**Supplementary Material**

1. ***The Responsible Innovation in Health Framework***

Responsible Innovation in Health (RIH) consists in a “collaborative endeavour wherein stakeholders are committed to clarify and meet a set of ethical, economic, social and environmental principles, values and requirements when they design, finance, produce, distribute and use sociotechnical solutions to address the needs and challenges of health systems in a sustainable way” (Silva et al., 2018). The RIH Framework is composed of nine attributes, which are described in Table S-1.

| **Attribute** | **Definition** |
| --- | --- |
| Health Relevance | Importance of the health needs addressed by the innovation within the overall burden of disease, considering the causes of death, injury and disability and associated risk factors in the region where the intended users are located. |
| Ethical, Legal and Social issues | Means by which the negative impacts of the innovation on the moral and sociocultural well-being of individuals and groups and the legal and regulatory issues it raises can be mitigated. |
| Health Inequalities | Extent to which the innovation contributes to the reduction (or increase) of avoidable health status differences across individuals and groups that are associated with one’s socioeconomic status, social position, and capabilities. |
| Inclusiveness | Degree of stakeholder engagement in the design, development, and pilot stages of an innovation using an accountable method. |
| Responsiveness | Ability to provide dynamic solutions to existing and emerging challenges in health systems (eg, demographic or epidemiologic shifts, service delivery or governance gaps). |
| Level and intensity of care | Labour intensity optimization by mobilizing the most decentralized unit in the health system to provide the service when it is possible to do so effectively and safely. |
| Frugality | Provision of greater value to more people using fewer resources, which may entail: (i) affordability; (ii) focus on core functionalities and ease of use; and (iii) optimized performance. |
| Business model | Organizational propensity to provide more value to users, purchasers, and society through a business model that supports: (i) a social, not-for-profit and/or environmental mission; (ii) a freely usable or exploitable innovation; (iii) a redistributive price scheme; (iv) employees with particular needs; or (v) compliance with social responsibility programs. |
| Eco-responsibility | Reduction of negative environmental impacts along the innovation’s lifecycle stages: raw material sourcing; manufacturing; distribution; use; and disposal. |

Table S-1 The Responsible Innovation in Health attributes

From Silva et al. (2018) and Silva et al. (2021)

1. ***Characterization of the Québec food system***
   1. ***Production***

We found that agriculture[[1]](#endnote-1) was an important economic sector in Québec (ÉcoRessources, 2016). Local agricultural production was diversified but concentrated around a few products (Figure S-1). The production value of livestock (where pigs represented more than 70% of the livestock production), poultry, and animal products (milk, eggs, and honey) accounted for 63% of agricultural output in 2017. While the production of milk, eggs, and poultry was governed by supply management to match the domestic demand (Heminthavong, 2018), pork production was oriented toward exports. Consequently, the province produced four times more pork than it needed and this entire industry was organized around the international market (Mundler, 2020).

Cereals, oilseeds, and protein crops represented 15% of the total production. Within this category, corn and soybeans respectively accounted for 52% and 38% of the total (Québec, 2019). Québec had the largest blueberry, cranberry, berries, nuts, and maple syrup production of any province in Canada. With over 90% of all maple taps in the country, the province was a global leader in this culture (StatCan, 2017b). Canada produced more than 70% of all the maple syrup in the world, and more than 90% of the Canadian production came from Québec (World Atlas, 2017).

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Figure S-1 Agricultural production in Québec, according to production value (% in 2017)

From: Québec (2019)

Québec had the biggest and largest number of farms with organic certification in the country. About 4% of its farms were certified for organic production compared to 2% in other provinces. Out of 1,049 certified farms, 345 were dedicated to maple production (33%). Milk and field vegetable production followed, accounting respectively for 13% and 10% of certified farms (Keable, 2018).

The number of farms in Québechas declined over the years with the evolution of agriculture. Nonetheless, productivity had been on the rise (StatCan, 2017b). The development of new technologies contributed largely to this trend. Such technologies are more accessible for medium and large farmers at the expense of smaller producers who can rarely benefit from policy incentives for increased productivity (Zombre, 2019).

* 1. ***Processing***

Food processing[[2]](#endnote-2) was one of Québec’s main economic activities and the leading employer in its manufacturing sector (Lacharité, 2017). This sector was the biggest consumer of agricultural products in the province: it purchased approximately 70% of the local production, which contributed to 80% of its agri-food exports (Antunes et al., 2015). The meat and dairy industries led the most important income-generating activity with 43% of the total income generated in the processing stage (Québec, 2019). The beverage industry, notably breweries and soft drinks, represented 15% of the income, followed by bakeries and tortilla manufacturing, which represented 9% of total income. While meat and dairy producers generated the most income and employed the most workers, bakeries and tortilla producers accounted for the highest number of companies, representing almost 30% of the food processing units in the province. Other important food processing industries in Québec are shown in Table S-2.

|  |  |  |
| --- | --- | --- |
| **Industry** | **Income ($M)** | **Pct in the processing stage** |
| Meat products | 6,909 | 24% |
| Dairy products | 5,388 | 19% |
| Bakeries and tortillas | 2,638 | 9% |
| Fruit and vegetable canning and speciality production | 2,030 | 7% |
| Animal feedstuffs | 2,152 | 7% |
| Milling of cereal grains and oilseeds | 1,036 | 4% |
| Sugar and confectionery | 1,203 | 4% |
| Preparation and packaging of fish and seafood products | 480 | 2% |
| Other food products | 2,528 | 9% |
| *Total - Food Manufacturing* | *24*,*365* | *85%* |
| *Total - Beverage and Tobacco Product Manufacturing* | *4*,*418* | *15%* |
| **Food, Beverage, and Tobacco Product Manufacturing** | **28**,**783** | **100%** |

Table S-2 Food, beverage, and tobacco industries’ revenues in Québec in 2016 and their participation in the processing stage

From: Quebec (2019)

* 1. ***Distribution***

Around 45% of the food produced in Québec was sold to consumers within the province, while 23% was sold to other Canadian provinces and 32% to other countries, mainly in the United States of America (USA) (MAPAQ, 2016). The Ministry of Agriculture, Fisheries, and Food (the French acronym is MAPAQ) indicates that these proportions have been quite stable over the last 10 years.

Following MAPAQ’s four categories of food distributors, the largest part of the GDP was generated by food services and drinking venues, with almost 50% of the total, followed by food stores with 31%. Food wholesaler-distributors occupied the third place (19%), followed by agricultural products wholesaler-distributors with only 1% of GDP (Figure S-2).

Figure S-2 GDP of food distributors (M$) in the province of Québec in 2017

From: Quebec (2019)

Food sales in Québec were estimated at around Can$40 billion dollars per year. About two thirds (around Can$26 billion) of sales were made through retailers and almost one third through food services (MAPAQ, 2016). Warehouse clubs and big box stores have increased in importance as points of purchase over the last few years. Other points of purchase were convenience stores and specialized shops, such as butcheries and natural food stores (MAPAQ, 2016).

* 1. ***International trade***

Both food exports and imports have grown in Québec over the years. MAPAQ data for 2017 show that the value of exports reached Can$8.8 billion, 26% higher than imports, which stood at Can$7.0 billion in the same year.

In 2017, about 70% of the food products exported by Québec went to the USA, with more than 50% of the export value concentrated in a few products: meat (21% of the total, 90% of which is associated to pork); oilseeds, cereals, and their by-products (18%); cocoa, chocolate, and their by-products (13%); food preparations and miscellaneous products (8%), and maple, sugars, and honey (7%) (Québec, 2019). When it comes to imports, the biggest value was concentrated in imports of beverages (including alcoholic beverages but excluding juice), which represented 22% of imports in 2017. Imports of fruits and nuts accounted for 11%, followed by cocoa, chocolate and their by-products with 10% of the total. Altogether, these four categories accounted for 43% of the value of food imports made by the province in 2017. Imported food products came from the European Union (29%), the USA (21%), China (4%), Mexico (1,5%), Japan (0,2%), as well as from other countries (44%) (Québec, 2019).[[3]](#endnote-3)

1. ***Characterization of the São Paulo food system***

# ***Production***

When it comes to agricultural production, vegetable production accounted for 8% of the sector’s GDP and was more important from an economic perspective than livestock at 3% of the GDP (CEPEA, 2017). Sugarcane, which is used to produce both alcohol and sugar for the domestic and international markets, was the main agricultural product in the state of São Paulo, representing 41% of its agricultural production value. Its production covered close to 67% of the cultivated area (Silva et al., 2015). Cattle production was another important activity in São Paulo, representing 12% of the agricultural production value in the state. Likewise, orange production for the beverage industry was among the most important agricultural activities. About 70% of Brazil’s orange production was concentrated in São Paulo, which was the main world producer of this fruit[[4]](#endnote-4) (Buainain et al., 2019; Neves et al., 2010). São Paulo produced a variety of other crops. Altogether, the production of fruits, vegetables, roots, and tubers contributed to 14% of the total agricultural production value. It included a variety of products, the most representative of which were bananas, citrus fruits (excluding orange for the beverage industry), grapes, tomatoes, and potatoes (IEA, 2017). The production value of the different agricultural products in the São Paulo food system is presented in Figure S-3.

Figure S-3 Total production value of agricultural products in São Paulo in 2017 (%)

From: Institute of Agricultural Economics (2017)

# ***Processing***

Food processing in São Paulo represented almost 30% of the country’s gross value of industrial food production. A significant part of the food processed in São Paulo comes from other parts of the country. These foods are processed and consumed locally or in other parts of Brazil or exported to other countries (Silva et al., 2015, p. 112). Food processing was characterized by “strictly coordinated chains” (Saes et al., 2019, p. 77) composed of large companies (Chaddad, 2016, p. 15).

The sugar industry represented 24% of the production value generated in processing and leads the sector in this territory. Despite its economic importance, sugar industries represented only 3% of all food and beverage companies units. We can infer that the sugar sector was thus characterized by the presence of large units (IBGE, 2019). Meat processing (especially beef) constituted another important activity. The firms operating in the São Paulo meat sector were consolidated in the 2000s and their activities became more international after 2005. Other important activities included grinding and manufacturing of starch and animal feed, canned fruit and vegetables manufacturing (especially orange juice), dairy and coffee (Table S-3) (IBGE, 2019).

|  |  |  |  |
| --- | --- | --- | --- |
| **Sector** | **Product** | **Industrial production value (1**,**000 R$)** | **Pct in production value** |
| Food Manufacturing | Sugar manufacturing and refining | 43,980,386 | 24% |
| Slaughter and manufacture of meat products (includes beef, chicken, and pork) | 26,394,457 | 14% |
| Grinding, manufacture of starch and animal feed products | 17,124,052 | 9% |
| Canned fruit and vegetables manufacturing (includes juices) | 14,286,277 | 8% |
| Dairy products | 13,283,065 | 7% |
| Coffee roasting and grinding | 9,195,970 | 5% |
| Vegetable and animal oils and fats | 6,056,123 | 3% |
| Other food products | 34,151,484 | 19% |
| *Total food manufacturing* | *164*,*471*,*814* | *89%* |
| Beverage Manufacturing | Alcoholic beverage manufacturing | 13,126,568 | 7% |
| Non-alcoholic beverage manufacturing | 6,348,103 | 4% |
| *Total beverage manufacturing* | *6*,*104*,*912* | *11%* |
| **Total food and beverage manufacturing** | | **183,946,485** | **100%** |

Table S-3 2017 industrial production value in the state of São Paulo per sector

From: IBGE – Censo Agropecuário (2019)

# ***Distribution***

Food distribution in São Paulo was mainly through wholesale, retail (food stores, including street markets), and food services. The revenue generated by food distribution through wholesale and retail added up to R$366 billion in 2017. Most of this income was in retail with 60%, against 40% in wholesale (IBGE, 2017). While most of the income generated in the retail sector came from non-specialized food shops, such as supermarkets (81%), most of the income generated in wholesale came from specialized food shops(71%), such as the wholesale of fruits and vegetables (IBGE, 2017).

# ***International trade***

São Paulo’s food system evolved from being primarily an exporter of traditional tropical products during Brazil’s colonial period, such as coffee and sugar, to being a global exporter in several major production chains in the beginning of the twenty-first century (Buainain et al., 2019). Since then, São Paulo has played an important role in the global food supply (Jank et al., 2019). Food exports from São Paulo added up to US$14.6 billion in 2017 (Ministry of Industry, Foreign Trade and Service, 2019)[[5]](#endnote-5). The main export is sugar, which represented 51% of all food products exported from São Paulo (in US$). Other important exported products are orange juice (12%), soy (9%), beef (6%), and coffee (5%). The main country buyers are China, the USA, the United Arab Emirates, Bangladesh, Belgium, and India (Ministry of Industry, Foreign Trade and Service, 2019).

Exports were more than four times greater than food imports. Data from the Ministry of Industry, Foreign Trade and Service show that food imports added up to US$3.5 billion in 2017[[6]](#endnote-6). Most food imports came from South America, including fish and crustaceans, molluscs, and other aquatic invertebrates (20% of the total), followed by cereals, mostly wheat and rice (10%).

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1. “Agriculture is the most comprehensive word used to denote the many ways in which crop plants and domestic animals sustain the global human population by providing food and other products” (Harris and Fuller, 2014). [↑](#endnote-ref-1)
2. The analysis of food processing in Quebec includes the beverage and tobacco industries, following the same methodology of the MAPAQ reports. [↑](#endnote-ref-2)
3. We may infer that Quebec tends to import products with lower added value (less processed) that are used as raw material by food companies, except for the beverage sector. Exports, on the other hand, tend to be more concentrated in processed products with higher added value. Nevertheless, the lack of sufficiently detailed data in the reports does not enable us to confirm this interpretation. However, the presence of some important food companies points to this type of trade. For example, the local branch of the Swiss company Barry Callebaut is an important supplier of primary processed products (such as cocoa butter and cocoa mass, which is obtained by processing cocoa beans) to the biggest chocolate brands in North America. The company Green Mountain coffee, which owns the Quebec-based company Van Houtte, is also an important exporter of coffee to the United States (Lacharité, 2017). [↑](#endnote-ref-3)
4. Oranges are grown on farms of independent growers as well as large-sized farms that belong to companies that produce and export orange juice (Boteon et al., 2013). [↑](#endnote-ref-4)
5. About 54% of the food products exported by São Paulo in 2017 were sold to international food industries and 46% for international consumption (Ministry of Industry, Foreign Trade and Service, 2019). Products sold to industries are usually lower added-value products, such as sugar and soy, which are used to manufacture other food products (Ministry of Industry, Foreign Trade and Service, 2019). As a consequence, they will not be identified as products from São Paulo (or even Brazil) in the consumer market (Paloviita et al., 2016). [↑](#endnote-ref-5)
6. It is not possible to affirm that all food products imported in São Paulo are consumed within this state. Sometimes, São Paulo serves as a gateway for imports that are then distributed to other Brazilian regions. [↑](#endnote-ref-6)