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The Timing and Nature of the Nutrition Transition in Chile, 1930-2019*

La temporalidad y naturaleza de la transición nutricional en Chile, 1930-2019

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Abstract

In this article we provide the first long-term series of Chile's per capita consumption of a wide range of key foodstuffs: cereals, legumes, potatoes, meats and dairy products from 1930 to 2019, based on food balance sheets and complementary information from FAO, consumer price indexes and surveys of family budget. Based on this information, we examined and characterised the timing and nature of Chile's nutrition transition (NT), concluding that there was a NT within a short period of time (common to countries which develop comparatively late), with the average dietary energy consumption increasing from 2,600-2,700 kcal per person per day to slightly over 3,000 within a few decades. In Chile, as in most countries that have experienced a NT, dietary options became more diverse, but also less vegetarian: the consumption of meat and dairy products increased dramatically; there was an unprecedented decline in the consumption of legumes, and there was also a less substantial reduction in the average intake of potatoes. Yet, if compared to the NT experienced by most developed countries, the combined consumption of cereals in Chile has remained unusually stable.

Keywords: nutrition transition, diet, Chile.

Resumen

En este artículo proporcionamos la primera serie de largo plazo de consumo per cápita en Chile de una amplia gama de alimentos clave: cereales, legumbres, papas, carnes y productos lácteos, desde 1930 a 2019, en base a los balances de alimentos e información complementaria de la FAO, índices de precios al consumidor y encuestas de presupuesto familiar. Basándonos en dicha información, examinamos y caracterizamos la temporalidad y naturaleza de la transición nutricional (NT) en Chile, concluyendo que hubo una NT en un corto periodo de tiempo (común en los países que se desarrollan comparativamente tarde), con un consumo promedio de energía alimentaria que aumentó de 2.600-2.700 kcal diarias por persona a poco más de 3.000 en unas pocas décadas. En Chile, como en la mayor parte de países que han experimentado una NT, las opciones dietéticas se volvieron más diversas pero también menos vegetarianas: el consumo de carne y productos lácteos aumentó drásticamente; hubo una disminución sin precedentes en el consumo de legumbres y también hubo una reducción, menos sustancial, en la ingesta promedio de papas. Sin embargo, si se compara con la NT experimentada por la mayoría de los países desarrollados, el consumo combinado de cereales en Chile se ha mantenido inusualmente estable.

Palabras clave: transición nutricional, dieta, Chile.

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Introduction

During the last century and a half, most countries have experienced a so-called nutrition transition, a multidimensional phenomenon characterized by abundant food supply: an overwhelmingly vegetarian and monotonous diet, below minimum standards of nutrition, gives way to the consumption of a greater variety of foodstuffs, including more products of animal origin such as meat and dairy goods, as well as more sugar, fruits, and vegetables. Although throughout most of human history chronic malnutrition was the norm for most societies, nowadays protein-energy malnutrition has been eradicated nearly everywhere (Fogel, 2004). In most western countries modern dietary transitions have been characterized by a pronounced decline in the average consumption of carbohydrates (e.g. cereals and potatoes) and an even greater decrease in the intake of legumes (Smil, 2000; Popkin, 1993; Poleman and Thomas, 1995; Den Hartog, 1992; Moreno *et al*., 2002; Caballero and Popkin, 2002; Semba, 2017). As a consequence, total per capita food energy consumption has increased to around 3,000-3,500 kcal/day, from less than 2,500 kcal/day.[1]

Unsurprisingly, due to large shifts in the composition of their diets, affluent nations have experienced continuous gains in height and changes in body composition (Popkin, 1993, 2002; Fogel, 2004). Diet and nutritional status have gained relevance as indicators of human welfare and economic growth (Cussó, 2005; Fogel, 1991). The reduction of chronic malnutrition is perhaps the main cause of the dramatic reduction of mortality experienced by most of the developed world between the 1890s and the 1950s.[2] Adequate nutrition is regarded as one of the most powerful instruments of preventive medicine. Measures of nutritional status are thought to be effective predictors of the risk of morbidity and mortality (Semba, 2017). Likewise, improvements in nutrition (and health) are responsible for an important share of the growth in labour productivity and per capita income during this period (Fogel, 1991). Improvements in the nutritional status of most populations are thought to have initiated a virtuous circle of technophysio evolution (Fogel and Costa, 1997; Fogel and Helmchen, 2002).[3] Humans are now taller and heavier, and experience lives which are healthier and longer than ever before, which is in part explained by their better nutrition (Floud *et al*., 2011). It is also now widely accepted that there is a synergy between nutrition and infection, and that nutrition affects virtually every vital organ system (Fogel, 2004). Hence the importance of studying secular changes in the diet and nutrition of any population.[4]

1 It is estimated that for the specific period 1965-1989, the availability of dietary energy increased by about 400 calories per capita worldwide (Fogel, 2004).

2 Even after this period, although hunger is less important, "It is possible that one of the reasons that mortality rates are falling among the elderly today is improvements in their nutrition seventy years ago, when they were being conceived, born, and nurtured as children" (Deaton, 2013: 142).

3 For the Chilean case, see Llorca-Jaña *et al*. (2021a).

4 Diet refers to nutrient intake, while nutritional status refers to the balance between the intake of nutrients and the claims against it (Fogel, 1993).

The nutrition transition, in turn, is commonly characterized by having several phases, although each country may have its own peculiarities. The first phase encompasses an increase in the per capita consumption of calories because of increasing consumption of cereals, legumes and potatoes,[5] as soon as per capita income increases beyond subsistence levels, leaving behind centuries of frequent famines. Per capita income has been identified as the main explanatory variable behind dietary changes (Popkin, 1993, 2002; Grigg, 1995),[6] together with increasing productivity in the agricultural sector;[7] transport improvements (and cheapening of national and international freights); increasing urbanization; the incorporation of women into the labour market; the growing importance of processed foods; expansion of mass media and communications; and improvements in the means of preserving perishable food (Grigg, 1995; Cussó and Garrabou, 2007; Araneda *et al*., 2016; Caballero and Popkin, 2002; Popkin, 2002; Semba, 2017).

This initial phase is typically followed by a stagnation in the consumption of these goods, but by an increase in the consumption of meats and dairy products, where demand elasticity is particularly high at low and medium levels of personal disposable income. In the third phase, there has often been a further increase in the consumption of meats and dairy products, but a decrease in the consumption of cereals and tubers, and in particular of legumes, together with an increase in the consumption of fruits, vegetables, oils and sugar (Smil, 2000; Cussó and Garrabou, 2007).[8] In most affluent countries, before the transition started, carbohydrate foods provided some two-thirds and even four-fifths of food energy, decreasing gradually to just one-third, and even less once the transition had finished. Many of these changes have also been linked to increasing urbanization, the cheapening of international freights, and to changes in public knowledge about the role of diet (Popkin, 1993; Den Hartog, 1992; Grigg, 1995).

At an international level, developed countries such as the US and the Netherlands enjoyed the overall gains in food intake described above in about three generations, between the 1880s and the 1960s (Smil, 2000; Fogel, 1991; Den Hartog, 1992). However not all developing countries will replicate the pattern of nutritional change that has occurred in most developed countries (Popkin, 1993), despite claims that the pattern is nearly universal (Poleman and Thomas, 1995). Pujol-Andreu and Cussó (2014) have recently argued that up to the 1950s there co-existed several (different) nutrition transition patterns.[9] Furthermore, it has been noted that even countries with documented evidence of having replicated these changes have accomplished their nutrition transitions at

5 These starchy staples are cheap to produce, which explains their wide consumption in low-income societies (Poleman and Thomas, 1995; Grigg, 1995).

6 This is not to say that other variables are to be dismissed, such as environmental conditions and the available technology in the agro-alimentary sector (Pujol-Andreu and Cussó, 2014).

7 In particular advances in seeds, dry farming techniques, improved fertilizer, new crops, and the expansion of arable land (Fogel, 2004).

8 A fourth phase would be characterized by health-conscious behavioral change, where high-fat foods and sugar decrease, while low fat foods increase (Popkin, 1993). For Chile in particular, see Albala *et al.* (2001).

9 For example, the timing of Atlantic Europe was very different to that of Mediterranean Europe (Pujol-Andreu and Cussó, 2014; Cussó and Garrabou, 2007; Martínez-Carrión *et al*., 2018; Grigg, 1995). The Mediterranean diet has many peculiarities (Echeverría *et al*., 2018).

different paces (Smil, 2000). Hence the need to analyse dietary changes case by case, and to provide new information for under-researched nations (such as Chile), to provide useful insights relating to likely future changes (Popkin, 1993).

In this article we wanted to analyse the Chilean experience, in particular to corroborate some of the most common beliefs about the nutrition transition. For example, it has been said that late starters, such as Chile, usually move faster than the pioneers, greatly improving the nutritional status of the developing world within a few decades;[10] that one of the most important changes of the nutrition transition has been a large decline in the consumption of all carbohydrate staples; and particularly of legumes (Smil, 2000; Poleman and Thomas, 1995; Popkin, 1993). Does Chile fit within this general pattern? In Chile's case, the rapid increase in the consumption of meat and dairy products occurred within a generation, during the 1990s-2000s (Llorca-Jaña *et al.*, 2020), while legume consumption has collapsed, as we shall see. These two facts would fit within the timeline described above. However, some carbohydrates continue to be important in the Chilean diet, such as potatoes and bread (from wheat), which differentiates Chile from developed countries such as the Netherlands (Den Hartog, 1992).

Understanding patterns of nutritional changes is useful for any country's authorities, since such knowledge can inform public policies to improve diets, reduce the recurrence of some diseases linked to the intake of specific products, and in the long run to increase life expectancy (Araneda *et al.*, 2016). Education campaigns and the implementation of policies such as subsidies or taxes to increase (or decrease) the intake of some foodstuffs need to rely on sound information (Popkin, 1993). We expect that this study will be a contribution to public health policy makers. Recently, before this article was written, research was conducted into the evolution of the consumption of two key foodstuffs: meat and dairy products (Llorca-Jaña *et al.*, 2020). Yet, nothing has been written about other key staples such as cereals, legumes and potatoes, which we are adding into this study.[11] This is unfortunate since during the period covered by this article Chile experienced a dramatic fall in general and child mortality (Llorca-Jaña *et al.*, 2021c). It also experienced an epidemiological transition, while we know that the high mortality rates suffered by most developing countries are usually associated with malnutrition, and that inadequate nutrition during childhood is also an important predictor of the probability of developing chronic diseases in middle and old age (Fogel, 1993).

This paper is divided into two further sections. The first deals with a description of methodology and sources used. We then turn to our results, before concluding.

10 Thanks to better nutrition, together with improvements in hygiene and public health, morbidity and mortality from infectious diseases has decreased dramatically worldwide (Semba, 2017). Diseases such as kwashiorkor, scurvy and pellagra have been eradicated nearly everywhere, although they were common before the 1970s.

11 Except for Mendoza *et al.* (2007), but for a short period of time. A comparable study was conducted for these same products for Spain, following Cussó and Garrabou (2007).

Sources and methodology

To estimate per capita consumption of the most relevant foodstuffs in the Chilean diet, we have resorted to the well-known methodology of food balance sheets, which estimate the yearly food supply available for national consumption (Popkin, 1993; Fogel, 1991; Grigg, 1995; Mendoza *et al*., 2007). Despite the shortcomings of this methodology,[12] it is good enough to get rough estimates of per capita consumption of key foodstuffs, in particular for long-term analysis. We covered the period circa 1930-2018, which is longer than that available in the dataset provided by the Food and Agricultural Organization (FAO) of the United Nations (available from 1960 only). We also preferred to build our own figures from scratch, for uniformity, but also on account of the lack of accuracy of FAO data for some products (on this, see Llorca-Jaña *et al*., 2020). Nonetheless, we have compared our own data to that available on the FAO website for the overlapping periods,[13] concluding that in general FAO data and our own data show the same long-term trends, despite some disparities. There are some differences for particular years, but our main contribution is to be able to cover the period before 1960, which was previously unavailable.

As we wanted to focus on cereals, legumes, potatoes, meats, and dairy products, it was fortunate for us that there is already good data available for the consumption of all meats and all dairy products for the same period we are dealing with: 1930s-2010s (Llorca-Jaña *et al*., 2020). We created new series for legumes (beans, lentils, peas, and chickpeas), potatoes, and cereal staples (i.e. wheat, corn, and rice). To estimate consumption for each product, we added national production to imports. We then deduced exports, and the production destined for seeds or animal feed, as well as estimates of production losses (following Fogel, 1991),[14] based on ODEPA and/or FAO estimates. Having thus estimated national apparent consumption, we calculated the per capita consumption of each product, a standard procedure in the literature and used by the FAO (Grigg, 1995; Cussó and Garrabou, 2007; González de Molina *et al*., 2013; Nicolau and Pujol, 2005).

National production data was obtained from Díaz *et al.* (2016), Ballesteros (1965), and from Oficina de Estudios y Políticas Agrarias (ODEPA). Estimates of losses of production were taken from ODEPA, FAO and the US's Foreign Agricultural Service (FAS).[15] Export and import data for 1990-2019 was taken from the ODEPA website, which is based on information provided by the National Customs Service. The foreign trade data for 1930-1989 was obtained from the Central Bank (*Indicadores de Comercio Exterior*), and

12 See in particular Fogel (1991) and Cussó (2005). An issue for short-term analysis would be changes in stock, for which we have no available data. This may be important for specific estimates for a particular year, but since we are working with annual averages for ten year periods, this problem is far less relevant for us. Another important issue would be the accuracy of production figures and of the coefficients used to transform outputs of these products into food available for human consumption. In this sense, all data on per capita consumption must be taken as an approximation only.

13 See http://www.fao.org/faostat/en/#country (accesed on 20 April 2022).

14 Another limitation of this methodology is that it does not allow us to obtain data per region, only national estimates.

15 On this, see also González de Molina *et al.* (2013).

from the Statistical Yearbooks (foreign trade section and *Estadísticas Agropecuarias*). We only included foreign trade for products destined for human consumption, thus excluding all product codes associated with imports of seeds, animal feed or any other non-human-food purpose. Population figures are also from Díaz *et al.* (2016) and the Institute of National Statistics (for the last decade).

For potato consumption we included fresh potatoes and imported processed potatoes (i.e. mainly frozen).[16] For production we took the national production of fresh potatoes (which could be processed later on, or not), deduced losses, as well as production for seeds and for animal consumption (25% in total). For foreign trade, we considered the following codes of the Harmonized System (HS): 07019000 (fresh or refrigerated), 07101000 (frozen), 20041000, and 20052000, thus including fresh and frozen potatoes.[17] Chile only started to import processed potatoes, in sizeable quantities, from the mid-1990s. Before 1990, most potatoes consumed in the country were fresh, and produced domestically.

As to legumes, we included lentils, peas, chickpeas and beans, which are the most commonly consumed pulses in Chile (beans in particular). We entered national production data for these products, and as far as foreign trade is concerned, we considered the following HS codes: 07081000, 07131090, 07136000, 20054000 (peas); 07132000 (chickpeas); 07082000, 07133190, 07133290, 07133390, 07133490, 07133590, 07133990 (beans, of which the most important was 07133390 for exports and imports and 07082000 for imports); and 07134000 (lentils).

For cereals, we considered wheat, corn, and rice, which are the most important cereals in the national consumption basket. For foreign trade, the HS considered were: 10011000, 10019000 for wheat; 11010000, for wheat flour; 10059020 for corn; 11022000 for corn flour; and 10061000, 10061090, 10062000, 10063000, 10063010, 10063020, 10063090, 10064000, for rice. Amongst cereals, wheat is the star staple in Chile. Most arable land is devoted to its production. In turn, most wheat is destined to be turned into flour, and then bread; Chile is one of the largest per capita consumers of bread in the world and the largest in Latin America. National wheat production is complemented with imports coming mainly from Argentina, the US, and Canada. The country also imports small volumes of wheat flour. Thus, we have converted flour imports into tons of wheat, by a factor of 75% (4 tons of wheat produce 3 tons of flour). This is an approximation only, although of little consequence since wheat imports are not sizeable. For example, in 2019 the country produced 1,399,919 tons of wheat, imported 1,156,282 tons of wheat, and imported only 15,282 tons of wheat flour.

16 For example, in 2016, 77% of potatoes consumed in Chile were freshly produced, while 23% were processed potatoes (mainly frozen).

17 We did not include other marginal categories of potatoes, such as potato flour, which are neither exported nor imported by Chile in relevant volumes. By far the most important product is imported frozen potatoes.

There are more complexities associated with rice.[18] The product must be divided into paddy rice and clean rice. The paddy rice is unclean or with its shell, so that production expressed in paddy rice must be converted into eatable tons of rice (i.e. it is estimated that the shell of the rice weights around 20% of the whole grain). Most foreign trade statistics for Chile are in clean rice (non-paddy). However, part of the production is destined for seeds. According to the US Department of Agriculture (USDA), which publishes the foreign production of several agricultural products through its Foreign Agricultural Service (FAS), to convert the gross weight of total production in Chile to the net weight destined for human consumption, we must use a conversion factor of 64%.

To complement our results, whenever necessary, we also consulted the shares of some our products within the consumer price index from 1928 to 2008, and the average monthly expenditure of Chilean households on legumes, potatoes and cereals, according to the Surveys of Family Budget[19] from 1978 to 2017, aiming to triangulate our evidence as in Collantes (2014), Llorca-Jaña *et al.* (2020); and Cussó and Garrabou (2007).[20] An advantage of these surveys is that they allow us to distinguish consumption patterns across socioeconomic groups, although coverage is usually limited in both time and regions (Araneda *et al.*, 2016; Fogel, 1993).[21]

General results

According to rough estimates produced by FAO (Figure 1), during the 1960s the average dietary energy consumption of Chile was nearly 2,600 kcal per person per day, increasing modestly during the 1970s (2,628), decreasing to some 2,550 during the so-called "lost decade" of Latin America (i.e. the 1980s), and from then on it increased slowly, but permanently, to slightly over 3.000 kcal per person per day during the last few years. Only recently has Chile achieved the average per capita food energy consumption of developed countries, according to the figures quoted above from Fogel (2004), when summarising the nutrition transition. Chile was a latecomer, completing its nutrition transition within a very short period time, compared to developed countries.

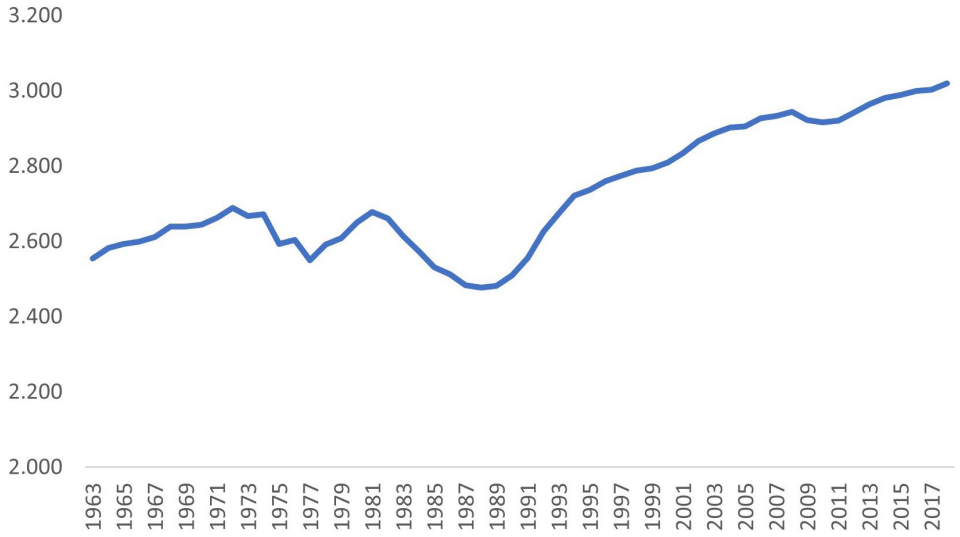
18 It is believed that Chilean rice production started as late as 1925 (ODEPA, 2016).

19 These surveys are typically based upon interviews with families who are asked to recall their diets for a certain period of time (Floud *et al.*, 2011).

20 Other studies prefer to focus on Surveys of Family Budget only, such as Moreno *et al.* (2002), although it is believed that national food balance sheets are of superior quality, as they are regarded as the best method for assessing trends in nutritional intake for populations (Fogel, 2004; Floud *et al.*, 2011). Food balance sheets also provide a far longer period of analysis.

21 Recent metabolic studies have shown that national food balance sheets provide the best measure of average caloric intake, especially for the estimation of long-term trends (Fogel, 2004). The information provided by FAO comes from this methodology.

Figure 1. Chile Dietary Energy Consumption (kcal per person per day), 3-years moving averages, 1961-2018
Figura 1. Consumo de energía alimentaria en Chile (kcal por persona al día), promedios móviles de tres años. 1961-2018



Source: own elaboration from FAO data. Fuente: elaboración propia en base a datos FAO (http://www.fao.org/faostat/en/#country).

Until the first decades of the twentieth century, judging from the relatively low stature of adult Chilean men and women up to that point, many Chileans continued to be inadequately fed (on a diet lacking animal proteins and dairy product), and likely to be undernourished (Llorca-Jaña *et al.*, 2021b). This is unsurprising; it is well known that during the first decades of the twentieth century, for most developing countries, meat was a "luxury item that formed a small portion of the diet of much of the population" (Orlove, 1997: 234). With time though, a recent study has shown that there was a sudden rise in Chile`s consumption of meat and dairy products: Chilean per capita consumption of dairy products increased from the equivalent of 105 liters per person per year during the 1970s-1980s to 160 liters during the 2010s, while per capita meat consumption increased from some 32-36 kg during the 1930s-1980s to 86 kg during the 2010s. This can be attributed to various factors: Chile belatedly joining the international agribusiness revolution; government support between the 1930s and the 1960s; increasing GDP per capita; macro-economic stability; changes in consumption habits; trade liberalization; and the fall in food prices, as both meat and milk had a high-income elasticity (Llorca-Jaña *et al.*, 2020). Yet, there was scant information about the consumption trends of many other key products, which we can now analyse.

Potatoes

Most potatoes consumed in Chile are both fresh and grown locally. Potatoes are the fourth largest crop in Chile (according to cultivated land), as they are produced mainly by small farmers highly concentrated in the south of Chile. Total production has been increasing gradually from the 1930s to the 2010s, a process characterised by increases in productivity, in particular during the 1960s, but also during the last two decades (Banco Central de Chile, 1981; Fundación para la Innovación Agraria, 2011). In the twenty-first century imports have gained in importance, in particular of processed frozen potatoes,

a development which is consistent with increasing income and urbanization. As a consequence, the share of processed potatoes has increased, but fresh potatoes remain most popular (López and Tapia, 2009; Pefaur, 2017; Tapia, 2020).

In the long-term, as can be seen from Table 1, there was a reduction in the per capita consumption of potatoes in Chile, from 66-72 kilos per person per year during the 1930s-1960s to some 49-54 kilos during the 1980s-2010s.[22] This is in line with the pattern of those countries that have experienced a nutrition transition: there is a reduction in the consumption of tubers. However, the decrease in the consumption of in Chile was less important that that experienced by wealthier nations: in most developed countries people eat fewer potatoes than Chileans do nowadays. During the previous decade Chileans consumed some 54 kg per person annually, while the world average is around 33 kg for this period.[23] Within Latin America, only Peruvians eat more potatoes than Chileans.

Table 1. Chile's food balance sheet for potatoes, 1930s-2010s (annual averages per decade)
Table 1. Balance alimentario de papas en Chile, de 1930 a 2010 (promedios anuales por década)

Decade	Production (tons)	Imports (tons)	Exports (tons)	Consumption (tons)(*)	Per capita consumption (kg per person per annum)
1930s	452.184	67	2.943	336.263	72
1940s	489.307	0,01	2.448	364.533	66
1950s	618.845	2.236	0,3	466.369	69
1960s	751.368	5.082	2.466	566.143	67
1970s	800.288	8.374	138	608.452	59
1980s	870.805	7	296	652.815	54
1990s	931.023	6.278	1.020	703.525	49
2000s	1.098.352	23.347	2.057	845.054	52
2010s	1.197.060	80.792	2.056	976.532	54

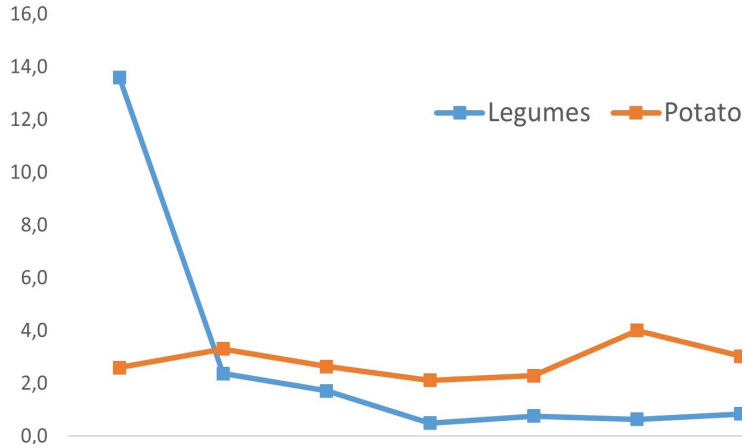
(*)75% of gross national production is considered to be destined for human consumption (i.e. it is estimated that around 25% of national production is either wasted, or destined for seeds or animal feed). Source: own elaboration. For this and the other tables, see methodology section. (*)Se considera que el 75% de la producción nacional está destinada al consumo humano (es decir, se estima que alrededor del 25% de la producción nacional es desperdiciada o destinada a semillas o alimentación animal). Fuente: elaboración propia, ver apartado de metodología.

The continuous importance of potatoes within the Chilean diet can be seen in Figure 2, which contains the weight of potatoes in Chile's food expenditure according to the consumer price index (CPI). The share of potatoes in Chilean food expenditure has remained stable (at 2%-4%), reaching its highest value quite recently, in the CPI of 2008 (4%). This percentage is a testimony to the persistence of potatoes in the Chilean diet.

22 For the periods for which we have data available from ODEPA and FAO on per capita consumption of potatoes, the three series (ours, FAO and ODEPA) are similar, showing the same long-term trends and similar levels.

23 See https://www.helgilibrary.com/indicators/potato-consumption-per-capita/world/ (accessed on 20 April 2022). The world leaders in the consumption of this product are Belarus, Ukraine and Latvia, which consume over 100 kg per annum.

Figure 2. Weight of legumes and potatoes in Chile's total food expenditure according to the national consumer price index, 1928-2018
Figura 2. Peso de las legumbres y papas en el gasto total de alimentos en Chile según Índice de Precios al consumidor (IPC), 1928-2018



Source: own elaboration from Chilean CPIs. Fuente: elaboración propia según IPC (https://www.ine.cl/ine-ciudadano/definiciones-estadisticas/economia/indice-de-precios-al-consumidor).

Legumes

Table 2 shows Chile's food balance sheets for legumes from the 1930s.[24] In the legume category, the most important products consumed by Chileans are beans (*porotos*), followed by lentils. If there is a Chilean product, that perfectly fits within the general narrative of the nutrition transition, it is the legume. During the 1930s Chileans consumed, on average, nearly 15 kg per person every year, falling to less than 11 kg during the 1940s-1950s and then sharply to 6,2-6,4 kg during the 1960s-1980s, and to less than 4kg per capita during the last three decades. Currently Chileans consume around 3kg of legumes per year, nearly a fifth of what was consumed during the 1930s, a fact already highlighted by Araneda *et al.* (2016) and Pinheiro *et al.* (2018).

National production of legumes has fallen sharply, even in relation to national consumption: during the last decade, for the first time in its entire history, Chile became a net importer of legumes. The volume of imported legumes was nearly double the amount grown domestically, while exports nearly disappeared from the export basket. Only from the 1990s, as part of the foreign trade liberalisation process undertaken by the country (Llorca-Jaña, 2015), did Chile start to import legumes on a sizeable scale, with Canada (lentils),[25] China (beans[26] and chickpeas) and Argentina (chickpeas)[27] becoming important suppliers of the Chilean market.

24 For the periods when there is overlapping data, our figures are similar to those of both ODEPA and FAO.

25 Canada became the largest producer of lentils in the world from the 1990s (when Chile deepened its trade liberalization), and the lentils are mainly for the international markets, rather than home consumption (Janzen *et al.*, 2014).

26 The leading world producers are India, Brazil, Myanmar, USA, Mexico and China (Siddiq *et al.*, 2011).

27 The world's largest exporters of chickpeas are India, Australia, and Mexico. Within Latin America, only Mexico and Argentina are large producers (Muehlbauer and Sarker, 2017).

Table 2. Chile's food balance sheet for legumes(*), annual averages per decade
Tabla 2. Balance alimentario de legumbres en Chile(*), *promedios anuales por década*

Decade	Production (tons)	Imports (tons)	Exports (tons)	Consumption (tons)	Per capita consumption (kg per person per annum)
1930s	122.327	3	52.943	69.387	14,9
1940s	111.993	0	53.462	58.531	10,7
1950s	97.286	24	26.685	70.624	10,7
1960s	80.353	239	24.415	56.176	6,6
1970s	101.200	51	35.168	66.083	6,4
1980s	135.178	695	61.831	74.042	6,2
1990s	85.658	8.607	38.989	55.276	3,9
2000s	46.714	20.425	5.466	61.672	3,8
2010s	20.756	38.495	1.389	57.862	3,2

(*)Considers beans, lentils, chickpeas and peas. Source: own elaboration.
(*)Considera porotos, garbanzos y arvejas. Fuente: elaboración propia.

Legume production costs in Chile are far higher than elsewhere: the sector is dominated by small farmers, who have not introduced technological innovations (Baginsky and Ramos, 2018). Chilean producers have been, therefore, unable to compete with countries such as Canada, where production is highly mechanised. Furthermore, many Chilean producers of legumes have switched to more profitable activities, such as horticulture and fruticulture. Even from the 1960s CORFO greatly supported the production of fruticulture and the forestry sector, in detriment of other crops such as legumes (Nazer, 2021). This would explain the changing composition of local production, but it does not explain the fall in total consumption. The decreasing intake of legumes has been linked to the substitution of vegetal proteins for animal proteins, while legumes are also associated with the diet of a lower strata of Chilean society, which would not promote their consumption. Cooking legumes takes longer than cooking other foodstuffs, which would discourage consumption in modern times (Pinheiro *et al.*, 2018), although cooked legumes are on the market, either canned or in tetra paks. As a reflection of the evident decline in the consumption of legumes, the share of legumes within the Chilean consumer price index, considering the expenditure on food only, sharply declined from nearly 14% in 1928 to 2.4% in 1969, and then to less than 1% from 1989 (Figure 2). This is consistent with our data in Table 2. Finally, we must also mention that the period when legumes were widely consumed coincides with a lack of refrigeration facilities at home (Llorca-Jaña *et al.*, 2020). Chilean households had to rely overwhelmingly on non-perishable products, such as dried legumes. Once refrigerators became more common within Chilean households, this barrier disappeared, in detriment of legumes consumption, *ceteris paribus*.

Wheat (for human consumption only)

Wheat is Chile's most important crop (therefore also the main cereal), as it is mainly produced by small farmers for the production of bread, and Chile is one of the largest per capita consumers of bread in the world.[28] Table 3 shows the food balance sheet of wheat for Chile.[29] As can be seen, per capita consumption was stable between the 1930s and the 1970s, declining sharply during the 1980s and 1990s. During the last three decades, the per capita consumption of wheat in Chile was around 82% of what it used to be in the 1930s-1970s. This is in line with the general pattern of those countries experiencing a nutrition transition: the consumption of the main cereal is partially substituted by more meat and more products, as well as by a more diverse diet (including a diversification in the cereal basket itself).

Table 3. Chile's food balance sheet for wheat (for human consumption), annual averages per decade(*)
Tabla 3. Balance alimentario de trigo (para consumo humano) en Chile, promedios anuales por década(*)

Decade	Production (tons)	Imports (tons)	Exports (tons)	Consumption (tons)(**)	Per capita consumption (kg per person per annum)
1930s	776.305	7.889	11.212	710.878	151,6
1940s	903.222	175	2.031	829.108	150,7
1950s	1.017.575	84.529	2.018	1.018.681	151,2
1960s	1.150.896	264.643	4.804	1.318.664	154,0
1970s	1.037.891	682.797	14.593	1.623.063	157,8
1980s	1.204.096	573.127	2.451	1.678.444	139,8
1990s	1.449.873	475.515	8.465	1.800.933	126,6
2000s	1.556.296	561.291	76	1.993.008	123,3
2010s	1.457.941	948.269	430	2.289.144	127,1

(*)No stock variation is considered.[30] (**)3% of national production goes to seeds, and 5% counts as losses (FAO estimates). Source: own elaboration. (*)No se considera variación de stock. (**)El 3% de la producción nacional se destina a semillas, mientras un 5% cuenta como pérdida (estimaciones de la FAO). Fuente: elaboración propia.

28 It is estimated that Chilean consume some 86 kg of bread per annum (per capita), well above any other Latin American country (figures for 2017). In https://www.statista.com/statistics/802811/per-capita-bread-consumption-latam/Worldwide (accessed on 20 April 2022) the ranking is topped by Turkey.

29 We compared our data to that of ODEPA, and the food balance sheets of ODEPA are similar to ours, which confirms our statistics. If compared to FAO statistics, our data (and ODEPA's) on per capita consumption is larger (by around 20% in the last decade). FAO data considers a large quantity of Chilean wheat exports for human consumption (e.g. 195.000 tons per annum in average for 2014-2018), which seems to be a mistake since Chile does not export large quantities of wheat; on the contrary, it is a large importer.

30 Since we are working with annual averages per decade, stock variations per annum are unimportant.

Until the 1950s, most wheat consumed in Chile was produced locally, but from the 1960s imports started to gather increasing importance (in particular from Argentina, Canada and the USA). The hectares allocated to wheat production stagnated during the 1930s-1960s, and although productivity increased by some 20%, it was not enough to supply the entire local demand. The stagnation in production is most usually associated with unfavourable price control during the period of state-led industrialisation, which made wheat production less profitable than other agricultural activities (Mellado, 1998; Ballesteros, 1965; Almonacid, 2009). However, during the last decade locally produced wheat still accounted for 60% of national consumption. Wheat was the dominant cereal crop in Chile during most of this period, and between the 1930s and 1970s, wheat accounted for over 90% of Chilean cereal consumption. During recent decades, though, corn has gained increasing importance.

Maize (corn)

Table 4 provides similar information to Table 3, but for maize, currently the second most popular cereal in Chile, and the most important for animal feed. National production (for human and animal consumption) has increased substantially, in particular from the 1960s, mainly because of the accelerated development of industrial poultry production in Chile, which accounts for the majority of corn consumption (Llorca-Jaña *et al*., 2020), as well as the emergence of a new industry producing frozen corn for human consumption (Saavedra, 2014; Valenzuela, 2018).[31] Imports, in turn, have also increased, but mainly from the 1990s, coinciding with the import liberalization process of Chilean foreign trade (Llorca-Jaña, 2015), in particular from Argentina and the USA (Tapia, 2006). The per capita consumption of corn increased around ten-fold between the 1930s-1950s and the 2000s-2010s, rising from only 2-3 kg per person per annum to around 29 kg.[32] Rising consumption is linked to higher corn intake during breakfast (mixed with either milk or yogurt), biscuits, cereal bars, flour, cooking oil,[33] cereal mix, semolina (e.g. for pasta production), salads, stews, amongst other products (ODEPA, 2016). Unlike wheat, the lion's share of Chilean corn is destined for animal feed (for poultry and pigs in particular). In turn, imports are currently more important than domestic production, as has been the case during the last two decades.

31 Before the emergence of the modern poultry industry in Chile (chicken broilers in particular), most maize produced in Chile was the so-called *choclero*, which was highly seasonal, and one of the main ingredients of Chilean cuisine. From the 1960s in particular, a new variety was introduced, the Zea mays, which is sweeter than *choclero*.

32 We compared our data to that of ODEPA, and the food balance sheets of ODEPA are similar to ours. However, if compared to FAO statistics, our data (and ODEPA's) on per capita consumption is larger (by around 33% in the last decade). FAO data is different, as it is for wheat; it considers a large quantity of Chilean corn exports (e.g. 34.000 tons per annum in average for 2014-2018), which seems to be a mistake since Chile does not export large quantities of corn for human consumption, on the contrary, it is a large importer.

33 It is believed that maize oil has important positive qualities such as tolerance of high temperatures, and it is recommended for those with cardiovascular diseases.

Table 4. Chile's food balance sheet for maize (for human consumption), annual averages per decade(*)
Tabla 4. Balance alimentario de maíz (para consumo humano) en Chile, promedios anuales por década(*)

Decade	Production (tons)	Imports (tons)	Exports (tons)	Consumption (tons)(**)	Per capita consumption (kg per person per annum)
1930s	65.066	635	287	12.437	3
1940s	66.727	975	5	13.109	2
1950s	110.030	26	0	21.307	3
1960s	230.422	43.927	1	53.395	6
1970s	315.397	176.203	876	95.426	9
1980s	634.994	169.939	349	156.574	13
1990s	863.105	550.968	221	277.070	19
2000s	1.183.349	1.242.699	1.003	476.633	29
2010s	1.285.297	1.351.263	135	518.951	29

(*)No stock variation is considered. (**)0,2% of national production goes to seeds, and 3% counts as losses. Only 20% of the aggregate sum of national production and imports, discounting seeds and losses, is destined for human consumption (estimates from FAO), the rest being destined for animal consumption and other uses.[34] Source: own elaboration. (*)No se considera variación de stock. (**)El 0,2% de la producción nacional está destinada a semillas y el 3% se considera como pérdida. Solo el 20% del monto agregado de la producción nacional y las importaciones, descontando semillas y pérdidas, se destina al consumo humano (según estimaciones de la FAO), siendo el resto destinado al consumo animal y otros usos. Fuente: elaboración propia.

Rice

Table 5 shows the food balance sheet for the third most important cereal in Chile: rice, commonly used as a side dish in Chilean popular cuisine. Before the 1920s, there was no production of note. This, however, changed during the 1920s, when Chilean farmers started to experiment with rice production. From the 1930s in particular, new varieties were introduced (mainly in Talca, Linares and Ñuble), which gave better results than the early experimental production of the 1920s (Astorga, 1944; Koller, 1958). Additionally, rice mills emerged to process raw rice, creating a rice industry for the first time in the country, facilitated by important firms such as Tucapel, Zaror and San Cristóbal (Paredes *et al.*, 2020). By the 1940s, Chilean production of rice was already important: most national consumption was self-supplied, thus saving foreign currency needed for imports. Furthermore, the industry generated some surpluses that were exported to nearby countries (Sims, 1959; Hartard, 1948). The national industry received some support from the state, in particular via tariff protection and the creation of the Instituto de Investigaciones Agropecuarias, INIA (Alvarado and Hernaíz, 2014). Yet, during the last three decades imports have increased dramatically, just below the level of national production during the last decade. Per capita consumption doubled between the 1930s and the 1940s, remaining stable until the 1980s. During the last three decades, though, rates of production increased again, in part because of immigration.

34 This is quite different to wheat: most wheat is destined for human consumption.

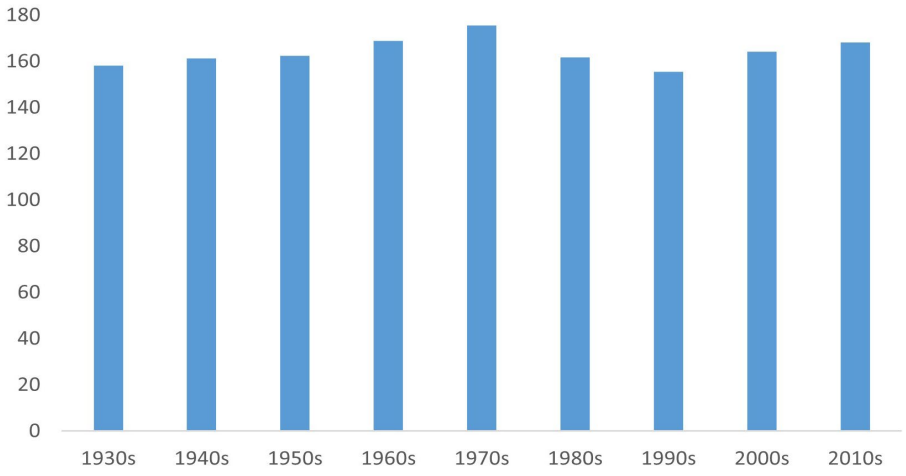
Table 5. Chile's food balance sheet for rice (for human consumption), annual averages per decade(*)
Tabla 5. Balance alimentario de arroz (para consumo humano) en Chile, promedios anuales por década(*)

Decade	Production (tons)	Imports (tons)	Exports (tons)	Consumption (tons) (**)	Per capita consumption (kg per person per annum)
1930s	6.220	14.391	18	18.353	3,9
1940s	95.782	47	15.247	46.100	8,3
1950s	85.183	2.305	1.891	54.931	8,1
1960s	82.147	25.557	3.470	74.661	8,7
1970s	90.094	33.353	3.663	87.350	8,5
1980s	138.471	19.509	126	108.004	8,9
1990s	122.185	59.286	906	136.579	9,6
2000s	131.649	101.429	261	185.423	11,5
2010s	147.317	132.513	2.218	224.578	12,4

(*)No stock variation is considered. (**)Considers 64% of raw national production (see above). Source: own elaboration. (*)No se considera variación de stock. (**)Considera el 64% de la producción nacional bruta (consultar más arriba). Fuente: elaboración propia.

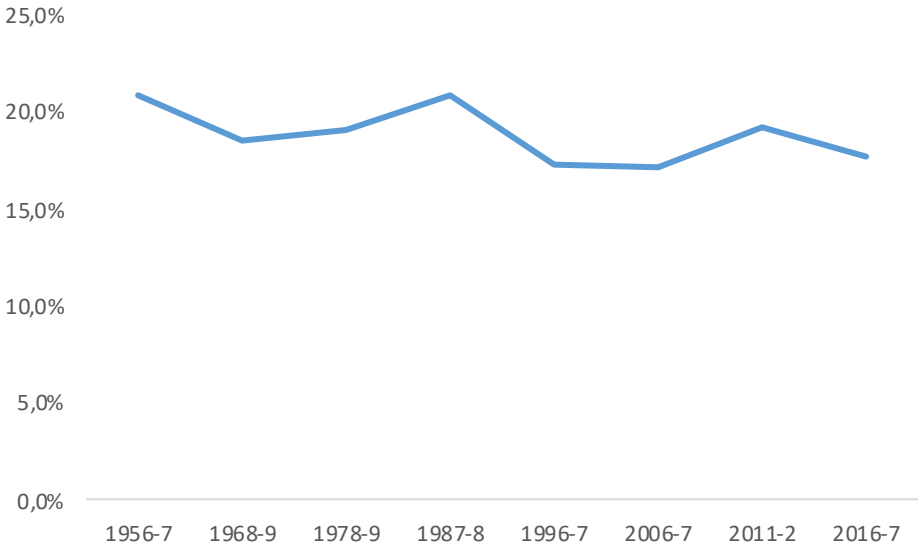
There was a continuous increase in the per capita consumption of staple cereals (wheat, maize, rice) from 158 kg per person per annum during the 1930s to 176 kg during the 1970s, followed by a decline during the 1980s and 1990s, and ending with a slight increase during the last two decades (Figure 3). It is clear from Figure 3 that Chile's cereal consumption has remained stable: the difference between the minimum and the maximum average consumption across decades is of little consequence. Figure 4 shows the share of cereal expenditure in family budgets from the 1950s to the 2010s: cereals account for some 17%-21% of food expenditure throughout the whole period. Cereal consumption became more diverse: wheat has lost some of its share to maize and rice. Increasing cereal diversity is in line with the idea of the nutrition transition being characterised by a wider range of foods being consumed by the average family.

Figure 3. Chile's per capita consumption of staple cereals (wheat, maize and rice), kg per person per annum
Figura 3. Consumo per cápita de cereales básicos (trigo, maíz y arroz) en Chile, en kilos por persona al año



Source: Tables 3, 4 and 5 of this article. Fuente: Tablas 3, 4 y 5 del presente artículo.

Figure 4. Share of cereals' expenditure within total food expenditure for Chilean households
Figura 4. Participación del gasto en cereales dentro del gasto total de alimentos en los hogares chilenos

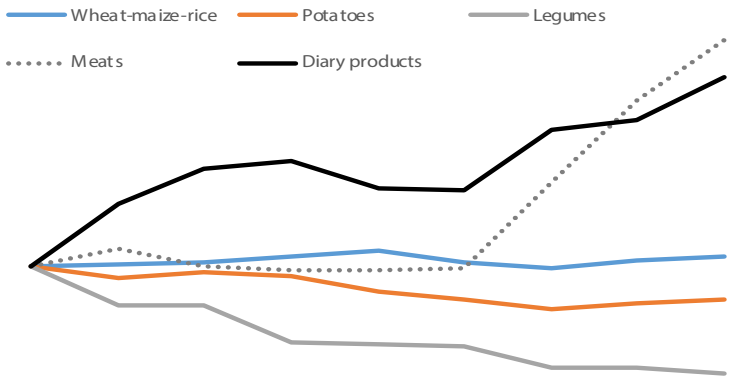


Source: Own elaboration from National Institute of National Statistics, all Surveys of Family Budget, available at https://www.ine.cl/estadisticas/ingresos-y-gastos/epf. Fuente: elaboración propia a partir del Instituto Nacional de Estadísticas en Encuestas de Presupuesto Familiar, disponibles en https://www.ine.cl/estadisticas/ingresos-y-gastos/epf

Conclusions

We have shown in this article that the average dietary energy consumption of Chile increased from 2.600-2.700 kcal per person per day to slightly over 3.000 kcal within a short period of time, less than a generation. Chile was able to control and prevent malnutrition over a relatively short period of time, as argued earlier by other scholars (Uauy and Vio, 2007). This level of energy consumption is necessary for a nutrition transition to take place.

Figure 5. Index of per capita consumption of staple products in Chile (1930s=100)
Figura 5. Índice de consumo per cápita de productos básicos en Chile (1930s=100)



Source: own elaboration. For meats and dairy products, Llorca-Jaña *et al.* (2020) and for all other products, Tables 1 to 5 of this article. Fuente: elaboración propia. Para carnes y lácteos, Llorca-Jaña *et al.* (2020) y para el resto de productos, Tablas 1 a 5 del presente artículo.

The nutrition transition in Chile is similar in many respects to the pattern usually described in developed countries. First, the Chilean diet became more diverse, but also less vegetarian. In the 1930s, meat consumption increased most sharply, followed by the consumption of dairy products (Figure 5). Second, there was a massive decline in the consumption of legumes which are no longer a staple of the Chilean diet. Third, there was also a smaller reduction in the average intake of potatoes: Chileans now consume around three-quarters of the amount they ate in the 1930s.

However, one of the most important features of the nutrition transition in most developed countries was a large decline in the consumption of all carbohydrate staples. Yet in Chile the combined consumption of the three staple cereals has remained stable, as shown in Figure 3. And although the consumption of potatoes declined from the 1960s to the 1980s, thereafter it remained stable: no further reduction has taken place. The nutrition transition in Chile took place within an extremely short period of time. Chile's case fits well with the idea that late starters move faster than the pioneers: the nutrition status of the population improved substantially only within the three last decades.

Future research agenda could include the estimation of Chile's per capita consumption of calories before 1930, and per consuming unit for the last century.[35] A wider range of products should be included in the analysis: eggs, sugar, vegetable oils, drinks, vegetables and fruits. Likewise, estimates of wild consumption should also be considered (and these are particularly relevant for rural areas), as well as plate waste. This, though, would be a Herculean task. Another important topics would be socio-economic inequalities in dietary intake (Vega-Salas *et al*., 2021) and Social Metabolism (as done for Spain, González de Molina *et al*., 2020; Kastner *et al*., 2012). Finally, obesity, which was rare a few decades ago in developing countries, is now increasing rapidly; it is an outcome of the nutrition transition itself in many countries, including Chile, mainly because of increasing urbanisation, a reduction in physical activity and changes in food consumption habits (Albala *et al*., 2001, 2002; Vio *et al*., 2008; Popkin *et al*., 2012). The country has transited from having worrying levels of undernutrition to concerns about overnutrition (Uauy and Vio, 2007; Vio and Albala, 2000), which is particularly worrying for the lower strata of society. Further research is also needed on long-term changes in the consumption of processed foods, added sugar, fats and fast food in developing countries (Popkin *et al*., 2012).

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35 Consuming unit is most usually the equivalent adult male aged 20-39 (Floud *et al*., 2011).

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