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IN INTERNATIONAL MANAGEMENT  
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**WE ARE WHAT WE EAT**

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ANALYSIS OF THE TRENDS AFFECTING  
FOOD AND DRINK INDUSTRY

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## ABSTRACT

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The food we eat defines us in many ways, forming a part of our identity. First of all, it is inevitably part of our culture. Secondly, it expresses our preferences on taste but also our lifestyle and habits. Food, tastes, and ingredients can change radically according to geographical areas, cultures, religions, availability of raw materials, climate, economic condition, etc., sometimes even within few kilometers, from one region to another, like it occurs very often, for example, in Italy.

The purpose of this thesis is to increase the awareness of the importance of our nutritional habits on our body, on our planet and in the end, on our life. The food industry is a business, like many other businesses in other sectors. The difference, in this case, is that we cannot choose not to eat, as it is a primary need, therefore the target of the food industry is very wide and extended to the whole living population. It is crucial to know what is good and what is bad for us, in which quantities, and the most important point, who is in charge of deciding the right balance.

Starting from a social cause, this thesis wants to deeply analyze the evolution of the food industry, its principal actors, and strategies, legislation and regulations from a general point of view of both customers and operating companies. As a solution, it discusses arguments as the conscious capitalism development and the evaluation of the benefits of substituting proteins deriving from animal meat with insects. For sure at the moment it could create some aversion, like for example it happened when firstly sushi was introduced in Europe during 2000. Nowadays instead, it is seen as the best option of convenience food on the market, with a favorable price/quantity/quality ratio and perceived as a healthier alternative to sandwiches and hamburgers.

Among the most significant environmental advantage of edible insect farming against livestock production are: less water and land required, higher feed conversion efficiencies, lower greenhouse gas emissions, the transformation of low-value organic by-products into high-quality food and feed, and certain insect species can also be used for aqua feed or animal feed. The benefits are more than valuable considering the current disproportional expenditures for meat production. Nowadays meat corresponds to 15% of our total energy intake in the human diet, while it uses more than 80% of the agricultural land for animal grazing or the production of livestock feed and fodder.

## 1. INTRODUCTION

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The food we eat defines us in many ways, forming a part of our identity. First of all, it is inevitably part of our culture, personal or family history. Tastes from childhood can be very nostalgic even after many years. Therefore, some people would never change traditional dishes for anything in the world. Secondly, it expresses our preferences on taste but also our lifestyle and habits. Eating out of home is becoming a viral trend all over the world not just because it is a necessity but because it is a way of spending quality time in different environments.

Food, tastes, and ingredients can change radically according to geographical areas, cultures, religions, availability of raw materials, climate, economic condition, etc., sometimes even within few kilometers, from one region to another, like it occurs very often, for example, in Italy. An outstanding professor (T. Vescovi), teaching Cross-Cultural Marketing at Ca' Foscari University of Venice, suggested that the best way of discovering a new culture is visiting local supermarkets or get invited in a local person's home. During my studies, I had the possibility to travel and most importantly, live like a local, in several European cities (Kaunas, Vienna, Köln, Madrid). These experiences were the drivers of the starting point of this thesis.

As an Economy student, I was always very intrigued to understand the origin of differences in prices, products, mentalities, lifestyles, and societies as a whole, so I decided to start my research from the most common resource – food. After watching some curious and mind opening documentaries (“What the Health”, “Fed Up”, “Rotten”) about the consequences of the food industry on population’s health in the United States of America, I decided to examine more in-depth this topic and compare it to the situation in Europe and the rest of the world.

Fortunately, the European Union has more strict regulations, and consumers are more protected, yet some negative aspects can be observed in Europe as well, like for example the dietary transition we are assisting with increases of meat consumption per person/ year. It has been proved that dietary transition does give birth to new non-communicable diseases (NCDs) or avoidable chronic diseases, and at the bottom of this situation lies colossal confusion and doubt.

This thesis aims at clarifying and explaining how we reached this current situation in the food industry, from the point of view of both firms, intended as economic entities, and consumers, intended as families. The food industry is a business, like many other businesses in other sectors, the difference in this case, is that we cannot choose not to eat, and we have to do it at least three times a day. Therefore, it is crucial to understand what is truly good and/or bad for us, in which quantities, and the most important point, who is officially in charge of deciding the right balance. Nevertheless, in the last period, this topic is becoming more and more popular, as new trends are guiding consumer's demand. Therefore companies operating in this sector will have to inevitably change their strategies to keep their competitive advantage.

## 2. THE HISTORICAL CONTEXT IN THE U.S. FROM THE WWII TO NOWADAYS

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In order to understand how we reached the current situation in our nutrition habits, it is necessary to go a little back in history. After the WWII, many countries involved, as the United States, started expanding the production of every type of products in order to recreate the wealth destructed during the years of war. *Academic Earth*, states in its video “How the end of World War II Made Us Fat”, that there was an economic Boom and a Baby



Boom, and a hungry consumer class driving it. Between 1940 and 1950, US GDP rose from \$ 103 to \$ 300 billion. By 1960 it had reached the level of \$ 543 billion (*K. Amadeo, 2018*).

Americans were experiencing the most substantial expansion in the nation's history according to the report "The U.S. Economy: Key Data". Cars started to be a common commodity for the middle class, reducing our daily amounts of physical activity and the television was present in almost every house. Apart from new inventions that were changing the society lifestyle, postwar technologies and economic changes were giving birth to a whole new kind of diet. WWII left the government with a large quantity of unused ammonium nitrate and poison gases – what became America's fertilizer and pesticides (*Will George F., 2009*).

The role of the woman had an important aspect as well as she started to be part of the working class. There was less time for cooking in the households, and with the mass production revolution, larger quantities and varieties were available. The goal was to create large food surplus, mainly based on corn, and a market for cheap and high-calorie food. Soon supermarkets – the suburb's food hub – stocked their shelves with everything salty, fried or sweet (*M. Crum, 2012*).

In the early 1960s, the average American male weighed 168 pounds while females weighed 142 pounds. What we see today, as a consequence to these factors influencing the nation's diet, is that men weigh nearly 180 pounds while women weight rose to 168,5 pounds (*MD J. Marcin, 2018*). Another alarming result is noted in the percentage of the population classified as overweight. In the early 1970s, 14 % of the U.S. population was classified as medically obese (*D. M. Cutler et al., 2003*). Today, the obesity rates achieved a score of 40%, which means that two out of every five adults are struggling with this disease (*D. Thompson, 2018*).

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## DO AMERICANS OVEREAT?

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From 1970 to the late 1990s, there was an increase of 25% of fat in the food supply. The situation appears to be quite mysterious considering that data from dietary intake surveys are not displaying an increase in its consumption. The trend in fat intake is hard to discern because of inconsistencies in data (*M. Nestle, 2017*). The example of the beverage consumption could explain this situation:

The supply of whole milk fell from 25.5 gallons per capita per year in 1970 to just 8.5 gallons in 1997. The supply of low-fat milk rose from 5.8 to 15.5 gallons during the same period, but the soft drinks' one rose from 24.3 to 53 gallons. To reduce the amount of fat intake, people switched to lower-fat milk. The point is that the beneficial change has been eliminated because of the increase in soft drinks consumption, thus sugar calories with no nutrients (*JJ Putnam et al., 1999*).

As the USDA's serving estimates are based on self-reports of dietary intakes, and people tend to underreport the intake of food considered undesirable and to overestimate the consumption of "healthy" foods, we can deduct that the discrepancy between recommended and actual servings is underestimated. For another, the USDA calculates the number of servings by adding up the individual components of mixed dishes and assigning them to the appropriate "Pyramid Category" (i.e., flour in cookies is assigned to the grain category, potatoes in chips to the vegetable group, apples in pies to the fruit group). This method makes high-calorie, low-nutrient foods appear as better nutritional choices than they may be, like another famous attempt, during the Reagan administration, to count ketchup as a vegetable in the federal school lunch program (*National Food Guide USDA, 1946*).

### 3. THE FOOD INDUSTRY

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Marion Nestle, in her book “Food Politics: How the Food Industry Influences Nutrition and Health” published in 2007, gives a very narrow description about the evolution of the food industry in the United States of America. The following chapters will describe the American food industry following the topics discussed in this book.

In 1900, 40% of the population lived on farms while today's rate is 2%. Starting from the 1960s, the number of farms dropped from 3.2 million to 1.9, but with an average increase in the size of 40% and a productivity higher by 82%. The twentieth-century trends that led from small farms to massive corporations and a society that buys nearly half of its meals prepared and consumed elsewhere created a farm system far more efficient and specialized from the labor-intensive it used to be. Most of the farms today raise just a single commodity, this way they became part of a system of “vertical integration” owned by one corporation. Chickens, in this case, are a perfect example. In the mid-1950s chickens were raised in small flocks by many farmers. Today this business is able to raise massive numbers in the factory-farms, under contract to a few large companies (*Beale C.L. et al., 2000*).

To keep the pace with the economic development, food and beverage companies had to expand enormously in size. In 2000, among the top 10 largest food companies in the world – seven were American (Philip Morris, ConAgra, Mars, IBP, Sara Lee, Heinz, and Tyson Foods. In the first position was Nestlé (Switzerland), Unilever (UK/Netherlands) third, and Danone (France) sixth. Other well-known U.S. companies like Coca-Cola, McDonald's, PepsiCo, P&G, and Roche were all ranked amount the top one hundred companies, with Philip Morris (Kraft Foods, Miller Brewing), ConAgra, and RJR-Nabisco accounted for almost 20% of all food expenditures.

Food industry (and consequently health) is affected as well by the increasing trend of consumption of food outside households due to the changing society lifestyle. Sandwich houses and fast-food chains are the most popular and highest-selling options. McDonald's, the pioneer in this field, announced (as of January 2018) to have more than 36.000 restaurants in 101 countries, serving 69 million people every day (*ThoughtCo, 2018*) [Table 1]. The drivers of the competitive advantage (greater efficiency, specialization, size, etc.) have led to the most unspoken secret about the American food system: overabundance. There is an excess of calories per capita supplied on the market that creates two uncomfortable situations: it stimulates overconsumption and increases competition.

The U.S. food supply (extracting exports and adding imports) provides a daily average of 3900 calories per person. This quantity is 1/3 more than that needed by most men, almost double with respect to women and much higher than that needed by babies, young children, and the sedentary elderly. It is clear that even people who overindulge cannot consume an infinite quantity of food, therefore at a certain point there must be a choice, thus reject others. From the food companies' point of view, this means an intense rivalry and a very well-studied strategy needed, i.e., creation of sales-friendly regulatory and political climate. The next paragraph will describe in details the marketing tools used by the big food producers to sell their goods.

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### MARKETING IMPERATIVES

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To understand consumers' behavior, why people chose to eat one food rather than another, we must analyze social and economic contexts and the cultural environment we live in. The possibility of choice is lower when food or money is scarce. The greatest irony of nutrition is that traditional plant-based diets, consumed by the poor people in many countries, are ideally suitable to meet all our nutritional needs, as long as the caloric limit is not

exceeded. When people become better off, they tend to enter a “nutrition transition,” as the possibility of choice becomes greater. Therefore, the traditional plant-based diet is abandoned in favor of a higher consumption of meat, fat, and processed food. The result is a drastic increase in obesity and related chronic diseases. Once people have access to meat, they usually become resilient to return to eat plant-based diets unless forced to do so for reasons like religion, the culture of health or is the worst case, because of a decreasing economic possibility.

Sales in the food industry are driven by consumer demand, therefore when food supply is broad and economically affordable basic biological needs switch places with personal preference that becomes the principal determinant. Food companies will imply significant effort to understand what the final consumer “wants” and how to meet his “needs.” Marketing imperatives are related to four factors: taste, cost, convenience, and public confusion.

#### **TASTE: MAKE FOODS SWEET, FAT AND SALTY**

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Preferences in food are highly personal, influenced by family and ethnic background, level of education, income, age, and gender. Flavor, smell, sight, and texture are the main criteria when we have to pick what we want to eat. It is also true that most of us opt for “energy-dense” foods that are high in calories, fat, and sugar. The reason behind this is that sugar, salt, and fat stimulates our neurons through our taste buds in the tongue. The neurons in our brain are part of the "opioid" circuitry or endorphins. When we eat highly palatable foods, they enable the body to perceive a highly rewarding experience, that tends to be reinforcing, thus makes us want to go back for more.

The food industry employs specialized “flavorists” whose primary job is to get the right mix of these attributes (*Seema C., 2016*). Whether a taste for

meat is innate or acquired can be debated, states Mrs. Marion in her book, but many people like to eat steak, hamburgers, and fried chicken, along with desserts, soft drinks, and salty snacks. These preferences are the drivers for new product developments as well as the creation of menus in the restaurants.



How have the farm and marketing shares changed over time?



**FIGURE 1:** *The distribution of the U.S. food dollar 2016: 85,2% of food expenditures go to categories other than the “farm value”. Source: USDA Economic Research Service.*

### COST: ADD VALUE BUT KEEP PRICES LOW

Another consequence of the overabundance is the attempt of adding value to foods through processing. The producers of raw foods receive only a fraction of the final price the consumer pays at the supermarket. For example,

eggs producers, beef, and chicken receive 50-60% of retail cost, whereas vegetables producers' share is as little as 5%.

As shown in [Figure 1], in 2016, farm value was equivalent to just 14,8% with respect to what the consumer pays. The marketing activities include labor, packaging, transportation, energy, profits, advertising, and all post-farm activities that culminate in final market food dollar sales. They are accountable for 85,2% of the total costs. The proportion is even bigger in food consumed away from home (95,6%) [Figure 2].

The transformation of potatoes (cheap) into chips (expensive) is a thoroughgoing example of how value added is created through processing. In the case of the very popular Kellogg's Corn Flakes, the cost of corn is as low as 10% of the retail price (*Canning P., 2011*). It becomes evident that companies seeking high profits are more likely to focus on the development of added-value products rather than fresh fruits and vegetables that have limited opportunity for increased value. Marketers can increase consumer's willingness to pay for fruits and vegetables by selling them frozen, canned, precooked or precut but this procedure increases consumer's concerns about safety, freshness, and price. Overabundance, as already mentioned, stimulates competition. Thus companies will maximize efficiency and reduce costs to gain an advantage on price.

### CONVENIENCE: MAKE EATING FAST

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As many people began to work more extended hours due to higher demand for flexibility in the labor market, the structure of American families changed as well. Women left the role of the housewife beginning to work, so often they do not have the time or willingness to spend it on grocery shopping, cooking, and cleaning up (*Zizza C. et al., 2001*). Supermarket "home meal replacement," prepackaged cereal in a bowl, salad bars, power bars, take-out

chicken are already trendy products among people who stay out of the home the entire day.

These types of products were introduced on the market on the base of consumers' need in the nowadays society. Convenience adds value to foods and stimulates food industry to create even more products that require minimal preparation and can be consumed promptly.

### CONFUSION: KEEP THE PUBLIC PUZZLED

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Newspaper sales and research grants may benefit from confusion over dietary advice, but the highest profit, achieved through public confusion, goes to the food industry. Research on the effects of single nutrients is more likely to be funded, and the results are extremely exciting, even more, if in conflict with previous studies. Every food and beverage product is represented by a trade association or public relation firm whose goal is the promotion of a positive image of a particular item among consumers, professionals, and the media. If people are confused about nutrition, they will be more likely to trust and accept such claims at face value.

Food and food service companies are spending more than \$ 11 billion on direct media advertising every year. Just 2,2% of it is for fruits, vegetables, grains and beans, and more than 70% dedicated to convenience food, snacks, alcoholic beverages, candies, desserts and soft drinks (*Yehuda S. et al., 2007*). Such advertising has implications for health outcomes over the life course into adulthood especially contributing to the creation of new dietary habits.

### 4. U.S. AND EU CONSUMPTION COMPARISONS

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After the initial framework on the marketing imperatives used nowadays in the food and drink industry, this paper would like to analyze not only differences but also similarities occurring among U.S. and EU. In doing



so, we will use The Agriculture and Trade Report from 2004 that evaluates the changing trends between the European and American food and agricultural sectors.

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### PRICES, EXPENDITURES, AND INCOME

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Available products vary within the U.S. from region to region and are different also with respect to the European ones. Quality might be one of the elements capturing price differences. For sure food prices vary not only between the United States and the EU, but there is a remarkable variation within the two continents. A quantity of bread and cereals items that cost \$100 in the United States would cost \$156 in Denmark, but only \$85 in Portugal, and only \$40 in the Czech Republic. The price for meat is on average higher in the EU, but lower in the Eastern European countries. A quantity of meat costing \$100 in the United States would cost \$210 in Denmark, but would only cost \$73 in Hungary or Poland.

The price for a balanced basket of food representing the consumption of an average consumer could vary as much as \$ 65 in the UK and \$109 in Denmark (*Lennernas M. et al., 1997*). The situation is reflected identically in the U.S. where a basket of groceries in Manhattan would cost \$141.50 while in Houston \$93.30, a difference of 52% (*ACCRA, 1999*). In [Figure 3], there are illustrated more recent data on the food expenditures per capita across selected countries, as published by the United States Department for Agriculture (USDA) on food consumed at home in 2016.

From the map illustrated in [Figure 4], we can have a visual representation of how much the average consumer spends on food consumed across some selected countries. Nigeria, Cameron, Kazakhstan, Philipines, and Pakistan spent at least 40% of their total expenditure on food in 2016. In developed countries in Europe, the average was around 15% during the same year. Eastern European countries instead, represent a higher percentage up

to 30% in Romania and Russia. On the other hand, Canada's rate was 9%, Australia 10%, while in the U.S. people spent only 6% of their expenditures on food consumed at home. These figures do not take into consideration alcoholic beverages and tobacco.

According to a study conducted by Lipsey and Swedenborg (1993), the factors that most contribute to the change in food prices are the difference in income, taxation on food, and protection of agriculture from international competition. The results of the study suggest that income might explain the difference in prices among many countries, while agricultural protection, consumption taxes, and wage structures could partially explain why food prices are lower in the U.S. with respect to EU countries with comparable income.

Engel's Law states that income share of food expenditure falls, as income rise, since consumers do not tend to increase their food intake drastically. In fact, these are the patterns observed both in the United States and in the European countries in the last years, as food expenditure as a share of income is falling and food prices fall relative to other goods. Consumers in the EU can be expected to be more price sensitive as a change in food prices would have a more significant impact on countries where food is a more significant share of the budget.

The FAO Food Price Index (FPI) is a measure of the international prices of food (e.g., between suppliers or nations), while the food consumer price index (CPI) is a measure of the price of food to the actual consumer (Roser M., Ritchie H., 2018). Increases in the FPI translate into higher consumer prices only to a very limited degree and with a time lag of a few months. The lag in transmission from international prices (as captured by the FPI) to consumer prices (food CPI) is explained, in large measure, by the time needed to harvest, ship and then process primary products into final food

items for consumers. The limited transmission is explained by a combination of factors that determine vertical price transmission in every food economy, including mark-ups for transportation, processing and marketing, and by any subsidies at the consumer level.

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### PATTERNS OF FOOD AVAILABILITY AND CONSUMPTION

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While the Mediterranean, far Northern European and Eastern European countries all have distinct dietary behaviors, in the U.S. we can observe a substantially higher consumption of few key commodities. The "Mediterranean Diet," which includes consumption of grains, fruits, and vegetables, olive oil, cheese, yogurt, and fish, has been recognized by many nutritionists as helpful to reduce heart diseases.

Although food availability is not entirely uniform, southern European countries (Greece, Italy, Spain, and Portugal) show a higher availability of fruits and vegetables. Furthermore, Portugal and Spain are rich in fish, while Greece and Italy show more cereal and fruits availability compared to the European average. In Italy, Greece, and Spain there are greater vegetable oils resources, probably due to higher olive oil consumption.

Sweden and Finland, two of the Far Northern European countries, have a diet with high proportions of calories from animal fat, milk, dairy, and sugar. Traditionally, Scandinavian countries have not had the land or the necessary climate to grow vegetables. Therefore, traditional diets include fewer of these products as the relative prices are higher due to transport expenditures. The United States has markedly more meat, sugar, and sweetener availability than the European counterpart. Due to the low prices of meat, relative to the price of other foods, beef and poultry consumption is higher.

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## DEMOGRAPHIC TRENDS

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Socio-demographic phenomena, such as the emergence of single person households and the aging population, are the main societal changes nowadays. It is inevitable that these changes will affect consumers' drink and food preferences and represent new opportunities for innovation in this sector.

The global pattern of the world growing population masks heterogeneity across countries. Population growth has had different rates at different points in time in each country. In [Figure 5] we can observe total population in some selected countries from 1700 to 2016. Earth's population reached a level of 7.3 billion in the mid-2015 and is steadily rising. In high-income countries, we can observe a notably slower rate.

In Europe for example, the population growth rate had decreased, while in other regions like USA, Canada, Brazil and Australia, it has been increasing in the past decade [Figure 5 and 6]. It is also true that in high-income regions like USA, Europe, and Japan, the share of seniors is increasing as well (*ECSIP Report, 2016*). For example, in 2012, Europeans older than 65 were accounted for 17.9% of the population. For 2030, it is estimated to reach a level of 23.5% (*Eurostat, 2014*).

Another important criterion that shouldn't be undervalued, is urbanization that increases the role of supermarkets in food sales and shifts employees from the agriculture sector to food processing, wholesaling, retailing, transport, and vending.

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## EMERGING TRENDS IN EUROPEAN FOOD, DIETS, AND FOOD INDUSTRY

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As income increases, consumers' attention shifts from having enough food to the quality of food they eat. Consumers in industrialized nations, in

fact, are becoming more concerned about food safety (pathogens and disease risks) and the production methods of the final product, particularly the consequences on animal welfare and the environment.

Changes in income and prices could potentially disrupt the correct balancing of the diet (*Santeramo F.G., Shamnam N., 2015*). This has been particularly noted during the recent economic crises when price volatility was high and global trade was strongly affected influencing global production and availability of food. Studies have shown the causality relationship between dietary patterns and lifestyle habits versus chronic illnesses (*Jacques P.F., Tucker K.L, 2001*). The increasing usage of functional foods, the emergence of nanotechnologies and development of novel foods industries are the latest trends at the moment as to the innovation in this sector (*Santeramo F.G. et al., 2017*).

Growing consumer's interest in ready to eat food (*Artés F. et al., 2009*) is one of the main reasons of the growth of fruits and vegetable market along with the growing demand for higher safety standards (*James J. B. et al., 2010*). Another reason, of course, are the positive effects of fruits and vegetable consumption on human health as it consumption help to reduce overweight problems and cardiovascular diseases. Fresh-cut products, since its origin in the early 1980's, are the most critical innovation in the industry with a double digits market growth. Ready to eat consumers' preferences are important also because of perception of food safety. Labeling information, nutritional facts readable and safety descriptions strongly affect food choice.

The other variables include country of origin, product familiarity, and materials adopted for the packaging. Consumption trends are evolving rapidly, along with them the importance of sensorial attributes that is likely to become relevant in orienting consumer's choices in the near future. Future opportunities for producers are based on the high segmentation of the market

with differentiation strategies that may be implemented to meet public interest toward environmental efficiency, the impact of carbon footprint, animal welfare, environmental efficiency, and healthiness. Below there are explained the latest innovation trends in the food industry:

### FUNCTIONAL FOODS

A recent report (Research and Markets, 2014) assesses the value of the global market for functional foods as to \$168 billion for 2013 and a forecast of more than \$300 billion for 2020. However, the development of new functional foods is quite risky due to a very high level of failure driven by technical feasibility (*Bleiel J., 2010*) and not by the potential acceptance among consumers (*Van Kleef E. et al., 2005*).

### NOVEL FOOD

Besides the very high failure rate, estimated around 70-80%, the food market is noticing a considerable increase in the number of new foods. The rejection towards new or unfamiliar products is recognized as a well-known phenomenon called neophobia when individuals tend to avoid new foods due to three main reasons: aversion, danger, and disgust. The willingness to try an unfamiliar product depends strongly on the nature of food and the available information (*Nordin S. et al., 2004*). Socio-demographic variables as age, gender, and place of residence also play an essential role. In fact, younger people living in urban centers have lower interest in traditional food.

“Novel food” is defined by the European Union Regulation as food or food ingredients that were not used for human consumption to a significant degree within the EU before 15 May 1997 (EU Regulation, 1997). It includes:

a) food and food ingredients with a new or intentionally modified primary molecular structure;

b) foods and food ingredients consisting of or isolated from microorganisms, fungi or algae;

c) foods and food ingredients consisting of or isolated from plants and food ingredients isolated from animals, except for foods and food ingredients obtained by traditional propagating or breeding practices with a history of safe use;

d) foods and food ingredients to which a production process not currently used has been applied, where the process gives rise to significant changes in the composition or the structure the foods or food ingredients which affect their nutritional value, metabolism or level of undesirable substances.

As a consequence of the new EU regulations, in the last few years, the interest in novel food from insects has been growing. Edible insects are attracting many interests also because of nutritional and environmental advantages as they contain low fatty acids, are rich in Omega 3 and are highly digestible. In addition, good environmental benefits can be obtained from the production of insect-based food, due to lower requirements of space and water and the better biomass conversion rate (*Van Huis A. et al., 2013*).

## NANOTECHNOLOGIES

Thanks to already developed engineered nanoparticles for the food sector, important benefits have been encountered, like increased absorption of nutrients, extended product shelf-life, sensory improvements, safety and quality monitoring (*Dasgupta N. et al., 2015*). There are two main categories of application: “nano-inside” – incorporated into the food product, and “nano-outside” - applications when nanoparticles are incorporated into the food contact materials like the packaging.

The problem when dealing with this issue is a lack of universal guidelines developed for the safety and environmental assessment of

nanotechnology. At the moment, neither in EU, USA nor elsewhere are present specific regulations on nanotechnology food application. A better knowledge of nanotechnologies, positive attitude toward novelty and higher social trust tend to reduce consumers' perceived risk and increase the acceptance of the benefits. Furthermore, consumers' acceptance varies among different applications, notably higher for "nano-outside" applications as associated with the minor hazard.

## 5. THE EUROPEAN DIETARY TRANSITION

The mix of less physical activity, a non-balanced mix of nutritional elements intake and increase in obesity rates are the trends that have been linked to the rise in the chronic diseases in the last decades. Indicators are strong. Therefore more research should be done to guide politicians and policymakers. Economic change can strongly influence health, unfortunately not always for the better. Equally, diseases have substantial implications for economic performance and inequality: HIV/ AIDS in Africa has reduced regional GDP by as much as 30%, while the costs of BSE (the mad cow disease) in Europe, was estimated for € 40 billion (*Rayner G., Rayner M., 2003*).

In 2001, non-communicable diseases (NCDs), or “lifestyle diseases” accounted for approximately 60% of the 56.5 million of total deaths and 46% of the global burden of disease, increasing to 57% by 2020 (*Murray C.J.L., Lopez A.D., 1996*). Chronic diseases (i.e., cardiovascular disease CVC and diabetes) are usually associated with older age groups, but recent studies are showing an increase also among young generations. The impact on the environment, health, and social inequalities, due to remarkable changes in the European food system, is readily observable nowadays. It can be seen as a medal with two sides: one of economic efficiency and technological



innovation and the other of environmental and social progress (sustainable development).

The **environment** is for sure frontline number one in the “food wars.” The shift in demand from local and seasonal toward imported, non-seasonal fruits and vegetables is corresponding to an increase in energy needs due to transportation, cooling and freezing inputs (*Rayner G. et al., 2008*). For processed foods, besides the more energy needed, there is the question of material input and the associated packaging waste. Improvements in technical efficiency are paid in environmental costs, with greater use of trucks to source foods to supermarkets.

Social responsibility is taking an emphasis in consumers' behavior as several indicators are demonstrating this development: growing sales of organic food sales in western countries, alternative channels of distribution, socially responsible action taken by major retailers, and also manufacturers actively introducing CSR into their daily business (*Krystallis A. et al., 2011*).

The second frontline is **cultural**: consciousness and impact on European food traditions. A study across 15 European countries has suggested three core attributes that guide Europeans in the selection of food products (*Debomy D., 2016*):

- Food as a source of pleasure and sensations (taste, sight, smell, origin, the trustworthiness of producer/retailer, etc.;
- Food as a matter of price, convenience or ease of use (functional approach);
- Food as a consideration for health (dietetic approach).

The listed approaches are a result of 3 features: societal (food cultures), demographic (gender, ethnicity, social class) and economic (level of available income). In countries with strong culinary traditions, i.e., Italy, Spain, Greece, France, Germany, the sensation/pleasure criteria appear more

marked. The dietetic approach is more pronounced in Northern Europe – UK, Sweden, and Ireland, particularly among women, while the price criterion has more weight in lower-middle social groups as well as in Eastern European countries.

Dietary transition and convergence of nutritional habits are being shaped by trade, urbanization, common food marketing campaigns, foreign direct investment, improved transport infrastructure, and the dominance of supermarkets in the food supply chain. The availability of an extremely wide choice of products from all around the world is causing fast changes in food cultures.

The third frontline is **health**. In 2002, WHO and FAO, aware of the problems linked to the post-World War II model of agriculture and health, organized a three days meeting in Geneva. The consultation between the two organizations gave birth to a report, published in 2003, titled "Diet, Nutrition and the Prevention of Chronic Diseases" that examines the science base of the relationship between diet and physical activity patterns, and the major nutrition-related chronic diseases.

The report indicates population nutritional intake and physical activity goals to reduce the risk of nutrition-related illness: obesity, diabetes, cardiovascular disease, several forms of cancer osteoporosis and dental disease (*WHO, 2018*). Food's role in health is the main driver of the WHO's Global Strategy on Diet, Physical Activity and Health (DPAS) ratified by the World Health Assembly in 2004 [Figure 7]. Consumer awareness of the correlation between food consumption and health continues to rise as more information is available. As pointed out in the initial part, the biggest problem is the chaos and doubt among consumers which is exploited by the food manufacturers for their advantage.

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## INNOVATION AND DISTRIBUTION INNOVATION

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Research and innovation are the key drivers of growth and innovative ideas according to the Europe 2020 strategy. In fact, one of the five targets is that 3% of the EU's GDP should be invested in R&D.

It must be said that investments in the food and drink manufacturing sector increased at a pace similar to other industrial sectors. This is due to R&D investments mainly sustained by the world's leading food and drink companies [Figure 8]. For example, Unilever invested over a €1 bn in 2013 in R&D, equivalent to 2.1% of the firm's turnover (*IRI, 2014*).

Factors influencing the innovation process differ from sector to sector and include the rate of technological change, organizational structures and institutional factors, and linkages and access to knowledge (*Hockmann H. et al., 2014*). According to the European Commission study from 2014 (*FoodDrinkEurope, 2014*) on the economic impact of modern retail on choice and innovation in the EU, the most innovative food sectors in 2013 and 2014 were the dairy, soft drinks, and ready-made meals. New packaging innovations represented nearly 30% of total innovations in 2012, compared to the 6% in 2004. As to this issue, innovation was particularly strong for cereals, baby food, and starters/pizzas.

According to another study, conducted by FoodDrinkEurope in 2014, consumers' expectations about a product can be identified into five axes: pleasure, health, physical, convenience, and ethics. Pleasure represents the leading axes accountable for 57% of the share. Given the linkages between innovation and consumers preferences, the industry's ability to respond to changing consumers' preferences is crucial to pioneer in innovation. Consumer preferences were at the base of innovation, but the industry has undergone specialization to adapt to specific target groups on the basis of

population, religion, social or environmentally sustainable preferences (halal, organic, healthy, etc.).

Regarding distribution, digitalization is another important driver lagging behind e-commerce. Digital communication technology advances allow for more direct communication with customers. An example is a trend towards "the individualization of products," which developed through the increasing use of social media. Current elements of the nowadays society highlight the need for the supply chain to evolve.

Stakeholders consider that digitalization has strengthened competition in retail and wholesale sectors as operation and interaction with consumers has changed, increasing opportunities for both manufacturers and consumers. Online labeling, the upcoming trend to provide additional information to consumers via smartphones, should help in making informed choices. EU Regulation 1169/2011 encourages this attitude by fostering a broad definition of food information and by encouraging the presentation of such information by other means than labels and packaging (*Regulation EU No 1169/2011*).

#### CASE STUDY: WHY AMAZON IS THE WORLD'S MOST INNOVATIVE COMPANY OF 2017

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Illuminating "garage ideas" from 20 years ago are radically changing the world nowadays. Another good example, besides Steve Job's iPhone, is the Amazon case. That small start-up at that time was able to decimate industry's standard for shipping speeds at all e-commerce companies. The created ecosystem that at a very reasonable fee, is able to provide enough value for customers, to prefer Amazon as the starting point for almost 1 every 3 purchases online in the U.S. Behind this service there are more than 45.000 robots distributing goods and collecting data for the most prominent cloud

compounding service in the world that owns roughly 30% of the entire market (*Senn A., 2017*).

One of the best features to make Amazon a success was their “Recommendation Engine” thus automatically recommending products after a purchase. The critical point was to start accumulating data right from the beginning to make sense of it over time. Carrying the entire purchase history from one customer’s lifetime is inestimably valuable to anticipate their next moves. This is the reason why it is wrong to see Amazon as merely a gigantic retail company. Their business is entirely focused on technology so far as it enhances the customer’s experience.

The most aggressive moves from Amazon in the next future concerns futuristic drones and distribution hubs they plan to use to even more increase the delivery speed around the world. Tye Michael Brady, chief technologist at Amazon Robotic, and Ethan Zane Evans, Amazon’s vice president for Twitch Prime, commerce and developer success, are the creators of the new Autonomous Ground Vehicle (AGV) that is able to transport parcels from delivery trucks and place them either at your front door or inside homes.

The firm’s plans were published as part of Amazon’s patent application at the U.S. Patent and Trademark Office in January 2018. The robot may have a touch-screen, a keypad, and a biometric scanner so that recipients of packages are able to confirm their identity. It also outlines systems to open barriers, such as doors, to gain access to properties, garages, delivery lockers and other outbuildings (*Borkhataria C., 2018*). It looks similar to a robot developed by Starship Technologies which has been already tested in 100 cities, encountering 12 million people so far. Other inventors of this type of robots are ThyssenKrupp Elevator, Nuro, Marble and Uriah Baalke (*Olson P., 2018*) which indicates that competition for this type of service is already boiling.

Regarding another recent Amazon acquisition, since 8th of February 2018, Amazon Prime members in certain states could get Whole Foods groceries delivered to their households in just two hours. The latest cities to get this service include Denver, Sacramento, San Diego and California (*Chan L., 2018*). Any purchase over \$35 can now be delivered free of charge in no more than 120 minutes, which sounds merely incredible from the consumer's perspective. If you are really in a rush, you can get your groceries delivered by Amazon in under 60 minutes, for just an additional \$8.

The debate on the strategic acquisition of Whole Foods by Amazon is still open, and the most likely explanation is that Amazon would like to expand its grocery business by exploiting its core e-commerce in this category. Looking at the market today, online grocery delivery service is more popular in Europe than in the U.S. but still has not taken hold, states professor Ralf W. Seifert (*Ralf W. Seifert, 2017*). In his article, he informs that online grocery spending accounts for about 6-7% of the UK grocery market, 5% in France and the U.S., and is less than 2% everywhere else. Developing markets are showing the highest potential as 37% of shoppers in Asia Pacific claimed to have ordered online groceries, compared to 13% in Europe.

The idea behind Amazon's program is that instead of stocking Whole Foods groceries in a warehouse and start Prime Now deliveries from there, the new program uses a Whole Foods store as a depot. Whole Foods' private-label brand, 365 Everyday Value, is already available on Prime Now delivery. It includes the vast majority of things people buy most frequently like fresh produce, seafood, meat, baked goods, flowers and dairy products. According to a 2017 Morgan Stanley survey, 48% of people using Prime Now were ordering groceries items with it – more than they were ordering more traditional e-commerce offerings. The survey was done before the Whole

Foods acquisition's close, and before its products were put on Amazon, so it is possible that adoption has increased even more (*Green D., 2018*).

Amazon's interest in grocery products aligns with the idea of the importance food industry is gaining nowadays. All the discussed trends affecting this sector could not be irrelevant to the huge online retailer in question as this strategy could allow Amazon to exploit early entrant's advantages over its competitors. Serving existing Prime customers at Whole Foods represents an omnichannel combination of online and instore goods, where customers can pick-up their entire Amazon order (food, books, and everything else at once) at their local Whole Foods store.

The synergies with Amazon's technology give the opportunity to Prime members to enter in a new Whole Foods benefit program, offer the option to pay for groceries using the Amazon app, or sync the Alex-made grocery list with your app while in-store, says Brent Franson, CEO of retail analytics firm Euclid Analytics. The Whole Foods supply chain, however, is far from monolithic. It sources many of its perishable and specialty products from a web of suppliers, a business Amazon would likely be able to reinvent – but possibly at the cost of what makes those particular products unique for customers (*Bloomberg J., 2017*).

As noticed from [Figure 9], Amazon is leading the chart of monthly visitors with 197 millions of users – a figure far from the second competitor Walmart with 127 millions of users in the same period (*Amazon – Statistics and facts, 2018*). When looking at the revenues generated by segments, Amazon's online stores generated a net revenue of \$108.35 billion in 2017 alone. Retail and third-party services were accountable for a net revenue of \$31.88 billion while AWS (Amazon's cloud compounding services) made \$17.46 billion. In 2017 physical stores were introduced, and generated \$5.8

billion. All the segments are showing an increasing trend over the past four years.

## 6. REGULATORY AND OTHER FRAMEWORK CONDITIONS

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Legislation concerning food innovation, food safety, and trade is as well a driver of change in the food and drink industry. For many companies, especially SMEs, it may constitute a burden. In 2002, The General Food Law (GFL - *EC Regulation Nr.178/2002*) was officially enacted to protect human life and health, taking into consideration also its consequences on animal health and welfare, plant health and environment (*Van der Meulen B.M.J., 2013*). Besides establishing the fundamental principles, requirements objectives and definitions, it also set up the European Food Safety Authority (EFSA) which is the independent agency responsible for scientific advice. The General Food Law is responsible for all food safety measures taken at EU and national level.

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### FOOD SAFETY

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To legalize a food product or ingredients (i.e., food additives, food enzymes and flavorings – also called “food improvement agents”) (*EC Regulation Nr. 1331/2008 to 1334/2008*), a company must apply for an authorization which must meet EFSA safety criteria. EU legislation, adopted after GFL, introduced rules on hygiene (HACCP) and set up pre-approval procedures in order to obtain the ease the authorization procedure at the EU level.

It has been noticed that many countries, particularly in Asia, are copying the European regulations and requirements for food safety. Labeling and traceability systems are improving consumer's confidence in specific products, favoring a positive perception of EU products in the domestic



market and abroad. It is also true that the increase in food safety regulation has increased responsibility for retailers as it is the retailer that is liable if the food products that it sells does not comply with the regulation. This situation created significant cost strains on retailers, especially the small ones, and as a direct consequence, stimulated the vertical integration of the supply chain.

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### WORLD HEALTH ORGANIZATION AND GLOBAL DIET PRIORITIES

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The World Health Organization (WHO) has been a leader in the field of global diet patterns. In the last years, the growing burden on NCDs, both in developed and non-developed countries and the unsustainability of the associated health costs, had driven WHO to take a position of multi-sector action instead of a position of advocacy. In fact, in the WHO's 2014-2019 General Program of Work, NCDs are one of the six leadership priorities (*WHO, 2014*). This argument is present as well in the 2013 Global Action Plan for the Prevention and Control of NCDs 2013-2020 (*WHO, 2012*).

As a potential solution, taxes on high in fat, sugar or salt foods (including non-alcoholic beverages) were introduced both within the EU and globally (i.e., Denmark, Finland, France, and Hungary). Such taxes are generally passed through to consumers with the increase in price being associated with a decline in average consumption of the taxed product (*Ecorys EC, 2014*). However, such taxes may not always have health-related considerations as the primary goal. The Ministry of Finance in France, for example, admitted that the soft drink tax was secondary to the need to raise income for the state.

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## FOOD INFORMATION TO CONSUMERS

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The Commission of the European Communities published in 2007 a white paper on a strategy for Europe on Nutrition, Overweight and Obesity related health issues (*Commission of the European Communities, 2007*). The strategy aims to stimulate better-informed customers, making the healthy option available, and encouraging physical activity through partnerships for action at European level and local networks.

The European Parliament approved the Directive 2000/13/EC with the intent of helping the consumer to make a choice in full knowledge of the exact nature and characteristics of the product. However, the Directive did not offer a complete list of the compulsory indicators that had to be included. This means the Member States adopted different national legislation, based on their interpretations, which led to a fragmentation of the requirements across Europe.

To face this situation, Regulation 1169/2011 on the Provision of Food Information to consumers was adopted by the European Parliament and Council. The regulation entered into force in 2011 and is effective since 13 December 2014 (*ECSIP Consortium, 2016*). The regulation aims to simplify and modernize the rules to ensure easier compliance and greater clarity for stakeholders by reducing administrative burden. Among other measures, it introduces a minimum font size and rules on nutrition labeling, as well as mandatory labeling of the country of origin or place of provenance in order to enable consumers to make informed choices.

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## INDUSTRY SELF-AND CO-REGULATION

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Besides the formal legislation, some representatives of the food and drink industry undertook co- and self-regulation initiatives. The developed and implemented responsible advertising rules are especially directed

towards children and voluntary commitments in partnership with different groups of stakeholders linked by nutrition and healthy diets. The retail sector has a crucial role as it stands right in between consumers on the one side and, on the other side the entire food supply chain. It can influence both sides, like the case of the German supermarket chain deciding to no longer sell products containing glyphosate, due to take effect later this year.

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### COMMON AGRICULTURAL POLICY (CAP)

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Europe's Common Agricultural Policy was introduced in 1962, and it represents one of the oldest policies of the European Union. The CAP was created to enable Europe to become self-sufficient in terms of food supply, productivity improvement, and market stabilization (*European Commission, 2015*). During the 1970s and 1980s, CAP led to a circumstance of over-production which was later translated in huge costs of both export subsidies and the purchase, storage, and disposal of food surpluses (*Hockmann H. et al., 2013*).

In 1992, a reform was introduced that extended the CAP's goal beyond food security with the addition of competitiveness as a key objective. The 'MacSharry' reform - named after the then-Commissioner in charge - started the shift from product support (through prices) to producer support (through income support, direct payments). Supply controls began to be implemented, and measures with a focus on price cuts, budget stabilization, and surplus reduction were formalized by the reform.

In 2003, the second most important reform was introduced, that consolidated the shift to income support by the introduction of a single payment scheme not linked to production of any particular product ('decoupled') and introduced the 'cross-compliance' concept, linking payments to respect of food safety, environmental protection and animal health and

welfare standards. With The Agenda 2000 and the 2003 reform, the focus was further extended to areas such as sustainability and cohesion goals (*EC website, 2018*).

Finally, the 2013 reform underpinned producer support, integrating a more land-based approach and sustainable agriculture with “green” direct payments. In order to improve the competitiveness and sustainability of the European agricultural sector, market mechanisms were adopted like abolished production constraints (milk and sugar quotas), as well as abolishment and modernization of some commodity schemes.

## 7. SUSTAINABLE DIETS: THE INTERACTION BETWEEN FOOD INDUSTRY, NUTRITION, HEALTH AND ENVIRONMENT

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World Food Programme established in 2014 that the earth has the capacity of feeding the entire global population of seven billion people (*World Food Programme, 2014*). Although, FAO-IFAD and WFP (2013) declared that one in eight people in the world is suffering from chronic hunger, thus not getting enough food regularly to conduct an active life. With the growing population that is expected to reach nine billion by 2050, the challenge of providing sufficient, safe and nutritious food is daunting. Processed foods have low nutrient density and this cause micronutrient and fiber deficiencies in the human body (*Monteiro C.A., 2009*).

Food processors and manufacturers have a critical role in the supply chain with regard to designing products that are integrated into sustainable diets (Martindale et al., 2014). Even if recent research shows that public interest in sustainability has increased, more action is needed. “Sustainable diet” is a notion firstly proposed during the early 1980s, and is defined as “those diets with low environmental impacts which contribute to food and nutrition security and a healthy life for present and future generations.”

Sustainable diets are protective and respectful of biodiversity and ecosystems, accessible, economically fair and affordable, culturally acceptable, nutritionally adequate, healthy and safe while optimizing natural and human resources (*FAO, 2012*). As shown in [Figure 10], the environment is just one of the components of the sustainability concepts.

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## FOOD INDUSTRY AND THE ENVIRONMENT

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Food and drink industry is accountable for 20-30% of the various environmental impacts, including the full food production and distribution chain “from farm to fork” (*EC Joint Research Centre, 2006*). The most common environmental issue related to the sector are related to food processing loss, logistic management, food wastage and packaging, energy consumption, water consumption, and waste management (*Roy P. et al., 2014*).

Food waste is related to losses occurring at the end of the food chain, thus depend on retailers’ and consumers’ behavior. The results emerging from a 2011 study (*Gustavsson et al., 2011*) suggest that around one-third of food produced for human consumption is lost or wasted globally, corresponding to 1.3 billion tons per year. Packaging could be part of the solution to combat food waste as it could prevent food from being spoiled or damaged, but from the other side, it contributes to environmental pollution.

Energy cost in the food industry is ranked third, behind raw materials and labor. The food and drink processing industry is the fifth highest industrial energy user in the US, fourth in the UK (*Wang L., 2014*). The two main types of used energy are fuels (coal, natural coal, and petroleum oil) and electricity. As mentioned earlier, meat and dairy processing sectors need high energy consumption, with a requirement of 4-40 times the energy to produce than they provide in nutrition when eaten, mainly because of the consumed feed by animals.

The food and drink industry is also one of the most water-intensive, after the chemical and refinery industries. It generates as well a significant amount of solid and liquid (organic and inorganic) waste that now are being converted into high-value by-products or used as raw material for food or feed industries, after biological treatment (*Roy et al., 2014*). The latest trends of conversion of food processing wastes into useful energy products (i.e., biodiesel, biogas, syngas, bioethanol, steam, and electricity) could represent a positive development among manufacturers as they represent cost advantages for the consumed energy and reduced waste disposal costs (*Wang, 2014*).

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## NUTRITION, HEALTH AND THE ENVIRONMENT

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The Institute of Medicine of the National Academies is defining the link between nutrition and environment as bidirectional. Human eating patterns impact the environment, but the environment can also impact dietary choice (*Remans et al., 2012*). An ethical synergy could be achieved by increasing the consumption of fruits and vegetables: it would improve human health and reduce the land used for meat as a protein source. The connection between health and dietary guidance has been studied for many decades. Nowadays the studies should start focusing as well on the connection between dietary guidelines and environmental protection, as new problems are arising (*Wilkins, 2014*).

The evidence is showing that it is possible to devise diets that generate lower environmental impact and align them with current nutritional guidelines in order to have a two-sided improvement (*Garnett, 2014*). (*Firel et al., 2014*) indicated three guidelines to be followed when developing a healthy and sustainable diet:

- 1) The risk of dietary disproportions and use of environmental resources can be lowered by reducing the consumption of food choices that are not essential to our diet. Therefore energy-dense and highly processed and packaged products, also called discretionary food;
- 2) Diets based on plant-derived foods, which are more beneficent for both health and ecology with respect to animal-derived foods;
- 3) Overabundance, related to all food that is consumed above a person's energy requirements, represent an unavoidable burden in the form of pressure on biodiversity, GHG emissions and use of natural resources.

Moreover, diets rich in plant-derived foods are generally associated with lower health risk, such as lower-rated of CVD and some cancers (*Denny and Buttriss, 2007*), reduced risk for diabetes, hypertension and of course obesity (*Philips, 2005*). Overweight and obesity are showing warning increasing rates. People tend to eat more outside their homes, and the fast food service is alimending this negative behavior by increasing its size of the portions and introducing high-calorie snacks over the last 30 years (*Piernas and Popkin, 2010*).

First time proposed in June 2009 by the Barilla Centre for Food & Nutrition, and still in development, the Double Pyramid illustrated in [Figure 11], highlights the extremely close links between two aspects of every food: its nutritional value and the environmental impact it has through the stages of its production and consumption. Our Nutritional Pyramid reveals to be inversely proportional to the Environmental Pyramid in terms of cost for the environment.

For each category of the pyramid it was calculated the its ecological footprint, and it appears that fruits, and vegetables (highly recommended) are the one with the lowest ecological footprint index. One kilogram of

vegetables in fact, requires 2 m<sup>2</sup> for the production, a kilo of pasta – 12 m<sup>2</sup>, while one kilogram of beef would need 118 m<sup>2</sup>.

The environmental impact of our food varies depending on the consumers' demand. According to study conducted at BCFN, if all the Italians stopped eating meat for one day per week, we would save 198.000 tons of CO<sub>2</sub>, equivalent to the annual electricity consumption of almost 105.000 families or 1.5 billion kilometers of car journeys.

## 8. THE ENVIRONMENTAL SUSTAINABILITY OF INSECTS AS FOOD AND FEED

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With a growing world population, increasingly demanding consumers, and a limited amount of agricultural land, there is an urgent need to find alternatives to conventional meat products. In agreement with Barilla's Research Centre idea, A. Van Huis and D. Oonincx are stating in their article from 2017 that more sustainable diets are needed that should include less meat consumption and alternative protein sources.

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### SUSTAINABILITY OF GATHERING EDIBLE INSECTS FROM ECOSYSTEMS

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A possible solution could be insect farming, that can be conducted either on small-scale farms or in large-scale industrialized rearing facilities. The major environmental advantages of insect farming [Figure 12] compared to livestock production are as follows:

- Less land and water is required;
- Greenhouse gas emissions are lower;
- Insects have high feed conversion efficiencies;
- Insects can transform low-value organic by-products into high-quality food and feed;



- Certain insects can be used as animal feed or aqua feed (*Van Huis A. et al., 2017*).

Apart from being collected from nature, insects can also be reared in confined industrial facilities. The feed market, from 2011 to 2015 increased by 14%, for a total of 464 million t for poultry, 254 million t for pigs, 35 million t for cultured fish, and 23 million t for pets (*Alltech, 2016*). This means that there is an enormous potential market for insects as feed. The demand for meat products is expected to increase in 2050 more than 75% from current levels due to rising incomes and population growth (*Herrero et al., 2015*). The relative increase in volume is more pronounced in developing countries with a rate of 113%, while developed countries have a rate of 27% (*Alexandratos and Bruinsma, 2012; p.94*).

Meat represents just 15% of the total energy intake in the global human diet, but it needs 80% of agricultural land (3,400 million ha as pastures and 500 million ha as crop land) for animal grazing or the production of livestock feed fodder. About a third of the world's cereal production is fed to animals (*Mottet et al., 2017*).

Livestock is an important contributor to climate change. The domesticated food-producing animals are 20 billion in total and are responsible for a range between 5.6 and 7.5 Gt CO<sub>2</sub> per year. The main source of these emissions is Methane (CH<sub>4</sub>) from enteric fermentation and animal manure (43%), CO<sub>2</sub> from land usage changes and fossil fuel usage (27%), and Nitrous Oxide (N<sub>2</sub>O) from manure and slurry management.

Western diets are characterized by a high intake of meat, dairy products, and eggs. This cause consequently an excessive consumption of saturated fat and red meat with respect to the dietary recommendations. Halving these products intakes would reduce greenhouse gas emissions by 25-40% in the European Union (*Westhoek et al., 2014*). Other alternative

protein sources, as to both food and feed, are: seaweed (*Mohamed et al., 2012; Makkar et al., 2016*), duckweed (*Apprenroth et al., 2017*), canola/rapeseed (*Campbell et al., 2016*), micro-algae and other microbes (*Vigani et al., 2015*) and as discussed previously insects (*Van Huis et al., 2013*).

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### FEED CONVERSION EFFICIENCY

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One of the main reason why insects are considered as potentially sustainable sources of protein is, how indicated earlier, their high feed conversion efficiency (*Nakagaki and deFoliart, 1991; Berenbaum, 1995; Gullan and Cranston, 2005; Ramos-Elorduy, 2008; Premalatha et al., 2011; Looy et al., 2013*).

The greater efficiency is due in part because of the poikilothermic nature of the insects. Poultry provided with especially studied and optimized diets convert 33% of dietary protein to edible body mass. Yellow mealworm utilizes 22-45% of dietary protein, black soldier fly larvae about half (43-55%), and Argentinean cockroaches 51 to 88% [Figure 13]. These data show higher levels of protein efficiency compared to conventional livestock, even without optimizing the genetic background or diets (*Oonincx et al., 2015*).

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## 9. THREE PARADOXES

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In chapter 5 there are illustrated the three features that lead to the nutritional transition in Europe. If taking in consideration global obesity rates, we should not exclude urbanization from the major driving forces. Reduced physical activity and increased sedentary time behaviors started in the early 1990s in the low and middle-income world together with diets relied on processed foods, increased away from home intake and greater use of edible oils and sugar-sweetened beverages.

Diabetes, hypertension and obesity rates are extremely alarming all around the globe, even more among the poor population as it has important implications for the distribution of health inequalities (*Popkin B.M. et al., 2013*). For this reason, the first of the three nowadays paradoxes [Figure 14], presented by Barilla Centre for Food and Nutrition and discussed in this chapter, is “Die of hunger or obesity”? For every undernourished person (868 million) there are two who are obese or overweight (1,5 billion). Every year, there are 36 million deaths for lack of food, while 29 million people die because of too much food.

The shift toward increased animal-source food intake was the beginning of a livestock revolution in the developing world. Most of the global increases in animal-source foods have been noticed in fact in middle-income countries. In India, for example, dairy products consumption has increased in the last years, while in China pork and eggs showed a major demand among consumers. The second paradox arising from this trend is: “Feed people, animal or cars?”.

This thesis starts with the description of how the postwar situation contributed to what we are living nowadays. In chapter 3, it is represented the distribution of the U.S. food dollar to show how big is the gap between the farm value and the retail expenditures nowadays, so how much of one dollar spent goes to whom. According to the U.S. Dept. of Agriculture publication on farm-retail spreads for food products in 1960, a farmer would have got 39% of the value of a basket of farm food products (*USDA, 1965*). More recent data, illustrated in [Figure 15], are showing the trend of this index was quite fluctuant over the time but steadily decreasing starting from 2014.

This growing rate is not sustainable. Only 29% of the Earth’s surface is land, but only the 71% of it is habitable. The 77% of the agricultural land is used for livestock, equivalent to 40 Million km<sup>2</sup>, while the remaining 23%

represents the share of land dedicated for the cultivation of crops minus feed. This is surprising given that just 17% of our caloric energy intake derives from meat and dairy products (*OurWorldInData, 2013*). Cars represent a threat as well. Invented in 1903, biofuel has been recently rediscovered and its production today already utilizes 6,6% of the grain produced in the world, with an increasing forecast up to 7,6% by 2020.

The last paradox that deserves attention from Earth's living population regards "Feeding the waste or feeding the hungry?" Every year, one-third of the total food produced ends in the garbage. The quantities are four times what it would take to feed the 868 million people who are hungry, equivalent to 1.3 billion tons of perfectly edible food wasted. The balance is negative also in terms of how much is consumed and planet's ability to regenerate the resources we need for living.

During the 1960s, the concept of food waste was not existing. After some environmental catastrophes, along with the publication of Rachel Carson's *Silent Spring*, the masses began to broadly think about the natural habitat in which they lived, worked and played, so the Environmental Movement started. During the same period, under the administration of the U.S. President Lyndon B. Johnson, "Unconditional War on Poverty" was announced in 1964 in the president's first State of the Union address. The rhetoric of the War on Poverty quickly found its way into law and the creation of new federal programs and agencies.

A study from 2013 conducted by economists at Columbia, analyzed how the government intervention, in the form of taxes and transfers, affected poverty rates after almost half-century of implementation. According to the study, government action contributed to reduce poverty rates from 26% to 16%, without which it would have actually increased over the period in question. These results are a proof that institutions have the power and

instruments to achieve the global welfare. A synergy between the economic systems all around the world together with political and national implications could have a positive impact in facing global issues nowadays.

## CONCLUSION

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Looking at the map of the food expenditures as a percentage of total consumer's expenditures [Figure 4], a complete analysis would be impossible as there are no data regarding some parts of Africa and Greenland. For sure the trends in the world population are increasing all over the world, particularly looking at Asia's rate that has an exponential curve. Even the Mediterranean Diet, the most famous for its benefits, was influenced over the time by the mass production of processed food. Greece, Spain, and Italy have doubled their intake of total fat from animal products starting from 1964.

The European food industry from the economic point of view, it is quite fragmented, considering that 49,5% of the operating companies are SMEs. Competition is high, so marketing instruments and continuous R&D are essential for survival. As innovations occur, the governments must deal with new legislation needs and food safety regulations. The Directive 2000/13/EC was approved regarding to this matter, in order to be sure that the consumer is able to make a choice full of knowledge of the exact nature and characteristics the product he is buying have.

Many innovative trends are oriented versus sustainability. Sustainable diets, firstly proposed in the 1980s, refers to various notions like equity and fair trade, well-being, and health, biodiversity, environment and climate, cultural heritage, eco-friendly, local and seasonal foods and food security accessibility. The environmental sustainability of insects is proposed in this thesis because of the prominent green advantages illustrated in

Chapter 8. The decisional point divides where harvesting should be done: in nature or in farms as mini-livestock.

In order to increase awareness about the alarming signals our planet is showing, in the last chapter, there are reported three paradoxes presented by the BCFN in “Eating in 2030: trends and perspective”. The rhetorical questions are:

- 1) Die of hungry or obesity?
- 2) Feed people, animals or cars?
- 3) Feed waste or feed the hungry?

The BCNF presented as well “The Double Pyramid” in 2010, and in 2016 published an updated report taking in consideration more indicators. Our Nutritional Pyramid reveals to be inversely proportional to the Environmental Pyramid in terms of cost for the environment.

New technologies allow us to collect significant amounts of data from all over the world in real time. Therefore, more detailed analyses could be done in the future. In the Annexes to this thesis, there are reported other interesting indicators that emerged during the research.

## TABLES AND FIGURES

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**TABLE 1:** Top 10 Quick Service Restaurants in the U.S. in 2015

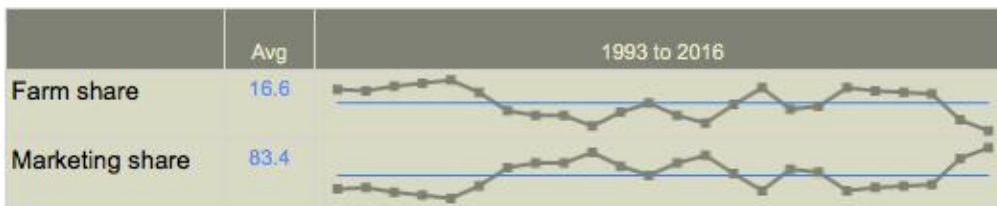
Rank	Company	2015 U.S. systemwide Sales (millions)	2015 U.S. Average Sales per unit (thousands)	Number of franchised units in 2015	Number of company units in 2015	Total units in 2015	Total change in units from 2014
1	McDonald's	\$ 35,800.0	\$ 2,500.0	12,899	1,360	14,259	- 91
2	Starbucks	\$ 13,300.0	\$ 1,062.2	4,962	7,559	12,521	303
3	Subway	\$ 11,500.0	\$ 424.3	27,103	0	27,103	145
4	Burger King	\$ 9,530.0	\$1,337.4	7,074	52	7,126	- 16
5	Taco Bell	\$8,820.2	\$ 1,460.0	5,227	894	6,121	170
6	Wendy's	\$ 8,811.9	\$ 1,540.0	5,090	632	5,722	- 58
7	Dunkin' Donuts	\$ 7,620.0	\$ 903.8	8,392	39	8,431	349
8	Chick-fil-A	\$ 6,825.9	\$ 3,977.3	1,646	337	1,983	96
9	Pizza Hut	\$ 5,703.8	\$ 725.0	7,311	511	7,822	- 109
10	Panera Bread	\$ 4,900.0	\$ 2,500.0	1,071	901	1,972	92

Source: QSR magazine. (2018). *The QSR 50*. [online] Available at: <https://www.qsrmagazine.com/reports/qsr50-2016-top-50-chart>

**FIGURE 1:** The distribution of the U.S. food dollar 2016: 85.2% of food expenditures go to categories other than the “farm value”. Source: USDA Economic Research Service.



How have the farm and marketing shares changed over time?



**FIGURE 2:** Marketing Bill Dollar 2016: Food away from home  
Available at: <https://data.ers.usda.gov/reports.aspx?ID=17885>



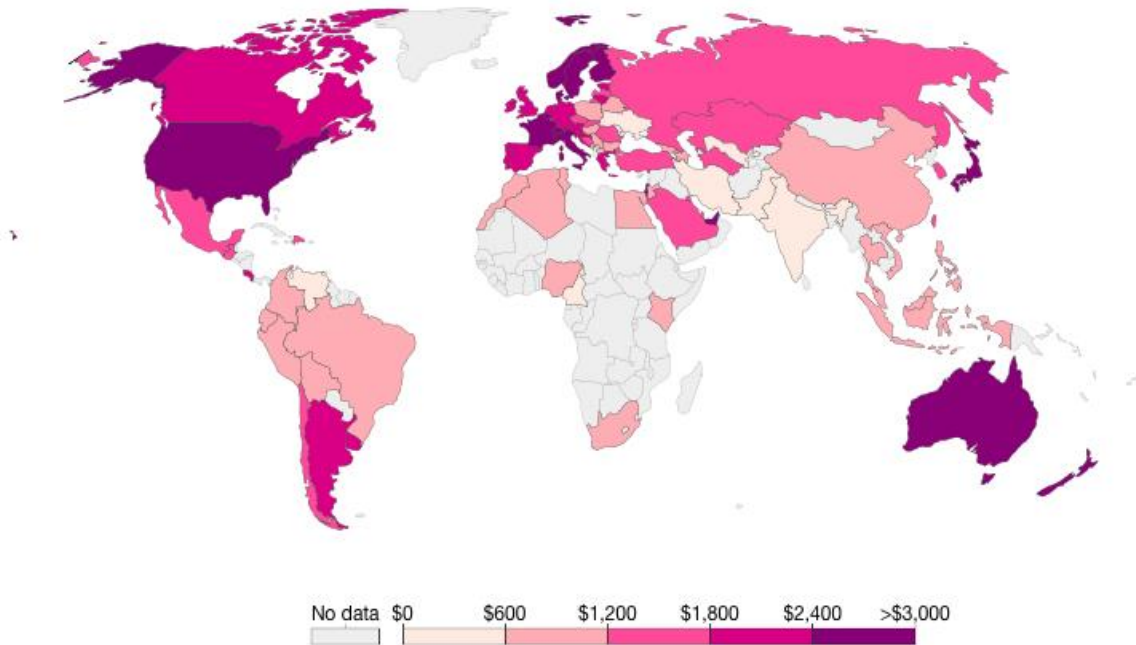
How have the farm and marketing shares changed over time?





**FIGURE 3:** Food expenditure per person per year. Average food expenditure per person, measured in US \$ per year. "Food Prices" Ourworldindata.Org

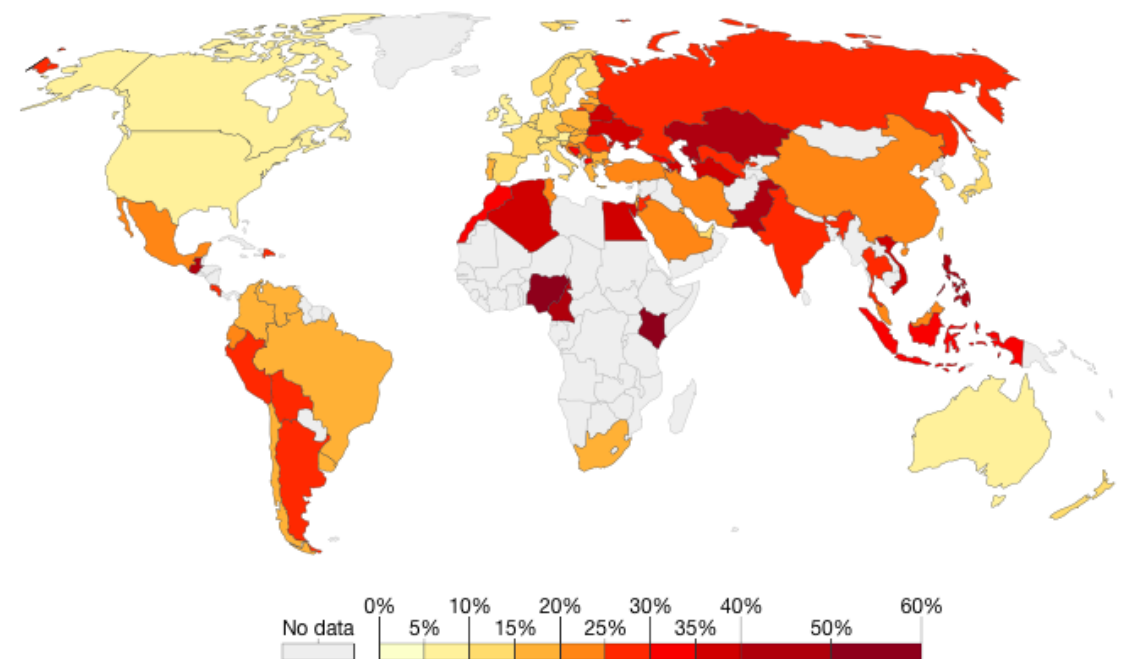
<https://ourworldindata.org/food-prices#determinants-of-food-prices>



Source: United States Department for Agriculture (USDA)

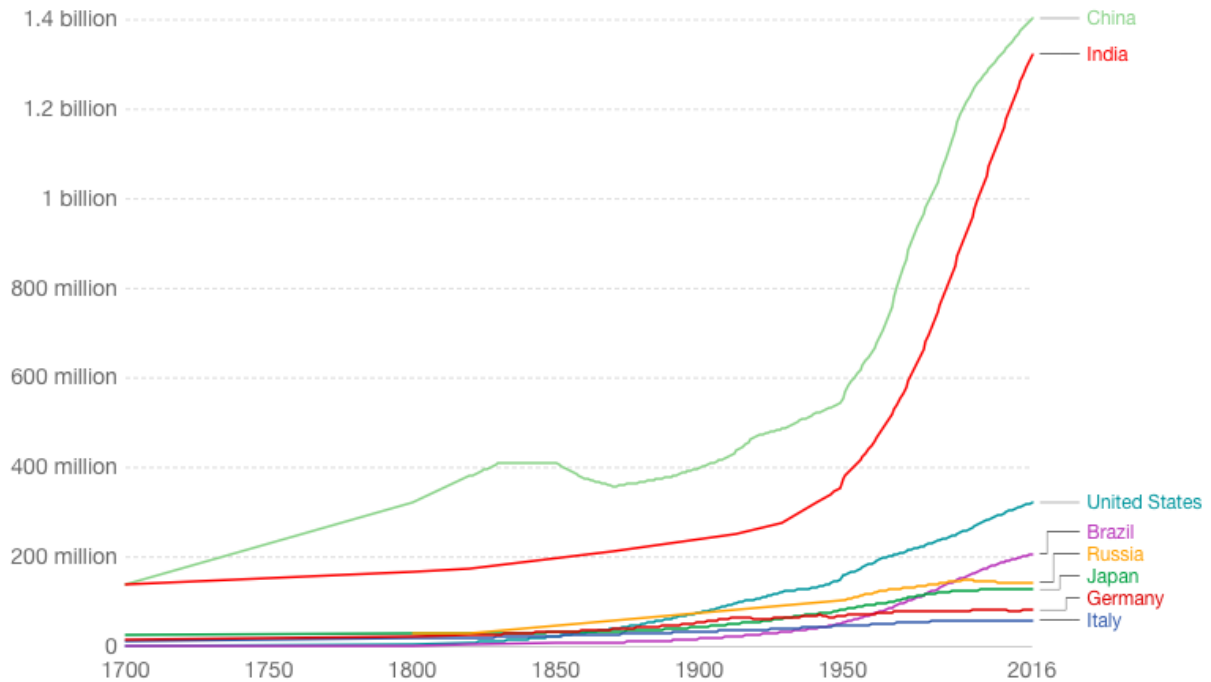
**FIGURE 4:** Food expenditures as a share of total consumer expenditure (2016).

"Food Prices" Ourworldindata.Org <https://ourworldindata.org/food-prices#determinants-of-food-prices>



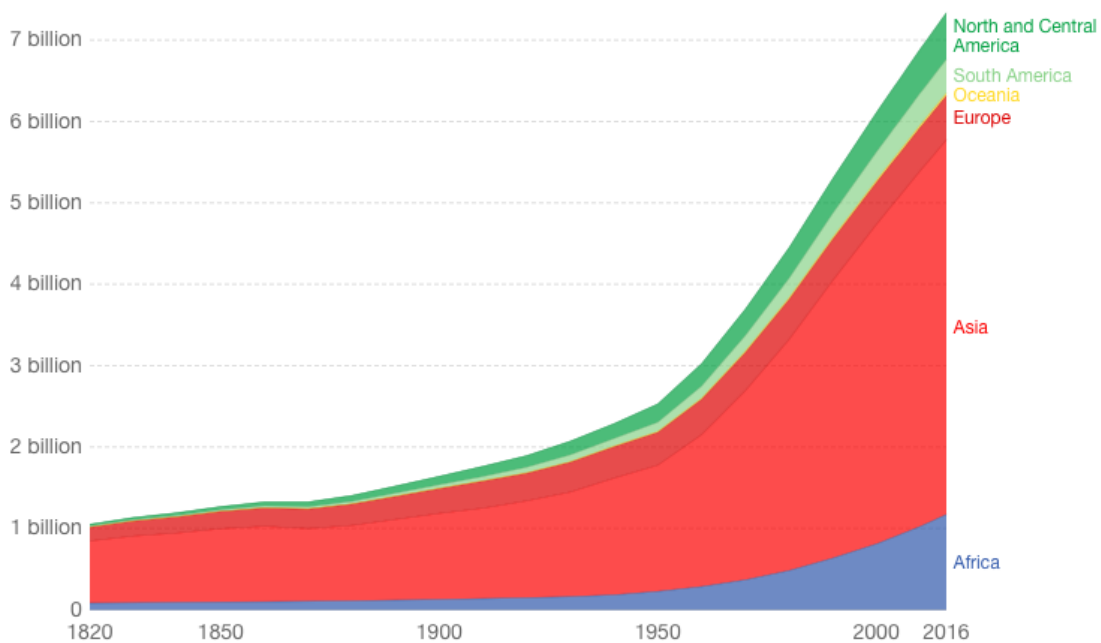
Source: United States Department for Agriculture (USDA)

**FIGURE 5:** Total population from 1700 to 2016. “World Population Growth”. Ourworldindata.Org <https://ourworldindata.org/world-population-growth>.



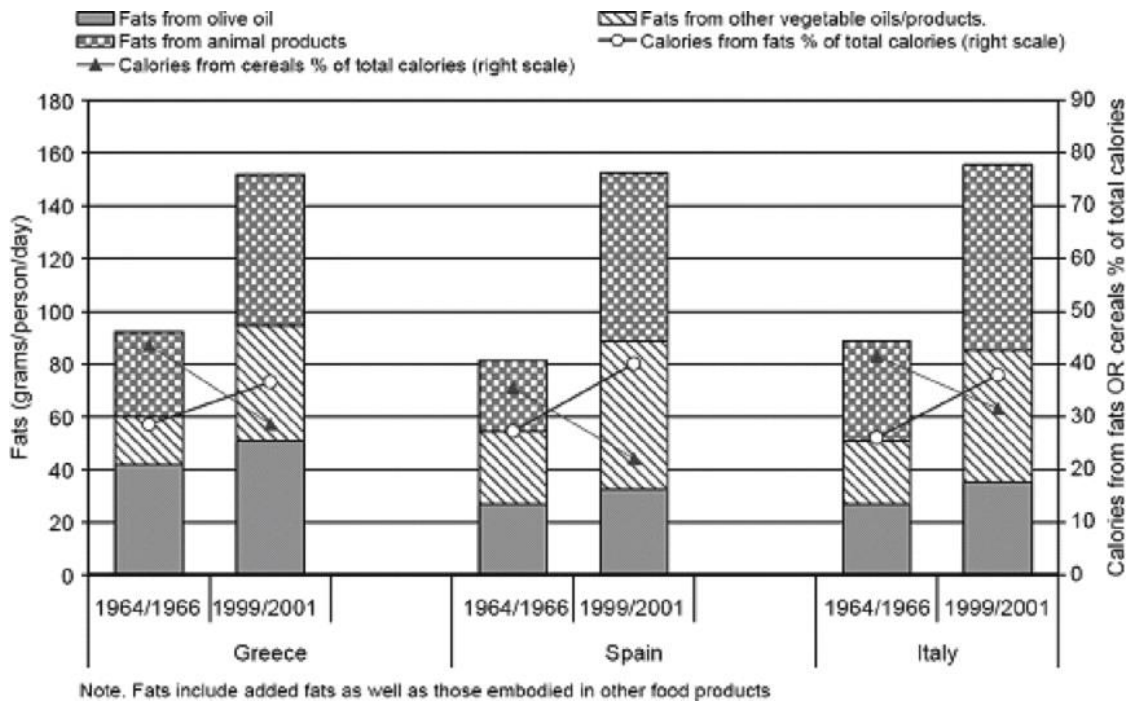
Source: Gapminder until 1949, UN Population Division from 1950-2016

**FIGURE 6:** World population by world regions. “World Population Growth”. Ourworldindata.Org <https://ourworldindata.org/world-population-growth>

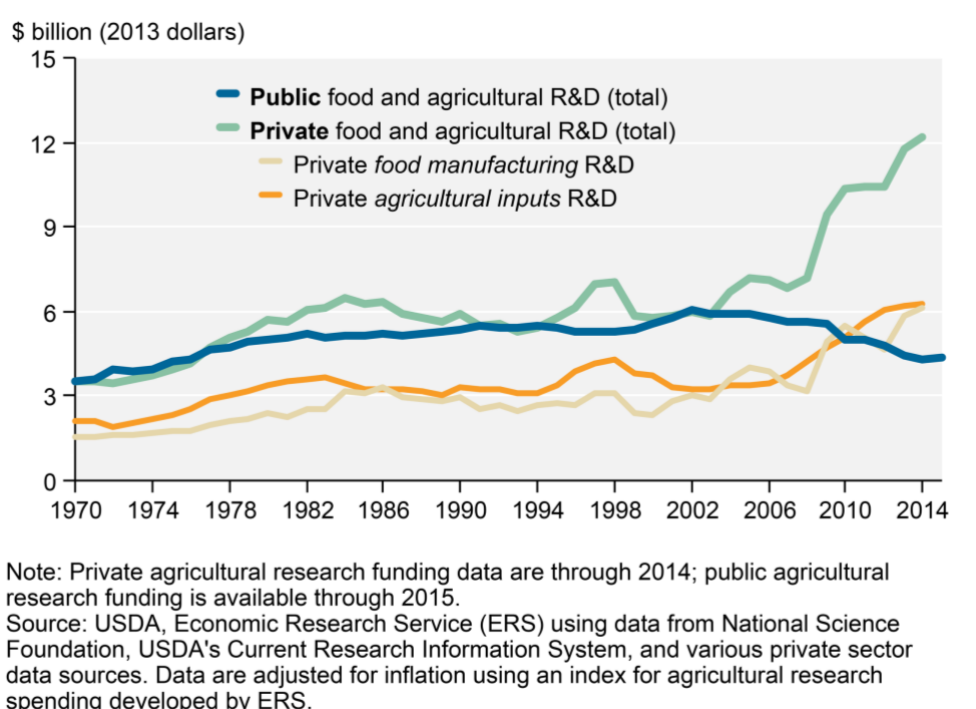


Source: Global Population by Region - HYDE (2016)

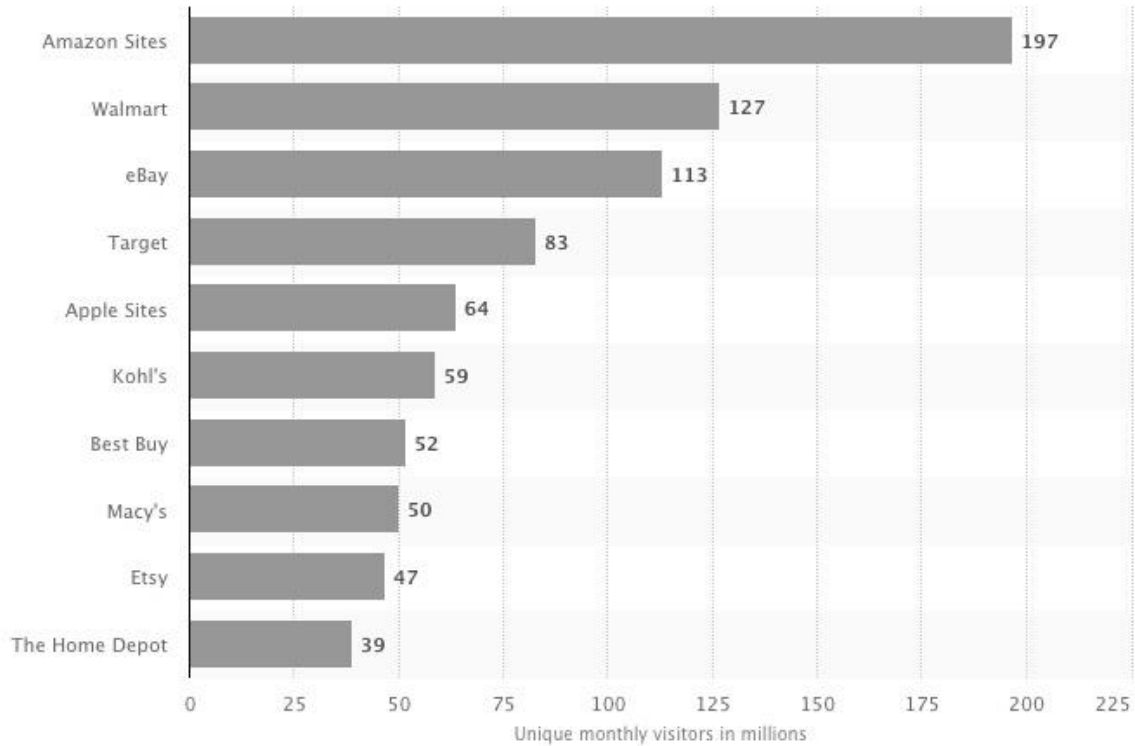
**FIGURE 7:** Greece, Spain, Italy: Diet Transition to Increased Fat Consumption. Debomy, D. 2006. The Europeans and Sustainable Food—Qualitative Study in 15 European Countries—Pan European Report, Brussels: Belgium: King Baudouin Foundation.



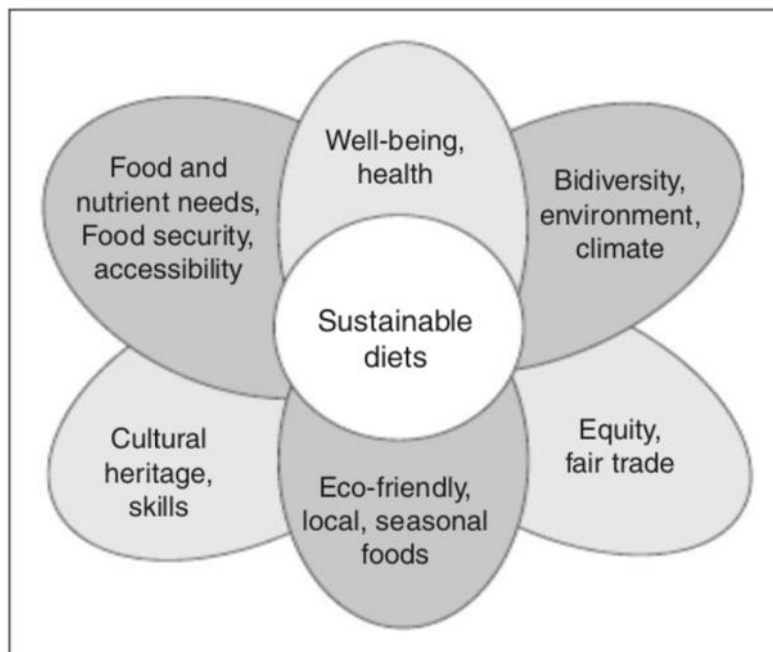
**FIGURE 8:** Food and agricultural research and development (R&D) funding, real (inflation-adjusted) dollars, 1970-2015. <https://www.ers.usda.gov/data-products/agricultural-research-funding-in-the-public-and-private-sectors/>



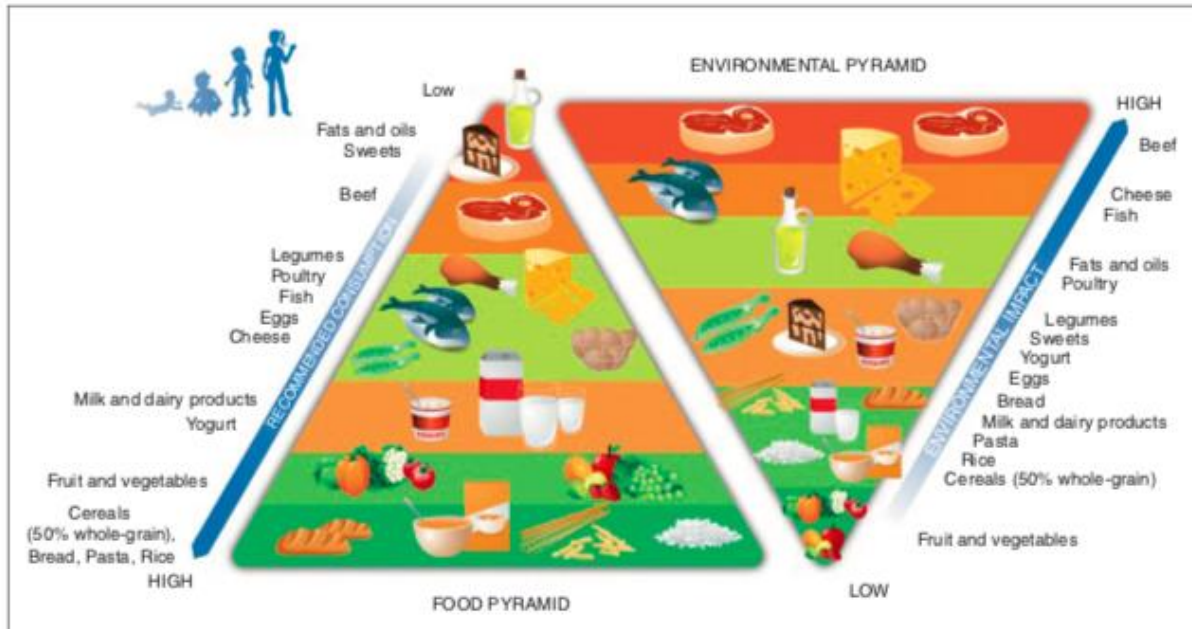
**FIGURE 9:** Most popular retail websites in the U.S. as of December 2017  
 Amazon – Statistics and facts. <https://www.statista.com/topics/846/amazon/>



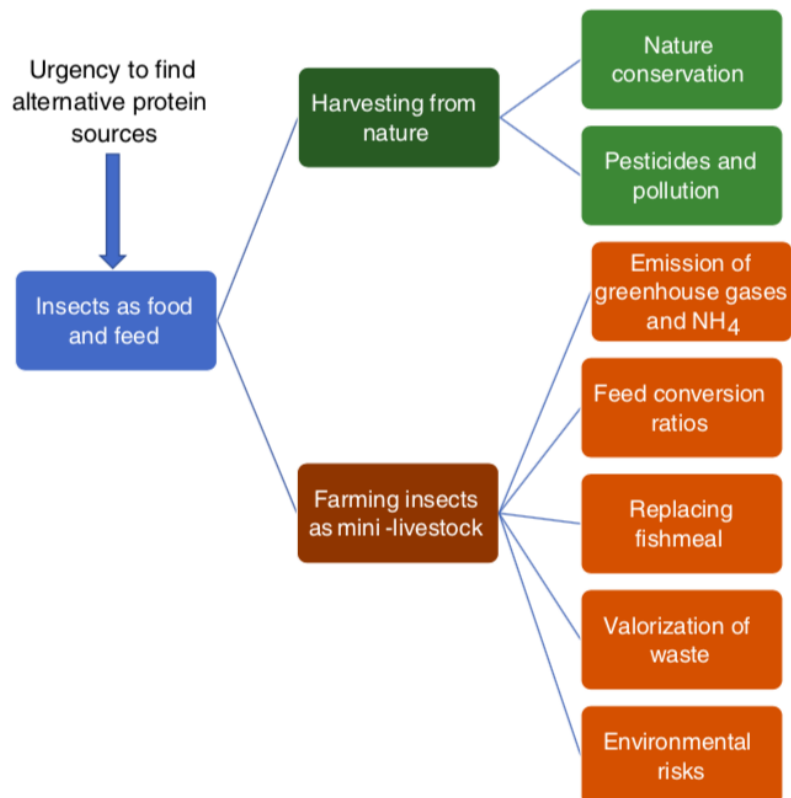
**FIGURE 10:** Schematic representation of the key components of a sustainable diet, Lairon, 2012. *Sustainable Diets and Biodiversity*; Burlingame, B., Dernini, S., Eds.; Food and Agriculture Organization and Bioversity International: Rome, Italy, 2012.



**FIGURE 11:** The Double Pyramid (Barilla Center for Food and Nutrition, 2013)  
[https://www.barillacfn.com/en/dissemination/double\\_pyramid/](https://www.barillacfn.com/en/dissemination/double_pyramid/)



**FIGURE 12:** Environmental issues involved when insects are harvested or when reared as production animals or mini- livestock.  
<https://link.springer.com/article/10.1007/s13593-017-0452-8>



**FIGURE 13:** Visual representation of the discussed insects, Online research.



- Yellow mealworm  
(*Tenebrio Molitor*)

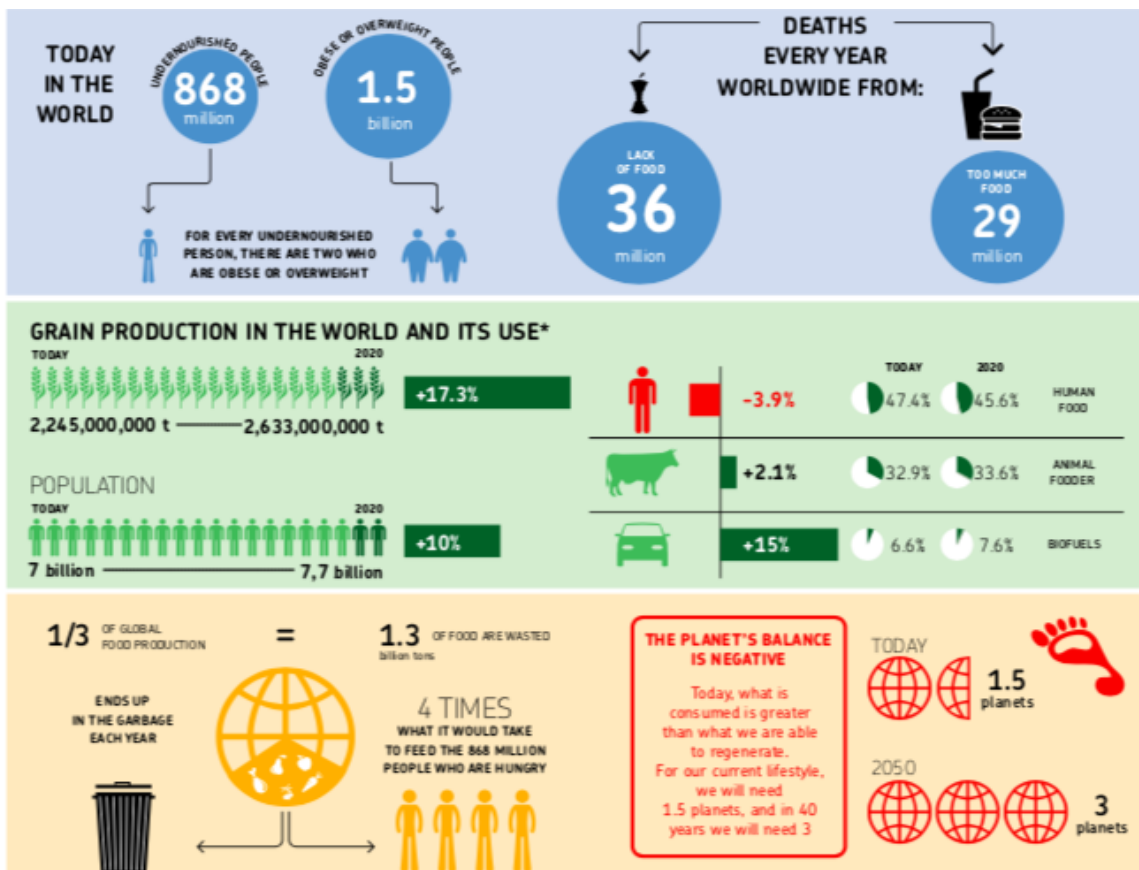


- Black soldier fly larvae  
(*Hermetia Illucens*)

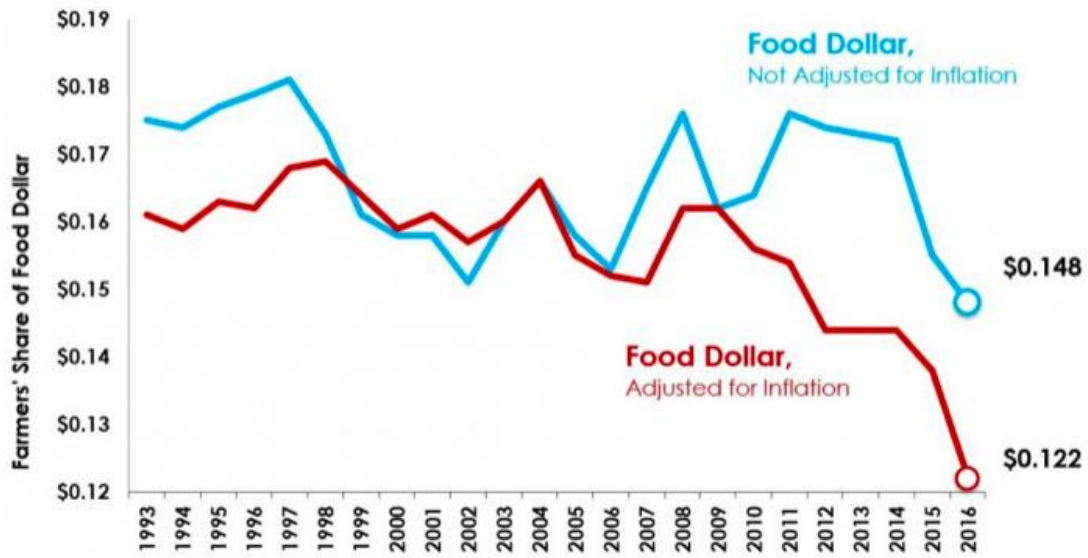


- Argentinean cockroach  
(*Blaptica Dubia*)

**FIGURE 14:** Three Present-Day Paradoxes about Food and Nutrition. Eating trends in 2030, BCFN <https://www.barillacfn.com/en/publications/eating-in-2030-trends-and-perspectives/>



**FIGURE 15:** Farm Share of the Food Dollar, Nominal and Real (1993-2016)  
<https://www.fb.org/market-intel/farmers-share-of-food-dollar-at-record-low>



Source: USDA ERS

## ANNEXES










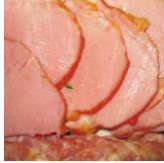







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# The Farmer's Share

Did you know that farmers and ranchers receive only 14.8\* cents of every food dollar that consumers spend? According to the USDA, off farm costs including marketing, processing, wholesaling, distribution and retailing account for more than 80 cents of every food dollar spent in the United States.

<p><b>Bacon</b> 1 lb.</p>  <p>Retail: \$4.99 Farmer: \$0.61</p>	<p><b>Top Sirloin Steak</b> 1 lb.</p>  <p>Retail: \$8.99 Farmer: \$1.92</p>	<p><b>Bread</b> 2 lbs.</p>  <p>Retail: \$3.49 Farmer: \$0.13</p>	<p><b>Fresh Carrots</b> 5 lbs.</p>  <p>Retail: \$4.49 Farmer: \$1.37</p>	<p><b>Beer</b> 6-pack cans</p>  <p>Retail: \$8.99 Farmer: \$0.04</p>
<p><b>Cereal</b> 18 oz. box</p>  <p>Retail: \$4.89 Farmer: \$0.09</p>	<p><b>Tomatoes</b> 1 lb.</p>  <p>Retail: \$4.49 Farmer: \$0.26</p>	<p><b>Eggs</b> 1 dozen</p>  <p>Retail: \$2.19 Farmer: \$1.20</p>	<p><b>Flour</b> King Arthur, 5 lbs.</p>  <p>Retail: \$6.09 Farmer: \$0.44</p>	<p><b>Boneless Ham</b> 1 lb.</p>  <p>Retail: \$3.99 Farmer: \$0.61</p>
<p><b>Lettuce</b> 1 lb.</p>  <p>Retail: \$2.79 Farmer: \$0.26</p>	<p><b>Milk</b> 1 gallon, fat free</p>  <p>Retail: \$4.49 Farmer: \$1.36</p>	<p><b>Fresh Apples</b> 1 lb.</p>  <p>Retail: \$2.19 Farmer: \$0.33</p>	<p><b>Fresh Potatoes</b> Russet, 5 lbs.</p>  <p>Retail: \$4.49 Farmer: \$0.56</p>	<p><b>Soda</b> 2 liters</p>  <p>Retail: \$2.19 Farmer: \$0.05</p>

Farmer's share derived from USDA NASS "Agricultural Prices," 2018 | Prices based on April 2018 data.  
Retail prices based on Safeway (SE) brand except where noted. | \* Figure according to U.S. Department of Agriculture Economic Research Service

May 30, 2018



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Available at: <https://nfu.org/farmers-share/> Accessed on 15 June 2018



## U.S. Dept. Agriculture, Economic Research Service 1965. Farm-retail spreads for food products, 1947-64.

Table 4.--The market basket of farm food products: Indexes of retail cost, farm value, farm-retail spread, and farmer's share of retail cost, 1913-64 1/

Year	Retail cost : 1957-59=100:	Farm value : 1957-59=100:	Farm-retail spread : 1957-59=100: 2/	Farmer's share	Year	Retail cost : 1957-59=100:	Farm value : 1957-59=100:	Farm-retail spread : 1957-59=100: 2/	Farmer's share
					Percent				
1913	36	41	32	46	1940	43	43	44	40
1914	37	42	34	45	1941	48	52	44	44
1915	36	40	34	44	1942	56	66	49	48
1916	44	49	40	45	1943	63	80	52	51
1917	60	70	53	47	1944	61	79	53	52
1918	62	79	51	51	1945	63	84	52	53
1919	70	84	60	48	1946	72	95	59	52
					1947	88	114	71	51
1920	77	83	74	43	1948	95	121	77	51
1921	58	58	58	40	1949	89	106	79	47
1922	56	55	56	40					
1923	56	56	57	40	1950	89	105	78	47
1924	55	55	55	40	1951	99	121	84	49
1925	60	63	58	42	1952	100	117	88	47
1926	61	63	60	42	1953	97	109	89	44
1927	59	60	58	41	1954	95	103	90	43
1928	59	63	57	42	1955	93	96	91	41
1929	59	62	58	42	1956	94	95	93	40
					1957	97	98	96	40
1930	58	55	59	39	1958	103	105	101	40
1931	46	41	50	35	1959	100	97	102	38
1932	39	31	44	32					
1933	38	31	42	32	1960	101	99	102	39
1934	43	36	45	34	1961	101	98	104	38
1935	47	46	46	39	1962	102	99	105	38
1936	48	48	48	40	1963	103	97	107	37
1937	49	51	48	42	1964	103	96	108	37
1938	45	43	46	39	1965				
1939	43	41	45	38	1966				

Available at:

<https://babel.hathitrust.org/cgi/pt?id=mdp.35128000310738;view=1up;seq=15>

Accessed on 15 June 2018

### Interview with Nicola Robinson, Senior Manager Global Sustainability Team at McDonald's Corp:

McDonald's championing research into insect feed for chickens

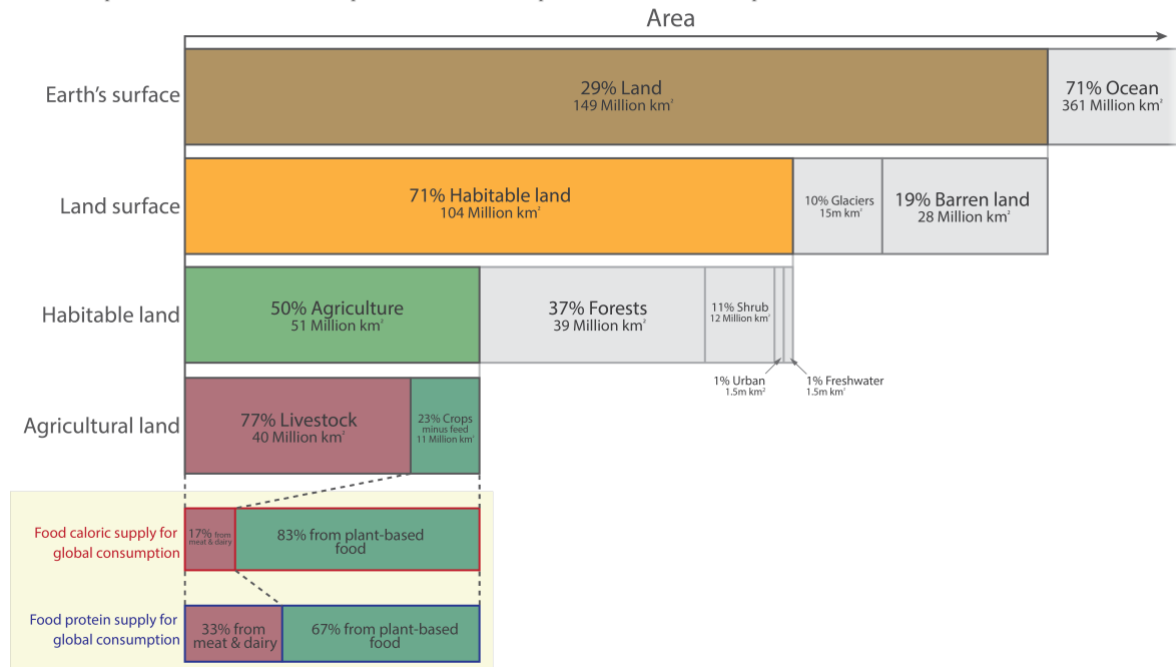
Link to the video:

<https://www.feednavigator.com/Article/2018/03/27/McDonald-s-championing-research-into-insect-feed-for-chickens> Accessed on 15 June 2018

# Global surface area allocation for food production



The breakdown of Earth surface area by functional and allocated uses, down to agricultural land allocation for livestock and food crop production, measured in millions of square kilometres. Area for livestock farming includes grazing land for animals, and arable land used for animal feed production. The relative production of food calories and protein for final consumption from livestock versus plant-based commodities is also shown.



Data source: based on UN Food and Agricultural Organization (FAO) Statistics.

The data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find research and more visualizations on this topic.

Licensed under CC-BY-SA by the authors Hannah Ritchie and Max Roser.

Available at: <https://ourworldindata.org/yields-and-land-use-in-agriculture> Accessed on 15 June 2018

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## ACKNOWLEDGMENTS

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I would like to express my gratitude to everybody who listened to me when I needed to share my discoveries during the writing process of this thesis.

It was a long work including tons of papers and hundreds of topics, but any of them helped to learn a new piece of information. Exchange views about the food and drink industry with people of different ages (from students to seniors) and especially workers from different fields of activity was a real pleasure.

A special thank you is for my supervisor Prof. Shouro Dasgupta, who is also a researcher at CMCC (Centro Euro-Mediterraneo sui Cambiamenti Climatici). He was able to guide me during these months without spoiling my final findings, which I'm really glad I'm able to share and disclose today.

Last but not the least, thank you to my mother, Angela, who gave me the possibility to study hard and make her proud.

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