



PLANT-BASED DIET A BALANCING ACT



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A publication of the Louis Bonduelle Foundation

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introduction



Over the past ten years or so, studies of future prospects have multiplied, drawing attention to the challenge posed by the ever increasing number of mouths to be fed on a planet endowed with limited resources and faced with the consequences of climate change that need urgently to be addressed. Diets will have to evolve to become healthier and more sustainable. Concretely, for those living in the developed countries it is a matter of reducing consumption of animal products, red meat in particular, and switching towards plant-based products.

Against this background, administrations in many countries, including Brazil and Canada, have recently updated their dietary recommendations, highlighting the importance of a diet containing mostly plant-based products. Though there are, as yet, no unified **recommendations at the European Union level**, individual EU members have not resisted this movement. Among them, Belgium and France recently introduced new nutritional policies. In addition, a commission of international experts, the **EAT-Lancet Commission on Food, Planet, Health**, published in early 2019 its definition of a healthy and sustainable diet on a world-wide scale as well as a set of recommendations to accompany it. Notably they advise that *“global consumption of fruits, vegetables, nuts and legumes will have to double, and consumption of foods such as red meat and sugar will have to be reduced by more than 50%”*.

In 2011, the Louis Bonduelle Foundation decided to give some attention to one particular aspect of the issue and to do so in a precise geographical context. This gave rise to the publication **«How to increase vegetable consumption in Europe?»**. In 2016, the International Year of Pulses, the Foundation looked at foods derived from vegetable proteins, from which it published the monograph **“Plant-Based Protein: Responding to New Challenges”**. In 2019, with this monograph, we are presenting an update on these topics, and in doing so have adopted a more international perspective.

The objectives of this monograph are to:

- Define the concept of plant-based food, indicating the foods thereby defined and their place in the diet;
- Take an inventory, focusing on fruits and vegetables, of plant-based food consumption levels in North America and Europe (including Russia), and;
- Analyze past developments and the likely future trends;
- Explain the trends through the various factors that influence eating behavior at the individual and societal levels.



WHAT DO WE MEAN BY PLANT-BASED DIET?

The plant-based diet refers to that part of any human diet that is composed of foods of vegetable origin. In this monograph, then, the term plant-based diet includes specific diets such as vegetarianism but is not restricted to them.

Plant-based foods



Plant-based foods are wide-ranging in variety. Their immediate availability varies country by country, depending on agricultural production, connectivity with external markets and local eating habits. The following description of the food categories that constitute plant-based foods is not exhaustive.

Fruits and vegetables

Fresh fruits and vegetables (F&V) are undoubtedly the first foods that spring to mind when plant-based foods are mentioned. Their availability depends on the season, and for this reason they are also consumed in other forms, all of which are also nutritionally beneficial: dried (for fruit), frozen, canned, juiced or as soup (for vegetables). Although globalization tends to smooth out seasonal patterns in the availability of fresh produce, the types of fruit and vegetables that are consumed varies considerably from one country and to another depending on the extent of their production, which is itself related to climate and soil quality, as well as to cultural legacies.

Nutritional characteristics

- Sources of fiber, minerals, vitamins (B, C, beta-carotene) and carbohydrates
- Negligible protein content
- Absence of lipids

Fresh vegetables are characterized by a very high water content (90% on average), a moderate amount of carbohydrates: 1 to 6% for plant leaves (salads, spinach, zucchini, tomatoes...) and about 9% for roots (carrots, celery, etc.). The composition of fruits is similar to that of vegetables, except for their higher carbohydrate content (mainly fructose and more rarely starch, as in the case of bananas) (Desalme et al., 2004).

KEY NUMBER

700 million

Is the number of hectares of **cereals cultivated across the world** (2017 figure)

Dietary recommendations

The World Health Organization (**WHO**) recommends a daily intake of at least 400 g per day of F&V, excluding potatoes and other starchy tubers (see Box p 15). There are no common recommendations across Europe in this regard, each country either drawing on the recommendation of WHO, as in Russia (FAO, 2003), or proposing higher quantities, ranging from 400-500 g per day in France (5 servings of 80-100 g per day - **PNNS**) to 600 g per day in Denmark (Yngve et al., 2005). In the United States, the recommendations are adapted to its standard measurement system: 1-2 cups per day for fruits and 1-2.5 cups per day for vegetables (**USDA**). **Canada's latest Food Guide**, launched in early 2019, no longer refers to servings (previously the recommendation was from 5 to 10 servings of F&V per day). Instead, general tips are provided for each food category, such as *"Try filling half your plate with vegetables and fruits"*, *"Choose different textures, colors and shapes to satisfy your tastes"*, or *"Choose canned vegetables with little or no added sodium"*.

Cereals and pseudo-cereals

700 million hectares of cereals are grown worldwide (2017 figure), but their use goes well beyond that of food for human beings (animal feed, bioethanol, starch for industrial use, seeds, etc.). Nevertheless, in all regions, of the world, cereals are for most people their main source of energy. They are a key component in many of the most popular processed foods (bread, biscuits, pasta, etc.) and typically serve as a key ingredient (starch) in meals.

The main cereals consumed in the world, in descending order, are maize, rice, wheat, barley, sorghum, millet, oats and rye. Some seeds, such as quinoa, amaranth and buckwheat, have the same food use as cereals although their plants do not belong to the graminaceous family; they are termed pseudo-cereals.

Nutritional characteristics

- Source of carbohydrates (starch), vegetable proteins, sulfur amino acids, B vitamins, fibers and minerals (Desalme et al., 2004)
- Negligible contributions of lysine (amino acid) and lipids
- In whole grains, presence of anti-nutritional factors (phytates, fibers, tannins) that restrict the bioavailability of proteins and minerals.

Dietary recommendations

Cereals, especially whole grains, are among the foods that ought to form the major part of the diet: “For example corn, millet, oats, wheat and brown rice unprocessed” (**WHO**); “At least one complete starchy food per day” (**PNNS**, France); “Cereals, of which at least half are whole grains” (**USDA**); “Whole grain foods are a healthier choice than refined grain foods” (**Canada’s Food Guide**).

Roots and tubers

Potato, cassava, sweet potato and yam are the principal roots and tubers (R&T) for human consumption. In Africa, R&T provide food security for millions of people and are the most productive in terms of crops per unit area of farmland. In sub-Saharan Africa in particular, R&T account for 20% of all calories consumed, as compared with 3-4% in Western countries. The four crops mentioned above produce staple foods that are both cheap and nutritionally rich (Scott et al., 2000).

Nutritional characteristics

- Sources of carbohydrates (starch), vegetable protein, fiber, vitamin C, vitamin A, potassium, zinc and iron (Desalme et al., 2004)
- Negligible contribution in lipids.

Dietary recommendations

R&T are particularly starchy foods. For this reason, there are no specific nutritio-

KEY NUMBER

20%

Roots and tubers account for 20% of calories consumed in sub-Saharan Africa, as compared with 3-4% in Western countries.

nal recommendations regarding them. R&T are consumed mainly alongside other starchy foods (pasta, bread, rice, semolina...). In dietary guidelines, they are sometimes mentioned as part of the vegetable category.

Legumes (pulses)

Legumes (pulses) are dicotyledonous plants belonging to the Fabaceae family. They are characterized by papilionaceous (butterfly) flowers, a pod containing seeds and, for the majority, the ability to draw on atmospheric nitrogen to produce their own protein compounds through symbiosis with nitrogen-fixing bacteria in the soil at root level (Schneider and Huyghe, 2015). There are two categories of legumes: grain pulses and forage pulses (alfalfa, white clover, etc.). The latter are grown for the purpose of using the entire aerial part of the plant as animal feed (grazing and fodder for ruminants in particular). In this document, the term pulses will therefore only concern those that are eaten by humans, i.e. dry pulses, which are legume seeds harvested at

maturity and then dried (Dupré, 2007). The principal dry pulses grown in the world are: red and white kidney beans, horse beans, chick peas, dry peas or split peas, as well as several varieties of lentils.

According to FAO figures, 77 million tonnes of pulses were produced in 2014, an increase of some 21 million tonnes on the 2001 figure. In order to encourage their consumption as part of efforts to combat climate change, malnutrition and obesity, the United Nations proclaimed 2016 to be **International Year of Pulses**. Since then, February 10 has been designated as **World Pulse Day**.

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SHOULD SOYBEANS AND GROUNDNUTS BE CATEGORIZED AS PULSES?

Soybeans and groundnuts belong to the botanical family of legumes (pulses). However, because of their high lipid content, typically 18% and 45% respectively (Desalme et al., 2004) **the Food and Agriculture Organization of the United Nations (FAO)** classifies them as oilseeds. Since this monograph relies heavily on FAO data, soybeans and groundnuts are not considered as part of the pulses category.

Nutritional characteristics

- Sources of vegetable protein, lysine (amino acid), starch, fiber, lipids, vitamins B1, B2, B3 and E, potassium, phosphorus, magnesium, zinc, manganese, calcium and iron (Schneider and Huyghe, 2015)
- Negligible contribution in sulfur amino acids
- Presence of antinutritional factors (phytates, fibers, tannins) that restrict the bioavailability of proteins and minerals.

Legumes are the plant world's principal protein resource, with concentration levels ranging from 8 to 17%, according to Schneider and Huyghe (2015) and as high as 25% according to other authors (Desalme et al., 2004; Agroligne, 2018). Legume proteins are easily digestible, albeit less so than animal proteins. Their levels of sulfur amino acids are also low, but they can nevertheless provide all the essential amino acids if they are consumed in combination with cereals. In addition, legumes comprise between 12 and 25% in fiber, hence their sometimes difficult digestibility (Desalme et al., 2004).

Dietary recommendations

In the past, pulses barely featured in dietary recommendations. Over recent years, however, they have become very popular. Their main positives? Their consumption makes it possible to introduce some variation into protein sources and thereby increase fiber

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LEGUMES AND PROTEIN CROPS, ARE THEY THE SAME?

The term “protein crops”, which is specific to European regulations, was created by analogy with the term «oleaginous» to refer to the peas, faba beans and sweet lupins intended for animal feed. Protein crops are legumes then, but not all legumes are protein crops. These latter do not fall within the scope of this monograph devoted to human nutrition.

intake while balancing simultaneously those of vegetable and animal protein. Canada recommends, for example, that people should “*prepare healthy protein foods*”, including ‘*lentils, beans or peas, dry or canned*’ (**Canada’s Food Guide**). In the United States, beans and peas feature in both the list of proteins and the varieties of vegetables to be included in a balanced diet (**USDA**). It is noteworthy that the consumption of pulses is widely encouraged in North America. For example, Pulse Canada, which coordinates the Canadian industry, conducts a particularly active communication campaign through the publication of recipe booklets and the diffusion of content in the

media (Schneider and Huyghe, 2015). In Europe, where the pulses sector is less developed, their potential benefits are much less publicized. In France, the latest update of the official recommendations has nevertheless made it possible to highlight the benefits of a source of nutrition previously categorized among the starches: “*Pulses (lentils, beans, chickpeas), at least twice a week*” (PNNS).

Oilseeds

Oilseeds are plants whose seeds or fruits are rich in lipids. They are grown for their oils and fats which are used either as food or in industry (for cosmetics, paint, biofuel, etc.). They are also high in protein, and can be destined for animal feed. A distinction is drawn between two types of oilseed: seeds and fruits; the latter are also referred to as nuts¹.

Oleaginous seeds

There are seven major oilseeds grown for their seeds that are rich in oil and protein: soybean, peanut, rapeseed, sunflower, oil palm, olive and sesame. Soybeans account for more than half of global oilseed production, followed by rapeseed and sunflower. In human nutrition, oilseeds are used mainly for cooking and table oils (peanut, rapeseed, sunflower, olive, sesame) and/or to produce margarine (peanut, palm oil). Soy is an exception

1. As stone fruits, olives do not fit into this dichotomy and are categorized instead among oilseeds (see Box p 15). We classify them here as seeds.

because of its lower lipid content (20% versus 42% for rapeseed and sunflower) and its protein content that approaches 40% (Agroligne, 2018): its main food uses are as a drink or as tofu.

Nutritional characteristics

- Sources of lipids with very variable fatty acid compositions: saturated fatty acids (50% in palm oil), mono-unsaturated (76% in olive oil, 62% in rapeseed oil), omega-6 fatty acids (54% in soybean oil, 66% in sunflower oil), omega-3 fatty acids (56% in linseed oil) (EUFIC)
- Presence of vitamin E and, depending on the species, iodine, magnesium and calcium.

Dietary recommendations

Recommendations regarding fats and oils vary from country to country. Canada, for example, focuses only on quality, indicating that *“the type of fat you eat over time is more important for health than the total amount of fat you eat”* and advocates *“healthy oils”* such as flaxseed, olive and soybean oil, and *“limit[ing] the amount of saturated oils and fats”* (**Canada’s Food Guide**). On the other hand, the French guidelines state that *“added fat can be consumed every day in small quantities”*, at the same time as advising that *“vegetable oils are to be preferred, especially rapeseed and nuts rich in omega-3, and olive oil”* (**PNNS**).

Oleaginous fruits (nuts)

Oleaginous fruits grow inside a shell, hence the commonly used label of ‘nuts’. The most common are walnuts, hazelnuts, almonds, peanuts, cashews, pistachios, pecans and Brazils. Total world nut production was estimated at 4.02 million tonnes per year during the period 2017-2018.

Nutritional characteristics

- These are high energy foods (about 700 kcal/100 g), since they have a high fat content and are low in water
- Lipid sources (over 50%), including mono and polyunsaturated fatty acids, vegetable proteins (10% to 15%), carbohydrates, fiber, B vitamins, vitamin E and many minerals (magnesium, phosphorus, potassium, zinc, selenium...) (Agroligne, 2018).

Dietary recommendations

Although recommended by the scientific community for their protective effects on the cardiovascular system, nuts are rarely mentioned in the advice transmitted by public authorities. A notable exception is North America: the **USDA** recommends them as a source of protein and **Canada’s Food Guide** as a source of good fat.

Other categories of plant-based food

In addition to these five major categories of food, plants are also used in human food in the form of drinks: the majority

of them are derived from plants (coffee, tea, alcohol, etc.).

Also present in the human diet are less common plants and others, though common, that are consumed in low quantity. These include algae, flowers, herbs and spices, which contribute to dietary diversity and to meeting nutritional needs, particularly within a diet rich in plant-based foods. Sugars, of course, should not be forgotten: all of them are of plant origin.

Algae

Algae are brown, green or red aquatic plants, of which there exist at least a dozen edible varieties. More than 95% of global seaweed production is carried out in Asia, with China accounting for more than 50% and Indonesia for around 25% (Agrocampus Ouest, 2014). In Europe, production is dominated by Norway (57% of the European total), followed by France, Ireland and Iceland. Between 20 and 45% of total world production is accounted for by direct human consumption (as a food). The phycocolloid industry (extraction of gelling agents and thickeners for the agri-food, chemical and microbiology sectors) takes between 40 and 70%. Finally, the agri-supply sector (fertilizer, animal feed) and cosmetics use between them around 10-15% of the total tonnage. Eating algae is traditional to many Asian countries, especially Japan. They are particularly rich in minerals, especially iodine, and vitamins. The main species



consumed are wakame (*Undaria pinnatifida*), kombu (*Laminaria japonica*) and nori (*Porphyra* sp.). Among the other readily comestible varieties are sea beans or sea spaghetti (*Himanthalia elongata*), sea lettuce or ulva (*Ulva* sp.) and dulse (*Palmaria palmata*) (Agrocampus Ouest, 2014).

Wild flowers and edible plants

Wild flowers and plants, generally referred to as 'weeds' when they impinge on gardens or crops, occasionally have neglected or forgotten virtues, medicinal and/or culinary. Stems, leaves and flowers are eaten raw or cooked according to variety, in salad, in soup or to flavor or decorate a dish (Couplan, 2011).

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ALGAE IS BECOMING INCREASINGLY POPULAR

Used since ancient times across wide range of countries (not only in Asia, but also Ireland, Norway, France and many other places), algae are now receiving increasing attention across the world. Their harvesting has undergone remarkable growth, from 2 million tonnes in 1970 to 20 million in 2010 (see Figure).

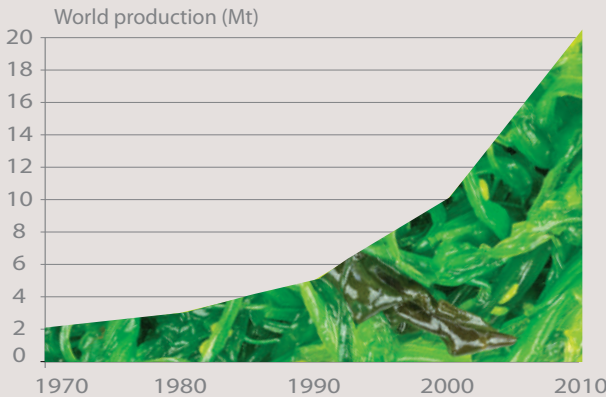


Figure. Trends in worldwide algae production (AgroCampus, 2014).

Their use as a food is developing in some European countries, most notably in France where the competent public health authorities established in the 1990s a list of edible species.

There are macro-algae, consumed as foods, and micro-algae, used as condiments or dietary supplements. Outside Asia, it is possible to obtain supplies of these from specialized distribution networks: health food stores, organic stores and Asian stores offering imported products.

In western countries, eating algae has been boosted by the rise in popularity of Japanese food. It attracts health-conscious consumers who are interested not only in the high levels of minerals,

fiber and vitamins found in algae, but also in finding 'natural', innovative and sustainably produced foods.

These positives aside, algae are not good alternatives sources of protein to animal products: a reasonable daily portion of between 5-7 g dry weight comprises less than 2 g of protein. Macro-algae are mainly rich in fiber and in polyphenols that impede protein digestibility and bioavailability of minerals. As for micro-algae, such as chlorella or spirulina, though they are particularly rich in readily digestible proteins (45-70% of the dry matter), their consumption remains marginal (Marfaing and Pierre, 2019).

These sources of vegetable proteins and fibers have high levels of minerals, including iron, calcium and potassium (Stark et al., 2019). They were part of the European diet in the 19th century, where they helped overcome episodes of famine (Luczaj et al., 2012). If nettles, dandelions or wild garlic are the most popular, lambsquarters (*Chenopodium berlandieri*) or everlasting flowers (*Xerochrysum-bracteatum*), which can replace, respectively, spinach or curry are worth (re)knowing about.

Aromatics, spices, herbs and condiments

- The aromatics are fragrant vegetable substances, used in cooking, as well as in medicine and perfumery (star anise, cinnamon, cardamom, cloves, ginger, vanilla etc.).
- Spices are aromatic botanicals, most often derived from plants originating in Asia, the Middle East or the Tropics. They are used to season dishes, sometimes in the form of a mixture (five berries, Colombo, turmeric, curry, garam masala, nutmeg, paprika, pepper etc.). Spices are distinguished from aromatics by having a taste that is stronger than their scent.
- Aromatic herbs are small plants with more or less pronounced scent, which can enhance the taste of a dish (dill, basil, chervil, chives, oregano, parsley etc.). There are also aromatic plants for which the primary culinary interest resides in their bulbs (garlic,

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CORN, OLIVES,

POTATOES ...

MULTIFACETED FOODS

Not only soya, peanuts, but also corn, olives and a range of others. There are many foods that can be classified in different categories according to their botanical origin, their nutritional composition or their use as a food. Depending on the variety selected, corn, apples or potatoes, for example, will have different standard uses (cooked, raw, processed). Maize, for example, which is categorized botanically as a cereal (grass), will indeed be considered as such if it is consumed in the form of cornflakes, semolina or corn starch (which may be used in the preparation of starchy foods such as polenta or pastries), but as a vegetable if eaten in a salad or as an oilseed if it is processed into oil. Similar observations apply notably to olives, which can be classed as a condiment or as oleaginous, and to coconuts, which can be classed as a fruit or as oleaginous.

It should also be borne in mind that the potato, regardless of its culinary use, can be classed both as a vegetable and as a tuber. In this monograph, it is placed in the roots and tubers (R&T) category.

shallots etc.) or whose tough leaves are used for their aromatic flavor (laurels, rosemary etc.).

- Finally, condiments are preparations made from vegetable substances. When added to foods, they help bring out their flavor (capers, gherkin, mustard, chilli etc).

Due to the fact that typically only small quantities used in cooking, the nutritional value of aromatics, herbs, spices and condiments have long been underestimated. They are, in fact, good sources of antioxidants and other phytochemicals; this indeed explains their many medicinal uses (Guldiken et al., 2018). Moreover, through their particular capacity to enhance flavors, they help reduce the desire to add salt and fat, thereby contributing to a better dietary balance (Dini, 2018). The culinary interest of these substances is undeniable: their palette of different colors and the variety of tastes and flavors they convey help extend the possibilities for creativity in food preparation.

Chocolate

Though difficult to classify because of the different forms in which it is consumed - solid, as a drink with milk or as an ingredient in desserts (confectionery, biscuits, pastries etc.), chocolate is nonetheless a vegetable food. It is produced from cocoa beans (originally from South and Central America), which are fermented, roasted and then crushed to

make a paste. Cocoa butter is extracted from this paste. The mix of cocoa paste, cocoa butter and sugar as well, possibly, as spices and vegetable fats results in chocolate.

Although fat and sweet and therefore rich in energy (500 to 600 kcal/100 g), chocolate has nutritional value especially in virtue of its flavonoid (antioxidant polyphenols) and magnesium content (Schlienger, 2012).

Hot beverages

All the world's hot beverages are derived from plants: coffee (roasted beans); chicory (roasted root); tea, mate and herbal tea (leaves and/or dried flowers). Whatever the plant used, the principle remains the same: in contact with hot water, the substance releases its flavors. Coffee and tea are also used for the stimulating properties of caffeine and theine they respectively contain. Most of these drinks contain polyphenols with antioxidant properties that give them varying health effects. They do not contain any nutrients, though the accompanying ingredients (sugar, milk, butter, lemon etc.) added according to taste and culture do.

Alcoholic beverages

Like hot beverages, all alcoholic beverages are derived from plants. Those with a relatively low degree of alcohol are produced though the fermentation of vegetable substances: cider (apple juice),

beer (wort from cereals) and wine (grape juice). Spirits are produced through a process of distillation: cognac (from wine), vodka (from cereals and/or potatoes), rum (from sugar cane), whiskey (from malted cereals), etc. Some spirits are referred to as being 'compound': they are produced by mixing distilled alcohol with macerated vegetable substances (fruits, plants or spices such as star anise).

Spirits provide approximately 700 kcal of energy per 100 g (5.6 kcal per ml of pure alcohol). For beer and for wine, the nutritive values are low (some minerals and group B vitamins). They are zero for other alcohols (Desalme et al., 2004).

Sugar

All of the sugars in our diets are derived from plants. Though sugar beet and sugar cane are the best known and the most commonly used, large quantities of sugar are extracted from other plants, often in the form of syrup: for example maple, agave, coconut, and flowering plants (via bees which transform the nectar into honey). The importance of corn syrup should also be highlighted: it is used extensively by the agri-food industry as it is cheaper than cane or beet sugar and has certain advantageous properties when used in processing. Stevia (*Stevia rebaudiana*), a sweet plant that originated in South America, has been marketed for some years now in various forms, in particular as a natural alternative to intense synthetic sweeteners such as aspartame.





Vegetable nutrition and specific diets

Though by nature omnivorous, humans have at all times adapted their diet to the actual availability of foods. This ability to adapt enables humans to forgo vegetables (as in the traditional Inuit diet) and likewise foods of animal origin (vegan diet). In this sense, with the exception of this first example, all human diets draw on plant-based food to a greater or lesser extent depending on resources and preferences, these latter being strongly influenced by ideology and culture.

Diets that exclude foods of animal origin

At present, the consumption of animal products, meat in particular, is the focus for a range of campaigns, occasionally contradictory, which sometimes take the form of injunctions that go well beyond the realms of nutrition and health. Respect for animal welfare and the protection of the environment - with, first and foremost, the desire to reduce greenhouse gas emissions as part of a move towards a more sustainable food regime - have led to many people in the advanced industrialized countries to completely or partially exclude foods of animal origin from their diet.

Vegetarian-type diets are characterized by the exclusion of foods contain-

ing animal flesh. The overall category comprises a range of dietary practices the precise details of which are not as yet officially defined. It is nevertheless possible among the dietary regimes that exclude meat to distinguish four of them clearly. These are, from the strictest to the least restrictive:

- veganism (vegan diet): 100% vegetable diet
- lacto vegetarianism: plant-based foods + dairy products
- ovo-lacto vegetarianism (more commonly referred to as vegetarianism): plant-based foods + dairy products + eggs
- pescetarianism: plant-based foods + dairy products + eggs + fish and shellfish

Flexitarianism

Flexitarianism is the flexible application of vegetarianism: the occasional consumption of meat is permitted. There does not exist a commonly shared definition of the threshold at which flexitarian becomes omnivorous. In general, the flexitarian is a very modest consumer of meat and a large consumer of cereals, pulses, fruits and vegetables. Although it is difficult to draw a standard portrait of the flexitarian, it would appear reductive to limit the term to the adoption of a scaling-back in the quantity of meat consumed: the

consumption choices of most flexitarians reflect also their concerns about their health, the planet, indeed societal issues in general. Thus, when flexitarians allow themselves to eat meat or

fish, it is usually after having verified its provenance and quality. They prefer homemade and locally-sourced organic products that are seasonal and are commercialized on a fair trade basis.

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OTHER SPECIFIC DIETS

Alongside classic vegetarianism, there are many specific diets that focus on foods of plant origin. **Macrobiotic diets**, for example, are based on applying the yin and yang principle to food. They comprise whole grains (50-60%), vegetables, algae, pulses, fermented soybeans and white fish. Raw foodism, as its name implies, entails eating exclusively raw food. In principle, followers of raw food diets are vegan (raw vegans), but can also be granivores (seed eaters), frugivores (fruit eaters) or others.

Other dietary regimes based on exclusionary principles accord a greater place to animal products. This is the case of the **ketogenic diet** which aims to limit carbohydrate intake and therefore favors proteins and lipids; this is typically followed for therapeutic purposes, such as managing epilepsy. Another example is the **Paleolithic diet**, which involves adopting the diet of our hunter-gatherer ancestors. It includes a large proportion of meat derived from grass-fed animals, as well as fish, roots, nuts and berries; it excludes farm products and anything sourced from the agri-food industry (cereals, pulses, oils, etc.).

Whatever the diet, each has its advantages and disadvantages. In the case of raw foodism, for example, while the absence of cooking serves to conserve vitamins and minerals, it is based on a form of exclusion that reduces dietary diversity and can become a source of social isolation. Before making any drastic change to one's diet, it should be borne in mind that there is no one universal nutritional truth.

CONSUMPTION LEVELS OF PLANT-BASED FOODS AND THEIR RECENT TRENDS

Trends in the level of plant-based food consumption are provided here for Europe, illustrated by the cases of two countries in particular (France and Russia), as well as for North America, with the separate figures for the United States and Canada distinguished. Two periods are also highlighted: from 1963 to 2013, based on FAO data, and the last ten years, drawing on the trends observed in France and the United States.



Introduction

We examine now the consumption levels of the various types of plant-based foods reviewed above and their consumption patterns in two geographical regions, each illustrated via two countries: Europe, by France and Russia; and North America, by the United States and Canada.

In the first section, drawing on **FAO data** compiled by researchers at the University of Oxford (see Box 'FAO consumption data' p 23), the principal trends are examined in these different regions over the last 50 years.

For each country (France, Russia, Canada and the United States) the contributions that the different food groups (Meat, Dairy products and eggs, Oils and fats, Sugars, Alcohol and Plant-based food - see Box p 22) make the population's diet are pre-

ented in the form of a pie-chart. The composition of the vegetable diet is also detailed with the contribution of the four main categories of plant-based foods (F&V, Cereals, Pulses, R&T). These pie-charts have been constructed for three particular years (1963, 1988 and 2013) in order to present a snapshot of the population's diet over three successive generations. This helps reveal the major trends, but does not enable us to draw detailed conclusions about them.

A graph is then presented showing the changes in the consumption of F&V from 1961 to 2013, distinguishing between the two components. This targeted choice is justified by the fact that F&V are plant-based foods whose beneficial effects on health are the most documented, hence their special place in nutrition policies across the world.



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DEFINITION OF PLANT-BASED NUTRITION IN THE REMAINDER OF THIS MONOGRAPH

The first part of this document presented an overview of the contribution that plant-based foods make to our diet. Below the criteria are set out that define precisely how the term plant-based food will be used in this second section:

- We refer to the plant-based part of a diet, not to specific diets that exclude certain foods.
- Certain foods of plant origin, such as sugar and alcohol, are significant components of our diets, in particular due to their calorific contribution. Nevertheless, their role as basic ingredients or as beverages led us to not include them among the plant-based foods.
- Oilseeds were also excluded, simply for reasons of data availability: the available statistics amalgamate vegetable oils with other fats.
- The plant-based nutrition analyzed in this section is therefore comprised of the following main categories: fruits and vegetables (F&V), cereals, pulses, roots and tubers (R&T), as well as oleaginous fruits that are in all likelihood also included in our data, either explicitly as fruits or as seeds included among the cereals.

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ESTIMATE OF THE VERITABLE CONSUMPTION OF FRUITS AND VEGETABLES

Food losses and waste worldwide are estimated at around 20% for oils, meat and dairy products, 30% for cereals, 35% for fish and 40-50% for R&T and for F&V (**FAO**). In order to evaluate the actual consumption of F&V from FAO data and to thereby assess the degree to which consumption meets international recommendations, we begin by supposing that only 60% of the F&V bought in all their forms in Europe and North America are actually consumed. That is why we apply a conversion factor of 0.6 on the data for gross consumption.

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FAO CONSUMPTION DATA

What the FAO refers to as consumption data, and which are analyzed in this monograph (data on the amounts of fruit and vegetables consumed) are in fact data on the production available for purchase (see Figure below). They do not take into account food loss and waste at the level of the consumer (households and catering services). Thus, while these figures enable one to analyze consumption trends and to draw inter-country comparisons, they do not precisely match actual consumption levels.

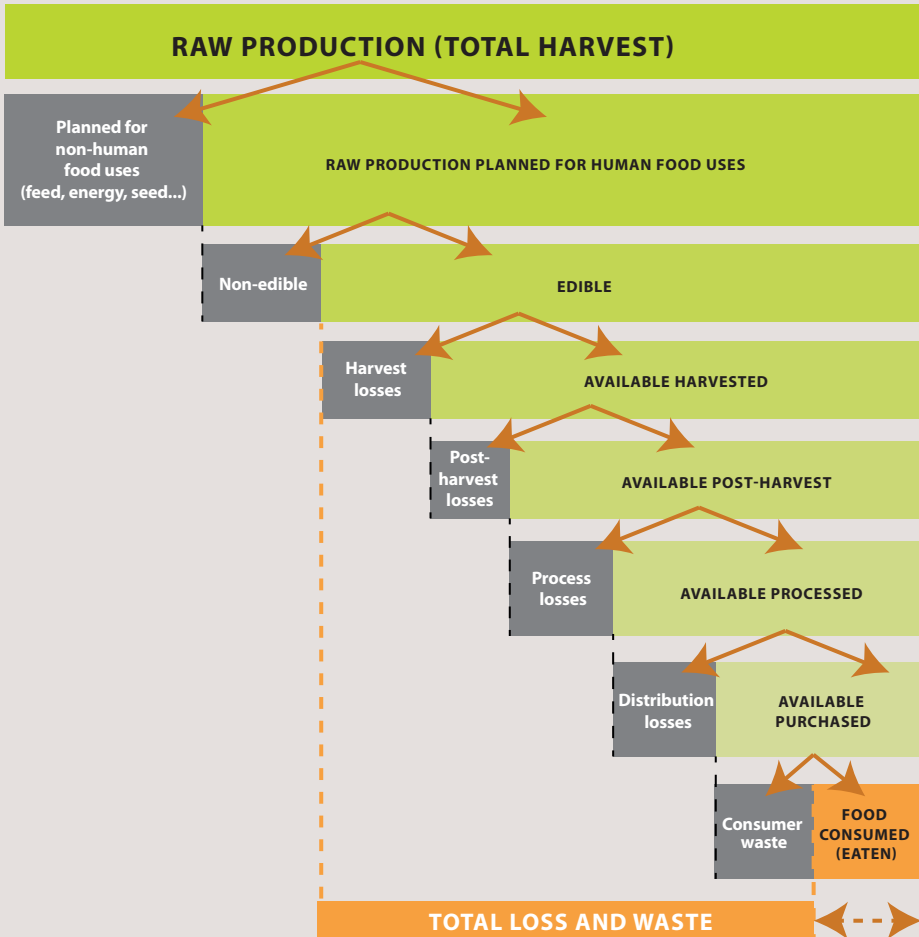


Figure. Schematic representation of food loss and waste along the food chain (Committee on World Food Security, 2014).

Consumption patterns in Europe over the last 50 years

➡ For the whole of Europe

The place of plant-based food in the European diet

Since aggregated food composition data from the FAO are not available for the whole of Europe, the place of the plant-based food in the European diet is assessed here through the information contained in national food consumption studies recently undertaken in a sample of four European countries considered to be representative at a sub-regional level: Denmark (Northern Europe), Czech Republic (Central-Eastern Europe), Italy (Southern Europe) and France (Western Europe) (Mertens et al., 2019). The plant-based food data were extracted from them and are summarized in **Table 1**.

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TABLE 1. COMPARISON OF AVERAGE DAILY CONSUMPTION PER CATEGORY OF PLANT-BASED FOOD CALCULATED AGAINST STANDARDIZED ENERGY INTAKES OF 2000 KCAL PER DAY IN FOUR EUROPEAN COUNTRIES, POPULATION GROUPS AGED 18 AND OVER.

Foods	Denmark	Czech Republic	Italy	France**
● Bread and crisp bread	140.0*	122.0*	109.0*	98.0*
● Breakfast cereals	11.8*	2.9	1.5	5.3*
● Pasta	5.2*	39.9*	52.0*	10.3*
● Rice, wheat and other cereals	26.1*	48.2	46.6	38.8*
● Vegetables	147.0*	95.0*	239.0*	187.0*
● Fruit	174.0*	118.0*	199.0*	140.0*
● Pulses	6.5	7.5	11.0	16.5*
● Oleaginous fruits	2.2	2.6	0.5*	1.7
● Vegetable fats	1.9*	15.0*	34.8*	11.2*
● Total vegetable ration (g per day)	514.7	451.1	693.4	508.8
● Total ration (g per day)	1 242.7	864.1	1086.0	1043.3
● Share of vegetable food	41.4%	52.2%	63.8%	48.8%

* Value significantly different from those of the other three countries according to the Bonferroni comparison test ($p < 0.0001$)

** Data from the INCA 2 study (2006-2007)

*** Indicative values calculated on the basis of the foods indicated in the source publication. They do not necessarily take account of all the consumption data contained in the various national studies.



The relative importance of plant-based food in the European diet displays a North to South slope.

Among these four European countries there is considerable variability in their consumption of all four categories of plant-based foods. This variability is explained by economic, geographical and cultural factors.

For each country, the proportional shares of plant-based food in the diet were calculated in order to compare the different countries and to observe the North-South slope in the plant-based component of the European diet.

The description of cohorts from ten European countries examined within the framework of the European Prospective Investigation into Cancer and Nutrition (EPIC) drew attention to this apparent slope in F&V consumption from Northern to Southern Europe (Agudo et al., 2002). We are bound to note, however, that these consumption levels range from 213 g per day in the Czech Republic to 438 g per day in Italy, with a figure of around 320-330 g per day in Denmark and France. It would appear, then, that a socio-economic factor is operating in combination with the North-South tendency that reflects the availability of F&V. A comparison of the FAO data

confirms these observations: in 2013, gross consumption of F&V was 189 kg per person per year in Eastern Europe, 205 kg in Western Europe, 219 kg in Northern Europe and 249 kg in Southern Europe². Note also that there is a North-South slope for vegetable fats, which vary from 1.9 g per day in Denmark to 34.8 g per day in Italy (figures for the consumption of animal fat go in the opposite direction, with the figures for butter being 24.8 g per day and 2.8 g per day respectively) (Mertens et al., 2019).

Finally, it should be noted that according to the EPIC study there are also marked disparities in R&T consumption (highest in Scandinavia and the Netherlands, and lowest in Italy, Greece and France). Likewise for pulses, with consumption highest in Spain and Greece, and lowest in Scandinavia and Germany (Agudo et al., 2002).

Trends in fruit and vegetable consumption in Europe between 1961 and 2013

During the period 1963-2013, the most recent 50 year period for which comparable data are available, gross consumption of F&V in Europe rose from 85 to 115 kg per person per year for vegetables and from 49 to 95 kg for fruits (Figure 1). Although these increases have not been linear, significantly key junctures cannot be discerned.

2. This average gross consumption at the European level disaggregates to 519 g per person per day in Eastern Europe and 683 g in Southern Europe, which equate respectively to 311 g and 410 g per person per day once the 0.6 conversion factor has been applied (see Box p 22).

Despite these substantial increases, consumption levels for both vegetables and fruit are still below the internationally recommended guidelines. Overall, Europeans consume more vegetables than fruits. Together, purchases of F&V in 2013 amounted to 210 kg per person per year, an average gross daily consumption of

575 g, which equates to just 345 g once the 0.6 conversion factor has been applied (see Box p 22).

According to the 2009 European Nutrition and Health Report, of the sixteen EU Member States it reviewed, only four met international recommendations for F&V consumption (Elmadfa et al., 2009).

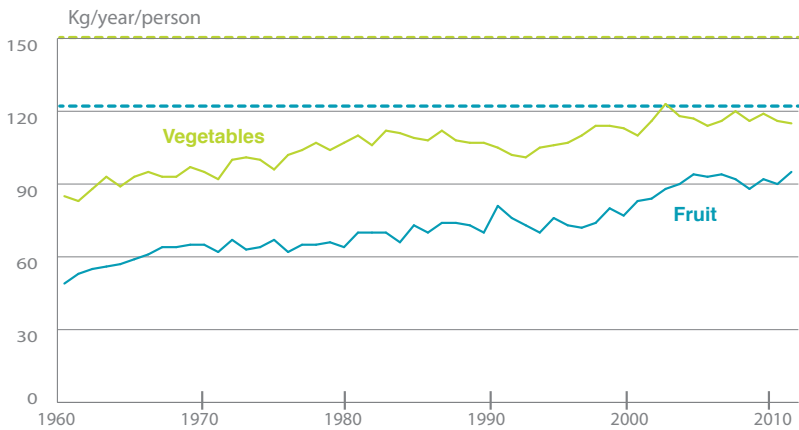


Figure 1. Gross consumption of fruits and vegetables in Europe, 1961-2013 (kg per person per year).

The lines in dashes indicate the international recommendations (WHO, 2015) for average daily intake, which are 250 g per person for vegetables and 200 g for fruit, these values having been annualized and converted (applying a factor of 0.6) in order to render them comparable to the FAO's gross consumption data, which are of approximately 150 kg per person per year for vegetables and 120 kg for fruits.

3. This figure differs from the one calculated in Table 1 (48.8%) which is derived from consumption data from INCA 2. This difference is explained in particular by the nature of the data taken into account, here expressed as a % of TEI, and in Table 1 as a % of the quantities consumed for a 2,000 kcal per day diet.



➔ The case of France

The contribution of plant-based food to the calorie intake in France in 2013

In France in 2013, 37% of the total energy intake (TEI) was of plant origin³: 28% in cereals, 5% F&V, 3% R&T and 1% pulses (Figure 2). The rest of the energy intake was comprised of 26% in animal products (15% meat and 11% in dairy and eggs), 22% of oil and fats (both of plant origin and animal), 11% sugars and 4% alcohol.

Note: It is logical that low-calorie foods, such as F&V, make only a modest contribution to the TEI. Inversely, oils and fats, very calorific, are major contributors.

Principal trends in plant-based nutrition in France, 1963-2013

Plant-based sources, having comprised 42% of the TEI in France in 1963, steadily declined in importance through to 1988 (35%) before rising slightly to 37% of TEI in 2013 (Figure 2). The 5% fall between 1963 and 2013 in the contribution of plant-based sources was compensated by an increase in the proportion of oils and fats, which grew from 14% to 22% (Figure 2). After an increase in the 1980s, the consumption of animal products fell back almost to their 1963 levels. The contribution of sugars has been relatively stable (10-11%), while that of alcohol, particularly high in the 1960s (10%), gradually declined to 4%.

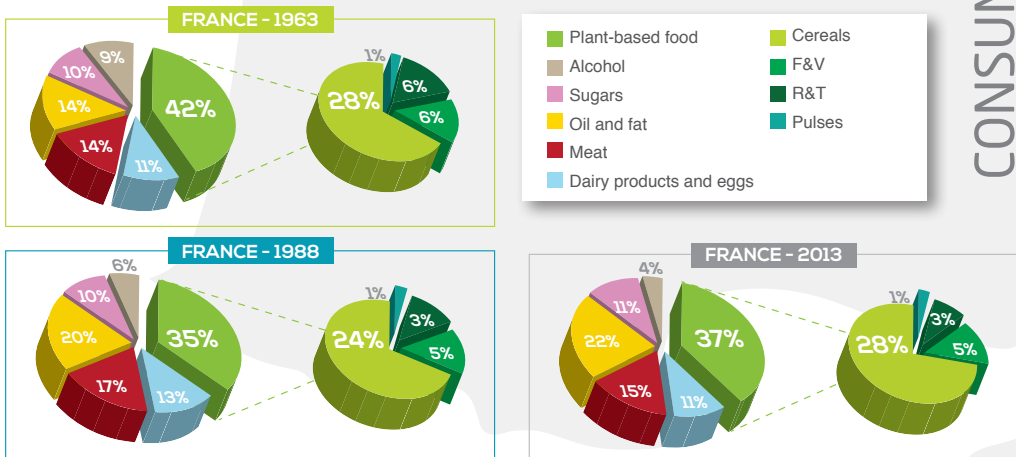


Figure 2. Contribution of different groups and categories of food to the French diet in 1963, 1988 and 2013, as % of total energy intake (TEI).

Evolution of fruit and vegetable consumption in France between 1963 and 2013

During the period 1961-2013, the consumption of vegetables in France fell from 150 to 97 kg per person per year (Figure 3). Until the mid-1970s, this decline was broadly linear; consumption then rose to 120 kg, and maintained this level until the mid-1990s before declining again and then remaining broadly stable until the mid-2000s at around 110 kg, only to decline again by around 10%. Fruit consumption, on the other hand, saw an upswing over the period, with gross consumption levels rising from

54kg per person per year to 114 kg. This data indicates, then, that in France the international recommendations on F&V consumption have not been respected for over 50 years. While the average consumption level for fruit is now approaching the recommended amount, for vegetables it clearly remains generally inadequate. In 2013, by weight, the French bought more fruits than vegetables, a total of 211 kg per person per year, an average gross consumption of 578 g per person per day, equivalent to an average consumption of 347 g per person per day once the 0.6 conversion factor has been applied (see Box p 22).

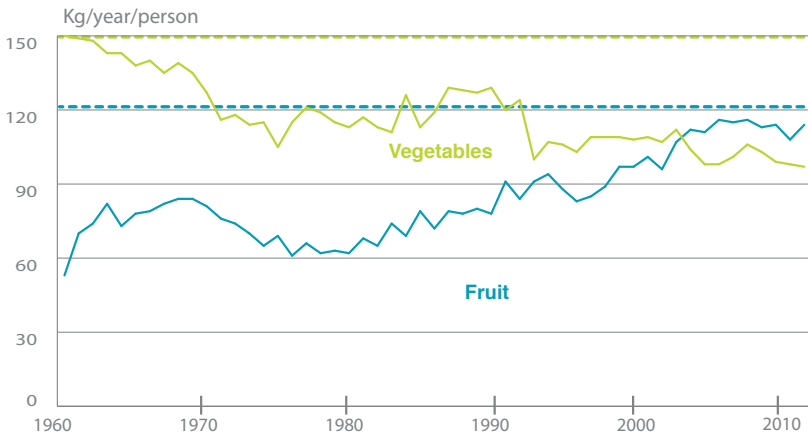


Figure 3. Trends in gross fruit and vegetable consumption in France from 1961 to 2013 (kg per person per year).

The lines in dashes indicate the international recommendations (WHO, 2015) for average daily intake, which are 250 g per person for vegetables and 200 g for fruit, these values having been annualized and converted (applying a factor of 0.6) in order to render them comparable to the FAO's gross consumption data, which are of approximately 150 kg per person per year for vegetables and 120 kg for fruits.



The case of Russia

The contribution of plant-based food to the calorie intake in Russia in 2013

In Russia in 2013, 46% of the total energy intake (TEI) was of plant origin: 35% in cereals, 5% F&V, 6% R&T and 1% pulses (see Figure 4).

The rest of the energy intake was comprised of 21% in animal products (11% meat and 10% in dairy and eggs), 14% of oil and fats (both of plant origin and animal), 13% sugars and 5% alcohol.

Principal trends in plant-based nutrition in the USSR/Russia, 1963-2013

Plant-based sources, having comprised 59% of Soviet citizens' TEI in 1963, declined markedly in importance in the 1980s, reaching 46% by 1988 (Figure 4).

The 13% fall between 1963 and 1988 in the contribution of plant-based sources was compensated by increases in the proportions of all other sources with the exceptions of dairy products and eggs: +3% for meats, +5% for oils and fats, +3% for sugars and +1% for alcohol (Figure 4).

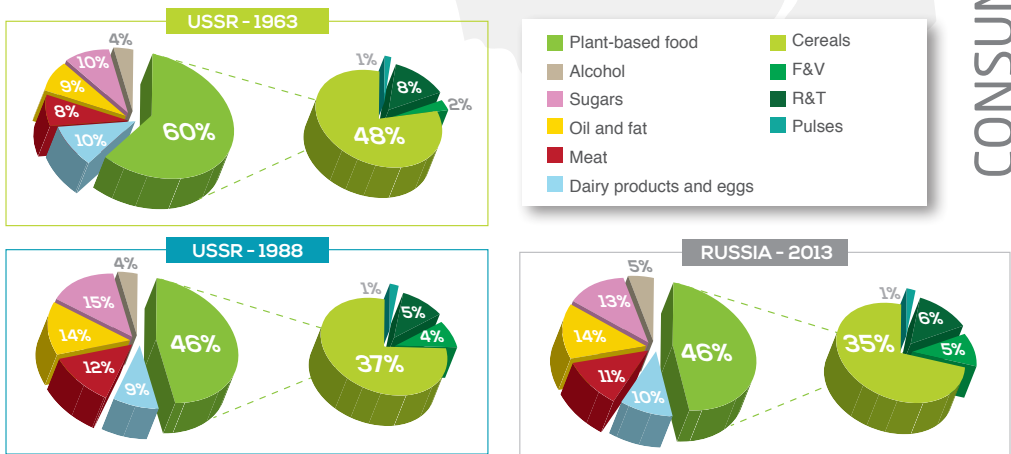


Figure 4. Contribution of different groups and categories of food to the Soviet/Russian diet in 1963, 1988 and 2013, as % of total energy intake (TEI).

Principal trends in fruit and vegetable consumption in the USSR/Russia, 1961-2013

Over the last 50 years, Russian F&V consumption has increased overall, from 75 to 113 kg per person per year for vegetables and from 18 to 69 kg per person per year for fruit (Figure 5).

During the period 1961-2013, fruit and

vegetable consumption in the USSR/Russia increased overall, rising from 75 kg to 113 kg per person per year for vegetables and soaring from 18 kg to 69 kg for fruits.

The steady increases that followed have not been sufficient to bring consumption levels up to the internationally recommended norms, either for vegetables or fruit.



“Food safety and nutrition in the Russian Federation - a health policy analysis” provides the historical and economic background necessary to interpret this data, in addition to providing much additional information on the country’s agricultural production and on the nutrition and health of the Russian population (Lunze et al., 2015).

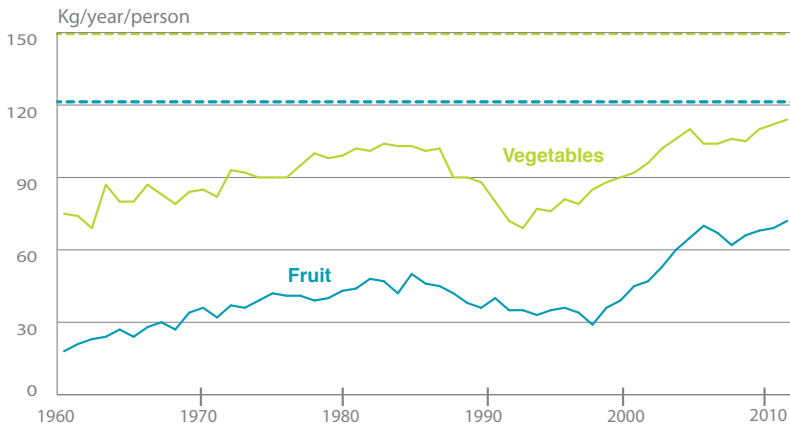


Figure 5. Trends in gross fruit and vegetable consumption in the USSR from 1961 to 1991 and in Russia from 1992 to 2013 (kg per person per year).

The lines in dashes indicate the international recommendations (WHO, 2015) for average daily intake, which are 250 g per person for vegetables and 200 g for fruit, these values having been annualized and converted (applying a factor of 0.6) in order to render them comparable to the FAO’s gross consumption data, which are of approximately 150 kg per person per year for vegetables and 120 kg for fruits.



Consumption patterns in North America over the last 50 years

United States

The contribution of plant-based food to the calorie intake of the United States in 2013

In the United States in 2013, 31% of the total energy intake (TEI) was of plant origin: 22% in cereals, 5% F&V, 3% R&T and 1% pulses (Figure 6).

The rest of the energy intake was comprised of 25% in animal products (13% meat and 12% in dairy and eggs), 24% of oil and fats (both of plant origin and animal), 16% sugars and 4% alcohol.

Principal trends in plant-based nutrition in the United States, 1963-2013

The contribution of plant-based sources stayed relatively stable, hovering around 31% of TEI over the period (Figure 6). Other parts of the US diet similarly underwent little change, with meat and alcohol consumption levels stable at 13% and 4% of TEI, respectively (Figure 6). The share of oils and fats did increase over the period, however, from 19 to 24%.

CONSUMPTION TRENDS

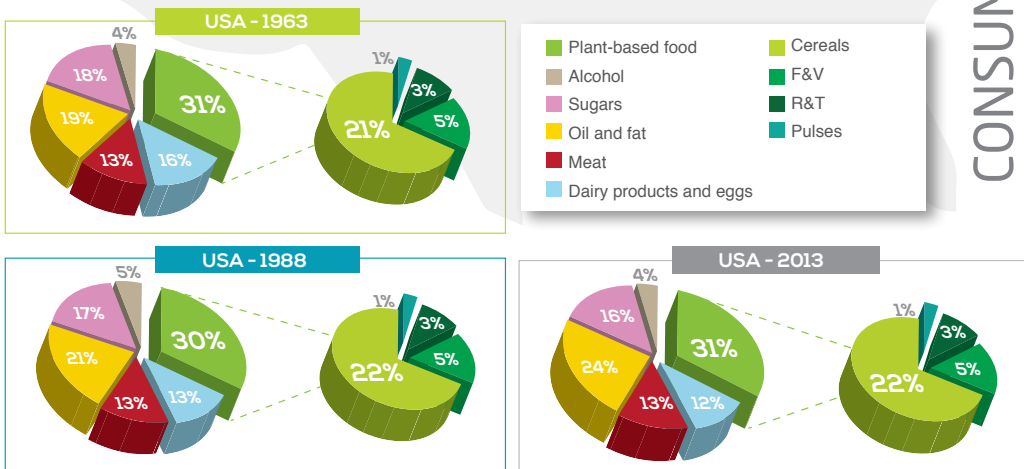


Figure 6. Contribution of different groups and categories of food to the US diet in 1963, 1988 and 2013, as % of total energy intake (TEI).

Principal trends in fruit and vegetable consumption in the United States, 1961- 2013

Between 1963 and 2013, F&V consumption in the United States increased overall, from 94 to 114 kg per person per year for vegetables and from 81 to 108 kg for fruit (Figure 7).

Vegetable consumption peaked in the early 2000s at more than 130 kg per person per year. Since 2008, there has been a decline, most likely attributable to the economic downturn that followed to the subprime crisis. Fruit consumption tended to increase until the mid-1980s, reaching 129 kg per person per year in 1987. There then followed years of

fluctuation during which the level varied between 106 and 125 kg. 2008 marked the start of a decline which persisted through to the end of the period.

From the mid-1980s onwards, American fruit consumption has broadly corresponded to international recommendations. On the other hand, vegetable consumption has remained insufficient. Since the 1990s, Americans have consumed a slightly greater weight of vegetables than fruits: purchases of F&V in 2013 amounted to 219 kg per person per year, an average gross consumption of 600 g per person per day, equivalent to an average consumption of 360 g once the conversion factor of 0.6 has been applied (see Box p 22).

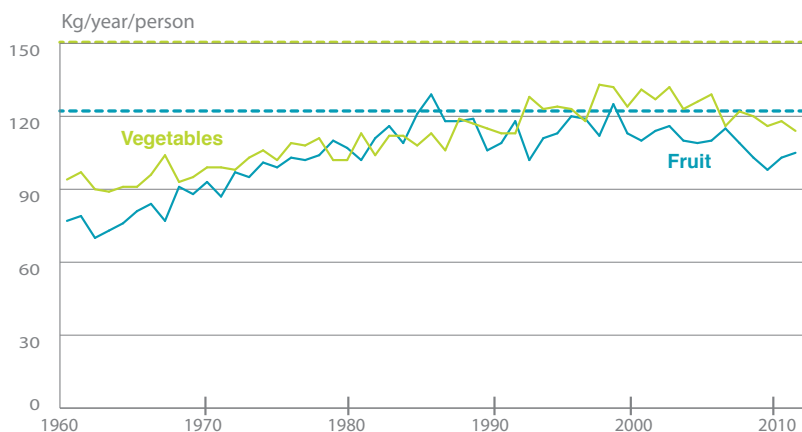


Figure 7. Trends in gross fruit and vegetable consumption in the United States from 1961 to 2013 (kg per person per year)

The lines in dashes indicate the international recommendations (WHO, 2015) for average daily intake, which are 250 g per person for vegetables and 200 g for fruit, these values having been annualized and converted (applying a factor of 0.6) in order to render them comparable to the FAO's gross consumption data, which are of approximately 150 kg per person per year for vegetables and 120 kg for fruits.



The contribution of plant-based food to Canada's calorie intake in 2013

In the United States in 2013, 40% of the total energy intake (TEI) was of plant origin: 26% in cereals, 6% F&V, 4% R&T and 3% pulses (Figure 6).

The rest of the energy intake was comprised of 18% in animal products (11% meat and 7% in dairy and eggs), 27% of oil and fats (both of plant origin and animal), 13% sugars and 3% alcohol.

Principal trends in plant-based nutrition in Canada, 1963-2013

Contributing 35% of TEI in 1963, the importance of plant-based sources remained almost unchanged through to 1988 (34%) before rising to 40% of TEI by 2013 (Figure 8).

The 5% increase in the share of plant-based food consumed between 1963 and 2013 occurred alongside a sharp decrease in the importance of eggs and dairy products, which fell from 14 to 7% of TEI, and of sugars, which fell by 4% but whose consumption remains relatively high at 13% of TEI. The consumption of oils and fats, on the other hand, increased substantially from 20 to 27% of TEI.

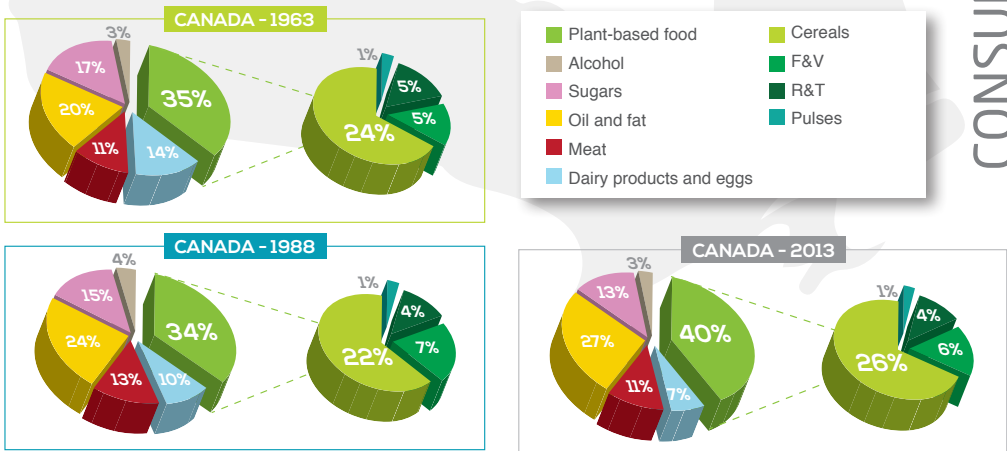


Figure 8. Contribution of different groups and categories of food to the Canadian diet in 1963, 1988 and 2013, as % of total energy intake (TEI).

Principal trends in fruit and vegetable consumption in Canada, 1961- 2013

Over the last fifty years, Canadian consumption of F&V has increased overall, from 81 to 108 kg per person per year for vegetables and from 96 to 136 kg for fruit (Figure 9).

The trends for F&V consumption in Canada are similar to those observed in the United States: following increases in the early 1970s, the levels remained broadly constant during the 1980s (at between 105 and 115 kg per person per year for vegetables and between 110 and 120 kg for fruits), and then rose

again through till 2008.

Between 1980 and 1996, fruit consumption was close to international recommendations and is now ahead. Vegetable consumption, on the other hand, remains insufficient. While Canadians have always consumed roughly the same total weight of fruits and vegetables, between 2005 and 2013 there was a switch in favor of fruits. In 2013, Canadian purchases of F&V were 244 kg per person per year, an average gross consumption of 668 g per person per day, equivalent to an average consumption of 401 g once the conversion factor of 0.6 has been applied (see Box p 22).

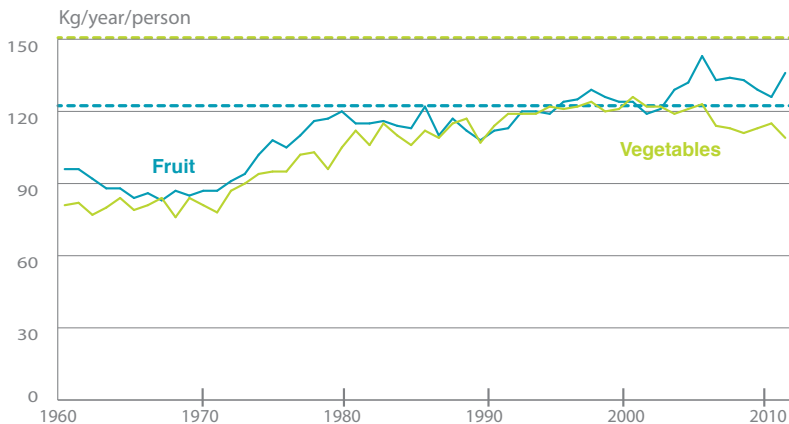


Figure 9. Trends in gross fruit and vegetable consumption in Canada from 1961 to 2013 (kg per person per year)

The lines in dashes indicate the international recommendations (WHO, 2015) for average daily intake, which are 250 g per person for vegetables and 200 g for fruit, these values having been annualized and converted (applying a factor of 0.6) in order to render them comparable to the FAO's gross consumption data, which are of approximately 150 kg per person per year for vegetables and 120 kg for fruits.

Inter-country comparisons over the last 50 years

🔍 Trends in the share of plant-based food

A downward trend was observed in the proportion of plant-based food consumed in the diets of both European countries examined. In North America, on the other hand, the proportion has remained broadly constant in the United States and increased in Canada (see Figure 10).

Russia nevertheless remained the country in 2013 with the greatest reliance on plant-based sources for its diet (46%) and the United States with the least (31%). France ranks third (37%), behind Canada (40%).

Note that Canada is the only one of these countries to have significantly increased the share of pulses in its diet (to 3%, as compared with 1% for the others). It is also in Canada that F&V account for the largest share of TIE (6%, as compared with 5% for the other countries).



Differences between countries in the extent of their reliance on plant-based foods are tending to diminish (as % of TEI).

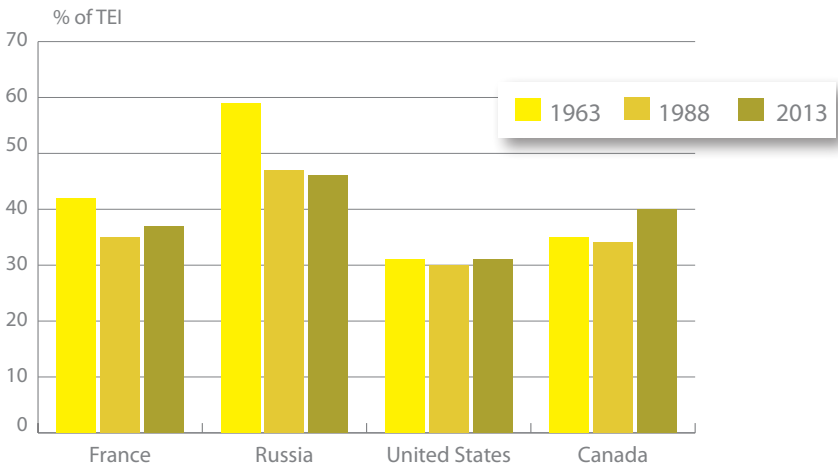


Figure 10. Contribution of the main categories of plant-based foods (cereals, F&V, R&T, pulses) to the diet of the examined areas in 1963, 1988 and 2013 (as % of TEI).

➔ Trends in fruit and vegetable consumptions

Average consumption of F&V has increased during the period in all the areas examined with the exception of France: + 47% for Europe overall, + 102% in Russia, - 5% in France, + 37% in the United States and + 45% in Canada (Figure 11). Looking at the consumption levels in 1963, however, relativizes these differences: at that time, France with an average gross consumption of 222 kg

per person per year, had the highest figure and Russia, with 92 kg, the lowest. What has occurred is broad harmonization in gross consumption levels across the different areas: the range is now from 186 kg per person per year in Russia to 245 kg in Canada. Set against the WHO's 450 g per person per day recommendation, these levels are all still too low, since once the conversion factor of 0.6 is applied (see Box p 22), the 186-245 kg per person per year range for gross annual consumption becomes one for estimated daily consumption of 306 g per person per day in Russia and 403 g in Canada.



Gross consumption of F&V has tended towards harmonization across the different regions.

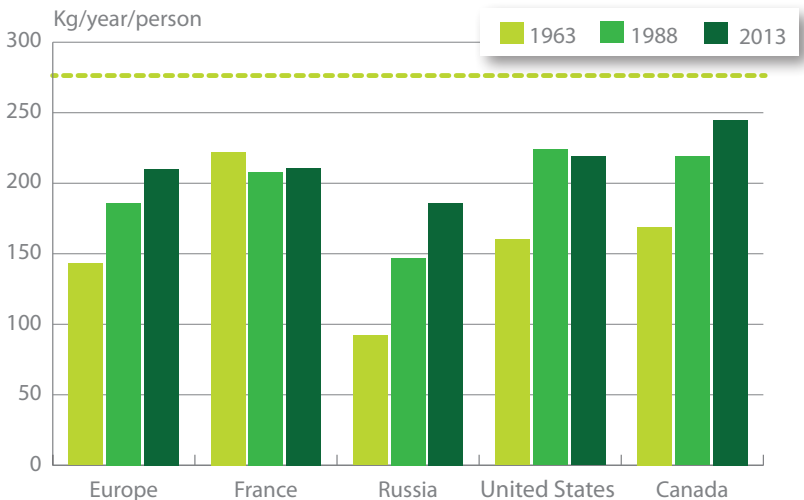


Figure 11. Gross fruit and vegetable consumption in the regions examined in 1963 and 2013 (kg per person per year).

The lines in dashes indicate the international recommendations (WHO, 2015) for average annual per capita intake, which are, as we saw from the earlier calculations, 150 kg for vegetables and 120 kg for fruit, a combined total of 270 kg per person per year.



Focus on the last 10 years

An example from Europe: France

In France, there are two principal sources of data for assessing dietary intake: first, the 'National food consumption surveys' (known by their French acronym INCA) carried out at the level of the individual every 7 years by ANSES (formerly Afssa) since 1999; second, the surveys on 'Dietary behavior and consumption in France' (abbreviated in French as CCAF), conducted every three years by CREDOC, the most recent of which was in 2016.

In view of the fact that the CCAF survey for 2019 is not yet available, we focus here on data from the two most recent INCA studies, collected on samples of more than 2000 adults aged 18 to 79, in 2006-2007 for INCA 2 (Afssa, 2009) and in 2014-2015 for INCA 3 (Anses, 2017). The data on plant-based nutrition extracted from these two studies are summarized in Table 2.

KEY NUMBER

+ 4%

The proportion of solid food
in the French diet that was plant-based
increased by 4% between 2007 and 2015.

The place of the plant-based food in the French diet, 2007-2015

According to the data, in France the proportion of solid food that was plant-based was 47% in 2007 and 51% in 2015, an increase of 4%. It should be noted that these figures are not comparable with the proportion calculated from FAO data, as that figure (37% in 2013) is a proportion of TEI contribution, rather than weight, used here.

The INCA 3 data indicate that the French consumed on average 599 g of solid plant-based food per day in 2014-2015, 50.9% of the total weight of solids consumed. The consumption of certain plant-based foods declined between 2007 and 2015, notably vegetable fats (by more than half) and to a lesser extent fruit. Variations in the consumption of other plant-based foods are difficult to interpret because of the changes in the way foods were categorized from one study to the next. The appearance in the last survey of combined potato, cereal and pulse dishes makes it impossible to evaluate a change in the overall consumption of pulses. It is interesting to note, however, that the proportion of pulse consumers declined from 29.7% to

TABLE 2. CONSUMPTION RATES AND AVERAGE DAILY CONSUMPTION BY PLANT-BASED FOOD GROUP, EXTRAPOLATED ACROSS THE INCA 2 AND INCA 3 SURVEY GROUPS.

Food group	INCA 2 (2006-2007)			INCA 3 (2014-2015)		
	Consumer rate	Consumption (g/j)	Contribution	Consumer rate	Consumption (g/j)	Contribution
● Bread and crisp bread *	98.5%	115.0	9.5%	ND	114.4	9.7%
● Breakfast cereals	16.8%	4.9	0.4%	15.0%	4.8	0.4%
● Pasta, rice, wheat and other cereals *	ND	63.0	5.2%	ND	64.3	5.5%
● Vegetable fats *	ND	15.1	1.3%	76.3%	7.5	0.6%
● Vegetables	98.9%	139.3	11.5%	93.4%	130.7	11.1%
● Vegetable dishes *	ND	ND	ND	24.8%	25.5	2.2%
● Potatoes and other tubers	90.6%	58.3	4.8%	57.5%	45.8	3.9%
● Pulses	29.7%	9.7	0.8%	14.7%	7.7	0.7%
● Dishes made from potatoes, cereals or pulses *	ND	ND	ND	46.2%	47.2	4.0%
● Fresh and dried fruits, nuts, seeds and oleaginous fruits *	ND	147.1	12.2%	ND	133.0	11.1%
● Compotes and cooked fruits	32.9%	13.3	1.1%	19.8%	13.6	1.2%
● Substitutes of animal products made from soya and other vegetables *	ND	ND	ND	4.1%	4.2	0.4%
● Fruit and vegetable juices **	55.1%	59.1	/	50.3%	63.9	/
● Soups and broths **	52.4%	86.1	/	35.7%	100.0	/
● Solid vegetable ration		566 g/j	46.9%		599 g/j	50.9%
● Total ration ***		2 745 g/j			2 942 g/j	

* Food categories were modified between INCA 2 and INCA 3. A consolidation has therefore been effected in this table to include all the available data on plant-based food consumption. However, in the course of consolidation, consumption rates cease to be available, as are data on certain items that are not included in one or other of the surveys (denoted as Not Available: NA).

** Foods consumed in liquid form are not counted as plant-based.

*** Of which 44% and 40% in solid form, respectively for INCA 2 and INCA 3.

14.7% over the period, which would suggest that approximately half of those who eat pulses do so only as part of ready meals. It will be interesting to observe the comparable figure for this in the next INCA study and see what impact recent increase in communication on vegetable proteins has had, as it did not really take-off until 2016 with the International Year of Pulses. The INCA data also point to an increase in the consumption of plant-based beverages: soups and broths, as well as and fruit and vegetable juices.

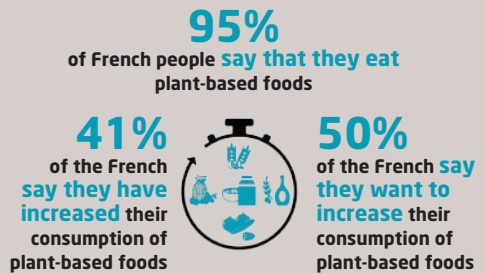
Trends in French fruit and vegetable consumption, 2007-2015

Per person per day, in 2007 the French consumed on average only 286 g of vegetables (in all various forms: fresh, canned, frozen, etc.) and fresh fruit; by 2015 this had declined to an average of 264 g. It may however be the case that this decline is one in appearance only: vegetable-based dishes were included in the survey for the first time in 2015; the addition of their weight indicates rather an increase in the total consumption of vegetables over the period. Fruit consumption, on the other hand, has certainly declined. Aggregating all plant-based solid foods including F&V (vegetables, vegetable-based dishes, fresh and dried fruits, nuts, seeds and oilseeds, compotes and cooked fruits), the average consumption in France was 300 g per person per day in 2007 and 303 g in 2015, an essentially stable figure.

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RESULT OF A SURVEY ON THE PLANT-BASED CONTRIBUTION TO THE FRENCH DIET

In 2017, the Observatoire des Cuisines Populaires (OCPop) and the edible oils company Lesieur asked the leading polling agency Ifop* to conduct a survey on the place of the vegetables in the French diet. Asked about the recent changes in their overall consumption of plant-based foods (vegetables, pulses, fruits, soya products, etc.), four in ten French declare that theirs has increased during the last two years. The proportion of those whose consumption has increased is as high as 5 out of 10 for vegetables and likewise for fruits; on the other hand, for pulses and for soy products the proportion is 3 out of 10.



* Institute of opinion and marketing studies in France and abroad (IFOP)
Source: *Vegetables in the French diet, an Ifop/Lesieur survey for OCPop, 2017.*



► An example from North America: the United States

The availability of food consumption data in North America

The survey data on food consumption in Canada are insufficiently recent and complete to confidently assess and analyse changes in behaviour: the most recent national study was conducted as far back as 2004; that was cycle 2.2 of the **Canadian Community Health Survey (CCHS)**. Furthermore, though the latest data available for the United States are as recent as 2015-2016, and the major national food study from which they are drawn, the **What We Eat in America (WWEIA)/National Health and Nutrition Examination Survey (NHANES)**, goes back as far as 2001-2002⁴, the data that these surveys provide address only the nutritional contributions of the macro- and micronutrients found in the foods and beverages consumed: they do not indicate the nutrients' source, whether animal or plant-based. For these reasons, we focus on the United States and limit ourselves to an analysis of food availability data, it being supposed that trends in plant-based food consumption will broadly match them.

The place of plant-based food in the American diet

A USDA report published in May 2019 analyzes changes in the availability of vegetables and pulses during the period

2014-18 (Figure 12). The data contained in the report equate to the FAO's raw consumption data analyzed in the previous sections.

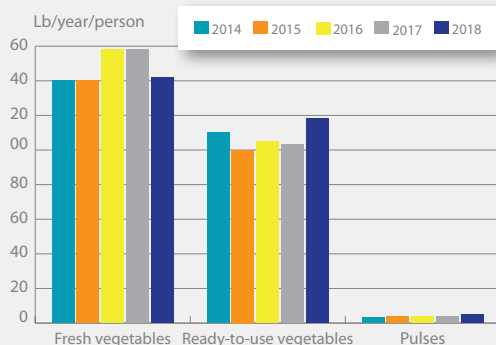


Figure 12. Changes in gross consumption (lb⁵ per person per year) of vegetables and pulses in the United States between 2014 and 2018 (Parr et al., 2019).

In 2018, gross consumption of fresh and ready-to-use vegetables amounted to approximately 117 kg per person per year. This figure is broadly the same as the 114 kg figure reported by the FAO for 2013. Note: there was an increase in the gross consumption of fresh vegetables, to the detriment of that of ready-to-use vegetables in 2016 and 2017. Pulses, on the other hand, experienced a doubling in gross consumption during the five year period, rising from approximately 2.3 to 4.6 kg per person per year. Another USDA publication, from its Economic Research Service, provides some

4. Prior to this, from 1935 to 1998, national surveys were conducted by the Department of Agriculture (**USDA Nationwide Food Surveys**). These included the first **NHANES studies** conducted periodically from 1971 to 1994 before becoming continuous from 1999 onwards.

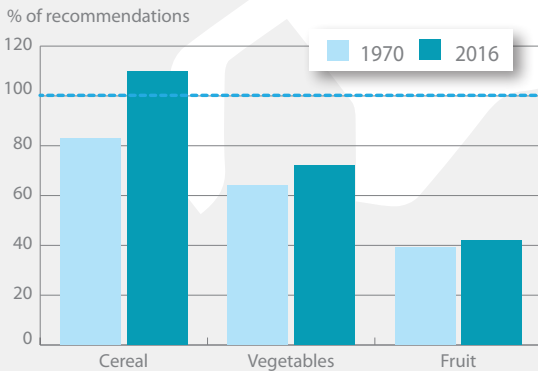
5. 1 lb = 0,45 kg.

information on consumption trends for other plant-based foods. Drawing on this, Figure 13 sets out how cereals, vegetables and fruits intakes in 1970 and 2016 compares with current guidelines. It indicates that cereal consumption, which had been broadly constant at around 22% of TEI since the 1970s

(see Figure 6), increased significantly, probably between 2013 and 2016. As for fruit, its intake increased only modestly between 1970 and 2016.



Over recent years, vegetable consumption has seen little change in the United States, while that of pulses has been soaring.



The line in dashes indicates the *2015-2020 Dietary Guidelines for Americans*.

Figure 13. Correspondence between cereals, vegetable and fruit consumption and dietary guidelines, 1970 and 2016 (based on ERS-USDA, 2018).



PLANT-BASED ALTERNATIVES: A GROWING MARKET IN THE UNITED STATES

According to the Plant-Based Foods Association, dedicated to the promotion of plant-based foods produced in the US, the market for plant-based alternatives to animal-sourced products is booming. US vegetable protein sales amounted to \$ 553 million in 2012 and are expected to reach \$ 5 billion by 2020. Overall growth in sales of plant-based alternatives was 8% in 2017 and reached 20% in 2018, compared to only 2% for the whole food sector. Milks derived from plants and plant-based alternatives to meat are the drivers of this market.

Source: *Plant Based Foods Association*.



Across the world: general trends and prospects

Energy consumption

Food consumption expressed in kcal per capita per day is a key indicator of a region's food situation and likely future direction. The available FAO data, which set out gross consumption data through their national food balance sheets, show a steady increase in this indicator on a world-wide scale: **on average, calorie availability increased by approximately 450 kcal per person per day between 1965 and 1998; for those in the developing countries the figure was more than 600 kcal** (FAO/WHO, 2003). There are, however, due to nutritional transition phenomena, substantial

KEY NUMBER

+ 50-70%

World food demand to increase by 50-70% by 2050.

geographical disparities in this availability of calories⁶. Furthermore, the food available is not necessarily the food that is best eaten for a healthy diet (Bahadur et al., 2018). According to the Mond'Alim forecast (Claquin et al., 2017), by 2050, world food demand is expected to increase by 50- 70%; the need then is urgent to rapidly reorient food production worldwide in order to best meet it.

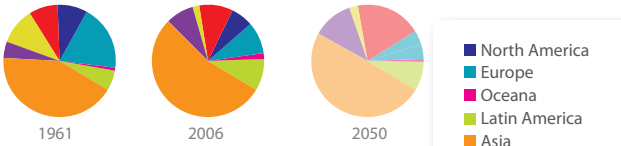
Diet composition

This increase in the demand for food will be accompanied by a change in how diets are composed in the different geographical areas (Figure 14). In the regions undergoing their nutritional transition, the shares of cereals and tubers will fall while those of animal products (milk, meat, eggs) and oils will rise.

On the other hand, the share of calories provided by cereals remains relatively stable over time worldwide, at around 50% of TEI. The principal cereals (wheat, maize, rice) will continue to be the staple foods in many countries (FAO/WHO, 2003).

6. The industrialization of food production and economic development lead to significant changes, a nutritional transition, in the population's diet. Several studies have demonstrated that this phenomenon - which occurs at different times and at different speeds in different countries - leads to a convergence of food consumption at the global level (Claquin et al., 2017).

Consumption of plant-derived calories in human food, by zone



Consumption of animal-derived calories, by zone

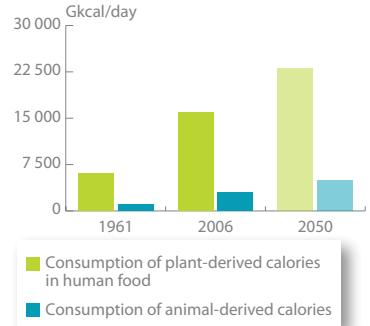
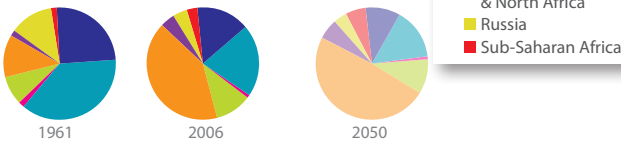


Figure 14. The geography of global food demand: general trends and prospects (Clavin et al., 2017).

Fruit and vegetable consumption

Although there has been an increase in F&V consumption in many parts of the world over the last 50 years (Figure 15), it is still insufficient in much of Europe as well as in most of the emerging (South America, India) and developing economies (Africa, South-East Asia).

Moreover, given that the issued FAO data overestimate actual consumption by around 40% (see Box p 22), only a small minority of countries across the globe are genuinely meeting the dietary recommendations on F&V.

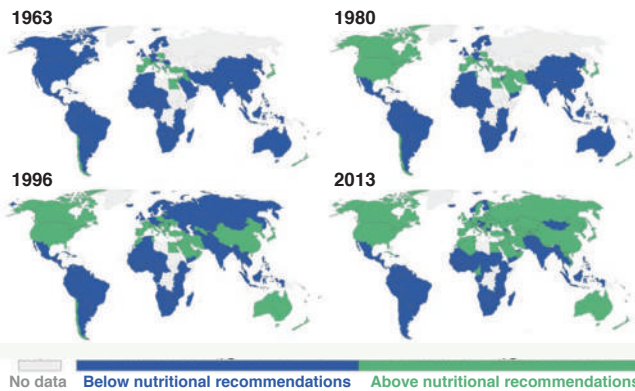


Figure 15. Worldwide gross consumption trends for vegetables over the past 50 years, set alongside internationally recommended levels.

Countries are marked in blue are those where average gross consumption for vegetables is below 250 g per person per day; they are marked in green when the values are higher (WHO, 2015). The FAO data represented here do not take into account food losses and waste at the level of the consumer. They therefore overestimate real consumption levels; this should be borne in mind when comparing them with WHO nutritional recommendations.



Towards a healthier and more sustainable diet

Achieving a sustainable diet is one of the main challenges that the world must face, hence the publication of a growing number of articles and reports on the subject. Achieving a sustainable diet is one of the main challenges that the world must face, hence the publication of a growing number of articles and reports on the subject.

According to the prospective study undertaken by **Agrimonde-Terra**, to feed the 9.7 billion earthlings of 2050, it will be necessary first of all to rebalance diets to 2,750 - 3,000 kcal per day (loss and waste included), which approximates to 1,850 - 2,000 kcal per day in food actually consumed. Moreover, this would have to be achieved without significantly increasing the area under cultivation and by moderately increasing the area grazed at the expense of the forest (Le Mouél et al.,



Feeding the 9.7 billion earthlings of 2050 will mean more plant-based food in Europe and North America.

2018). For Europe and North America, this implies: reducing meat consumption by around half (as a % of TEI) and making up the balance with fruits, vegetables and starches (cereals, pulses, potatoes). It is noteworthy that this scenario envisages an increase in meat consumption in certain areas, particularly in Africa (Figure 16).

Across the Atlantic, a Canadian team has compared current global food production with that required to allow everyone to adopt the **Healthy Eating Plate**

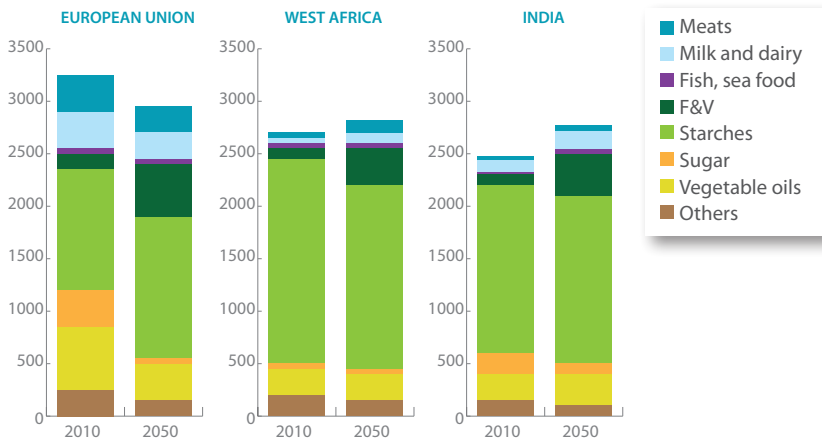
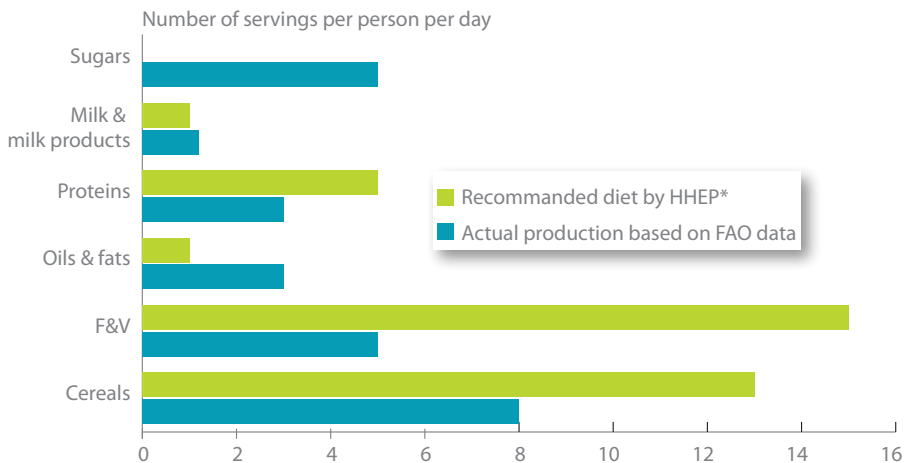


Figure 16. Three examples of how diets could change between 2010 and 2050, according to the prospective study undertaken by Agrimonde-Terra (INRA).



* Nutritional recommendations based on **Healthy Eating Plate** defined by experts at the Harvard TH Chan School of Public Health

Figure 17. Global production versus recommended consumption (Bahadur et al., 2018).

defined by experts at the Harvard TH Chan School of Public Health (Bahadur et al., 2018) and of which plant-based foods (F&V, whole grains and vegetable proteins) comprise more than 75% (by volume). The conclusion: the world produces too much grain, fat and sugar, and not produce enough F&V and, to a lesser extent, plant-based protein (Figure 17).

A further study (Mason-D’Croz et al., 2019), which evaluates the match between the supply and demand of F&V in 150 countries, draws the same conclusion.

We should also take note of the recommendations put forward in early 2019 by an international commission of experts, the **EAT-Lancet Commission** on Food, Planet, Health (Willett et al., 2019). It concludes that *“global consumption of fruits, vegetables, nuts and legumes will have to double, and consumption of foods such as red meat and sugar will have to be reduced by more than 50%”*.

+ THREATS TO PLANT-BASED FOOD

Managing to feed a growing population is not the only challenge that our farming and food systems have to face during the coming decades. They will also have to withstand a range of other threats, many of which are specific to the plant world:

- Private sector appropriation of public resources (e.g., through the patenting of genes that occur naturally in plants).
- Increased pest resistance to plant protection products leading to increased risks to plant health (emerging diseases, fungal infections, insect contamination)
- Location of much agricultural land (cultivated notably for wheat and maize) in areas of high water stress
- Fluctuating production yields resulting from climate change

Source : Claquin et al., 2017.

HOW TO EXPLAIN THE OBSERVED TRENDS IN THE CONSUMPTION OF PLANT-BASED FOODS?

Eating behavior, and hence the resulting consumption of food, depends on a host of factors. In addition to those inherent to the individual, as well as to the wider society, these factors also include the individual's food environment, that is to say, the availability and accessibility of different products. In this section, we discuss these factors and try to assess for each one its influence on consumption trends for plant-based food outlined in the preceding sections.

At the individual level

➡ Age, gender and household composition

Age, gender and household composition are the main factors influencing food consumption at the individual level. It is not possible, however, to make generalizations regarding the impact of these factors.

- **Regarding the gender effect** with respect to adults, for example, in Europe the EPIC study reports higher consumption of vegetables among men than women in some countries (Greece, Spain) and vice versa in others. (Denmark, Sweden). Similar observations pertain to fruit consumption, which is higher for men in Greece and Italy, and for women in countries further north (Agudo et al., 2002). In the United States, on the other hand, a CDC⁷ study points to women conforming more than men to public health recommendations regarding both consumption of fruit (15.1% vs. 9.2%) and vegetables (10.9% vs. 7.6%) (Lee-Kwan et al., 2017). Furthermore, a literature review of studies on adolescents in the United States, Canada and Australia, found that some of them pointed to a greater consumption of F&V among females while others found no significant difference at all (Rosi et al., 2019). Regarding other plant-based foods, there might well exist differences in consumption according to gender, but these, and the reasons for them, will



probably be specific to the particular country. According to the INCA 3 study in France, for example, men consume more potatoes, while women eat more whole-grain cereals, stewed fruit and fruits in syrup, as well as plant-based substitutes for animal products (Anses, 2017).

- **The effect of age** on food consumption, especially of F&V, seems more generalizable. Thus, in the United States, as in France, among adults there is a positive correlation between age and the quantities of F&V consumed (Lee-Kwan et al., 2017, Anses, 2017). But this age effect is also combined with a generational effect, eating behaviors being linked to forces of habit. So, in many parts of the world, F&V consumption among current generations may be lower than that of their predecessors



Age, gender and household composition have a strong influence on food consumption, but it is not possible to make generalizations about their impact.

(Tavoularis and Hébel, 2017). This generation effect might itself be countered societal changes, such as rising average levels of education or increasing sensitivity to environmental matters.

● **Regarding household composition,** French data suggest that single men and families with children consume fewer vegetables than single women and couples without children (Plessz et al., 2010).

Finally, it should be noted that the age and sex parameters influence attitudes to consuming a more plant-based diet. For example, in Australia older adults tend to be reluctant to modify their eating habits, while young adults declare themselves to be held back by a lack of information about plant-based diets; women are less likely than men to believe that humans are supposed to consume lots of meat (Lea et al., 2006).



Socio-economic status and level of education

The household's socio-economic status, and likewise the head of the

household's level of education or occupation (which influence income), are also strong determinants of the overall quality of food it eats and especially the amount of plant-based food.

Nevertheless, though some systematic reviews do conclude that people with the lowest incomes (or socio-economic status) are those who consume the least F&V (Kamphuis et al., 2006; Giskes et al., 2010), it has proved difficult (as with the case of gender) to identify a clear link that applies across all countries. In some European countries, it is true that the consumption of plant-based foods (F&V, but also whole grains and oleaginous fruits) is higher among adults with a higher level of education or who belonging to the higher socio-professional categories (SPC). This is the case, for example, in France (Anses, 2017). And the EPIC study confirms a positive association between F&V consumption and level of education (Agudo et al., 2002). However, taking a closer look at vegetable consumption in Europe complicates the picture: a positive association with the level of education is observed for the Baltic and Scandinavian countries, but not for the Mediterranean countries (Prättälä et al., 2009). This association therefore depends on other determinants, such as the availability and accessibility of products. This probably explains the lower consumption of F&V observed in Eastern Europe as compared with the Scandinavian countries (see p 25).

8. *Income-to-Poverty Ratio (IPR), indice défini selon les recommandations fédérales concernant la pauvreté.*

This complexity is brought out in the systematic review by Rosi et al. (2019) on the dietary habits of adolescents in North America, Europe and Australia, where the correlations for the individual countries point to no clear pattern.

Looking further at the United States, categorizing F&V consumption via an index of poverty⁸ does highlight significant differences in behaviour with respect to income, though again this applies only to vegetables, the poorest

consuming the least (Lee-Kwan et al., 2017). Another study, which assesses the influence of socioeconomic status, income and educational attainment on the degree to which Americans follow a plant-based diet did not point to any significant overall differences. However, applying the distinction of ethnicity enabled the authors to identify a significant difference between whites and African-Americans by level of education (Kell et al., 2015).

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PLANT-BASED FOOD, A MEANS TO COMBAT FOOD INSECURITY IN THE UNITED STATES

In North America, as well as in New Zealand and Australia, the prevalence of food insecurity is monitored regularly and is done so more accurately than in Europe. The United States Department of Agriculture has been collecting annual data since 1995. In 2017, 11.8% of US households (15 million) were categorized as food insecure (Coleman-Jensen et al., 2018). Though this is a decline on the 17 million figure recorded in 2008 (Nord et al., 2009), the number of households suffering severe food insecurity was still very substantial: 5.8 million.

To address this problem, the US government has put in place a federal food aid program, the **Supplemental Nutrition Assistance Program (SNAP)**, which distributes about \$70 billion per year to the poorest households. With a view to improving public health, the possibility is under consideration of introducing through this program incentives to consume certain foods (giving vouchers for F&V, or oleaginous fruits, whole grains etc.) as a complement to the implementation of disincentives (taxes on sugary drinks etc.). Indeed, according to a recent study, it would appear that such a policy could be an effective and economically efficient means of increasing the share of plant-based food in the poorest Americans' diets (Mozaffarian et al., 2018). Another study, not focussing specifically on SNAP, based this time on data from the Seattle Obesity Study, also highlights the economic benefit of a shift to more plant-based food. According to its findings, increasing the proportion of plant-based proteins in the diet would be a good way to improve diet quality, and this regardless of income level (Aggarwal and Drewnowski, 2019).



The drive to eat plant-based foods involves hedonic factors, such as a taste for vegetables or meat.



Lifestyles

Over the past half-century, eating habits have undergone major changes, due in part to changes in lifestyle.

In general, we can say that people with a healthy lifestyle (not smoking, drinking alcohol in moderation, watching their weight, practicing a regular sports activity...) consume more F&V. In Europe, for example, the EPIC study found a positive correlation between F&V consumption and physical activity and a negative correlation with smoking (Agudo et al., 2002). Several systematic reviews have highlighted a correlation between sedentary and a relatively lower consumption of F&V (Pearson and Biddle, 2011).

Moreover, a stressful lifestyle, often associated with a lack of time, likely constitutes an obstacle to consuming plant-based foods regarded as time-consuming to prepare (especially fresh vegetables and pulses). Stress attributable to a difficult social situation is also linked with less favorable eating habits, including a lower consumption of F&V (Moore and Cunningham, 2012).



Tastes, preferences and food intake

Food preferences and tastes, which depend on a set of determinants related to childhood (whether breastfed or not, weaning age and the extent of nutritional diversity immediately thereafter, etc.), also appear to be influential factors in the degree to which plant-based foods are selected in adulthood; recent papers have reported on the acquisition of a taste for vegetables (Guillaumie et al., 2010; Appleton et al., 2016) and a taste for meat, which can, in itself, serve as a barrier to switching to a more plant-based diet (Pohjolainen et al., 2015; Sabate et al., 2019).

Moreover, these factors interplay with dietary preferences that are themselves influenced by the physiological mechanisms that regulate food intake, such as hunger (physical sensation indicating a need to eat) and satiety (state at which the feeling of hunger has disappeared). Yet, these mechanisms cause in humans an innate preference for high-calorie foods that are presumed to provide us with the energy we need (Perry et al., 2015). That is why, when one feels hungry, a steak will seem more attractive than a plate of vegetables. It is for this reason worthwhile for consumers to be better informed about the nutritional attributes of plant-based foods, and especially pulses, as protein sources capable of substituting for animal proteins.



At the societal level

While our eating habits depend primarily on individual factors, they are also influenced by a range of collective values which in turn are subject to modification in response to societal transformations, including transformations to the food system itself. Here are some examples from a working paper produced by the French Ministry of Agriculture and Food (Hérault et al., 2019).

Individualism and social segmentation

In Western countries, a certain form of individualism has been developing, encouraged by changes in family structure (increases in divorce rates and the number of people living alone) and extensions to individual freedoms. This individualism has repercussions on consumer behavior. Consumers express their individuality by excluding certain products (adopting “no” diets, vegetarianism, etc.) and/or consuming in accordance with their religious affiliation (halal, kosher), ethical (equity, social solidarity, animal welfare) or environmental (short circuits to market, localism, organics, seasonal, flexitarian). Food communities are thereby created, bringing together people who share similar aspirations; this results in a degree of social segmentation. This phenomenon tends to increase the

share of plant-based foods in the diet because many of these communities, whatever their motives, accord them a privileged place.

New attitudes towards time

In the most advanced economies, growth in female employment rates has led to a marked reduction in the time devoted to preparing meals.

This has been accompanied by and given rise to an increase in the availability of ready-prepared food and home deliveries of freshly cooked meals, as well as in a greater consumption of meals outside the home. Increasing urbanization has also been contributing to this phenomenon by increasing transport times (Sabbagh and Etiévant, 2012). As a result, the time spent on preparing food is increasingly being given over to other activities, even in





The time spent on preparing food is increasingly being given over to other activities.

countries such as France that have a strong tradition of family meals (Fischler and Masson, 2008): the famous French model of dining is withering.

This new attitude towards the time spent on preparing food has had a mixed effect on the consumption of plant-based foods. It is understood that diminutions in the available time are an obstacle to the consumption of vegetables,

as they are regarded as time-consuming to prepare (Pohjolainen et al., 2015), and likewise pulses, which in many cases need to be soaked for a day prior to consumption. However, their limits as raw ingredients may promote the development of pre-prepared ranges of fresh foods, as well as other food innovations that facilitate consumers' efforts to increase the amount of vegetables in their diet (Milford et al., 2019). Furthermore, lack of time encourages the consumption of starches, which are easy to store, preserve and quickly prepare.



GROWING AWARENESS OF SOCIAL ISSUES

In contrast to this tendency towards greater individualism, consumer behaviors grounded in solidarity have also emerged. In many Western countries, rising concern about sustainable development is leading consumers to favor local sources for their provisions, and especially food. The proximity is at once geographical and social: in favoring the shortest circuits to market (those involving the fewest intermediaries), regional products and locavorism (consumption of food produced within a small radius around one's home), these consumers also appreciate the work of the producers, participate directly in boosting their incomes and create a social bond. In the United States, for example, the number of farmers' markets has quadrupled since the 1990s and now stands at 8,600, according to figures from the **USDA**.

At the same time, against a backdrop of globalized food markets increasing numbers of people are seeking to consume more ethically. According to a study conducted in 2012 in seven countries (urban China, France, Germany, urban Russia, Spain, United Kingdom and the United States), 66% of consumers were impressed by food brands that offered products that respected workers and/or their suppliers conditions (**TNS Sofres Food 360**, 2013). When purchasing food that cannot be produced locally (coffee, cocoa, tea, Asian rice, etc.), such respondents favor fair-trade products, which pledge to ensure decent working conditions and wages for their local producers, especially those in developing countries. In France, for example, this market grew by 72% between 2012 and 2015.



➡ **Feminization of society**

Throughout the world, sociological studies observe a process of feminization of societies taking place. The place of women in the education system and in the world of work is evolving, which is resulting in a greater diffusion of feminine values across the public sphere and, through this, to changes in behavior. As it affects nutrition, this feminization is illustrated not only by the search for a healthy, natural and balanced diet, but also by a greater sensitivity to ecology and animal welfare, and therefore by the rise of vegetarianism and flexitarianism in most Western countries.

It is also interesting to note that, according to the results of a study based on data from 137 countries, one of the main determinants of household meat consumption is whether or not the

female has a paid job, the correlation being positive (Milford et al., 2019). Thus, while on the one hand the feminization of society gives impetus to a reduction in meat consumption, on the other, an opposing effect arises from the growing need for women to reduce the time they spend preparing meals, animal proteins being relatively speedier to prepare than their plant-based equivalents.

➡ **Increasing awareness of health and well-being**

Health has always been a social concern. Hopes and, indeed, expectations, of good health are becoming ever greater with the focus of healthcare moving increasingly towards the preventative aspect of healthcare and the quest for a better quality of life, towards maintaining comfort in body as well as mind, rather than seeking a cure for illness or disease.

In this context, food is particularly important. It stands out as one of the main levers for preserving one's health and "ageing well". A multitude of attitudes and practices proceed from this, such as following a diet, fasting, sourcing food locally, preparing meals at home from the basic ingredients, or indeed employers organizing lessons in the workplace on nutrition. These behaviors help procure feelings of self-control, personal development, civic responsibility, indeed moral uplift. There can be a

downside however: they can engender a sense of rigor that modifies the perception of the body, leading the person towards a feeling of shame and anxiety, away from the desired sense well-being initially sought.

In this context, vegetable food often appears the ideal “remedy”. According to an Australian study, the principal health-related benefits of plant-based diets are nutritional, arising through reduced saturated fat intake, increased

““ Even though developed countries have been according greater interest to nutrition since the 1980s, fruit and vegetable consumption is still remains below recommended levels.

+

VARIABLE COUNTRY EXPECTATIONS FOR HEALTHY FOODS

According to a study conducted in 2012 in seven countries (urban China, France, Germany, urban Russia, Spain, United Kingdom and the United States), not all seem to have the same interest in healthy nutrition or, at least, do not expect the agri-food industries to take much interest. Though, on average, 76% of consumers are appreciative when food companies innovate or invest in creating products that help maintain or improve one’s health, this concern is much more pronounced in Russia and China than in the United States, the United Kingdom and Germany.

Source : *TNS Sofres Food 360*, 2013.

fiber intake and the prevention of illness (Lea et al., 2006). A more recent study in the same country concluded that these health-related benefits outweigh those to the environment (Hoek et al., 2017). In addition, according to the results of a poll conducted in France (*Ifop/Lesieur*, see Box p 39), among the 4 out of 10 interviewees who stated that they had increased their consumption of plant-based products in the preceding two years, 82% had done so for reasons of nutritional balance, health or to keep their weight down.

It is nevertheless troubling to observe that though since the 1980s developed countries have been according greater interest to nutrition (Sabbagh and Etiévant, 2012), F&V consumption, a fundamental element in all public information campaigns on nutrition, remains below recommended levels. The health benefits of diets rich in plant-based foods appear to the majority to be insufficiently important to warrant a change in their eating habits.

The quest for naturalness

In an increasingly globalized world, consumers are looking for greater clarity and transparency in the information they receive, as well as more security. With regard to their diet, this attitude translates into a desire for naturalness. For most consumers, naturalness implies a rejection of ‘chemicals’ (preservatives, dyes, additives), but also, driven by concerns for health and environmental safety, products associated with biotechnology, GMOs and pesticides (Burzala, 2018). Foods considered as ‘natural’ include the products of organic farming and so-called “clean label” products. We also find in this category a range of products positioned to capitalize on the trend towards a return to basics, to the soil, to making wholesome meals with simple ingredients. The perceived ‘naturalness’ of a product depends, then, on the ingredients from which it is made, the approach to agriculture that was adopted for its cultivation and the transformation process that

was employed to bring it to market. Most plant-based foods (F&V, R&T, rice, quinoa, pulses, oleaginous fruits, algae, spices, etc.) logically fall into this definition since they do not undergo profound changes from field to table. Thus, in France, 30% of those surveyed in an **lfop/ Lesieur study** said they had increased their consumption of plant-based products because they appeared to them as unprocessed and more natural. According to the **TNS Sofres Food 360 study**, this interest in naturalness is global, with the Russians leading the way, 71% of whom say they are careful about the ingredients used in the composition of the products they buy and 41% being reassured by a label indicating ‘organic’ (for all countries surveyed combined, the average was 25%). Overall, the consumers surveyed sought natural ingredients (79%) and rejected preservatives (77%), pesticides (76%), artificial flavors (72%), antibiotics (71%) and GMOs (69%). Hence, on average across the countries surveyed, 82% of consumers are appreciative when food companies innovate or invest in producing products that are more natural.



➔ A new attitude towards animals and to plants

Over the past two decades, the status of animals and of the products derived from them (above all meat) has changed. Concerns about health, the economy, the environment and about ethics are at the root of this transformation. The result has been a reorientation of the purchases towards sectors that are perceived as particularly respectful of the animal welfare, the development of total or partial exclusion diets (veganism, raw veganism, vegetarianism, flexitarianism), as well as the engagement in militant and anti-speciesist activities, etc.

Countries are not all in phase on these issues and hence the nutrition transition that follows from them: Consumers in Northern Europe, for example, are, according to **World Animal Protection's** assessment, particularly sensitive to the issue of animal welfare.

A critical attitude towards animal proteins mechanically leads to a reassessment of vegetable proteins (pulses, soya, cereals) and other protein alternatives (insects, yeasts) (Graça et al., 2015). For example, in France, where sensitivity to animal welfare issues not yet highly developed, the results of a declarative survey conducted in 2017 indicated that 22% of the consumers who had recently increased the plant-based share of their diet had done so, wholly or in part, with the intention of preventing suffering to animals



(**lfop/Lesieur study**, see Box p 39).

In countries that have begun their transition to a reduced proportion of food sourced from animals in their diets the products whose consumption is progressing include plant-based drinks (soy, rice, almond etc.), tofu, ultra-fresh soy products, vegetable steaks (derived from wheat, quinoa etc.), roux and jellies (soy, coconut, oats, etc.), yeasts, algae (see p 14) and pulses (provided that there is an adequate offer of ready-to-use products). Amid this propitious trend towards the development of increasingly plant-based diets has emerged the specter of a “plant welfare” cause, the advocates of which believe that plants are susceptible to suffering and are calling for this to be recognized. Were this cause to be adopted by substantial numbers of people, the consequences for our way of life and for our relationship to nature would be manifold.

Consumers and their environment

➡ The consumer's food environment

The wider food environment comprises the individuals' homes and immediate surroundings, as well as the other places in which they spend their day such as the workplace and school and their vicinities (Inserm, 2014). In the United States, for example, the school environment is of particular interest because the canteens supported by the federal government have to compete with food on sale elsewhere in school. The food environment is not simply geographic, it also includes the

dimensions of accessibility (i.e., the possibility of accessing a resource, which varies according to characteristics specific to the resource and to the individual) and availability (i.e., the possibility of actually using the resource given the number of inhabitants who might want to use it) (Inserm, 2014).

In the literature analyzing the relationships between food environments and eating behavior, a large number of studies have focussed on the purchase, consumption or use of F&V (Sleddens et al., 2015). Most of these studies, which have been conducted in a range of countries (including Australia, New Zealand, the United Kingdom and the United States) have shown that F&V consumption is not dependent on differences in the spatial accessibility of supermarkets (Lin et al., 2014). It is impossible, however, to generalize this conclusion to other supply outlets; indeed, these studies generally take inadequate account of them. As for research attempting to assess the influence of F&V's availability in-store, this has not yet produced consistent results (Inserm, 2014). It would appear then that the spatial accessibility of healthy dietary options has little impact on eating behavior.

Affordability, on the other hand, has a definite influence, especially on the consumption of F&V, the high price of



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PLANT-BASED FOOD IS INCREASINGLY BEING EATEN IN HEALTHCARE FACILITIES

In certain situations (hospitalization, placement in a care home, etc.), individuals become dependent on others for their diets; the food environment acquires a definite impact.

Over recent years, many developed countries have integrated the health and environmental aspects of food into their healthcare systems. As early as 2006,

Canada and the United States began a program to encourage hospitals to upgrade their service, including through an increase in plant-based foods. A report was published in 2017.

In September 2018, the NGO **Health Care Without Harm (HCWH) Europe** published a brochure entitled "Plant-Based Food - Guidelines for Healthcare", which outlines the initiatives implemented in various European countries and proposes recommendations to help promote plant-based diets in healthcare facilities.

*Source : **Plant-Based Food - Guidelines for Healthcare, 2018.***

which in many countries appears to be one of the main obstacles to their purchase (Lin et al., 2014; Sleddens et al., 2015). The marked correlation between fruit consumption and GDP per capita in a range of countries points to this effect (Figure 18). In light of this obstacle, the United States Department of Agriculture (USDA) conducted a study to estimate the amount of expenditure on F&V necessary for an individual to meet its 2015-2020 recommendations. Result: \$2.10 to \$2.60 per person per day for a 2,000 kcal diet. An affordable budget, according to the authors, for a family of four with limited income, subject to it reducing the expenditure on other items such as fatty, salty and sweet products (Stewart et al., 2016). Conversely, in countries where F&V are less expensive, it appears that their low price is a boost to consumption during a period of tight financial constraints, as in Greece between 2006 and 2016, which was particularly affected by the economic crisis in Europe (Kyrkou et al., 2018).



Consumers and sustainable food

For several decades, rising social, ecological and ethical concerns have led consumers to seek a more sustainable diet. According to the FAO definition, such a diet encompasses environmental, nutritional, economic, social, cultural, and health dimensions. Nevertheless, each individual has their own conception of sustainability, which rarely includes all of these dimensions: in practice, consumers who want to achieve a more sustainable diet seek above all to reduce their environmental impact and improve their own health. According to the **TNS Sofres Food 360** study, this enthusiasm exists in most developed countries: 74% of consumers expressed the desire for manufacturers to offer food products that respect the environment and conserve natural resources. In essence, they were calling for products sourced from more sustainable modes of agricultural production, processing and

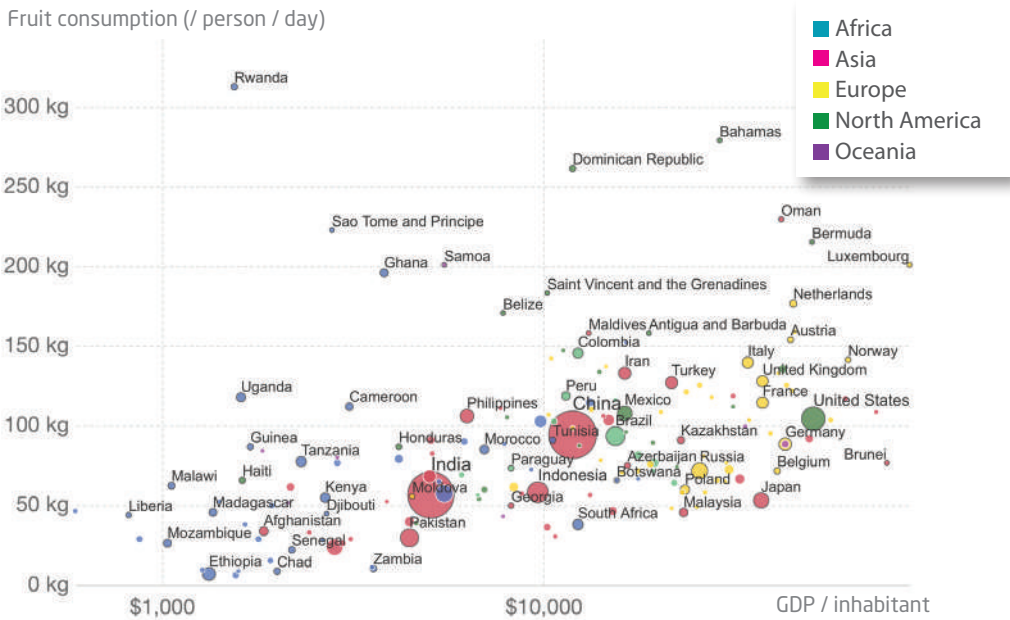


Figure 18. Relationship between fruit consumption and GDP per capita (FAO, 2013).

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THE LEVEL OF INFORMATION, A PARAMETER TO INTEGRATE INTO THE FOOD ENVIRONMENT

Though little discussed in the literature to date, the extent of consumers' information seems to be an important determinant of their behavior towards integrating new foods into their diets. According to an Australian study, a lack of information appears indeed to be the main obstacle to switching to a more plant-based diet, and this regardless of sex, age or level of education (Lea et al., 2006). This barrier is linked to the widespread perception, fostered in the generational transfer of dietary habits, that preparing plant-based dishes is difficult (Pohjolainen et al., 2015; Hoek et al., 2017). In addition, it would appear that some people are turning away from a diet that occasionally includes vegetarian dishes for no other reason than to avoid association, considered by them as stigmatizing, with the practitioners of an exclusionary diet (Hoek et al., 2017).

One way to help boost the consumption of plant-based foods, then, would be to communicate information about the different kinds alongside details of how to use them in a meal (descriptive sheet, nutritional information, recipes, etc.).



The return of plant-based proteins in the diets of developed countries marks a second nutritional transition.

distribution (respecting biodiversity and natural resources, using fewer pesticides, reducing greenhouse gas emissions, etc.). A supply is developing of foods that meet these expectations. Their production employs alternative methods (organic, biodynamic, agro-ecology ...); labels that enable consumers to identify products more respectful of the environment are being created at the national and international levels (European organic label, Marine Stewardship Council, etc.); packaging is being reduced or eliminated (use of deposit-return systems, biodegradable packaging, selling items loose); products that creatively use vegetable proteins are being developed; etc. Largely because of the considerable greenhouse gas emissions generated by the production of ruminant meat, it would appear that cutting consumption of animal proteins, especially meat, is a prerequisite for achieving a more sustainable diet (Joyce et al., 2012; Gerber et al., 2013). Though consumers tend not

to be fully cognizant of the problem (de Boer et al., 2016; Lea et al., 2016), there is a general, if vague, understanding of the nutritional challenges that humanity will have to face during the first half of this century, if only to take account of the expanding global population. This is evidenced by the changes observed in recent years in terms of protein consumption in developed countries (Rous, 2015). Described as a second nutritional transition, this phenomenon is characterized by the return of plant-based proteins and the adoption of one of two models, depending on the country: the model observed in Norway, Denmark, Austria and France, where the rose in plant-based protein consumption is mirrored by a decline in that of animal protein; and the model observed in the United States, Germany, Finland and Sweden, where animal protein intake is maintained while the plant-based protein intake rises. Whatever the model followed, the developed countries are increasing their consumption of plant-based proteins, which requires, on the one hand, increasing the world's (responsible) production of pulses and, on the other, creating desirable food products that utilize plant-based protein so as to match the rising potential demand.





SUSTAINABILITY OF DIETS, NOT LOSING SIGHT OF THE GOAL

There exists a range of methods, drawing on a variety of scientific approaches, by which to calibrate sustainable diets. One is to employ mathematical models to assess the viability of changing the composition of the diet according to a set of constraints, while at the same time minimizing the difference from the original diet. A

second approach is to identify groups of individuals whose diets already have the characteristics of nutritional and environmental sustainability; referred to as the positive deviance approach, this has the merit of helping to minimise the impediments that sociocultural norms pose to changes in dietary behavior. Whatever the approach, there is also an economic aspect to be taken into account, incorporating the dimension of affordability for consumers, so that the new diet is adopted by the greatest number, alongside that of fairness in the remuneration of the people working along the supply chain.

A range of impacts to be taken into account

Most of the studies take as a basic assumption a continued high level of consumption of animal products in developed countries. The reductions envisaged in these countries' levels of meat consumption, in order to arrive at a more sustainable diet, do nevertheless vary from one to another depending on their current eating habits (Vieux et al., 2018). It should also be noted that by focusing on reducing greenhouse gas emissions, many studies neglect the nutritional quality of the diets they construct: a meta-analysis shows that 64% of the studies that sought to address this environmental criterion put forward diets higher in sugar and lower in micronutrients than the original (Payne et al., 2016). It therefore seems important to increase the range of dimensions of sustainability taken into account in developing more sustainable diets in different countries so as not to be diverted from the ultimate objective. Among the criteria that ought to be taken into account, seemingly essential are those of economic and cultural accessibility, nutritional adequacy for the different subgroups of the population, impacts on local agricultural sectors and impacts on water resources.

KEY NUMBER

64%

of the studies on how to reduce greenhouse gas emissions propose diets with higher levels of sugar and lower levels of micronutrients.

Conclusion

Plant-based foods have a particularly important role to play in our diets: fruits, vegetables, roots, tubers, nuts, cereals and pulses, their multiple by-products (including oils), as well as sugar, chocolate, spices, herbs and condiments, algae and most of our favorite drinks (coffee, tea, alcoholic beverages, etc.). This immense variety of sources provides us in turn with a great diversity of flavors, colors and textures, as well as an array of nutritional benefits. That said, it is important to emphasize that the adoption of a plant-based diet does not rule out the consumption of other foods as well.

How has the share of the diet accounted for by plant-based foods modified over recent decades in the regions under review? **In both North America and Europe, it seems that countries have entered a new phase of nutrition transition, in which plant-based foods are gradually taking share from animal sources.** According to the ethnologist Claude Lévi-Strauss, *“For a food to be ingested, it is not enough that it be good to eat; it must also be good to think”*. So, plant-based food has now to become good to think with. This development is recent however. Only in Canada can the transition be said to have commenced before 2013, with a net increase observed in the proportion of plant-based food in the diet when compared to the preceding two generations. This increase is perceptible notably in higher consumption of pulses, encouraged by a particularly dynamic supply chain. The United States and some European countries (among them the Scandinavian countries and France) seem for their part to have begun their shift towards a more plant-based diet during this last decade. The Eastern European countries and Russia, on the other hand, have not yet begun their transition.





In spite of this movement in North America as well as a large part of Europe towards a greater share of plant-based food in the diet, **fruit and vegetable consumption remains insufficient**. While most of the world has seen significant increases in fruit and vegetable intake during the last 50 years, consumption levels in **all the regions studied** are still well below nutritional recommendations. Here again, only Canada is getting close, gradually. Improving awareness of the benefits of these foods – both in terms of nutrition and as a means of making meals more interesting – should therefore be a key priority of nutrition policy, with fruits and vegetables as the principal focuses of the efforts at promotion.

In closing, **It must not be forgotten that many of the societal transformations taking place now in the most prosperous countries appear**, indeed, to be driving this second nutritional transition, alongside a few other determinants specific to individuals.

Among these transformations: the rise of individualism itself, the feminization of society, increasing awareness of health and well-being, the quest for naturalness and a greater concern for animal welfare. Though as yet not greatly developed, awareness of food-related environmental issues is also giving impetus to the increasing importance of plant-based foods. Giving consumers more information about these issues and how to respond to them through their food choices, appears therefore to be an essential aid to accompany this development.

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Monograph
Plant-based diet
A balancing act
October 2019
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