷

	Brazil	LATAM	BRICS	World
Universidade de São Paulo (São Paulo state)	1	2	7	132
Universidade estadual de Campinas (Campinas in SP)	2	3	9	206
Universidade Federal do Rio de Janeiro (Rio de Janeiro)	3	4	21	271
Universidade Estadual Paulista (São Paulo)	4	9	30	420+
Universidade Federal de Minas Gerais (Minas Gerais)	5	10	40	420+

However, human capital remains a huge bottleneck in a country as large and diverse as Brazil. The challenges range from primary education enrolment, to PISA (Programme for International Student Assessment) science scores, to access to tertiary education, to limited numbers of STEM (Science, Technology, Engineering and Mathematics)

¹⁵ <http://www.slideshare.net/CesarNog/science-without-borders-program>

¹⁶ The Global Innovation Index 2014. Most recent figures are from 2011.

¹⁷ QS University rankings, <http://www.topuniversities.com/university-rankings>

graduates and scientists, to shortage of researches in the private sector. Brazil's academic output has increased significantly over the past years.¹⁸ Brazil's share of the world's publication output grew with 4.24% per year between 2008 and 2012, with medicine as the main subject of its publications (19% of all output 2010-2014), followed by agriculture and biological sciences (12,5%). Though the impact of these publications remained below the world average by 20%,¹⁹ Brazil's share of the world's citations grew with 2% between 2008-2012.

Moreover, Brazil's international academic collaborations are growing.²⁰ For example, Brazil forms an important node in the global co-authorship network, connecting the United States and Europe (Portugal, Spain, France, The United Kingdom and Germany) to Middle- and South-America (e.g. Argentina). Internationally co-authored publications now account for 24% of Brazil's total academic output. The share of Brazil – Netherlands collaboration is only 4% of Brazil's international collaboration, but this collaboration is of very high quality with an impact of more than three times the world average.

Education and research is historically closely linked to scientific institutes. MCTI estimated that 80% of Brazilian researchers carry out their activities within public institutions (universities or research centres), concentrating on the production of scientific papers. Increasingly, however, government aims to stimulate cooperation with the private sector in order to make science contribute more to the economy and to stimulate innovation. For example, the Brazilian agriculture research institute Embrapa was for 25 years responsible for 95% of all seed research and development. Now the balance has shifted to companies and Embrapa conducts less than 5%.²¹

As described in the next box, the Netherlands has similarly reformed the national research funding system to stimulate university-business cooperation.

Box 1. The Dutch funding system for research.

By law, Dutch Universities may receive three sources of funding.

► Funding source 1:

The Ministry of Education, Culture and Sciences (OCW) allocates a budget to each University based upon a complicated calculation model.

¹⁸ Elsevier Research Intelligence, 2015, A custom analysis of Brazil's research output & impact. Analytical Services Report for AWTI.

¹⁹ FWCI of 0.80. Field-Weighted Citation Impact (FWCI) is an indicator of mean citation impact, and is used as a proxy for research quality. In contrast to simple counts of citations, this measure accounts for differences in citation behaviour between fields, document types and publication years. A value of 0.8 means the publications are cited 20% less than the world average.

²⁰ Elsevier Research Intelligence, 2015, A custom analysis of Brazil's research output & impact. Analytical Services Report for AWTI.

²¹ Interview and presentation by EMBRAPA, June 2015.

► Funding source 2:

The second source comes from research funding organisations such as the Netherlands Organisation for Scientific Research (NWO²²), research-oriented foundations and European Union Programs (EU Horizon 2020). The NWO has several funding programs and selects the best and innovative research projects. Each program and call has its own criteria. Currently NWO funds more than 5,600 research projects.

► Funding source 3:

The third funding source is the money that comes from companies based upon contracts. Universities may be contracted by companies to do research and provide education. Universities are also allowed to start companies (start-ups and spin-offs).

The advantage of the system is thought to be that it allows universities to undertake fundamental research, while it also stimulates the application by companies of the knowledge generated by universities or university-business collaborations.

3.2 From knowledge to innovation

Despite of the growing number of qualified scientific publications, Brazil is still producing a very modest number of international patents²³ compared to other countries. For example, in 2014, Brazil filed for only 334 international patents (the Netherlands filed for 2,505). In fact, Brazilian universities are producing more patents (but very few are licensed) than the industrial sector, which illustrates the need for a more innovative industrial sector, investing in R&D.

The interest in Brazil in research and innovation centres has grown fast. Among others, the Innovation Law of 2004 intended to stimulate innovation and technology transfer through the use of innovation centres, called NITs (*Núcleos de Inovação Tecnológica*). In 2006, the 120 centres were brought together in a network called FORTEC (*Fórum dos Gestores de Inovação e Transferência de Tecnologia*). The majority (74%) of the NITs are linked to Universities and 19% are linked to federal or state research institutes.²⁴

For example, UNICAMP-INOVA became the NIT of the University of Campinas in 2004. Obtaining patents is a difficult process in Brazil and the Brazilian-wide INOVA program provides support to obtain patents. So far, UNICAMP has obtained 935 patents

²² <http://www.nwo.nl/en>

²³ USPTO, United States Patent and Trademark Office, patents

²⁴ Ritter dos Santos et al (2009), Livro Transferência de tecnologia: Estratégias para a estruturação e gestão de Núcleos de Inovação Tecnológica.

(77 in 2014). UNICAMP has 900 technologies available for licensing of which 60 are currently licensed to companies. Moreover, to facilitate university-business cooperation UNICAMP has established a 10 ha Science & Technology Park.²⁵

But there are other centres where innovation happens. FAPESP in São Paulo provides \$680 million of funding for 17 Research, Innovation and Dissemination Centres (RIDCs) in the State of São Paulo. This funding will keep the centres going for up to 11 years and will link 535 scientists from the state of São Paulo with another 69 from abroad. The research topics to be covered by the Centres include: food and nutrition; glasses and glass-ceramics; functional materials; neuroscience and neuro-technology; inflammatory diseases; biodiversity and drug discovery; toxins, immune-response and cell signalling; neuro-mathematics; mathematical sciences applied to industry; obesity and associated diseases; cellular therapy; metropolitan studies; human genome and stem-cells; computational engineering; redox processes in biomedicine; violence; and optics, photonics, and atomic and molecular physics.²⁶

In addition, several state-funded incubators function as hotspots of innovation, among which:

- ▶ **Rio's Technology Park**, next to the Federal University of Rio de Janeiro and close to the offshore oil fields, thus closely linked to Petrobras and foreign companies as GE, Halliburton and Siemens. Innovation is driven by the discovery of oil fields in the pre-salt layers of the ocean bottom.
- ▶ **Campinas**, linked to the strong research university of Campinas (UNICAMP) and located in an industrial and sugarcane producing region, thus focusing on biofuels. However, the area also specialises in telecommunications, being linked to the Telebras Centre for R&D in Telecommunications (CPqD).
- ▶ **Supera** in Ribeirão Preto, on the campus of the University of São Paulo (USP), with a focus on biomedicine, biotechnology and dental equipment and supplies. The centre is responsible for the majority of academic studies in this field but also conducts consultancies in the area of biotechnology and medical equipment.
- ▶ **Porto Digital and CESAR** (Centre for Advanced Studies and Systems),²⁷ in the city of Recife, where companies such as Motorola, Samsung and Sony are active.
- ▶ **São José dos Campos**, which hosts Embraer and ITA and several other aerospace and defence-related institutes (since 1950s).

²⁵ <http://www.inova.unicamp.br/>

²⁶ See: <http://cepid.fapesp.br/en/home>

²⁷ Centro de Estudos e Sistemas Avancados do Reci.

3.3 Brazil within South America

According to the Global Innovation Index 2014, both Netherlands and Brazil fall in the top ten countries for their income group with regard to innovation quality, in particular due to knowledge creation through universities (e.g. measured by university ranking and citations). The Netherlands scores well on the global indices in general, ranking number five on the Global Innovation Index (before the USA).

However, it is not always a very useful exercise to compare Brazil and the Netherlands directly. Brazil has more than ten times the population of the Netherlands and a much higher overall GDP. As a result, Brazil ranks 11th in total R&D investments with 19.4 billion US\$, which entails 0.9% of GDP. The Netherlands ranks 17th with 10.8 billion US\$, which is, however, 1.6% of GDP.²⁸ Furthermore, Brazil is an upper middle-income country with a huge domestic market, while the Netherlands, being a small trade-dependent country, has a huge abroad. This has since long formed the countries' policies and business environment, thus impacting on innovation, science and technology.

Comparing Brazil to other South American countries in the rankings of the Global Innovation Index (GII) shows a mixed picture (see table 4).²⁹ Brazil scores highest in the University rankings, has a relatively high number of scientists and publications, and has the highest citation ranking and number of USPTO patents. However, Chile has a higher overall GII-ranking than Brazil (due to higher PISA scores and more university-industry collaboration) and also scores higher in the Global Competitiveness Index. Brazil and Argentina have more researchers per billion GDP than Chile, Colombia, Peru and Uruguay. Both Brazil as well as Colombia have relatively high net imports of high-tech. Brazil has the highest high-tech exports (which are very low for the other countries).

Such a mixed picture is to be expected from a continent that is culturally, socially, economically and politically diverse as Latin America. For example, Chile, Argentina and Uruguay score better on the Human Development Index, have a higher GDP per capita and have a higher life expectancy at birth than Brazil. Brazil, Colombia and Peru have a younger population than Chile, Argentina and Peru and a relatively low percentage of population of 65yrs old and above.

²⁸ http://en.wikipedia.org/wiki/List_of_countries_by_research_and_development_spending

²⁹ The choice of comparators in Table 3 is based on the trade with the Netherlands, whereby Uruguay, which scores relatively high on the GII, replaces Venezuela (trading mostly constitutes technology, probably for the oil and gas industry). CBS (2012) Evaluatie Nederlandse Handel en Investerings met Latijns Amerika 2002-2011.

Table 4 Comparative table Brazil, some other South-American countries and the Netherlands

	Brazil	Argentina	Chile	Colombia	Peru	Uruguay	Netherlands
Global Innovation Index ranking	#61	#70	#46	#68	#73	#72	#5
Population (millions)	200.4	41.1	17.5	47.7	30	3.4	16.8
Population ages 0-14 (% of total) ³⁰	24%	24%	18%	27%	28%	22%	17%
Population ages 15-64 (% of total)	69%	65%	69%	66%	65%	65%	64%
Population ages 65 and above (% of total)	8%	11%	10%	6%	7%	14%	18%
Life expectancy at birth total (years)	74	76	80	74	75	77	81
UNDP Human Development Index	#79	#49	#41	#98	#82	#50	#4
GDP per capita (US\$, 2013)	11,208	18,749	19,067	11,189	11,124	16,722	50,793
GDP (US\$ billions, 2013)	2,246 (#7)	488	277	382	206	56.3	853 (#17)
Gross expenditure on R&D (% GDP)	0,9%	0,65%	0,42%	0,17%	0,15%	0,43%	1,6%
Global Competitiveness Index 2014	#57	#104	#33	#66	#65	#80	#8
Trade balance	positive	positive	positive	negative	negative	positive	positive
Business environment (World Bank)³¹							
Ease of Doing Business	#120	#124	#41	#34	#35	#82	#27
Ease of Starting a Business	#167	#146	#59	#84	#89	#60	#21
Ease of paying taxes	#177	#170	#29	#146	#55	#140	#23
Enforcing contracts	#118	#63	#64	#168	#100	#106	#19
Ease of resolving insolvency	#55	#83	#73	#30	#76	#57	#12

³⁰ <http://data.worldbank.org/indicator/SP.POP.0014.TO.ZS/countries>

³¹ <http://www.doingbusiness.org/rankings>

Global Innovation index 2014³²	#53	#55	#45	#58	#61	#52	#10
PISA scales (reading, maths, science)							
Graduates in science and engineering (% total)	12%	14%	19%	22%	n/a	16%	14%
Researchers (per mln population)	1,203	1,942	551	346	181	735	4,979
Innovation efficiency ratio	0.7	0.8	0.7	0.6	0.6	0.7	0.9
QS university ranking (average score top 3 Univ.)	51.5	42.7	45.2	39.1	20.6	7.2	74
Scientific & technical publications (per billion GDP)	15 (#59)	10 (#72)	17 (#52)	6 (#97)	2 (#133)	13 (#67)	47 (#11)
Citable documents H index	305 (#22)	222 (#35)	194 (#37)	133 (#47)	109 (#57)	104 (#63)	576 (#8)
University/industry research collaboration (1-7)	3.98 (#46)	3.7 (#59)	4.27 (#39)	3.85 (#51)	3.14 (#105)	3.6 (#64)	5.25 (#11)
New businesses density (per thousand pop.)	2.2	0.47	5.7	2	3.8	3	4.4
Royalty & license fees receipts (% total trade)	0.2% (#39)	0.2% (#38)	0.08% (#58)	0.13% (#43)	0.01% (#91)	0% (#105)	4.7% (#3)
High tech net imports (% total)	11.3%	10.6%	9.7%	13%	8.37%	8.07	12.2%
High-tech net exports (% total)	3.3%	2.2%	0.63	0.85%	0.4%	1.4%	12.6%
Creative goods exports (% total)	0.21%	0.17%	0.21%	0.3%	0.3%	0.1%	5.9%
ICT & organisational model creation (1-7)	4.54	3.91	4.66	4.39	4.41	4.49	5.41
USPTO Patents ³³	334 (2014) 3,371 total	71 (2014) 1,597 total	63 (2014) 523 total	21 (2014) 313 total	5 (2014) 146 total	9 (2014) 102 total	2,505 49,453 total

³² <https://www.globalinnovationindex.org/content.aspx?page=gii-full-report-2014>

³³ http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

Brazilian – Dutch cooperation

4.1 Introduction

The shared history of Brazil and the Netherlands goes back for more than 400 years, with the presence of the Dutch West India Company (WIC) between 1630 and 1654. During the governorship of Johan Maurits van Naussau-Seigen the historical relationship between Brazil and the Netherlands took its shape and is still valued today in Brazil (relative for their time): tolerant policies, equal economic and social benefits, and the development of the infrastructure in Brazil (e.g. Recife).³⁴ The governorship of Johan Maurits also brought in artists who visually documented the peoples and landscapes of Brazil, as well as scholars who researched and documented the flora, fauna and geography of the country. The trade posts of the West India Company became important hubs of convergence of the Dutch and Brazilian culture. Later on, in the 19th century, different groups of Dutch emigrants settled in Brazil, often in agricultural colonies such as Holambra, since then renowned for its horticulture.³⁵

However, despite the recognition of the shared history, the Netherlands is not a country well-known to Brazilians today. The Brazilian perception of *Holanda* is rather traditional, with associations of agriculture, dikes, bikes, cows, tulips, and a liberal marijuana policy.³⁶ However, this perception does not acknowledge the 250 Dutch companies active in Brazil, such as ABN AMRO, Akzo Nobel, Amsterdam Arena, Arcadis, C&A, DSM, Getronics, Golden Tulip, Heineken, ING, KLM, KPMG, Makro, Philips, Rabobank, Randstad, Shell, Smit International, TNT, Unilever, Vescom, and SNV. It also does not do justice to the Dutch-Brazilian trade relations: Netherlands exports € 2.3 billion worth of goods and services to Brazil and its Brazilian imports are worth € 5.6 billion.

As the remainder of this report will illustrate, there is much more potential for cooperation in the field of ST&I. As a high-tech and knowledge-intensive country, the Netherlands has the potential to be an interesting ST&I partner for Brazil, while Brazil is an interesting ST&I partner for the Netherlands given the innovation that is happening in specific sectors of joint interest. Brazil faces challenges the world is facing: food and water

³⁴ <http://www.heritage-activities.org/#!brazil/c1qhl>

³⁵ The Brazilian Jose Duarte Pereira Hyginio travelled to the Netherlands in the 19th century to research and collect manuscripts on the Dutch in Brazil. Wiesebron, Marianne: *Brazilië in de Nederlandse archieven (1624-1654)*. Documenten in het Koninklijk huisarchief en in het archief van de Staten-Generaal. Leiden: CNWS Publicaties, 174.

³⁶ QualiBest (may 2015), *Projeto Imagen de Holanda*. Research for the Dutch Embassy in Brazil. In the perception of the Brazilian public, the most politically and economically active countries in Brazil are USA, Canada, Germany, France and Japan. From a technological point of view, China and South Korea are considered to be leading. The most 'modern' countries in the eyes of Brazilians are Japan, USA, Canada, South Korea, Germany and China.

security, climate change, urbanisation, an aging population and high pressure on logistics to transport food, water & people (see box 2 below).

Box 2. Brazil: the world in one country³⁷

According to a Brazilian industrial representative interviewed: “If your product is suitable for the Brazilian market, it is suitable for the world”. Exports of goods and services accounted for only 12.6% of GDP in 2014, illustrating the importance of the domestic market for Brazilian producers. Agriculture accounted for 5.7% of GDP and 15.3% of employment. Industry accounted for 21.9% of employment and services. Brazil’s GDP was US\$ 2,245 billion in 2014 (from a record high of US\$ 2,476 billion in 2012).

The population of Brazil was 202 million in 2014, increased by 11% from 182 million in 2004, (EU-28 has 507 million with a GDP of € 13,921 billion in 2014). The median age is 30.7 years (EU-28 is 41.9 years). Brazil is still young but aging fast. Brazil is also rapidly urbanising and already has 17 cities with a population above 1 million people (EU-28 has 19).

Land and wealth are unequally distributed in Brazil. The official unemployment rate is extremely low at 1.5% but 8.9% of the population (app. 16 million people) still live at the national poverty level. Of these, 38% live in the historically most impoverished Northeast region (most poor are subsistence farmers with low levels of formal education). The literacy rate is 83.3%. However, one of the successes of the last decade has been the income growth and reduction of poverty. The minimum wage is set by law at 788 R\$ per month.

Brazil is ethnic diverse with a confluence of people of different origins with original indigenous peoples, European colonisers (Portuguese mainly), African slaves and more recent immigration from Europe, Japan, Arab countries, Korea, China, Paraguay and Bolivia. Interestingly, the categorisation of people used by the Brazilian census bureau (IBGE) are heavily disputed. For example, most Brazilians see *Indígena* as a cultural rather than racial term, and rather describe themselves as part of the mainstream Brazilian culture. Many Brazilians would actually prefer to self-describe as *morenos* (“tanned” or “brunettes”). Such a cultural and ethnic mix in an open, tolerant and equal society is probably a challenge also EU-28 will soon face.

³⁷ Sources various including IBGE, data.worldbank.org, and FAOSTAT.

4.2 Government cooperation

Representation

The Netherlands has established an extensive presence in Brazil to support both Dutch and Brazilian companies. The economic network consists of the economic department at the embassy in Brasilia and consulate general offices in Rio de Janeiro and São Paulo. Throughout the country there are honorary consuls. Moreover, the Netherlands has so-called Netherlands Business Support Offices (NBSO) in Belo Horizonte, in the state of Minas Gerais, with a presence in Porto Alegre, in the state of Rio Grande do Sul.³⁸ The Netherlands Foreign Investment Agency has an office in São Paulo.³⁹ Furthermore, the Dutch Nuffic-Neso Brazil office has the responsibility for facilitating exchanges between universities and students in the Netherlands and Brazil.

For knowledge and innovation specifically, there is a so-called Counselor for Innovation, Technology and Science, with assistant, in São Paulo, and an Innovation Advisor, in Brasilia. This network aims to link innovative developments and innovative entrepreneurship in Brazil with the Netherlands and vice versa. To identify opportunities, this network has used roadshows throughout Brazil as well as cooperated with the production of the TV programme *Rota da Inovacao*.⁴⁰ They work in close cooperation with the broader economic network (which also includes a Defense attaché and an Agricultural Counselor). Their knowledge and understanding of innovative developments in both countries can be very helpful for both Brazilian and Dutch companies, research institutes and others interested.⁴¹

Figure 2 The Netherlands in Brazil



Government-related agreements

The Netherlands and Brazil have signed several (governmental) agreements with the intention of stimulating cooperation in the field of knowledge and innovation. In Brazil,

³⁸ <http://nbsso-brazil.com.br/>

³⁹ <http://www.nfia.nl/brasil.html>

⁴⁰ <https://www.youtube.com/watch?v=sNlq5hsIDY4>

⁴¹ Interviews with various stakeholders.

such formal agreements are considered to be the very first start of collaborations as they provide the legal framework for both governments to explore each other's strengths (e.g. through visits) and engage in joint activities (e.g. joint studies, student exchanges). According to interviews for this report, but also earlier studies of Dutch economic involvement in Brazil, Dutch signatories are not always aware of the significance of such agreements to Brazilians.⁴²

The main government-related agreements in the area of ST&I are the following:

► **Memorandum of Understanding on Science, Technology and Innovation**

This MoU between the Brazilian Ministry of Science, Technology and Innovation (MCTI) and the Dutch Ministries of Economic Affairs and of Education, Culture and Research (OCW) was signed in 2012 during the visit of the Dutch Royal Family to Brazil. The MoU is automatically renewed every two years. However, it is recommended to officially resign a MoU and use the opportunity to reconfirm commitment and adjust priorities are required.⁴³

The MoU has been accompanied by a Joint Committee through which both countries have the opportunity to present themselves and identify possible areas for cooperation. The first meeting took place on June 24th, 2013, in Brazil. At the meeting the delegations expressed interest to define a joint work program on the thematic areas on sustainable cities, bioeconomy, climate change, astronomy, food and agriculture technology, water resources, science communication policy, and renewable energy policies. A second Joint Committee, in the Netherlands or Brazil, is now overdue in order to further strengthen the cooperation between the countries (a.o. more joint calls for research proposals in specific areas).⁴⁴

► **Memorandum of Understanding on Biofuels⁴⁵**

In 2008 the Netherlands and Brazil first signed a MoU on Biofuels (one of five MoUs signed at the time). The formal objective of the MoU is "to promote a mutually beneficial partnership between the signatories in the field of bioenergy, including biofuels' and identified areas of cooperation".⁴⁶ The commitment to work together in

⁴² IOB, 2011, Economic diplomacy in practice. An evaluation of Dutch economic diplomacy in Latin America, Evaluation report nr. 385.

⁴³ For example, at the moment Brazil is considering severe budget cuts, also to science and technology. The implications are not yet clear but it seems plausible that the reduced budget might both stimulate the interest of Brazil in international cooperation and require setting of new priorities.

⁴⁴ Interviews.

⁴⁵ There are many more MoU that focus on specific sectors. For example, a Letter of Intent was signed in 2013 by the Government of the Netherlands and the National Water Agency (Agência Nacional de Águas, ANA) of Brazil to continue their successful cooperation and enhance the knowledge exchange on flood and drought risk management.

⁴⁶ Memorandum of Understanding between the government of the Federative Republic of Brazil and the government of the Netherlands on bioenergy cooperation including biofuels (2008).

this area was reconfirmed during the mission of the Dutch Minister of Economic Affairs, in 2010, when the issue of the sustainability of bioenergy was on the agenda as well. On 25 June 2012, the Dutch State Secretary of Infrastructure and Environment, and the Brazilian Ambassador at Rio+20 renewed the MoU Biofuels.

The MoU was expected to result in closer cooperation on biofuels that meet the EU sustainability criteria for renewable energy,⁴⁷ and in more exchange of knowledge on new technologies. An evaluation has pointed out that the MoU was, however, insufficiently operationalized to be of significant effect for both countries. Several meetings were organised, which did enhance mutual understanding between participants, but this is a limited effect given that the two countries have so much more to offer to each other in this area.⁴⁸

Furthermore, both in the Netherlands and in Brazil, there is mutual interest of decentralised governments, such as the Brazilian states and Dutch cities (e.g. Amsterdam, Rotterdam). There is, for example, a

► **Letter of Intent between municipality of São José dos Campos and the Dutch Ministry of Economic Affairs**

The purpose of Lol is to structure the cooperation related to the aerospace cluster and facilitate Dutch institutes/companies to establish themselves in São José dos Campos. Both Brazilian as well as Dutch actors in aerospace hope that joined projects can be developed and implemented in the nearby future.

► **Havenbedrijf Rotterdam in Brazil**

The Dutch public company Havenbedrijf Rotterdam, responsible for the management of Rotterdam harbour, signed a joint venture agreement with TPK Logistica in Vitória to develop the new harbour Porto Central in Espirito Santo.

► **The city of Amsterdam has defined Brazil as focal country**

Amsterdam has established a Brazil Desk of AmsterdamInBusiness to attract Brazilian companies to Amsterdam metropolis and visits are organised. Brazilian companies with linkages to this region are Samarco Minerações (through Samarco Iron Ore Europe), Companhia Brasileira de Metalurgia e Mineração (CBMM Europe), Probiotica Laboratorios Ltda (Probiotica Sports Nutrition), Marfrig Alimentos (owns Seara Meats).

⁴⁷ Sustainability was not specified and no specific targets were set.

⁴⁸ IOB (2013) Evaluation of Dutch Foreign Policy with respect to Latin America: case study sustainable bio-ethanol from Brazil. Authors: P.C.de Koning and M. Moreira.

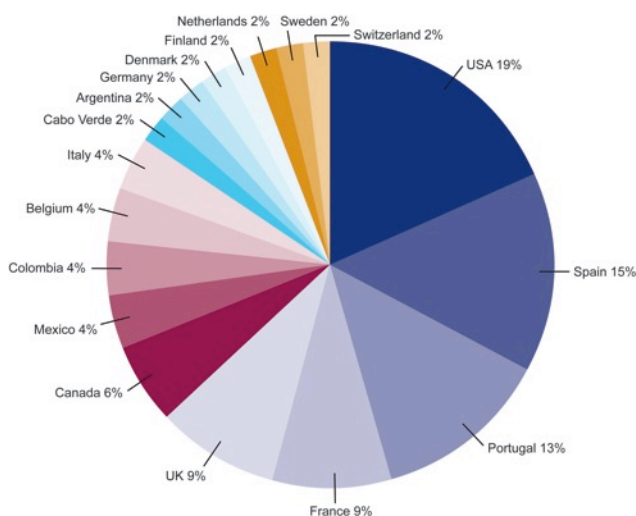
4.3 Academic cooperation

International students

Ciência sem Fronteiras / Science without Borders (SwB) is a large-scale Brazilian scholarship programme primarily funded by the Brazilian federal government (MCTI and MEC), with additional support from the Brazilian private sector.⁴⁹ It is run by the funding agencies of both Ministries: the Brazilian National Council for Scientific and Technological Development (CNPq) and the Brazilian Federal Agency for Support and Evaluation of Postgraduate Education (CAPES). The programme aims to enhance the international mobility of graduate students, researchers, and post-docs through short scholarships, and thus encourage research, innovation and exchange between Brazilian universities and colleges around the world.⁵⁰

Since the start 101.000 students received a scholarship for studying abroad as part of their Brazilian higher education programme. In July 2014 president Rousseff announced the continuation of the programme. From 2015 to 2018 another 100.100 scholarships will be made available (though some budget cuts are to be expected). For a career in Brazil, a Brazilian-accepted degree is rather important, for example to qualify for a government position or to receive funding for research. One general constraint of SWB is credit recognition between Brazil and the host country.

Figure 3 SwB graduates main country destinations⁵¹



⁴⁹ <http://www.cienciasemfronteiras.gov.br/web/csf>

⁵⁰ There are more programmes for researchers' mobility, such as PAPPE.

⁵¹ For undergraduate degrees, the Netherlands takes up about 2% as well. AEPLAN/Anuário de Pesquisa, 2014. VRERI/2014.

The programme to attract Brazilian SwB students to the Netherlands, called SwB Holland, is facilitated by the Dutch organisation Nuffic Neso.⁵² Nuffic Neso is active in Brazil with an office in Brasilia to promote Dutch higher education, stimulate institutional cooperation between Brazilian and Dutch universities and develop Holland alumni relations.⁵³ Dutch universities have also contracted commercial companies, such as the Brazilian company SetWeb, located in the Netherlands, to learn to attract Brazilian students.⁵⁴

Up to 2013 the Netherlands was the 10th destination for SwB students (nr 11 in 2014 being surpassed by Ireland and Hungary). On the basis of visa applications, Nuffic estimates that there are between 800-1,000 Brazilian students in the Netherlands, of which 10-20% have a double passport (and thus do not require a visa).⁵⁵ The possibility of studying in English, the connectedness of the Netherlands within Europe, the creative culture of the country and the high quality of its higher education are deemed to be attractive for the Brazilian exchange students.⁵⁶

From 2011 to 2014 the Dutch Higher Education Institutions received 1,284 undergraduate students for one year programmes, with a majority of students in engineering and other technical areas (49%) but also a significant amount in creative industry (19%) and biomedical and health sciences (13%). Between 2011 and 2013, the Netherlands received 343 researchers at PhD and Postdoc level, with the so-called 'Sandwich PhD' (a one or two years PhD programme in Holland) the most popular exchange (177 students in 3 years, compared to only 67 full PhDs). The most popular research areas are Biology, Biomedical Sciences and Health Sciences, Sustainable Agriculture Production and Engineering and other technical areas.

⁵² www.swbholland.org

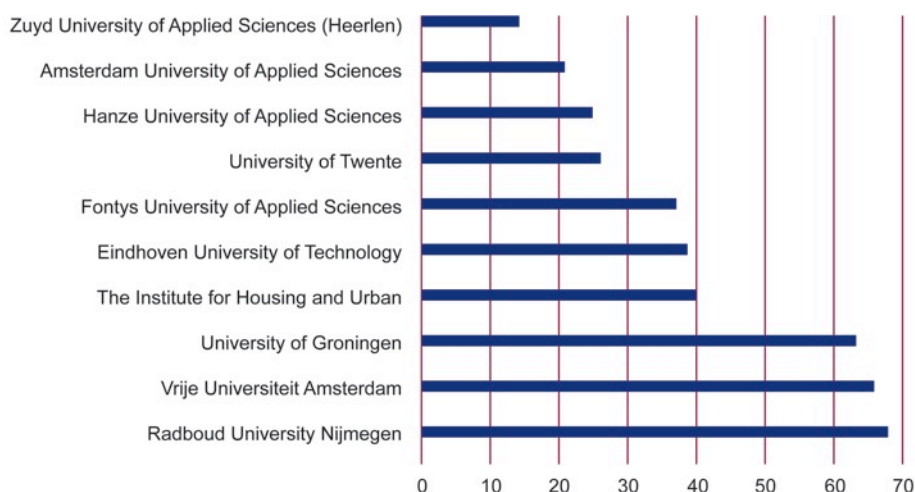
⁵³ www.nesobrazil.org and <https://www.nuffic.nl/en>

⁵⁴ SetWeb is a digital agency from Salvador, Brazil with headquarters in Amsterdam. <http://www.setweb.nl/about/>

⁵⁵ Interviews. These students include students that have a Sciences without Borders scholarship, students that pay for themselves and (maybe) students that are eligible for Dutch student support. See also: <https://www.nuffic.nl/bibliotheek/internationalisering-in-beeld-2013.pdf>

⁵⁶ http://swbholland.org/en/internas/?page_id=20. Nuffic Neso is currently conducting a study on the incentives for studying in the Netherlands.

Figure 4 Top 10 institutes in the Netherlands for SwB scholarships, 2015⁵⁷



In general, according to Brazilian Universities interviewed, the most popular destinations are those countries where students can receive a double diploma (called 'sandwich' programmes between Brazilian and foreign universities based upon a MoU). Unfortunately the Netherlands and Brazil do not yet accept each other's bachelor degrees but Dutch Universities are working to solve this constraint. At the moment there is not a very strong alumni network with Brazil (only per individual university).

Co-operation between Brazilian and Dutch research institutes

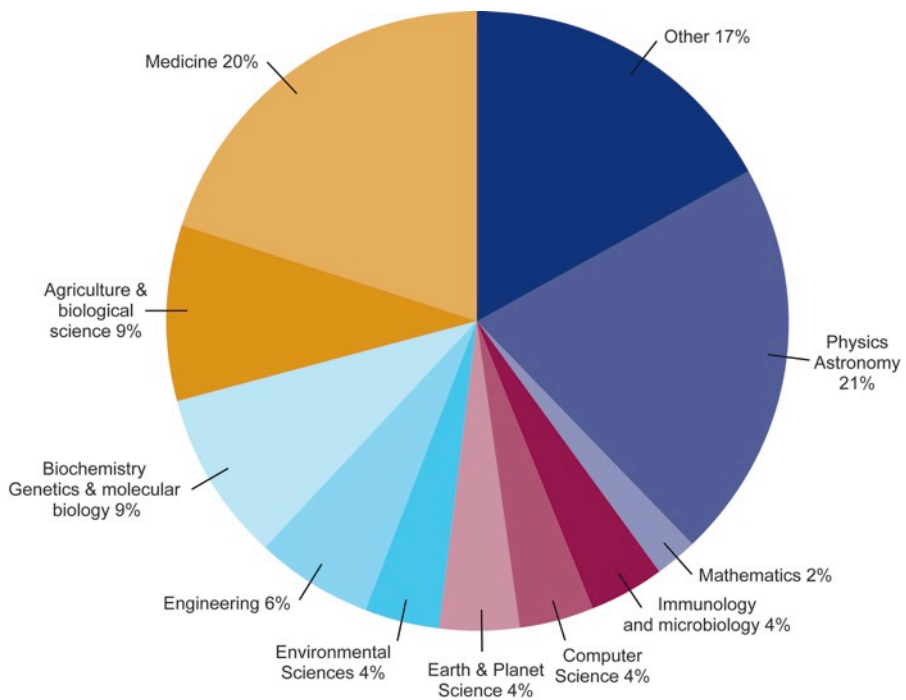
The academic collaboration between the Netherlands and Brazil is highly effective. Between 2008 and 2012, the countries produced 2,313 publications together, with 32% in Physics and Astronomy and 31% in Medicine. This might amount to only 4,3% of Brazil's total international collaboration (2.2% of the Netherlands). However, the impact of the publications is more than 3.5 times the world average (FWCI 3.7) and over twice the average Brazil's internally collaborated publications with other countries (FWCI 1,5).⁵⁸ It is then no surprise that the academic collaboration between Brazil and the Netherlands has been growing in recent years (19% since 2010).⁵⁹

⁵⁷ <http://www.ru.nl/io/actueel/nieuws/@992225/radboud-universiteit-0/>

⁵⁸ FWCI, Field-Weighted Citation Impact, is an indicator of mean citation impact, and is used as a proxy for research quality. In contrast to simple counts of citations, this measure accounts for differences in citation behaviour between fields, document types and publication years.

⁵⁹ Elsevier Research Intelligence, 2015, A custom analysis of Brazil's research output & impact. Analytical Services Report for AWTI.

Figure 5 Subject areas of co-authored publications



There are numerous agreements and Memoranda of Understanding (MoUs) between Dutch and Brazilian research institutes and universities. There is no formal overview or coordination, but all 13 universities in the Netherlands appear to have some sort of relationship with Brazil. The universities of Wageningen, Erasmus, Twente, Delft, Groningen and Eindhoven seem most active recently with new MoUs. Also Leiden is active in Brazil and wants to strengthen cooperation. Also UNESCO-IHE in Delft and various Dutch *Hogescholen* (universities of applied sciences) signed agreements with Brazilian counterparts (e.g. Inholland and NHTV Breda with USP).

Table 5 Dutch universities partnering with Brazil

University	QS ranking (2014)	Co-operation and MoUs in Brazil (not complete)
Utrecht University	80	USP
Leiden University	75	USP, UFPE, UFSC, UFRGS
Groningen University	90	USP, UFRJ
VU University Amsterdam	171	UFMG, UFRGS, UFPE, UERJ
Radboud Univ. Nijmegen	156	USP, program SWB
Univ. of Amsterdam (UVA)	50	USP, program SWB
Wageningen University	151	UFLA, USP, UFV
Erasmus Rotterdam	90	USP, FAPESP with Erasmus MC
Delft Univ. of Technology	86	ITA
Maastricht University	118	USP, FGV, PUC-RIO
Eindhoven Univ. of Technology	147	USP, FAPESP
University of Twente	212	USP, ITA
Tilburg University	367	USP, FGV

The interviews and reports on these agreements indicate that most of them are of a very general nature and at early stages. In general, three distinct phases can be identified in university cooperation:

1. Exchange of students and staff;
2. Joint projects: agreements are expected to be followed up by a joint projects (e.g. between two professors), beyond ad hoc co-authoring publications;
3. Institutional cooperation: Long-term, strategic cooperation on subjects of mutual interest.

Most MoUs between the Dutch and Brazilian universities are still at the stage of exchange of students and joint publications. Transferring to the next phase of joint projects requires longer term relations, a clear purpose and significant investments (in time and resources).

Fortunately there is funding reserved for Dutch-Brazilian academic cooperation. For example, the Dutch national research organisation, NWO,⁶⁰ and its Brazilian counterparts have issued several joint calls:

- ▶ NWO-CNPq Joint Calls for Proposals (2013) on
 - ▶ Bio-based economy: CNPq provided funding up to R\$ 4,000,000 and NWO provided funding up to € 1,650,000. Under this call 13 projects were approved.
- ▶ NWO-FAPEESP Joint Calls for Proposals on
 - ▶ Bio-based economy.
 - ▶ Sustainable cities (trilateral met ESRC from UK)⁶¹: The total budget amounts to € 5.4 million. The ESRC's contribution is up to € 2.4 million, NOW and FAPEESP will each contribute up to € 1.5 million.⁶² Seven multidisciplinary projects were selected e.g. on housing, transport, urban redevelopment and the nexus food-water-energy-environment).
 - ▶ Advanced instrumentation (Astronomy).

Moreover, CAPES and Nuffic-Neso Brazil signed an agreement to foster joint projects. In 2014 a joint call for proposals was issued for up to 30 joint projects from any area of study.⁶³ The call closed early 2015 and the results are expected soon.

4.4 Brazilian-Dutch Triple Helix

Increasingly, both in Brazil and in the Netherlands, governments aim to stimulate innovation by facilitating cooperation between the private sector and academia. In the Netherlands, the innovation model explicitly joins three main partners into the so-called 'Triple Helix' or 'Golden Triangle': government (e.g. Ministries, government institutes, city councils), companies, and universities and knowledge institutes. In some sectors, social actors and not-for-profit organisations are included in the model as well ('Dutch diamond' model). There are various potential benefits and risks.⁶⁴ A major advantage is the close connection between "demand" (i.e. the client being a company,⁶⁵ its customers,⁶⁶ society or local people) and "supply" (i.e. the available expertise and research capacity) that stimulates scientific research to address social, economic/commercial and environmental challenges, and facilitates the use of innovative knowledge and technology. The Living Lab concept (box 3) is developed based upon this perception.

⁶⁰ <http://www.nwo.nl/en>

⁶¹ <http://www.esrc.ac.uk/>

⁶² <https://www.nuffic.nl/en/education-promotion/institutional-cooperation/sources-of-funding/nuffic-and-capes-calls-for-proposals>

⁶³ <https://www.nuffic.nl/en/education-promotion/institutional-cooperation/sources-of-funding/nuffic-and-capes-calls-for-proposals>

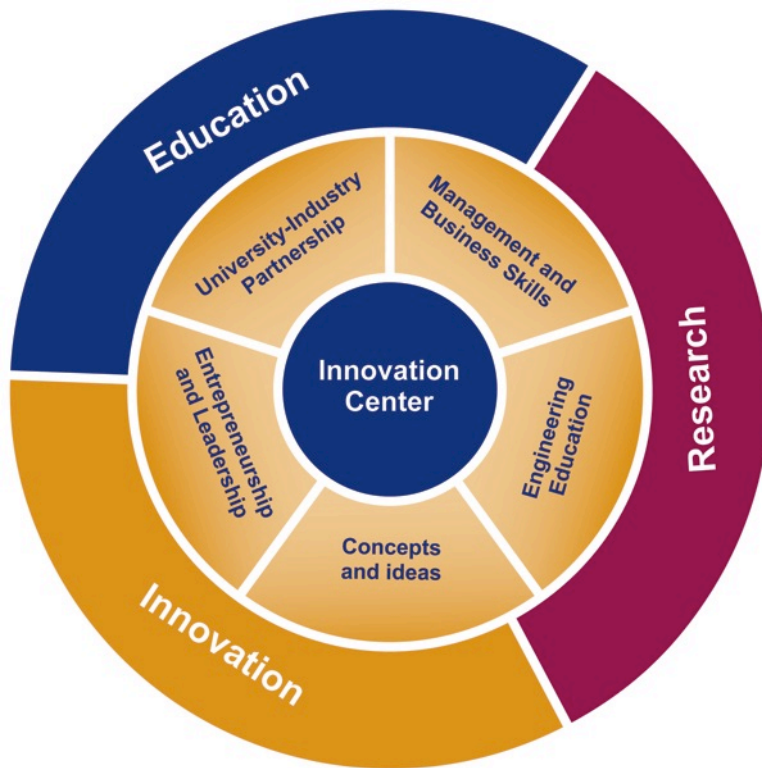
⁶⁴ <http://ppp.worldbank.org/public-private-partnership/overview/ppp-objectives>

⁶⁵ This might also lower the costs of doing business, including by diminishing opportunistic behaviour by companies (e.g. short term copying of technology or shopping elsewhere for similar but cheaper solutions). Source: experience by consultant with PPPs.

⁶⁶ With the rise of the Internet and social media the "demand" side, i.e. the opinions, interests and desires of people, has become more prominent.

The Brazilian government, academia and private sector equally recognise that innovation often originates from such cooperation. The concept of C2I, “Collaborate to Innovate”, is applied, for example, by ITA (Technological institute for Aeronautics).⁶⁷

Figure 6 ITA’s model for ‘Collaborate to innovate’⁶⁸



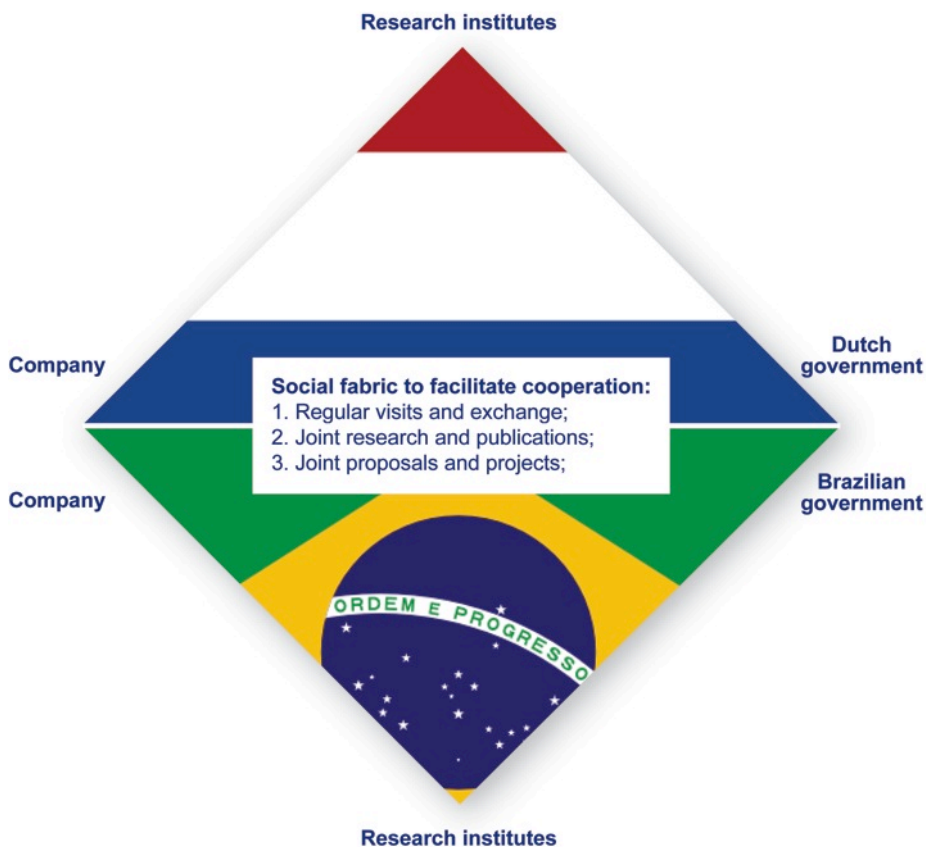
The interviews and experience of the Netherlands in Brazil clearly identify a great interest in this form of cooperation to be applied to Dutch activities in Brazil. This mutual interest should be used to inform the set-up of bilateral partnership, obviously adapted to the local context.⁶⁹

⁶⁷ Interview and presentation by ITA (2015). The basic premise of the C2i Project is that the process of innovation is not solely performed internally within a company, but is best performed in a cooperative mode with other external organisations.

⁶⁸ Presentation ITA during interview.

⁶⁹ The Dutch NWO has useful experience with such models in China and India (interviews).

Figure 7 Dutch-Brazilian cooperation model.



There are actually already several remarkable examples of such Dutch-Brazilian, Public-Private Partnerships, illustrating the variety of possible partnership formats (in different stages). For example:

- ▶ BE-Basic (Brazil office in Campinas): www.be-basic.org.
- ▶ Living Lab Bio-based economy (in Belo Horizonte): www.biobasedbrazil.org.
- ▶ The Aerospace Cluster – under development (in São José dos Campos).

Box 3. Living Lab on Biobased Economy

A Living Lab is a research concept. It consists of an open innovation ecosystem in which a service or product is co-created, tested and implemented together with the end-users as a form of public-private partnership. Projects are implemented in a real-life context. The Netherlands has several living labs, which are part of the European Network of Living Labs (ENoLL).

Together with Brazilian partners, Dutch higher education institutions are working on establishing a *Living Lab on Biobased Economy* in Belo Horizonte (Minas Gerais).⁷⁰ The focus is on value creation of waste streams, waste-water, bio-polymers, and logistical concepts. On the Dutch side are involved: the Centre of Expertise Bio-based Economy (CoE-BBE), Avans Hogeschool, HAS Hogeschool, HZ University of Applied Science, Nuffic, and on the Brazilian side: Universidade Federal de Minas Gerais (UFMG), Pontifícia Universidade Católica de Minas Gerais, Universidade Federal de Viçosa, and FAPEMIG (Fundação de Amparo à Pesquisa do estado de Minas Gerais).⁷¹ The next step in the development of Living Lab will be the involvement of the private sector.

4.5 The EU in Brazil

Brazil and the European Community signed a bilateral agreement for scientific and technological cooperation in 2004. It came into force in 2007 and was renewed for another five years in 2012. The objective of the agreement is to encourage, develop and facilitate cooperative activities in areas of common interest by supporting scientific and technological research and development activities. The counterparts are: MCTI on the Brazilian side and the Directorate General for Research and Innovation (RTD) on the EU side. In addition, a cooperation arrangement was signed in 2013 between the European Commission's Joint Research Centre (JRC) and MCTI. The agreement focuses on disaster prevention and crisis management; climate change and sustainable management of natural resources and ecosystem services; energy, including bioenergy and smart grids; food security; bio-economy; information and communication technologies (ICT), as well as nanotechnologies. Moreover, the EU established B.BICE+, an international cooperation project to facilitate cooperation and dialogue on science, technology and innovation, working with Brazilian CPqD.⁷² While Brazilian institutes are

⁷⁰ Originally there were two Living Labs in Brazil. The remaining LL in Espírito Santo aims at housing technologies for low-income people <http://www.openlivinglabs.eu/livinglab/habitat-living-lab>

⁷¹ <http://biobaseddelta.nl/artikel/biobased-delta-start-living-lab-in-brazilië>

⁷² <http://www.b-bice-plus.eu/> From the interviews, B.BISE+ appears to be rather unknown in Brazil.

not directly eligible to benefit from the European Horizon 2020 funding scheme, this has been used by EU member states to facilitate cooperation with Brazilian researchers (funded by Brazilian funding agencies).⁷³

However, in general Brazilian government and research institutes seem more interested to cooperate bilaterally with EU member states.⁷⁴ The most active EU government in Brazil on research and development is France with 24 joint calls with Brazilian institutes.⁷⁵ France is followed by Germany (17), United Kingdom (10) and Portugal (9). The most common research and innovation topics of EU member states are agribusiness, biotechnology, health, bioenergy and renewable energy, biodiversity and nanotechnology.

France earmarked Brazil as a strategic partner for international STI cooperation in its national strategy. France has also its own network with the Latin American countries (MATH AMSUD, STIC AMSUD). Over 800 bilateral agreements have also been signed between French universities and Brazilian partners.

Germany also considers Brazil its most important partner in the South American region. The priority research areas are:

- ▶ Sustainability, climate and environment
- ▶ Aerospace
- ▶ Life sciences and biotechnology
- ▶ Manufacturing technology
- ▶ University cooperation
- ▶ Bio-economy
- ▶ Vocational training

Germany has an active presence in Brazil. The German House of Science and Innovation in São Paulo (DWIH-SP) represents German universities and research institutions in Brazil and promotes exchange of scientific staff. The German Fraunhofer Institute (or rather *Gesellschaft*: about 20 institutes) was regularly mentioned during interviews as an example of cooperation between universities and companies. They also advice CNI, the National Confederation of Industry, since 2012. Embrapa established a food and farming laboratory in Germany based at the research centre Jülich.

⁷³ Horizon 2020' predecessor FP7 supported 78 German-Brazil projects and 69 France-Brazil projects.

⁷⁴ Interviews June 2015.

⁷⁵ Strategic Forum for International S&T Cooperation (2013), Research and Innovation cooperation between the European Union, Member States, Associated Countries and Brazil.

Given that Germany is a very important economic partner of the Netherlands in close proximity within Europe, and that the German ST&I priority topics are similar to Dutch priorities, Dutch-Brazilian-German trilateral collaborations could potentially be interesting. Furthermore, in 2012, UK and Brazil set up an innovation collaboration platform with the participation of leading Brazilian and British institutions. Denmark has established an Innovation Centre in Sao Paulo. There is also a Swedish Brazilian Research and Innovation Centre. Innovation Norway Brazil provides advisory, promotion and networking services for Norwegian companies, in addition to temporary office facilities at the Business Incubator Office in Rio de Janeiro. Portugal has a long-standing cooperation history with Brazil and signed various MoUs and bilateral agreements. Spain and Portugal are both involved in the Ibero-American research and development program (CYTED), in innovation cooperation networks (IBEROEKA⁷⁶), and in a network of 20 universities promoting innovation (RedEmprendia). The three countries signed a MoU in 2013, on cooperation in nanotechnology and established a joint nanotechnology laboratory in Braga, Portugal.

⁷⁶ IBEROEKA: Since 1991, Brazil (FINEP and CNPq since 2012) and Spain (CDTI) are part of the IBEROEKA initiative aimed at promoting market oriented and industry led R&D&I collaborations in the Ibero-American region. IBEROEKA is part of the Ibero-American Programme for Science, Technology and Development (CYTED), created in 1984 and gathering Spain, Portugal and 19 Latin American countries. It's main objective being to promote cooperation in Research and Innovation for the development of the Latin American region.

Brazilian – Dutch cooperation per sector

5.1 Introduction

The Netherlands has identified nine so-called ‘Top Sectors’, in which the country should excel with regard to international trade but also innovation and research.⁷⁷ In line with the Dutch cooperative model, business, researchers and government all work together to implement this policy.⁷⁸ The nine top sectors are:

1. Agro & Food
2. Chemicals
3. Creative industry
4. Energy
5. High Tech Systems and materials
6. Life Sciences & Health
7. Logistics
8. Horticulture and propagating stock
9. Water

Unsurprisingly, Brazil is a focus country for the international strategy of each of these nine top sectors. The Dutch enthusiasm and mutual interest is illustrated by the 160 Dutch companies that joined the Dutch Royals on their official visit to Brazil in 2012. Subsequently, the Dutch government decided to visit Brazil with a trade mission each year.⁷⁹ The organisation of incoming missions, inviting Brazilian stakeholders to the Netherlands to experience the potential of the Netherlands first hand and explore possibilities for cooperation on the spot, might be even more effective according to an evaluation of Dutch economic diplomacy in Latin America.⁸⁰

For this report a selection was made of sectors in which Brazil and the Netherlands are increasingly cooperating with mutual benefits. This list could easily have been much longer, including all top sectors (e.g. oil & gas). However, the focus for now is on:

1. Agriculture (Agro & Food sector)
2. Biomass (Agro & food, Energy and Chemicals sectors)
3. Water (in particular integrated water management, water and delta technology)
4. Life sciences & Health
5. Aerospace (High Tech Systems and materials, but also applications in Agriculture)

⁷⁷ <http://topsectoren.nl/english>.

⁷⁸ Top consortiums for Knowledge and Innovation (TKIs)

⁷⁹ Organised by the Netherlands Enterprise Agency (www.rvo.nl)

⁸⁰ IOB, 2013, Economic Diplomacy in Practice.

5.2 Agriculture

Agriculture in Brazil

The Brazilian agribusiness sector is domestically and internationally very competitive and considered to be an innovative sector. Brazil is one of the world's leading exporters for various commodities, such as soy, sugar, coffee, meat (chicken, beef), tobacco, maize, cotton lint and orange juice.⁸¹ The country has several large agricultural companies such as Bunge (soy), JBS⁸² (beef) Cosan (sugar) and BRF⁸³ (animal protein).⁸⁴ There are also numerous successful small and medium-sized farmers that produce for the domestic as well as the international market. The flipside of this success is, however, that Brazil's GDP might actually be too dependent on agricultural commodities.⁸⁵

Brazil is self-sufficient in basic food-stuffs and the bulk of domestic production in cassava, maize, beans, cacao, bananas, and rice is consumed domestically. In the Southern part of Brazil the interest in organic products is growing among urban consumers. Besides agricultural commodities, Brazil also produces timber and other forest products (Brazil nut, the fruit Açaí, essence oil Copaíba, scent fixer Rosewood)⁸⁶, which have a high commercial value and find their way to the European market. However, in poorer regions, like the Northeast, food security remains an issue.

For Brazil to maintain its international competitiveness, productivity-enhancing R&D is considered very important (per hectare, per labourer). This is a challenge for Dutch agricultural production as well, and a possible area for cooperation. Though obviously the challenge in Brazil is of a different nature, not in the least due to the different scale (e.g. given the size of agricultural land in Brazil compared to the Netherlands).

Both in Brazil and the Netherlands, the agriculture sector increasingly uses sophisticated technology for production and processing, including climate resilient seeds, GPS positioning, satellite imagery, remote sensors (e.g. to monitor soil and climate conditions) and Geographic Information Systems (GIS). The 'Internet of Things' and the 'big data' revolution are expected to further stimulate so-called Smart or Precision Farming, which should help improve productivity (e.g. timing of planting, interventions and harvesting), resource efficiency, storage and reduce waste.

⁸¹ <http://faostat.fao.org/site/342/default.aspx>.

⁸² http://www.jbs.com.br/en/about_jbs

⁸³ <http://www.brf-global.com/brasil/en/about-brf/our-history>

⁸⁴ ADM, Cargill, Bunge, Louis Dreyfus Corp are the other main trading companies in the soy sector. Cosan SA, São Martinho and Açúcar Guarani are the main producers of sugar.

⁸⁵ Interviews. <http://www.americasquarterly.org/kingstone>

⁸⁶ Natura Brasil (#1 in Brazil) established itself in Europe (France) and started selling in the Netherlands (see BelezaBrasil.nl)

Part of the strength of Brazil comes from the large investments in agriculture research that have been made since the '70s, including institutes such as the National System for Agricultural Research and Innovation (SNPA) and Embrapa, the knowledge institute of the Ministry of Agriculture, Livestock and Food Supply.⁸⁷ 79% of the research spending is by federal and state organizations (mainly Embrapa) and 15% by higher education agencies.⁸⁸

Embrapa has been responsible for the science-based development of new crops specific to Brazilian conditions since the 70s.⁸⁹ One of these crops were soybeans, of which Brazil is now the largest producer globally. More recently, Embrapa has played an important role in the biofuels sector by improving the productivity of sugar cane. Embrapa employs 10,000 staff of which 3,000 PhD-level researchers, spread over 46 centres within 22 concentration areas. The total budget amounts to 1.2 billion US\$. The government funds most of the budget though this funding has declined recently (-30% in 2015).⁹⁰

International cooperation and exchange has increasingly been used to enhance staff capacity and address complex challenges such as climate change.⁹¹ This is promoted through:

1. Visiting scientists (e.g. with Dutch Wageningen University, WUR).
2. Brazilian scientists abroad (including through Science without Borders).
3. Bilateral joint courses.
4. Joint calls for research proposals.
5. Partnerships.
6. LABEX, a virtual laboratory for international exchanges.⁹²

Besides Embrapa, the main Brazilian organisations conducting research related to agriculture are:⁹³

1. State University of Campinas (UNICAMP).
2. Agronomic institute of Campinas (IAC).⁹⁴
3. University of São Paulo (USP).

Private expenditures on research are limited (not much more than 5%). Among those, BRF started its own innovation centre in 2013, focusing on meat products, pastas, margarines, vegetables and packaging.⁹⁵

⁸⁷ Embrapa (2010), The Brazilian Agriculture Research for Development System.

⁸⁸ IFPRI (2001), Agriculture R&D in Brazil: Policy, investments and institutional profile.

⁸⁹ <https://www.embrapa.br/>

⁹⁰ Website EMBRAPA and interview 2015

⁹¹ Currently focusing on USA, South Korea, Germany and France

⁹² <https://www.embrapa.br/programa-embrapa-labex>

⁹³ Moreover, 70 agronomy schools provide technical education for this sector.

⁹⁴ <http://www.iac.sp.gov.br>

Cooperation Brazil - Netherlands

Firstly, the Netherlands and Brazil are close trading partners in the agricultural sector. Several Brazilian soy traders (Bunge, ADM) export to Europe via the Netherlands. Dutch companies as Unilever and Aviko successfully sell their products in the Brazilian market. While no Dutch company owns agricultural land in Brazil, Dutch companies have invested in agriculture related companies. For example, in 2012, the Dutch multinational DSM bought the Brazilian Tortuga company, the leader in nutritional supplements for ruminant and beef cattle market in Brazil.

Moreover, several Dutch non-governmental organisations (NGO), such as Solidaridad and Tropenbos International are active in Brazil in the agricultural and forestry sector, given its importance for the world as a whole. For example, Tropenbos cooperates with Brazilian entities, such as Amazon Cooperation Treaty Organisation (OTCA),⁹⁶ on sustainable production for the domestic market by Brazilian forest producers.

The Netherlands and Brazil also cooperate in the area of research and development. Various agreements have been signed between Dutch and Brazilian universities, often overlapping, e.g.

► **Wageningen University (WUR) and Universidade de São Paulo (USP)**

In 2006 the WUR established collaboration with the Faculty for Food and Agriculture of USP and opened a local office in Piracicaba in 2007. This office was to become the Latin American office of WUR with a focus on Brazil, Argentina, and Chile and lead to the expansion of WUR's network, new partnerships and the development of a research portfolio. While the Latin America office moved to Chile in 2012 (because of an generous offer made by the Chilean government), the cooperation with USP continues in the area of dairy, horticulture and environment & water.

► **Wageningen University (WUR) and Universidade Federal de Viçosa (UFV)**

In 2013, the WUR signed a memorandum of understanding with UFV to fortify their existing cooperation on education and research on the dairy chain.⁹⁷ The cooperation includes an exchange of scientists, PhDs and graduate students.

► **University of Twente and the Universidade de São Paulo (USP)**

USP and UT cooperate on water management and natural resources. In 2014, a MoU was signed to also include cooperation in the field of nano-technology, energy technology and materials. Cooperation does not only involve research, but also includes the development of new teaching models and programs.

⁹⁵ <http://www.brf-global.com/brasil/en/innovation/innovation-center>

⁹⁶ <http://otca.info/portal/>

⁹⁷ <https://www.wageningenur.nl/en/show/MoU-with-UVF-Brazil.htm>

Box 4. Agriculture innovation in the Netherlands

The Netherlands is a leading exporter in vegetables and fruit, and a major portal to the European Union for other export countries such as Brazil. With more than 10% of the GDP and more than 20% of the industrial export, Agro-Food is one of the biggest economic sectors in the Netherlands.⁹⁸ Most companies are small and medium sized companies (90-95%) but 8 of the 25 largest companies in the Netherlands are food companies. In each food-chain segment there are internationally operating world-class companies. Four Dutch food companies are in the world top 30 companies (Unilever, Heineken, Vion and Friesland Campina). All segments of the chain are highly interactive. A company active in one specific segment can work together with world-class companies in other parts of the chain.

The agriculture knowledge infrastructure in the Netherlands is very strong. Wageningen University is internationally renowned, but also the entities such as the Top Institute Food & Nutrition; the public-private innovation program Food & Nutrition Delta; TNO⁹⁹ and NIZO food research are well known internationally. All in all, an estimated 8,000 scientists are involved divided over 20 research institutes and 70 research companies. Moreover, there are interesting cross-disciplinary interactions, for example as part of the Netherlands Genomics Initiative with dedicated Genomic Centers all over the country. Moreover, the Dutch government, in cooperation with the private sector, has a dedicated program for start-ups in this sector (StartLife).¹⁰⁰

Companies in the agriculture sector in the Netherlands invest above average in R&D, leveraging the knowledge infrastructure for their innovation portfolio. An interesting example of the way in which innovative R&D is organised in the Netherlands, is the Dutch Food Valley, which was established in 2004 as an innovation network, facilitating cooperation between science and companies. The initiative now includes 135 companies and Denmark, Japan, Thailand and USA as international members.¹⁰¹

⁹⁸ <http://www.hollandtrade.com/sector-information/agriculture-and-food/>

⁹⁹ Netherlands Organization for Applied Scientific Research

¹⁰⁰ <https://start-life.nl>

¹⁰¹ <http://www.foodvalley.nl/eng/>

5.3 Biomass¹⁰²

Biomass in Brazil

Brazil is renowned in the area of biomass, which includes the production of bio-ethanol from sugar cane, production of biodiesel from soy and the use of wood for iron ore production. Brazil has many other waste streams that could be useful for a bio-based economy, but are not used yet (e.g. biogas from agricultural waste, solid biowaste).¹⁰³

Brazil is the leading producer of bio-ethanol from sugar cane. According to a recent study on biomass in Brazil, sugarcane-ethanol sector has gone through two distinct phases to arrive where it is now: expansion and consolidation. During the biofuel boom of the mid-2000s, Brazilian and international companies invested heavily in Brazilian agriculture and biofuel companies. This hype has now subsided with the decline of the global economy and more subdued and realistic commercial expectations.¹⁰⁴

Currently, Brazil continues to expand its biomass production to meet the growing domestic demand. The government actively stimulates the use of oils for the production of bio-diesel for domestic use and in the transport sector (80% from soy, but also from sunflower, castor and palm oil). Government, universities and companies in Brazil all invest in biomass research, often in cooperation with international partners, including the Netherlands. High-tech, bio-based product and material development is still limited however.¹⁰⁵

There are some very interesting innovative developments in the field of biomass in Brazil, among others in the field of energy diversification and bioplastics. For example, with some limited modifications on the car engine, car companies in Brazil started to sell Flex Fuel Vehicles (FFV) that could run on any blend, from pure petrol to 100% Ethanol. Brazilian consumers thus have the choice between two different kinds of fuels with completely different production structures: ethanol and petrol. The opportunity to choose the type of fuel at the pump station was a public success, and by 2009 more than 80% of all new vehicles sold in the Brazilian market were FFV. The substitution of petrol cars by FFV is seen to boost demand for ethanol (as long as the ethanol prices at the pump are

¹⁰² In this report biomass includes biofuels and bio-based materials. Biofuels refers to both biodiesel and bio-ethanol. EU Renewable Energy Directive: "the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste".

¹⁰³ See for the latest update the recent Ecofys (2015) report "Market opportunities related to biomass in Brazil".

¹⁰⁴ IOB (2013) Evaluation of Dutch Foreign Policy with respect to Latin America: case study sustainable bio-ethanol from Brazil. Authors: P.C.de Koning and M. Moreira.

¹⁰⁵ Souza, G. M., Victoria, R., Joly, C., & Verdade, L. (Eds.). (2015). Bioenergy & Sustainability: Bridging the gaps (Vol. 72, p. 779). Paris: SCOPE. ISBN 978-2-9545557-0-6. Download available at: <http://bioenfapesp.org/scopebioenergy/index.php/chapters>

lower than 70% of the price of petrol).¹⁰⁶ Moreover, Embraer has developed an airplane that flies on ethanol (the so-called Ipanema agriculture aircraft).

Also interesting is the fact that electricity is now the third product originating from the sugarcane industry, besides sugar and ethanol. The sugarcane mills use sugarcane residue (*bagasse*) to produce steam and electricity for their production process and as such need no additional energy input. This makes sugar and ethanol production very energy efficient and provides the opportunity to direct surplus electricity elsewhere. The timing of *bagasse*-based electricity (i.e. in the dry season when production from hydropower is lower) and the proximity to large cities, could give it a strategic significance in Brazil's energy production.

Bio-plastic is another area of innovative development in Brazil, together with the development of second-generation biofuels (alongside improving the efficiency of the first-generation biofuels). Brazilian companies are investing in technology to produce bio-plastics from sugarcane (e.g. Braskem SA)¹⁰⁷ and researching new products, e.g. the use of biomass as feed-stock material for other bio-based materials such as composites and paint (e.g. GranBio Investments with the Belgium company Solvay) or cellulosic fibers (e.g. Cosun).¹⁰⁸ As the next section illustrates, there is also some interesting Dutch-Brazilian cooperation in this field.

These innovative developments benefit from several well established research centres, such as the Sugarcane Technology Centre (Centro de Tecnologia Canavieira, CTC), Brazil's main sugarcane research centre located in Piracicaba (SP).¹⁰⁹ In the biomass sector, research is often conducted through close cooperation between companies and universities or research institutes. For example, the companies EMBRAER and Boeing, interested in the use of biofuels instead of kerosene, established a Biofuels Research Centre in close cooperation with FAPESP and UNICAMP.¹¹⁰

Co-operation Brazil - Netherlands

The cooperation with Dutch organizations on biomass concentrates on a few companies and research institutes (in the Netherlands in particular Wageningen University, WUR). Researchers have been able to make use of the joint financing mechanisms of FAPESP (São Paulo universities) and NWO (Dutch universities). Another interesting initiative where biomass researchers meet entrepreneurs in a Brazilian-Dutch cooperation is the so-called Living Lab (see box 4) and the BE-Basic initiative (see box 5 here below).

¹⁰⁶ In high ethanol blends, the energy content of ethanol is approximately 70% of the gasoline.

¹⁰⁷ Other new sugarcane related products (e.g. pyrolysis oil and animal feed are not yet considered as there is no commercial incentive).

¹⁰⁸ www.cosunbiobased.com/explore-our-portfolio/explore-by-product/betafib-mcf.aspx

¹⁰⁹ <http://www.ctcanavieira.com.br/index.html>

¹¹⁰ <http://biomassmagazine.com/articles/11431/boeing-embraer-open-aviation-biofuel-research-center-in-brazil>

Box 5. BE-Basic Brazil¹¹¹

The BE-Basic Foundation is an international public-private partnership that develops industrial biobased solutions for a sustainable society. The BE-Basic Foundation initiates and stimulates collaboration between academia and industry, between scientists and entrepreneurs and between the Netherlands and abroad. The definition used by BE-Basic for innovation = invention + implementation. The ambition is to develop at least 60 patents, 120 invention disclosures and create at least 4-5 new start-ups and promote 4-5 existing start-ups. In addition, BE-Basic promotes entrepreneurship among young scientists through training, support and competition.

BE-Basic with the Technical University of Delft (TU) established an office in Campinas (São Paulo state) in 2012. The foundations for the collaboration with Brazil originate from the nineties with academic and industrial partners from the B-Basic consortium, the predecessor of BE-Basic.

Collaborations with Brazil build on an integrated business plan of activities, which are formalised in joint agreements:

- ▶ FAPESP - São Paulo Research Foundation and its BIOEN Research Programme (2010)
- ▶ CTBE - Brazilian Bioethanol Science and Technology Laboratory (2011)
- ▶ UNICAMP - University of Campinas (2012)
- ▶ FIESP - Federation of Industries of São Paulo State (2012).

The added value of the Dutch partners is thought to be the focus on the whole biomass chain and especially its interactions with the insight in multiple products (chemical value chain or 'cascading').¹¹²

Every year BE-Basic issues a joint call with FAPESP. The budget is € 2-3 million per call (50-50%). So far three calls for proposal were launched and 10 projects approved. The main results are expected 2016-2017.

Some lessons from the experience of BE-Basic Brazil are:¹¹³

- ▶ Local presence is a major advantage in Brazil.
- ▶ Importance of building on already existing academic (personal) relations and addressing a clear mutual interest.

¹¹¹ Based on interviews and www.be-basic.org.

¹¹² Interviews.

¹¹³ Interviews.

- ▶ The first 3-4 years were required to build up a profile, for the concept to be well understood and to develop joint publications and projects.
- ▶ Expansion follows from this basis, which takes time to establish.
- ▶ A wider consortium (rather than just a Dutch and a Brazilian university also including government and private sector) helps to retain momentum and push the agenda forward. It also supports the budget (e.g. for joint calls).

An interesting example of Dutch-Brazilian cooperation in the private sector is Raízen. Raízen is the joint venture between Royal Dutch Shell, the largest global trader in ethanol, and Cosan, the largest ethanol producer of Brazil.¹¹⁴ For its R&D Raízen cooperates with private research institutes such as Logen and Codexis (e.g. on the development of biocatalysis and biocatalyst products). Moreover, Raízen is one of the institutional partners of CTC, the Sugarcane Technology Centre, and has an educational partnership with the Centre for Innovation in Logistics Engineering (CISLOG, Centro de Inovação em Engenharia de Sistemas Logísticos).¹¹⁵ Moreover, the Dutch company DSM, well advanced in biotechnology, materials sciences and chemistry, is active in Brazil.¹¹⁶ DSM Bio-based Products & Services is pioneering renewable energies such as bio-ethanol, biodiesel and in renewable chemical building blocks like bio-based succinic acid (used for a variety of products from packaging to footwear).

Furthermore, Dutch and Brazilian companies have found each other in active involvement with improving the sustainability of the sugarcane and ethanol production. In 2010, the Better Sugarcane Initiative evolved into the BonSucro organisation and standard, with memberships from 19 different countries. Bonsucro is a collaboration of sugar producers, retailers, investors, traders, producers and NGOs with the aim of reducing the social and environmental impact of sugarcane production to the benefit of sugar farmers and all others concerned with the sugarcane supply chain. Dutch members include the companies Argos NSG Ltd., CSM Ltd., Rabobank Ltd., Suiker Unie Ltd. and the NGO Solidaridad.¹¹⁷ Members from Brazil include 17 large companies, including Agrovale, Braskem, Bunge, Copersugar, and Raízen.

¹¹⁴ <http://www.shell.com/global/environment-society/environment/climate-change/biofuels-alternative-energies-transport/biofuels/raizen.html>

¹¹⁵ CISLOG belongs to the Production Engineering Department of the University of São Paulo (USP) and the Vanzolini Foundation, and offers assistance for the training of Raízen's staff in the area of logistics, distribution and trading.

¹¹⁶ <http://www.dsm.com/corporate/about/business-entities/dsm-biobased-productsandservices.html>

¹¹⁷ <http://nl.solidaridadnetwork.org/sugarcane>

Box 6. The Netherlands and biomass¹¹⁸

The current use of biomass in the Netherlands mainly consists of low-tech use of wood pellets in co-firing to produce electricity. However, the Dutch government and industry is very interested in developing a high-value use of bio-based resources to replace fossil resources, i.e. a bio-based economy. The Netherlands has set blending targets for the use of ethanol and bio-diesel. The target for 2015 is 6.25%.¹¹⁹ The experience Brazil of in this area is therefore of great interest for the Netherlands.

An interesting development in the pursuit of the bio-based economy is the cooperation of companies and research institutes from different sectors in a value chain with a variety of end-users (e.g. covering agriculture, chemical, energy, paper and pharmacy sectors). For example, Dutch research on aviation biofuels includes actors as the jet fuel supplier, SkyNRG,¹²⁰ aviation companies such as KLM, and a company like DSM, focusing on bio-based products and services.

There are, moreover, several actors in the Netherlands, companies and researchers, that invested in advanced technology for thermochemical conversion of lignocellulosic materials from sugarcane, which might be attractive for the Brazilian market. For example, the Dutch BTG BioLiquids is a pyrolysis technology provider, where most types of non-food biomass are converted into a second generation bio-oil within seconds.¹²¹ Torrgas is a Dutch, privately funded, clean technology company that works with the Energy research Centre of the Netherlands (ECN) to produce Syngas from torrefied (biocoal) biomass as feedstock.¹²²

Sustainability is an important aim of the Dutch involvement in the biomass sector. The Netherlands adheres to the sustainability criteria in the EU's Renewable Energy Directive and established a Sustainable Biomass Commission to provide advice to the Dutch government.¹²³ The concept of a bio-based economy is considered to be closely related to the concepts of a circular economy and cradle-to-cradle, whereby the aim is for products and materials to be re-used and basic resources to retain their value. These concepts are drivers of technological innovation world-wide.

¹¹⁸ <http://www.biobasedeconomy.nl/bedrijfsleven-biobased/sectoren/>

¹¹⁹ The EU target for 2020 is 10% (EU Renewable Energy Directive).

¹²⁰ <http://skynrg.com/>

¹²¹ Biomass-to-Liquid (BTL). See <http://www.btg-btl.com/en>

¹²² ECN (2006) Synthesis gas from biomass for fuels and chemicals c06001

¹²³ <http://www.corbey.nl/de-commissie/>

5.4 Water sector

Water sector in Brazil

Brazil is a water-rich country, but the country also faces regular droughts (as well as floods and mudslides). A striking example of the country's water related problems was the severe drought early 2015, the worst since 1930, with major consequences for water reserves, energy production from hydroelectric dams and the availability of drinking water.¹²⁴ Moreover, the drying up of Amazon rivers, linked to deforestation, climate change and weather circumstances as El Niña, has been a cause of concern in the past decade.¹²⁵ The term Amazon's 'flying rivers' was introduced to describe the connections between the vapour clouds in the Amazon and the rainfall patterns in the South.¹²⁶

Moreover, despite having improved access to water services since the '90s, including through (reluctant) cooperation between government and the private sector,¹²⁷ the growing demand from industry and population is expected to add pressure on Brazil's system for water management, drinking water and sanitation. A study of the Academia Brasileira de Ciencias (2010) identified as the main challenges of the water sector:¹²⁸

- ▶ lack of access to safe drinking water for rural and poor people in some regions (related to over-extraction by agriculture and erosion, which causes silting up of rivers).
- ▶ water pollution (e.g. untreated sewage, agriculture run-off, sludge and waste water from heavy industry).¹²⁹

Another study by the National Water Authority (ANA) predicted that more than half of the municipalities will face problems with the provision of drinking water if they do not invest in diversification of water resources, strengthening production, storage and distribution, and water treatment /purification.¹³⁰

The organisation CEMADEN (the National Centre for the Monitoring and Warning of Natural Disasters) was established in 2011 (after mudslides killed 900 people), which now monitors more than 800 cities (mostly concentrated along the coast as these are the most critical areas in terms of risk and people potentially affected) with 9 radar systems, 3,000 automated rain meters and 960 semi-automatic meters. Recent droughts

¹²⁴ <http://www.independent.co.uk/news/world/americas/brazil-hit-by-worst-drought-since-1930-as-taps-in-sao-paulo-and-rio-de-janeiro-run-dry-10000234.html>

¹²⁵ <http://www.carbonbrief.org/blog/2013/10/drying-in-the-amazon-rainforest-what-could-it-mean-for-climate-change/>

¹²⁶ <http://www.theguardian.com/environment/2014/sep/15/drought-bites-as-amazons-flying-rivers-dry-up>

¹²⁷ Rossi de Oliveira (2011) impact of private sector participation in the provision of water services in Brazil: Empirical analysis and policy recommendations.

¹²⁸ http://www.abc.org.br/rubrique.php3?id_rubrique=150

¹²⁹ For example, the Sao Francisco river:

<http://cpwfbfp.pbworks.com/w/page/5926998/S%C3%A3o%20Francisco%20River%20Basin>, confirmed by research such as <http://agenciabrasil.ebc.com.br/geral/noticia/2015-03/pesquisa-com-111-rios-brasileiros-mostra-que-23-estao-impropios-para-o>

¹³⁰ ANA, 2nd National Investment Programme.

experienced by the citizens in São Paulo and Rio de Janeiro (and ensuing protests and media attention) have put pressure on the Brazilian government to address prevention, and work on long-term water management solutions.

Moreover, Brazil has taken advantage of Information and Communication Technology (ICT) innovations in the water sector, partly as a result of the efforts of the National Council for Scientific and Technological Development (CPqD) to promote ICT innovation in various sectors. The country has, for example, built up useful experience with monitoring and surveying using remote sensing and extensive databases for the water sector, including a National Sanitation Information System (SNIS, Sistema Nacional de Informações sobre Saneamento). Another interesting example of ICT innovation in the water sector is the Sistema Irriga,¹³¹ developed and patented by the Federal University of Santa Maria (Rio Grande do Sul). This system provides 24/7 irrigation advice to farmers through the Internet by determining the best period for irrigation based upon soil characteristics, meteorological data and irrigation methods. Also promising is the so-called Brazilian System for Digital TV (SBTVD)¹³² that includes an emergency warning broadcasting system that turns on TV-sets in standby modus to send out early warning messages.

The most important public water-related institutes are:

- ▶ ANA - National Water Authority: monitoring and education,¹³³
- ▶ CEMADEN - The National Centre for the Monitoring and Warning of Natural Disasters: develops, tests and implements an early warning system for the occurrence of natural disasters and susceptible areas,¹³⁴
- ▶ CENAD - the National Centre for the Management of Risks and Disasters of the Ministry of National Integration: collects information, analysis risk, monitors disasters and provides information to states and municipalities,¹³⁵
- ▶ Embrapa: water for agriculture,
- ▶ IBAMA- Brazilian Institute of Environment and Renewable Natural Resources: fish-resources and water pollution,¹³⁶
- ▶ INPE/CPTEC – Weather Forecast and Climate Studies Centre.

The most renowned universities in this area are:¹³⁷

1. University of São Paulo (USP).
2. Federal University of Santa Catarina (UFSC).

¹³¹ <http://www.sistemairriga.com.br/>

¹³² Sistema Brasileiro de TV Digital

¹³³ <http://www2.ana.gov.br/Paginas/EN/default.aspx>

¹³⁴ <http://www.cemaden.gov.br/>

¹³⁵ <http://www.mi.gov.br/defesa-civil/cenad/apresentacao>

¹³⁶ <http://www.ibama.gov.br/institucional/recursos-pesqueiros>

¹³⁷ For an overview of research in this area, see E. Fadul et al (2012), *Produção Científica em Gestão de Recursos Hídricos no Brasil no período de 2002 a 2011: uma análise da sua contribuição para o setor.*

3. Federal University of Rio de Janeiro (UFRJ).
4. LABDES (laboratory for desalinization)¹³⁸ of Federal University of Campina Grande (UFCG)
5. Federal University of Minas Gerais (UFMG)

Cooperation Brazil - Netherlands

Brazil, as the Netherlands, has extensive experience with implementing large and small water infrastructure works. The Brazilian-Dutch company Arcadis-Logos is already supporting the Brazilian company Norte Energia S.A. with its expertise for the Belo Monte dam in the Xingu-river (as part of a larger consortium).¹³⁹ The added value of the Netherlands in Brazil is thought to be not merely in the area of water-related technology, but particularly in doing so with integrated management concepts. For example, when planning to construct dams (e.g. 150 dams in the Pantanal), a broad integrated water management strategy could be added, including strategic environmental and social assessments, spatial planning, the use of nature design principles, and integrated watershed management.

Another example of Dutch-Brazilian cooperation is Deltares, a Dutch independent institute for applied research in the field of water and subsurface, which signed a cooperation agreement with CEMADEN, Brazil's national centre for early warning and monitoring of national disasters.¹⁴⁰ This cooperation has not yet fully materialised, but is intended to share knowledge about software prediction models and early warning systems. Deltares has also signed a Letter of Intent with INPE/CPTEC, Weather Forecast and Climate Studies Centre.¹⁴¹ Other on-going projects by Deltares in Brazil include the São Francisco river integration project and the cleaning of Guanabara Bay near Rio de Janeiro for the Olympic games of 2016.¹⁴²

Dutch and Brazilian companies have been cooperating in the water sector for a long time. For example, the Dutch maritime company Van Oord is specialised in dredging and off-shore construction work, and active in Brazil since 1985. Examples of recent projects are the installation of an off-shore gas pipeline from the coast (São Paulo) to the Santos basin (Rota Cabiúnas), dredging work for a new ship yard in Aracruz (Espírito Santo), and deepening of the access channel to the harbour of Rio de Janeiro. Van Oord actively cooperates with research institutes, e.g. to reduce the impact of dredging works or to improve coral rehabilitation. Van Oord is one of the partners of an innovative Dutch

¹³⁸ Laboratório de Referência em Dessalinização.

¹³⁹ www.arcadis.com/press/ARCADIS_WINS_LARGE_CONTRACT_FOR_BELO_MONTE_HYDROELECTRIC_POWER_PLANT_IN_BRAZIL.aspx

¹⁴⁰ <http://www.dredgingtoday.com/2013/10/30/deltares-cemaden-collaborate-on-natural-disaster-prevention-in-brazil/>

¹⁴¹ Deltares Annual Report (2013). <https://www.deltares.nl/app/uploads/2015/01/Deltares-Jaarverslag-2013.pdf>

¹⁴² <http://www.groenervaren.nl/deltares-helpt-olympische-baai-schoon-te-maken/>

consortium called Ecoshape (www.ecoshape.nl) that promotes a Building with Nature (BwN) concept to improve the CO₂ absorption capacity of marine ecosystems.¹⁴³

However, several key players interviewed pointed out that there are unfortunately still quite some barriers to the introduction of such innovations in the Brazilian water sector. For example, by law the Brazilian government selects projects on price and does not regularly include quality or innovation as a selection criteria for public procurements. If competition thus continues to focus on price, there is very little incentive for companies to include new technology or concepts in bids.

Box 7. The Netherlands and water

The Netherlands is internationally renowned for its expertise in water management and infrastructure, based on a long history of conquering water. In particular, the Netherlands has expertise in a) delta technology; b) maritime technology; and c) water technology. At the moment, focus areas for science and technology include sensor technology, ecosystem-based water solutions ('Building-with Nature'), high-tech water purification (incl. recycling of valuable materials) and blue energy.

There are in the Netherlands several well-known institutes specialised in water, such as

- ▶ Universities such as TU Delft, Wageningen (WUR), University Twente, University Utrecht and the University of Amsterdam (UvA).
- ▶ Research institutes such as Wetsus¹⁴⁴, Deltares, KWR Water Recycling Institute, TNO¹⁴⁵ and NIOZ.¹⁴⁶
- ▶ UNESCO-IHE, located in Delft, which supports water-related education globally.¹⁴⁷

The Dutch approach is characterised by integrated solutions e.g. water as part of a circular economy or systems of water risk management, which include prevention, sustainable area management and disaster response.

Moreover, as in other top sectors, government works in close cooperation with business and research. For example, different actors in the water sector cooperate in a Netherlands Water Partnership (NWP) to enhance export opportunities and international cooperation. The NWP includes more than 200 organisations: private and public companies, NGOs, knowledge institutes and government organisations.¹⁴⁸

¹⁴³ <http://www.ecoshape.nl/overview-bwn.html>

¹⁴⁴ Centre of Excellence for Sustainable Water Technology (www.wetsus.nl)

¹⁴⁵ Netherlands Organisation for Applied Scientific Research (www.tno.nl)

¹⁴⁶ Royal Netherlands Institute for Sea Research (www.nioz.nl)

¹⁴⁷ <https://www.unesco-ihe.org>

¹⁴⁸ <http://www.nwp.nl/>

5.5 Health care sector

Health sector in Brazil

Brazil ranks around 95 out of 213 countries for both life expectancy and infant mortality. Over 80% of the Brazilian population lives in cities and typical urban diseases include cerebrovascular diseases, heart diseases, pneumonia, diabetes mellitus and cancer. Moreover, poor sanitation and drinking water quality causes health risks. In rural Brazil infectious and parasitic diseases such as cholera, malaria and diarrhoea predominate. Malnutrition is also an issue in certain areas.¹⁴⁹ Furthermore, the ratio of elderly (over 65) to population in the productive ages is expected to increase from 11% in 2005 to 49% by 2050. Aging and lifestyle changes are expected to lead to a relative increase in non-communicable diseases.

As of 1988, a national public health system (SUS, Sistema Único de Saúde) provides free health care for everybody with legal status in Brazil.¹⁵⁰ This includes doctor's visits, prescription drugs, hospitalization and surgeries. However, though only 25% of the population has a private health plan, private expenditure on health was approximately 54% versus 46% public expenditures (in 2012). The quality of health care varies significantly throughout the country. Therefore, the Brazilian government seeks to improve the coverage of the public health system (SUS) in remote areas, mainly the North and Northeast regions, among others through a system of internet-based long-distance consultations.

Country-wide pressure on the government to improve the social health care (e.g. voiced during demonstrations around the World Football Championship), in combination with a growing middle class with rising spending capacity, and the challenges of aging, calls for system improvements and innovation in the health care sector in Brazil. As stated in an interview: "It is very important for a Brazilian to be seen by a doctor. If you have seen a doctor and you die, it is the will of God. If you are not seen by a doctor and you die, it is the government's fault". The growing middle class in Brazil now expects more personal and participatory care. Personal devices (e.g. smart watches), of which Brazilians are often early adopters, in combination with the availability of big data in the health sector, are expected to change the demand for services as well as the organization of the health system. Moreover, combined with aging, the hospital of the future in Brazil will most probably focus less on treatment and cure of acute diseases (the current focus) but focus more on treatment of chronically ill over a longer period of time.¹⁵¹

¹⁴⁹ Dutch embassy in Brazil (2014) Opportunities in Life Sciences and Health sector.

¹⁵⁰ World Bank (2013) 20 years of Health System Reform in Brazil: An assessment of the Sistema Único de Saúde.

¹⁵¹ Dutch embassy in Brazil (2014) Opportunities in Life Sciences and Health sector.

Brazil is among the five largest pharmaceutical markets in the world in terms of unit sales and the 8th in market size. Foreign firms mostly from the United States and Europe, along with their Brazilian subsidiaries, supply 70% of the market. About 80% of pharmaceutical companies operating in Brazil are national, but they are only responsible for a minority of domestic sales. Almost 94% of Brazilian medical equipment and devices are manufactured in the south and southeast regions of Brazil, mainly by small and medium-sized family enterprises (68%) that make use of the region as manufacturing hub (access to supply chains).¹⁵²

Though there remains room for improving the cooperation between universities and the private sector, several of those manufacturing clusters are connected to the main research hubs in this area:

- ▶ Centre for Innovation, Entrepreneurship and Technology (CIETEC, São Paulo),
- ▶ Biotechnology Pole, BioRio (Rio de Janeiro),
- ▶ BioMinas (Minas Gerais),
- ▶ Institute Foundation for the Health Advance Pole (FIPASE, São Paulo).

Research institutes

In a recent speech, the Brazilian Minister for Health stated that new strategies have to be developed for biosecurity, biotechnology, genetic heritage and intellectual property rights.¹⁵³ Moreover, Brazil aims to become more independent in the production of equipment and medicines. As this would require an active interest from companies in the health sector, Brazil's overall innovation programme (Plano Inova Empresa) specifically targets the health sector (Inova Saúde) in order to stimulate innovation in the area of biopharmacy, pharmaceuticals and medicines. The main implementing partners of this programme are FINEP, the national development bank BNDES and the Ministry of Health.

The Brazilian Ministry of Health has initiated various other programs to promote knowledge and innovation in the health sector as part of the National Policy of Science, Technology and Innovation in Health. Since 2003, the Ministry of Health allocated, in partnership with other institutions, about R\$700 million for 3,600 studies by 400 academic institutions on diverse health challenges such as AIDS, tuberculosis, cancer, children's health, cardiovascular diseases, mental health and capacity building. Almost 80% of all scientific health research has originated from the scientific research program PPSUS (Programa Pesquisa de Sistema Único de Saúde), which financed 2,619 projects with 291 scientific institutes.¹⁵⁴ Moreover, the health sector development programme, PROCIS (Programa para o Desenvolvimento do Complexo Industrial da Saúde)

¹⁵² Pharmaceutical Industry Syndicate (SINDUSFARMA)

¹⁵³ FIESP (May 2015) Perspectivas para a Saúde.

¹⁵⁴ <http://rebrats.saude.gov.br/noticias/165-saude-anuncia-5-edicao-do-programa-pesquisa-para-o-sus-ppsus>

stimulated research - business linkages. So far, the program invested 88% of its projected R\$ 690 million budget in combinations of 18 public producers and 20 scientific institutes.¹⁵⁵ Moreover, in order to build the capacity of professionals in the public health system (SUS), government created the Open University of the SUS (UMA-SUS) in 2010, which currently includes a collaborative network of 36 institutions of higher education. As a result of these programmes, the number of researchers increased from 7,309 in 2000 to 19,719 in 2010.¹⁵⁶

The most important governmental research institutions in the health area are:

- ▶ Oswaldo Cruz Foundation (Fiocruz),¹⁵⁷ a public company, linked to the Ministry of Health, produces knowledge and technology to strengthen the public health system (SUS) and promote health and quality of life of the population. It conducts research in the area of aids, malaria, Chagas, tuberculosis, hanseníase, measles, rubella, Schistosomiasis, meningitis and hepatitis, beside other problems related to collective health like violence and climate change,
- ▶ National Institute for Cardiology (Inc)¹⁵⁸ focuses on the highly complex treatment of cardiac diseases, particularly for surgery and heart transplants,
- ▶ National Cancer Institute José Alencar Gomes da Silva (Inca)¹⁵⁹ is the auxiliary institution of the Ministry of Health for the development and coordination of integrated action for the control and prevention of cancer, including medical and hospital services for the early detection and treatment of this ailment,
- ▶ National Institute for Traumatology and Orthopaedics Jamil Haddad (Into)¹⁶⁰ is a reference center of the Ministry of Health for the treatment of medium and high complexity illnesses and orthopedic traumas,
- ▶ Butantan Institute¹⁶¹ is linked to the Secretariat of Health of the State of São Paulo and constitutes one of the major centers for biomedical research in the world, responsible for 51% of vaccines and 56% of serums production for prophylactic and curative care in the country.

Other important medical research takes place in the main universities. The top five being:

1. The University of São Paulo (USP);
2. The State University of Campinas (UNICAMP);
3. The Federal University of Minas Gerais (UFMG);
4. The Federal University of Rio de Janeiro (UFRJ);
5. The State University of São Paulo “Julio de Mesquita Filho” (UNESP);

¹⁵⁵ <http://portalsaude.saude.gov.br/index.php/o-ministerio/principal/leia-mais-o-ministerio/581-ctcie-raiz/decis/l2-decis/12091-programa-para-o-desenvolvimento-do-complexo-industrial-da-saude-procis>

¹⁵⁶ ApexBrazil (2010) Innovate in Brazil: Healthcare.

¹⁵⁷ www.fiocruz.br

¹⁵⁸ www.inc.saude.gov.br

¹⁵⁹ www.inca.gov.br

¹⁶⁰ www.into.saude.gov.br

¹⁶¹ www.butantan.gov.br

Hospitals are also involved in medical research. For example, the renowned private Einstein Hospital in São Paulo provides post-graduate medical training and conducts high-class research. Einstein hospital also provides consultancy services to 50 other hospitals through a ‘telemedicine’ system and also provide laboratory services if needed.¹⁶²

Cooperation Brazil - Netherlands

The main form of cooperation between Brazil and the Netherlands is in the form of exchange of medical students (e.g. through Science without Borders). The interest of Brazilian students in health sciences in the Netherlands grew from 14% in 2014 to 31% in 2015.¹⁶³ Especially the Radboud University Nijmegen, Groningen University Medical Centre and Erasmus Medical Centre Rotterdam are popular among Brazilian medical students. Furthermore, Leiden University has since long been present and cooperating with Brazilian universities (USP, UFRGS, UFSC, UFPE). For example, the university works together with USP in Ribeirão Preto on pharmacology.

Though several Dutch medical centres receive Brazilian students, as yet, the Medical Centres of Dutch universities do not seem to cooperate much with Brazilian universities or hospitals in the area of research.¹⁶⁴ However, very recently, in June 2014, the Haagse Hogeschool, Sophia Revalidation and SARAH networks (a Brazilian chain of hospitals and revalidation centres)¹⁶⁵ signed an agreement to exchange knowledge and conduct joined projects on healthcare and technology. Moreover, the Einstein Hospital in São Paulo expressed an interest in cooperation with the Netherlands, e.g. in the area of Healthy Aging. The hospital learned about the integrated approach from the Dutch Groningen Medical School and copied their admission system.¹⁶⁶ Similarly, Leiden University Medical Centre is very interested to co-operate with Einstein hospital. This is probably the case for more Brazilian hospitals, such as Supera in Ribeirão Preto, focusing on dental care and proceeding with the application of 3D printing, and universities with a Medical Faculty and hospitals.

Several Dutch health sector companies are active in Brazil (e.g. Berenschot International; Delft Imaging Systems; Diagnostica Technologies; NDS Surgical Imaging). In June 2015, several of them conducted an exploratory mission to Brazil (including a/o ORTEC, Philips and Royal Haskoning) to learn about the Brazilian health care system and identify potential projects (organised by TFHC, described in the box below). The group visited the main cities of Brasilia, Belo Horizonte, Rio de Janeiro and São Paulo but were fully aware

¹⁶² <http://www.einstein.br>

¹⁶³ Nuffic-Neso.

¹⁶⁴ Such cooperation does exist in Brazil with universities from other countries (e.g. USA's Cornell University cooperates with UFBA and FioCruz).

¹⁶⁵ <http://www.sarah.br/>

¹⁶⁶ Interview June 2015

of the urgency of Brazilian health care in rural areas. Here there is, for example, an opportunity for mobile health care systems, of which 2 of the 4 companies worldwide are Dutch.¹⁶⁷

Some general observations made by the Dutch participants of the health sector mission to Brazil, and confirmed through interviews in other sectors, are:¹⁶⁸

- ▶ The Brazilian market is protective, though there is now more willingness to cooperate than 4 years ago.
- ▶ Larger companies enter the Brazilian market through joint ventures and buying local companies.
- ▶ SME however have difficulties to enter the market. Working through a local distributor is not sufficient. It seems better for SME to seek cooperation with a university or hospital, conduct a pilot and co-create. The local partners can then become the local ambassadors and market partner.
- ▶ There are interesting opportunities for Dutch companies, e.g. in primary health care, maternity health care, eHealth, hospital logistics, diagnostics, revalidation, and oncology.

Box 8. The health sector in the Netherlands

In the Netherlands, over 900 companies are active in health related life sciences, with over 400 in the biopharmaceutical industry, and almost 400 in diagnostics. The sector has a strong R&D component in cancer research, infectious diseases (e.g. VUMC Amsterdam, KIT Amsterdam), cardiovascular diseases, clinical research, and medical imaging in preventive healthcare.¹⁶⁹

The cooperation between companies and universities is very strong in the Dutch health sector. Approximately 20% of the current 55,000 employees in the sector are researchers.

The Task Force Health Care (TFHC) is an interesting public-private partnership in the health sector.¹⁷⁰ TFHC is a not-for-profit platform, which was founded in 1996. Total turnover of all partners is around 10 billion euros. TFHC stimulates cooperation among organisations within the Dutch life sciences & health sector and promotes sustainability in healthcare. The partners of TFHC consist of a vast network of companies (manufacturers, ICT, services, insurance), medical research centres (Erasmus MC; Maastricht University; KIT; Utrecht MC; Groningen MC), NGOs

¹⁶⁷ <http://www.mobile-medical.eu/about-us.html>

¹⁶⁸ Interviews June and July 2015.

¹⁶⁹ Innolab (2011) #15, page 28-34. Website: <http://www.media-matter.com/innolab/15/>

¹⁷⁰ <http://www.tfhc.org>

(e.g. Cordaid, Simavi) and the government (Ministries of Economic Affairs; Foreign Affairs; Health, Welfare & Sport) active in the Dutch life sciences & health sector. TFHC provides education, knowledge and services on medical devices, building hospitals, life sciences & health (including infectious diseases, health financing, development cooperation).

5.6 Astronomy and aerospace

Astronomy and aerospace in Brazil

As in most countries, the Brazilian aerospace industry has its origins in the military in the 1940s (DCTA, Ministry of Defence, Department of Aerospace Science and Technology).¹⁷¹ In Northeast Brazil, close to the equator, there are two public rocket launch centres: Barreira do Inferno Launch Center¹⁷² (CLBI) in Natal, and Centro de Lançamento de Alcântara (CLA)¹⁷³ in Maranhão.

The centre of the aerospace industry is, however, located in São José dos Campos, a small city strategically located between São Paulo and Rio de Janeiro and near the coast. Brazil's aerospace cluster contains entities such as the Instituto Tecnológico de Aeronáutica (ITA), Embraer and is coordinated by CECOMPI.¹⁷⁴ Brazilian aerospace includes manufacturing, maintenance, repair and overhaul of different aircraft, engines, components, assemblies, structural parts, navigation and on-board equipment systems, Unmanned Aerial Vehicles, systems for air traffic control and also industrial engineering and design services).

ITA is the main research organisation in Brazil in aerospace engineering,¹⁷⁵ ITA is a university institute linked to Brazilian Air Command (COMAER) with the responsibility for higher education (graduate and post-graduate) and promotion of science, technology and innovation in the fields of aeronautics and space.¹⁷⁶ The majority of people graduating from ITA start working for Embraer.

¹⁷¹ <http://www.cta.br/historico.php>

¹⁷² <http://www.clbi.cta.br>

¹⁷³ <http://www.cla.aer.mil.br/index.php>

¹⁷⁴ Centro para a Competitividade e Inovação do Cone Leste Paulista. Located in São José dos Campos. Website: <http://www2.cecompi.org.br/st/>

¹⁷⁵ <http://www.ita.br>

¹⁷⁶ DCTA (2015), A Description of DCTA's History, Structure, Organization, Programs and Projects, and its Contributions to the Establishment and Development of the Brazilian Aeronautic, Space and Defense Industry: A Background Study for Supporting Cooperation Relationships among the DCTA, the Municipality of São José dos Campos, and Dutch Academic, and Research, Development, and Innovation Institutions.

In 1969, the government-owned aircraft manufacturer, Embraer (*Empresa Brasileira de Aeronáutica*) was established. The company originated from the Institute of Research and Development (IPD), created in 1959 to develop aeronautical technology and systems, both for the military and civilian sectors of the country. At first Embraer only produced small military aircraft but since 1985 it also produces small business jets and mid-sized commercial airliners. Embraer was privatised in 1994 and is now the third largest airplane producer after Airbus and Boeing. Their main rival is Bombardier from Canada, with regards to sales as well as employees.¹⁷⁷

The Institute of Technological Studies (IPT) established a research centre in São José dos Campos in 2014, focused on lightweight structures. IPT Lightweight Structures Laboratory (LSL) has five clients but the main client is Embraer (95%). IPT aims to bridge the gap between academic research by universities and practical application by companies by offering research as well as services. IPT could potentially be an interested party for joint projects with Dutch universities, such as TU Delft, on composite materials, including exchange of students and researchers.

Furthermore, the National Institute of Space Research (INPE)¹⁷⁸ has three research centres of which one is located in São José dos Campos, one in the Amazon and one in the Northeast (Natal). INPE is not only focused on space research but also well-known for its earth observatory work in Brazil, for example related to monitoring Amazon deforestation and forest fires. Other institutes associated with DCTA, are the Institute of Aeronautics and Space (IAE), the Institute of Advanced Studies (IEAv), the Institute of Research and Flight Testing (IPEV), the Institute of Industrial Promotion and Coordination (IFI), the Infrastructure Group (GIA) and the Coordinating Commission of the Combat Aircraft Program (COPAC).

Cooperation Brazil - Netherlands

Brazil is an attractive market for Dutch companies, especially on materials and aerial safety. The appreciation of the quality of the Brazilian airplanes has been demonstrated by the very recent acquisition by the Dutch/French air flight company KLM/Air France of 17 airplanes from Embraer. The good relations between the Netherlands and Brazil in the aerospace sector will be further strengthened by the decision to move the European office of Embraer to Amsterdam, the Netherlands. Furthermore, during the Dutch trade mission and Royal visit of 2012, Embraer signed a cooperation agreement with DNW, the German-Dutch Wind Tunnels.¹⁷⁹ Furthermore, Brazil and the Netherlands cooperate in the area of aerospace research, often drawing in both research institutes and companies.

¹⁷⁷ Interviews.

¹⁷⁸ <http://www.inpe.br/ingles/>

¹⁷⁹ DNW is a cooperation between Dutch National Aerospace Laboratory, NLR, and the German Aerospace Centre, DLR.

In 2012, the Netherlands Aerospace Group (NAG), the Dutch sectoral organisation, signed a cooperation agreement with its Brazilian counterpart CECOMPI.

There are several Memoranda of Understanding in this area:

► **Technical University Delft (TU Delft) - Instituto Tecnológico de Aeronáutica (ITA)**

The MoU covers joint research and cooperation in education, such as the exchange of students, PhDs and staff (part of SwB). TU Delft will support ITA to achieve its ambition to double their education program for 1st year students (ITA now has app. 100 students). Moreover, the MoU also envisages joint projects with ITA and Embraer, focusing on materials, which is an area of specific interest for Embraer. They will also develop joint research programs.

► **University of Twente (UT) - Instituto Tecnológico de Aeronáutica (ITA)**

This agreement builds on the existing relation between the institutes in aeronautics and add to that the possibility of cooperation in the field of energy technology and materials. ITA and UT will develop joint Masters and PhDs and exchange staff and students.

In order to continue and strengthen these different forms of cooperation in the aerospace sector, the Netherlands organised a sector-specific mission in June 2014. Through joint workshops a mutual interest was defined in the areas of:

1. Thermoplastic composites, thermoset composites, fiber metal laminates, additive manufacturing and high-energy hydroforming, and
2. Aerodynamics, structures (PHM, big data and fleet management), interiors (cabin simulator), structures interiors (weight reduction), systems (air management-energy management) and aerodynamics (aero acoustics scaling).

Box 9. Aerospace in the Netherlands

The Dutch aerospace industry employs 16,000 people with an annual turnover of 2.3 billion in 2014 (80% exports). The sector grows with 5-6% per year (80% civil aviation, 20% military).¹⁸⁰

The Netherlands is one of the leading countries in high tech solutions such as lightweight materials (e.g. glare and thermoplastic for Airbus 380) amongst other through promotion of cooperation between industry, knowledge institutes and government institutes. Some key, internationally active, actors in the sector are:¹⁸¹

¹⁸⁰ <https://www.youtube.com/watch?v=wFFIKTTCI28&feature=youtu.be>

¹⁸¹ <https://www.youtube.com/watch?v=wFFIKTTCI28&feature=youtu.be>

- ▶ **NAG**, Netherlands Aerospace Group:¹⁸² representing the Dutch Aerospace Cluster abroad. The members are large companies, research institutes, education centres and many specialized SMEs. Two-thirds of the activities are aimed at Maintenance, Repair and Overhaul (MRO) and the rest at new development.
- ▶ **Schiphol Airport**: located in Amsterdam and the 16th busiest airport in terms of passenger numbers (4th in Europe). It is, however, the 5th busiest airport worldwide in international passenger traffic. Schiphol is also an important logistical hub for air cargo (17th largest worldwide).
- ▶ **KLM**: being established in 1919, the oldest airline in the world still operating and employing 32,000 people. KLM is now part of the Air France Group.
- ▶ **NLR**, National Aerospace Laboratory:¹⁸³ independent knowledge enterprise on aerospace with the aim of making air transport and space exploration safer, more sustainable and more efficient. NLR's multidisciplinary approach focuses on developing new and cost effective technologies for aviation and space, from design support to production technology and MRO.
- ▶ **Fokker Technologies**: leading global aerospace specialist that designs, develops and manufactures highly engineered aircraft systems for aircraft manufacturers and provides through-life aircraft fleet support services.
- ▶ **TNO/TU Delft**: Europe's largest aerospace engineering faculty. Moreover, TNO is active in optical space and scientific instrumentation (e.g. space telescope GAIA).
- ▶ Last but not least, the European Space Agency (**ESA**) is located in the Netherlands.¹⁸⁴

¹⁸² <http://www.nag.aero>

¹⁸³ <http://www.nlr.nl/>

¹⁸⁴ <http://www.esa.int/ESA>

Short-run opportunities and longer term developments

6.1 Short term opportunities

Brazilians in general have a rather traditional view on the Netherlands (cows, water,...).¹⁸⁵ Fortunately however, those interviewed for this report have a different perception. They see the Netherlands as a technological and knowledge-intensive country where universities and companies work together in an interesting manner. Moreover, the Dutch are considered pleasant to work with. The Netherlands is deemed non-threatening and complementary to Brazil. Nevertheless, even those interviewed in Brazil did not have a clear picture of what exactly the Netherlands has to offer Brazil.

Dutch operating and investing in Brazil are pleased with the results even though these results are often below initial expectations. One of the challenges identified by those with experience in Brazil is the scale of the country, which requires adaptation of technologies, products and services. The experiences of Dutch companies suggest that the Netherlands might have better chances as suppliers of knowledge and technology, participating in larger consortia with key Brazilian actors.

Based on literature review and interviews in Brazil and the Netherlands, several short-term opportunities can be identified for each sector, including cross-sectoral linkages and public-private partnerships, with which the Netherlands has experience. Of course this list is not exhaustive but it does provide a few interesting examples.

Agriculture

- ▶ Information and Communication Technology
 - ▶ The agriculture sector increasingly uses sophisticated technology for production and processing, including climate resilient seeds, GPS positioning, satellite imagery, the use of remote sensors (to monitor soil and climate conditions) and Geographic Information Systems. The 'Internet of Things' and the 'big data' revolution will stimulate Smart or Precision Farming, which will help improve productivity (e.g. timing of planting, interventions and harvesting), resource efficiency, storage and to reduce waste.

¹⁸⁵ Research by Qualibest for the Dutch embassy (May, 2015).

- ▶ **Biotechnology**
 - ▶ Brazil has a strong interest in the development of its biodiversity into products¹⁸⁶. Several Dutch research institutes have interesting experience in such biotechnology, which could be further developed in cooperation with, e.g. Embrapa and Brazilian universities. Opportunities might be sought out through trade fairs such as Agrishow 2015¹⁸⁷ and the annual Biofach,¹⁸⁸ both in São Paulo.
 - ▶ Other promising areas of cooperation, as identified in the first SCTI Joint Committee and interviews for this report, are horticulture, climate-smart & precision agriculture, environmental issues. Moreover, there is an opportunity to make a link with life sciences, addressing the treatment of specific diseases and aspects of aging.

Biomass

- ▶ **Value creation**
 - ▶ R&D and market opportunities exist in high added value creation through biotechnology. Dutch expertise on advanced thermochemical conversion of lignocellulosic materials from sugarcane (pyrolysis oil, torrefaction for synthesis gas) could be very interesting for Brazilian producers.
 - ▶ Moreover, interesting forms of cooperation such as BE-Basic in Campinas and the recent Living Lab on Bio-based economy in Belo Horizonte, could be further developed. The focus is on value creation of waste streams, waste-water, bio-polymers, logistical concepts.
- ▶ **Ethanol: first and second generation**
 - ▶ Both countries are interested in the use of ethanol as jet fuel. Brazil has made a lot of progress in the area of first generation biofuels (ethanol from sugarcane), which provides linkages with developments in the Netherlands. Though each country focuses on different feed-stocks, there certainly exist opportunities in second-generation ethanol.

Water

The Brazilian priorities, as expressed at the first SCTI Joint Committee meeting and in interviews for this report, are:

- ▶ **Drinking water treatment and purification**
 - ▶ The main interest is in basic decentralised water treatment and purification technology and management (with emphasis on emerging organic and inorganic micropollutants). Moreover, in relation to knowledge and innovation, circular economy concepts are thought to be appealing e.g. coupled with emerging

¹⁸⁶ A major obstacle is thought to be the Brazilian fear for bio-piracy and legislation on Intellectual Property Rights. Interviews and newspaper articles on biopiracy.

¹⁸⁷ <http://www.agrishow.com.br/en/>

¹⁸⁸ <http://www.biofach-americalatina.com.br/en/index.php?pgid=home&mi=00100000000>

commercial technology for purification and recycling. Moreover, there are potential linkages with the health sector.¹⁸⁹

- ▶ Water management
 - ▶ This interest includes ecosystem-based adaptive management, technology and intervention ('building-with-nature', circular economy), water quality (standards, monitoring and classification of water bodies, hydro-meteorological networks), inner-city water storage combined with architectural and landscape design and social functions (e.g. for São Paulo).¹⁹⁰
- ▶ Disaster prevention
 - ▶ As discussed earlier in the report, Brazil is increasingly giving attention to water disaster prevention, which includes flood risk prevention studies and spatial planning, control, early warning models, ICT and mobile technology.

Health care

The Brazilian government and actors in the health care sector communicated a particular interest to establish cooperation with the Netherlands on:¹⁹¹

- ▶ Innovation in care for the elderly
 - ▶ This is an area of interest and expertise of the Netherlands as well. Both countries need to prepare for the aging population and could learn together.
- ▶ Approach towards specific health challenges, such as
 - ▶ infectious diseases,
 - ▶ alcohol and drug abuse, in particular the use of crack
 - ▶ sexual and reproductive health and rights, related to successful Dutch programs such as those with regard to abortions and premature pregnancies
 - ▶ domestic violence, which is a serious issue in Brazil affecting all social classes
- ▶ Reform of the public health system to increase quality and affordability

The Netherlands adds to these fields of interest the following:

- ▶ Joint Public Private Partnerships, e.g. in the field of medical technology and medical implements (such as orthotics and prosthetics)
- ▶ Joint work on antibiotics resistance, a global challenge which could benefit from combining the experience of Brazil and the Netherlands.

Aerosector

During the aerospace trade mission in June 2014, in which key actors in Brazil and the Netherlands presented themselves to each other, mutual interests identified in the technical areas:

¹⁸⁹ There is also an interest in industrial sludge treatment, i.e. finding cost-effective solutions for water and effluent treatment.

¹⁹⁰ Rotterdam water square: <https://www.youtube.com/watch?v=kujf4BTL3pE>

¹⁹¹ Dutch embassy Brazil (2014) Opportunities in Life Sciences and Health sector.

- ▶ Thermoplastic composites, thermoset composites, fiber metal laminates, additive manufacturing and high-energy hydroforming, and
- ▶ Aerodynamics, structures (PHM, big data and fleet management), interiors (cabin simulator), structures interiors (weight reduction), systems (air management-energy management) and aerodynamics (aero acoustics scaling).

6.2 Longer term developments

An analysis of Brazil's future challenges leads to the identification of several entry points for R&D, where linkages with the Netherlands can potentially be made.

1. The rise of domestic consumption in Brazil

Over the last decade Brazilians have become less poor (minimum wage increased by 12%) and the Brazilian middle class has grown significantly, creating an attractive consumer market interested in the latest developments and high tech. The Brazilian population is still young and expected to grow further. Productivity and quality has to rise to meet the growing demand. In addition, although the majority of the Brazilian live in the city, numerous people live in remote rural areas, which provides interest in and opportunities for internet and mobile solutions.

2. Sustainable Brazilian cities

The main Brazilian cities such as Brasilia, Rio de Janeiro, São Paulo are confronted with multiple problems typical of megacities that negatively affect the quality of life of its inhabitants. Although Brazil has experience with developing an environmental and liveable city (e.g. Curitiba), the scale of the challenges in the largest cities is such that it could benefit from new skills, management concepts and technologies, for example in the areas of urban water management, planning, agriculture, energy production and distribution, logistics, transport, waste etc.

3. Food and Health: Brazilian and global food security and obesity

The growing Brazilian and world population means a growing demand for food that has to be produced taking into account its impact on the environment and climate change. Storage and distribution are major challenges for food to reach the market without too much post-harvest losses. Awareness on the quality of food and its production is growing in Brazil as elsewhere. Growing welfare also means more and more people are confronted with food-related health issues, including obesity. Moreover, the Brazilian population is aging, which requires the health sector to provide more attention to prevention (e.g. healthy diets, sport, non-smoking) and chronic diseases than is currently practice in Brazil.

4. Climate change

It has been suggested that due to large-scale deforestation and climate change the rainfall patterns (“Flying Rivers”) further south become more erratic.¹⁹² This has major economic consequences as it affects agricultural production.¹⁹³ Adaptation to climate change is a complex multi-stakeholder problem, which demands a strong government and multi-stakeholder, landscape-level approaches. Moreover, the challenges of climate change demand more investments in knowledge and innovation in climate adaptation technology, renewable energy (biomass, solar, wind, geothermal), energy efficiency and low carbon / bio-based materials.

5. Transforming our economies

In order to remain successful in the global economy and provide a decent quality of life to the growing urban population in the coming next decades, a transformation is required of the linear, consumptive, resource-intensive economies into circular and green economies. A circular economy requires, for example, strong integration of cradle-to-cradle concepts in all economic sectors, climate change resilience, a low-carbon, diverse energy matrix and job creation for all people from low to high education.

6. Disruption (disruptive technologies)

Innovation goes quick and businesses have to adapt to new realities faster than ever before. For example, the mobile phone application Uber challenges traditional taxi companies. Robotics and 3-D printing challenge traditional factories. New business models and corporate cultures will have to be developed that can deal with such changes. Important responses include the hiring of talent, embracing new technology and partnering.¹⁹⁴ However, the current business environment and economic policies are not always that conducive to innovation. For example, the Brazilian market remains relatively protective, which makes it expensive to import new technologies or materials, but also affects the incentives for the Brazilian companies to pursue innovation as part of their competitiveness strategy.

¹⁹² <http://www.theguardian.com/environment/2014/sep/15/drought-bites-as-amazons-flying-rivers-dry-up>

¹⁹³ <http://www.bloomberg.com/news/articles/2010-09-24/brazilian-crops-shrivel-as-amazon-river-dries-to-lowest-level-in-47-years>

¹⁹⁴ <http://www.ideaslaboratory.com/projects/innovation-barometer-2014>

General observations and recommendations

7.1 General observations

Brazil and Netherlands, partners in Knowledge and Innovation

- ▶ Brazil is resource intensive, whereas the Netherlands is knowledge intensive. Both countries can be very complementary as Brazil has huge resource diversity and wants to diversify its economy, while for the Netherlands resource-security is increasingly important and Brazil is considered a reliable, democratic partner in this area.
- ▶ The experts interviewed for this report acknowledge the potential benefits of cooperation and diverse areas of mutual interest. For example, Brazilian actors saw a role for the Netherlands in improving human capital and university-business linkages. Dutch actors clearly saw the innovative pockets in the Brazilian economy and linkages with Dutch innovative developments. Respect for each other's capabilities is crucial.
- ▶ The KIS in Brazil is relatively young and requires time to bear fruits, in particular with regard to the diversification of innovation-activity (regionally, in more sectors, increased innovation by SMEs). The potential for innovation in Brazil is strengthened by government's current focus on innovation as part of their development strategy, including promotion of university-business collaboration, outward engagement and the innovation environment (including human capital). It is in these areas that cooperation with the Netherlands fits.

Brazil and Netherlands, two ways of working combined

Two countries

- ▶ The Netherlands, being a small country with a large abroad, will have to find ways to deal with Brazil, a huge, inward looking country with a large domestic market. Not much Brazilian companies actively reach out to the European market, let alone the Netherlands. Knowledge and innovation are firstly for use in the Brazilian market rather than as part of global competition. There is a tendency in Brazil to develop own technologies or adapt foreign technologies.
- ▶ This requires adaptation on both sides, but also potential learning from each other. The implications for Dutch actors are, i.a. the importance of Brazilian partners and adaptation of technologies to the Brazilian context. Also, expectations need to be realistic, as results require serious investments in relations, time and resources.

Two KIS

- ▶ The Brazilian knowledge and innovation system is very focused on structures (e.g. the complex variety of institutions, instruments and laws), often with a broad aim of advancing science, technology and innovation. The Dutch system is focused on specific sectors and has, compared to Brazil, only a few actors in the KIS. In order to bridge these two approaches, understanding and common priorities are crucial.
- ▶ Similarly, funding organisations in Brazil do not receive political guidance on the social, economic or environmental challenges to address. Research projects or university-business collaborations are selected based on their quality. As a consequence, R&D is supply-driven rather than demand-driven. This requires the Netherlands to clearly, widely and repeatedly profile and promote its 'supply', i.e. what it has to offer and how this could benefit different actors in Brazil. From the interviews for this report, this promotion is still insufficient, despite the efforts of the Dutch representation in Brazil and the annual trade missions.

Two ways of working

- ▶ There are many MoUs and other kinds of agreements signed in Brazil (USP has, for example, approximately 1,000 agreements), and several different ones with the Netherlands. The research for this report indicates that for Brazil such agreements are the very starting point of a relationship to be built, while the Dutch consider it the start of implementation. Given that many agreements are signed without immediate funding attached and the longer term nature of developing joint projects, the Brazilian perspective seems to be more realistic, in particular given the country context. As such, in order to avoid frustrations at both sides, the Dutch actors need to make use of the agreements as the starting point from which some interesting and meaningful personal and institutional relations can be built (with required investments).
- ▶ Increasingly, both in Brazil and in the Netherlands, governments aim to stimulate innovation by facilitating cooperation between the private sector and academia. The interviews and experience of the Netherlands in Brazil clearly identify a great interest in this form of cooperation to be applied to Dutch activities in Brazil. In that case, some sort of partnership between research institutes and companies in the Netherlands and Brazil (obviously adapted to the local context) seems promising. Several of such Dutch-Brazilian, Public Private Partnerships already exist in different forms to learn from and develop further.

7.2 Recommendations for science & innovation cooperation

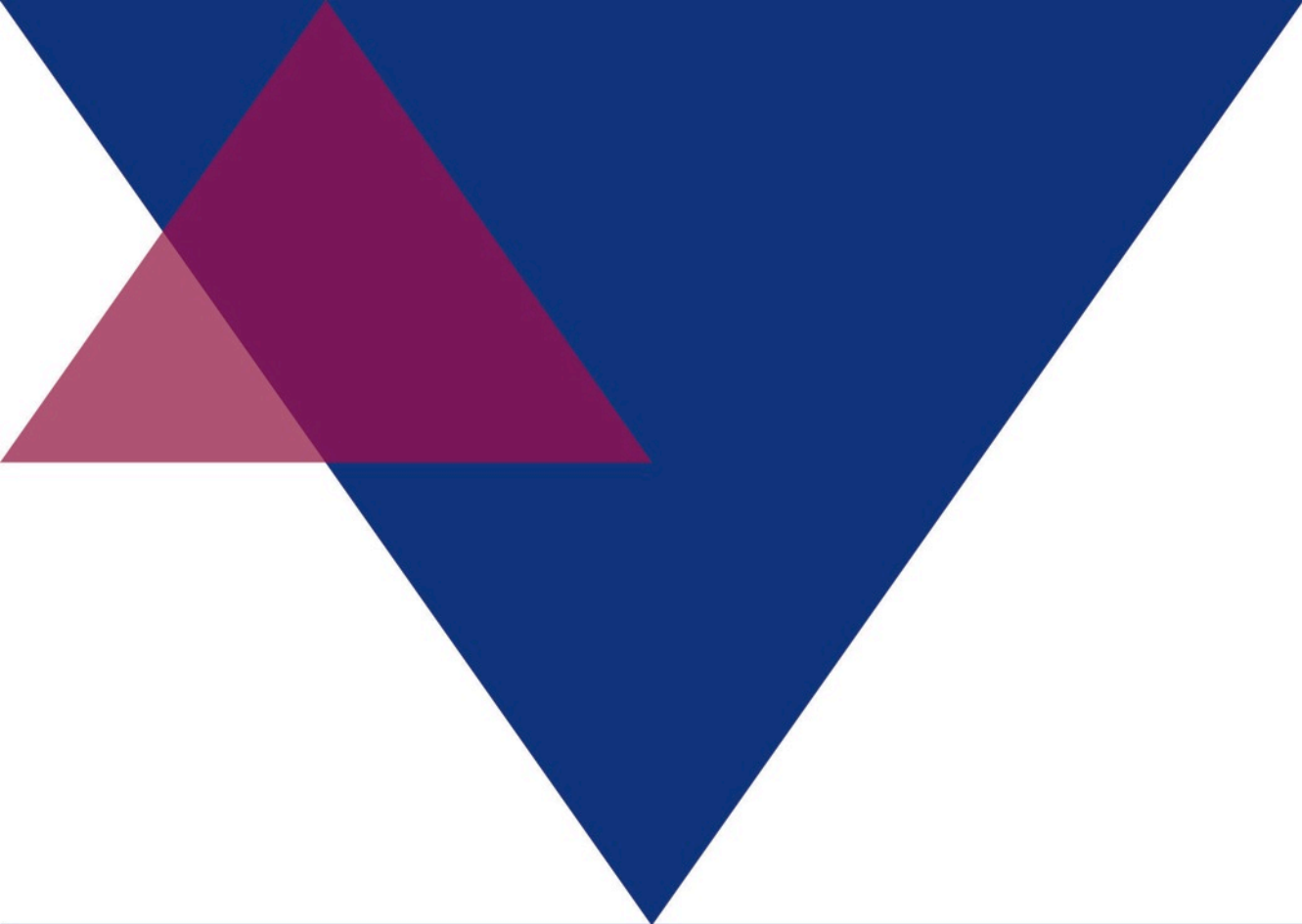
- ▶ **Companies:** Though increasing, Brazilian companies still invest relatively little in R&D and do not often cooperate with Brazilian universities. However, they have a high potential for uptake of innovative materials, technology or services. This provides a market opportunity for Dutch companies and institutes (such as NLR, TNO).
 - ▶ Dutch companies and institutes have a better market chance if they are suppliers of knowledge and technology and participate in larger consortia (projects are often too big and Brazilian partners are required within the local context).
 - ▶ Dutch companies with attractive and innovative products that have to be adapted to the Brazilian context could seek cooperation with organisations such as IPT, ITA and Embrapa.
 - ▶ Lastly, companies can actively connect with universities, e.g. by disseminating their expertise in university courses (often there is even a budget for these activities from the hosting Brazilian universities).¹⁹⁵

- ▶ **Universities:** Brazilian universities still focus mainly on fundamental research, though their activity in technology and innovation is growing (e.g. UNICAMP-INOVA). Based on experience in the Netherlands, Dutch universities can work with their Brazilian partners to further a start-up culture and improve university-business linkages.
 - ▶ The lack of R&D investments of Brazilian companies also means that for Dutch universities cooperation with partner universities is the most obvious entry point for collaboration with Brazilian private sector.
 - ▶ Dutch-Brazilian collaborations, such as the Living Lab on Bioeconomy, are to be developed further with the cooperation of the private sector (Brazilian and the Netherlands).
 - ▶ The exchange of students (Masters, PhD) is a good starting point for building relations, soon to be followed by joint projects and ultimately stronger institutional relations. Alumni network(s) could be developed or strengthened.
 - ▶ Many agreements have been signed between universities. However, for these agreements the same advice applies: they need investment. Good personal relations are a prerequisite and need to be built over time. Moreover, the implementation of the agreements also require financial investments (e.g. seed money for joint workshops and exchanges).

- ▶ **Government:** Given the interest of Brazil in the Dutch model of cooperation between government, business and universities (Triple Helix), the Dutch government could further this model in its approach towards Brazil.

¹⁹⁵ Interviews with Brazilian Universities.

- ▶ The Dutch government could also create more awareness in Brazil of the high-tech and creative expertise in the Netherlands in specific sectors. As the Brazilian system is rather supply-driven, it is important to clearly articulate the Dutch top-notch 'supply', i.e. what exactly the country has to offer and how this could benefit specific actors in Brazil. Presentations at trade fairs of existing Brazilian-Dutch PPPs might be one way to raise Brazilian interest and investments.
- ▶ The MoU on STI plays a crucial role in the relationship between both countries (as well as similar agreements with state governments and universities). Such agreements should be treated as the umbrella for different activities. Moreover, agreements require funding for their implementation (e.g. Nuffic-Neso has no funds while its Brazilian partner CAPES does). Initiation of concrete projects can be the start of longer term cooperation.



Appendix

Appendix 1 List of people interviewed

Organisation	Persons interviewed
Arcadis Brazil	Márcio Moraes (Water Director) Renato Motta (Contract Manager) Luciano Teixeira Mendes (Director) Frederico Adbo de Vilhena (Civil engineer)
BE-Basic Brasil	Ernst-Jan Bakker (BE-Basic Director Brazil Office)
Biosfera Brasil Foundation	Daniel Lipschitts (Director)
Brazilian Embassy in the Netherlands	Elizabeth-Sophie Balsa Ivens Signorini Anne Vrolijk
CEMADEN	Regina Alvalá (Director) Carlos Frederico (Chief for Science & Technology Division) José Marengo (Chief for General Coordination of Science & Technology Division)
CNI (Confederação Nacional da Indústria)	Isabela Moori de Andrade Mateus Simões de Freitas Gloria Maria Pinto Leite
DSM	Ward Mosmuller (Director Corporate Public Affairs)
CTBE and UNICAMP - FEAGRI	Paulo Graziano Magalhaes (Researcher agriculture program)
Dutch embassy Brasilia	Han Peters (Ambassador) Hans Dorresteyjn (Innovation Advisor) Paul Zwetsloot (Minister Counselor) Patricia de Vries-Van Loon (Agricultural Counselor) Jörgen Leeuwestein (Economic Policy) Jan Bruin (Economic Officer)
Dutch Consulate-General São Paulo	Cor van Honk (Consul-General) Rogier van Tooren (Deputy Consul-General)

	<p>Nico Schiettekatte (Counselor for Innovation, Technology and Science)</p> <p>Lucienne Vaartjes (Assistant Innovation Counselor)</p>
Dutch Consulate-General Rio de Janeiro	<p>Arjan Uijterlinde (Consul-General)</p> <p>Arie Plieger (Deputy Consul-General)</p>
EMBRAER	<p>Fernando Ranieri (Vice President, Technological Development)</p> <p>Sandro Valeri (Business Excellence)</p> <p>Paulo Lourenção (Technical Coordinator)</p> <p>Luciano Pedrote (Chief Research & Technology Advisor)</p>
Embrapa	<p>Ladislau Martin Neto (Diretor-Executivo de Pesquisa & Desenvolvimento)</p>
FAPESP	<p>Roberto Cesar (Coordinator Research, Innovation and Dissemination Centers)</p>
FIESP	<p>Eduardo Giacomazzi (Deputy Coordinator Biobrasil)</p>
FGV	<p>Michiel Kortstee (Researcher healthcare)</p>
Itamaraty	<p>Benedicto Fonseca Junior (Embaixador)</p>
IPT	<p>Gerhard Ett (Head of Laboratory, Thermal Engineering)</p> <p>Maria Filomena de Andrade Rodrigues (Head of Laboratory, Industrial Biotechnology)</p> <p>Gisele Sayuri Hashida (Corporate affairs)</p>
IPT Lightweight Laboratory	<p>Hugo Borelli Resende (Group Director, Aeronautical engineer)</p>
ITA	<p>Luiz Goes (professor, Aeronautical Engineering)</p>

Leiden University	Marianne Wiesebron (Department of Latin American Studies, Faculty of Humanities)
MCTI (Ministério da Ciência, Tecnologia e Inovação)	Sanderson Medeiros Leitão (Secretariat for Science and Social Inclusion)
Min. Economic Affairs	Astrid Boschker (Coordinator aviation and international innovationpolicy)
Min. OCW	Thijs Geurts (Senior Policy Advisor)
Nuffic	Ellen Bijlsma (Director)
NWO	Marije Wassenaar (Policy Officer)
Pontis Engineering	Dirk Jan Kootstra (Director)
RVO.nl	No interview. Sent basic information.
São José dos Campos municipality	José Henrique de Sousa Damiani (Director Economic Development, Science and Technology Department)
TNO	Wim de Klerk (Scientific Coordinator) Laurens Steen (Representante)
TU Delft, Faculty Aerospace	Ingrid Houthuysen (External relations)
União Européia - Delegação da Comissão Européia no Brasil	Piero Venturi (Counsellor for Science, Technology and Innovation)
Unicamp - INOVA	Milton Mori (Executive Director) Max Costa (International relations) Angelica Cristina Toressin (International cooperation) Gustavo Palm Valença (Advisor)
USP (University São Paulo)	Prof. Maurício da Silva Baptista (Associate Director for International Cooperation)
Van Oord	Approached, did not respond.
WUR in Piracicaba (former)	Peter Zuurbier (Retired)

Appendix 2 Abbreviations

ANA	Autoridade Nacional da Aguas – National Water Authority
BNDES	Banco Nacional de Desenvolvimento Econômico e Social – National bank for Economic and Social Development
CAPES	Campanha Nacional de Aperfeiçoamento de Pessoal de Nível Superior – National campaign for personnel training in higher education
CEMADEN	Centro Nacional de Monitoramento e Alertas de Desastres Naturais – National Centre for the Monitoring and Warning of Natural Disasters
CENAD	Centro Nacional de Gerenciamento de Riscos e Desastres – National Centre for the Management of Risk and Disasters
CISLOG	Centro de Inovação em Engenharia de Sistemas Logísticos - Centre for Innovation in Logistics Engineering
CNI	Confederação Nacional da Indústria – National Confederation of Industry
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico - National Council for Scientific and Technological Development
CTC	Centro de Tecnologia Canavieira - Sugarcane Technology Centre
EC / EU	União Européia – Delegação da Comissão Européia no Brasil – Delegation of the European Commission in Brazil
Embrapa	Empresa Brasileira de Pesquisa Agropecuária - Brazilian Agricultural Research Corporation
EMBRAPII	Empresa Brasileira de Pesquisa Inovação Industrial - Brazilian Corporation for Research and Industrial Innovation
ENCTI	Estratégia Nacional de Ciência, Tecnologia e Inovação – National Strategy for Science, Technology and Innovation Brazil
EZ	Ministerie van Economische Zaken – Ministry of Economic Affairs
FAPESP	Fundação de Amparo à Pesquisa do Estado de São Paulo – Research Support Foundation of the State of São Paulo
FIESP	Federação das Industrias do Estado de São Paulo – Federation of the Industries of the State of São Paulo
FINEP	Financiadora de Estudos e Projetos – Funding Authority for Studies and Projects of MCTI
FIOCRUZ	Oswaldo Cruz Foundation
FGV	Fundação Getulio Vargas – Foundation Getulio Vargas (one of the best private Universities in Brazil)
FORTEC	Fórum dos Gestores de Inovação e Transferência de Tecnologia
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – Brazilian Institute of Environment and Renewable Natural Resources

IFSCar	Universidade Federal São Carlos – Federal University of São Carlos
IPT	Instituto das Pesquisas Tecnologias – Institute of Technological Studies
ITA	Instituto Tecnológico de Aeronáutica – Technological institute for Aeronautics
GDP	Gross Domestic Product
KIS	Knowledge and Innovation System
KWR	KWR Water Recycle Institute (www.kwrwater.nl)
LABDES	Laboratório de Referência em Dessalinização Universidade Federal de Capina Grande – Reference Laboratory for Desalination of the Federal University of Campina Grande
MCTI	Ministérios da Ciência, Tecnologia e Inovação – Ministry of Science, technology and Innovation
MEC	Ministério da Educação – Ministry of Education
MS	Ministério de Saúde – Ministry of Health
NBSO	Netherlands Business Support Offices
NIOZ	Royal Netherlands Institute for Sea Research (www.nioz.nl)
NAG	Netherlands Aerospace Group
NITs	Núcleos de Inovação Tecnológica – Innovation and Technology Centers
NLR	Nederlandse Lucht- en Ruimtevaart Laboratorium – Dutch National Aerospace Laboratory
Nuffic	Nederlandse Organisatie voor de Internationalisering van het Hoger Onderwijs - Netherlands organisation for international cooperation in higher education
OCW	Ministerie van Onderwijs, Cultuur en Wetenschap - Ministry of Education, Culture and Science
PISA	Programme for International Student Assessment
PUC-Rio	Pontific Catholic University of Rio de Janeiro
PUC-SP	Pontific Catholic University of São Paulo
R&D	Research and Development
RIDCs	Research, Innovation and Dissemination Centres
STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
TNO	Netherlands Organisation for Applied Scientific Research (www.tno.nl)
UNESP	State University of São Paulo “Julio de Mesquita Filho”
UNIFESP	Federal University of São Paulo
UFGC	Universidade Federal de Capina Grande – Federal University of Campina Grande
UFMG	Universidade Federal de Minais Gerais – Federal University of Minas Gerais

UFPE	Universidade Federal de Pernambuco – Federal University of Pernambuco
UFRJ	Universidade Federal de Rio de Janeiro – Federal University of Rio de Janeiro
UFRGS	Universidade Federal de Rio Grande do Sul – Federal University of Rio Grande do Sul
UFSC	Universidade Federal de Santa Catarina – Federal University of Santa Catarina
UNESP	Universidade Estadual Paulista – State University Paulista in São Paulo
UNICAMP	Universidade Estadual de Campinas – State University of Campinas
USP	Universidade de São Paulo – University of São Paulo
WETSUS	Centre of Excellence for Sustainable Water Technology (www.wetsus.nl)

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