Chapter 1
Novel Food Technologies and Their Acceptance

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1.1 Introduction

When we were confronted with the idea of writing a book on food tech transitions we had to revise what it means to make sense of a particular subject; we came from different backgrounds – one of us from food technology, one from social science and one from crop science – and there couldn't be any taken-for-granted assumptions if we were to build a common ground for working together. Each had a different perspective but we agreed that we had to reflect on the challenges posed in front of us not only from a technical and sectorial perspective, and try to be as inclusive as possible because, on the basis of our academic experience, only the multifaceted contributions can deliver a significant tool for readers. It was clear that food technology is such a comprehensive term that can even be traced back till the scientific revolutions of 1500–1600s, but we all agreed that it was in more recent times that food tech has developed to the point of posing now central questions for our jobs, our role as consumers, our citizenship. It seems to us that two main challenges currently stand out among the many and they are interrelated: one relates to sustainability, to the very existence of humanity in its ecological context, about which food security is central – and still informs a strong social debate because of the alarming numbers provided by the FAO[1] each year – and therefore constitutes the second challenge. In the realization of the transition challenges of this second decade of the

[1] The United Nations Food and Agricultural Organization released the projected numbers on malnutrition and food insecurity for 2017, surprisingly on the rise, with of 815 million ca. people going hungry regularly.

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century, we agree that technologies will continue to be central and pivotal, because of their role in our lives and how we relate to them, and will constitute more and more the main axes around which agricultural production will revolve. Whether technology is value free or not is of course a huge on-going debate upon which we cannot focus in this brief space; suffice it to say, though, that before deliberating whether these technologies will have an environmental- or social- heavy impact we have to also be aware that how much of what we accept of technology and on what basis, depends on the historical period we analyse, which of course will concur in our assessment of the impact of technology itself. Different historical periods have seen a wider or more restricted acceptance of technology in our lives because they were characterised by different sensitivities. Whether the technologies employed in the food industry are going to be accepted or not depend on what sort of sensitivity is part of the social, economic, political and historical context of one period and one specific people. How we can make sense of all of this from an agri-food perspective is the goal of this chapter. In here we want to provide some composite reflections on the role and acceptance of food technology in the context of the two main challenges in agri-food (and beyond). For doing this, we employ the risk society theory offered by Beck (1992) to propose why technologies acceptance are welcomed or opposed in large social contexts, specifically from the past mid-century to understand the cultural turns happening in specific periods of uncertainty, as the one we live in. We do so following the convincing narration in the theory of food regimes as advanced by Friedmann and McMichael (1989), that proposes the existence of different periods of stability, crisis and regulation in food provisioning; in this periodization food security (declined differently in different time periods) provided a strong social justification for organizing production along industrial forms, of which the role of technologies is paramount, and consequently transforming consumption too. The strength of the theory is in the meticulous analysis of historical and cultural events, and in making sense of the role of actors and politics in the unfolding of each regime. The most recent strands of the theory specifically focus on the ecological imperatives characterising our age starting from the millennium, assigning a position and role to the juxtaposing forces on the stage (namely, corporations and social movements) and analysing specific trends, of which food waste has emerged as a (by-)product (pun intended) of the period after World War II. Aligning our argument with the periodization proposed by classic food regime theory, we want to situate food technologies in a manner in which their acceptance emerges clearly as both a challenge and the result of specific historical, political and cultural arrangements. We will start with food technologies in the context of food security, followed by an overlook on food regimes, in which the food tech development will be highlighted, in order to arrive to contemporary issues and novel food technologies.

1.2 Food Security and Food Technologies

According to the definition introduced by the FAO, “food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life” (FAO 1996). Arguably, then, food security is a general term which emphasizes security in nutrition, the undeniable importance of food safety assurance, environmental and ethical issues (Karunasagar and Karunasagar 2016). The prediction that the world population will reach more than 9 billion by 2050 leaves no wonder about the fact that developing strategies to assure the global food security has attracted the attention of scientists from various backgrounds (Godfray et al. 2010; Karunasagar and Karunasagar 2016). Connections can be drawn between global food security issues and other global problems such as the sustainable management of rising demand for resources among which energy and water are the most important ones, together with climate change, and the progressive increase of world population before it stabilizes (Beddington 2010; Rosegrant and Cline 2003).

It has been stated that the solution to meet the food demand for the next decades might not be only by boosting the production output in primary production of food materials (Augustin et al. 2016). Optimizing the food processing system in the post-harvest end of food production chains in accordance with energy consumption, nutritional quality, yield of final products, and application of waste of food processing in other sectors (e.g. biofuel production, textile industry, chemical industry) or in development of value-added products can be influential too in improving food security by responding to contemporary sustainability issues such as energy crisis, malnutrition and waste management in post-harvest sectors (Augustin et al. 2016; Beddington 2010; Godfray et al. 2010). In addition, megatrends in the world have a foremost impact on the design of new foods product and the technologies which are used to produce them (Augustin et al. 2016; Hajkowicz 2015). Consequently, the perception of consumers toward food products and factors which will define the consumption habits and consumer acceptance should be determined in order to secure the success of these same new food products in the market (Augustin et al. 2016). In this sense, the development of food technologies in managing food products which will be accepted or rejected - and therefore might have an impact on food security- is paramount. This is why we focus on food processing technologies, as on one hand environment friendly and sustainable products constitute the new source of economic reward and help placate the modern consumers’ anxiety over ‘healthy and natural' food; and on the other hand can also provide viable fixes for meeting food security in both developed and developing countries.

In a wide way, food processing can be referred to any change to raw food material before its consumption (Floros et al. 2010). Such changes can impose negative effects to the food product by reducing the nutritional value because of the destruction of nutritional compounds. However, the benefits of food processing should not be neglected (Weaver et al. 2014). Food processing is essential to make the food consumable, increase the shelf life, enhance the bioavailability of critical nutrients

in food, and destroy the toxic ingredient of food material (Van Boekel et al. 2010). Seasonality and perishable nature of food materials made the food processing a key factor to secure the food demands around the globe. However, as results of some factors including energy crisis, environmental impacts and nutritional losses during food processing by means of conventional technologies, research has focused on developing new techniques which enhance the food production chain by using sustainable energy while having less impact on environment and initial nutritional characteristics of raw food materials (Augustin et al. 2016; Pereira and Vicente 2010; Van Boekel et al. 2010; Van der Goot et al. 2016; Weaver et al. 2014). The interdisciplinary cooperation between pre-harvest and post-harvest sides of food production systems by taking advantage of novel technologies has been introduced as an effective way to make available to the population a diet that provides them with sufficient energy and nutrition besides satisfying environmental and ethical values (Augustin et al. 2016; Karunasagar and Karunasagar 2016). Food security, from a food industry perspective, would therefore emerge as the result of specific combinations of technological advancement made possible by social acceptance, political organization and market operations. In this regard, research and advancement must take a holistic and multidimensional approach taking all aspects of food production and consumption chain including cultural, economic, environmental, political, social and technological aspects combined into account. For that, an analysis of changes that food production and consumption has gone through and the present situation is essential.

1.3 Food Regime Theory and Food Technology

The ‘Food Regime’ theory as elaborated by Friedmann and McMichael (1989) was firstly introduced to explain the changes in economic and political characteristics of food systems in a particular period of history (Friedmann 2009; McMichael 2009) in which both food security and technological advancement played an important role. As such, it serves as a tool to identify the social, political and economic roots of success or failure of a functional food system for a period of time in history (Friedmann 2009; Sage 2013). Friedmann and McMichael posited the existence of a first (1870–1914 ca.) and a second (1945–1973 ca.) food regime, which have been then examined and used by several researchers to analyse food provisioning and their different aspects historically, economically and politically (Dixon 2009; Campbell et al. 2017). The theory later develops contending the existence of different regimes following the historical development of capitalist systems, upon which the US one is central for establishing much of the western world perspectives and practices globally. In particular, the role of the industry and food technology is paramount in both regimes but assumes a pivotal role during the second regime and in the aftermath of its crisis, until modern day. Campbell (2012) proposes that at the basis of the development of the second food regime is food security, which provided a social legitimation of food production organized around industrial patterns, of

which food technology was essential. In the later development of the food regime concept, for which different food regime authors have different theories and names, technologies disappear from main view, and political and legal apparatuses are more evident but keep acting at an incredible pace. We hope to contribute to the re-visibility of them with this food regime theory periodization of food technologies.

1.4 Food Tech During First Food Regime

The First Food Regime was used to determine the properties of food provisioning between 1870 and 1914 and addressed its characteristics as a function of hegemony in the world (McMichael 2009). In this regard, this regime has been used to describe the causes and effects of British hegemony on food production under colonial empire configuration. During this period, the main inventions and discoveries of the Industrial Revolution were employed and maximised, mostly in terms of transporting food and raw material from tropical and temperate settler colonies to feed the rising population of working class in European countries such as Great Britain. Some tropical food commodities which shaped the diet of industrial workers in UK and Europe were vegetable oils, tea, coffee, sugar and bananas made their entrance on the diets of Western people and stayed since then. Such move contributed to stabilize the status of food security in the growing industrial Europe by importing wheat and meat, which became staple foods for industrial workers in Europe; the settler states, on their side, imported manufactured commodities, labour and some forms of capitals from European countries. In this regime, basically, distance becomes a main characteristic in the food production and consumption continuum. Friedmann and McMichael (1989) propose that food production, which has the main characteristic of durability in this period, was relocated in the settler states where the advancement in technology contributed to adaptation to cheaper forms of agricultural production. The main technologies employed here are those related to transport with the advent of railways and the first big shipments of refrigerated meat, and those related to mechanization of work in the field, namely ploughing machines, thresher, reapers, water- or wind- energy motioned mills and animal-led equipment being at the basis of a somatic energy regime (Derry and Williams 1960); in fact mechanized harvesting helped the settler agricultural system to overcome the issue of the shortage of labour. In terms of properly said food technologies, the main forms of food transformation already in use were perfected and use of fossil fuels for making engines work were employed. These technologies, although quite basic for us in the 21st century, had the capacity to revolutionize production and processing operations; therefore from a sociological perspective acceptance was arguably determined by the time freeing and human labour saving, something most longed for. At the household level the common tools used in kitchen (and cuisine) in this period are the maximum form of help household keepers (usually women) have, and basic forms of knowledge passed on for generations such as those for food preservation and storage (such as curing, salting, smoking, brining, pickling; Huang 2000)

are still the most important guarantee of food availability. Also raw forms of modern technologies based on the then-beginning chemical industry (Truninger 2013) make their appearance, for instance canning around 1850s, and the discoveries of Appert in terms of vacuum sealed containers and Pasteur on the role of bacteria a decade later (Thorne 1986) which enhanced the canning industry techniques. In particular, the meat canning's history indeed illustrates Friedmann and McMichael's observation of the relations between settler states and empires, as this branch of the canning industry developed in Australia and South America enabling 'the export of cheap meat to feed the working classes of European industrial cities' (Truninger 2013: 84). Lastly, refrigeration became the indispensable partner for allowing the industry to progress from durable to perishable foods: the industry of the cold chain developed in reaction to negative perception (such as food not being fresh or at the risk of poisoning) of food being stored using natural ice, as was the case for products travelling from Australia, South America and South Africa (Teuteberg 1995), and paved the way to the introduction of artificially-made cold, 'revolutionizing the organization and scale of production, storage, distribution and ultimately consumption' (Truninger 2013:84). For Friedmann and McMichael (1989) this state of the affairs remains stable until the advent of World War I, which causes enormous disruptions in the way food provisioning is operated. The time gap between the emergence of a second regime is referred to as an experimental and 'chaotic' era (1914–1947) during which the main features of the first food regime evolved into the second one to meet the demand of world population for food (Friedmann 2009; Sage 2013). This transitional period may be characterized by several remarkable historical turning points including World War I, the Great Depression, followed by World War II. A second regime emerged and stabilized between 1943 and 1973 ca., during which food production and consumption were dramatically transformed under the transition of colonial empires into capitalist nation-states configuration (Campbell et al. 2017), the most important of which was the United States of America (Friedmann 2009), a country which has made technological advancement at the forefront of economic stability.

1.5 Food Tech During Second Food Regime

This second regime stabilized by taking advantage and pushing for more of the technological advancement that started during wartime; the tools and machinery then employed were forced into agricultural application and domestic agricultural production in both industrialized and non-industrialized countries since 1950s, the most famous and important outcome of which is known as the Green Revolution (GR; Campbell 2012). In fact, this second food regime owes its success to the investment in crop science, development of infrastructure and market, as well as policy support during the GR and post GR period until 1970s (Pingali 2012). The GR response to the growing population was through adaptation of high yield new breeds and varieties, application of fertilizers and mechanization of agriculture with

the fundamental support of governments in terms of subsidies (Campbell 2012). GR led to remarkable shifts in productivity of the food supply chain, to significant production of specific staple crops (wheat, maize, rice) and contributed to significant change in diet, giving rise to a new system of food consumption (Sage 2013). The raise and stabilization of globalized fast food restaurants, big food industry, and retailers and eventually powerful cooperation operating and controlling the food system stemmed from the many domestic and international policies that were in place to support this wave of agricultural intensification. Such policies of food aid and distribution, particularly the policies of USA with reference to production supports and price stability system, followed the Marshall Plan and contributed to the political hegemony of the USA; this set of operations went hand in hand with the GR-created agricultural surpluses and helped stabilize the conditions typical of this second food regime. The foreign policies forced by US and later in UK and Europe accorded the flow of agricultural surplus and their processed food products in the form of food aids to developing countries and ultimately it constituted the beginning of the growth of agri-corporate (Campbell 2012). It is in this context that the main evolutions of food technologies as we know them today happen, and we contend that it happened on the basis of the role of agri-corporations, which relied massively on development of further technologies, as they respond to the need of mass production. There is a subtle observation to be made here: the social legitimation provided by food security we mentioned in a previous section is the outcome of the post-war compromise; as Campbell (2012) points, the experience of hunger during the war was paramount in allowing for the creation of common grounds for rebuilding Europe. It is clear that this sad experience, together with the brutalities of war, was the common element which cemented the international agreement for creating supranational institutions (necessary in a world constituted by nation-states instead of empires) that would implement plans to ensure peace and reconstruction. This would have been done enhancing international agreements, promoting cooperation and enhancing production through the means of technology, among which food production was paramount in the first years after the war. It is in fact in these years that a strong cooperation between political institutions and scientific ones begin, as the memories of war had pushed for hope in something neutral (or impersonal) enough which could ensure that human beings would not get back to the past atrocities, namely markets and science. It is here that we see the precedents of Beck's theory of risk society (1992, 1994); Beck proposed that throughout history from the starting point of industrial revolution, societies went through changes and modernization which brought them to this specific moment. German sociologist Beck (1999) believed that this period was one of immense trust in science and technology as a sign of modernity, of being different from the past because of the possibility to overcome uncertainty (represented by risks). The economic boom constitutes a period of exclusive trust in these institutions and the human intellect to deliver, through technology, solutions for production and consumption for the betterment of human living conditions, of which hunger reduction was essential; this would last 20 years ca., and would then transform again in unimagined ways.

Most importantly for our argument is that the second food regime represents a period of mass production and consumption of new and heavily processed food products (Pritchard 2009). First of all, the canning techniques mentioned before reached an important level of precision and industrialization; this was used at the beginning in the military and then, later, as a way of penetration of American culture and products in Europe (Thorne 1986). Secondly, refrigeration techniques advanced, not only at the industrial level but more importantly entering the households in a massive way only after World War II. For Freidberg (2009) this was made possible together with positive reinforcement of the importance of freshness and cold storage starting from World War I from governments, nutritional science and industry. Thirdly, a new diet based on widely versatile processed food commodities produced in the factories in this historical period, went global. It is in this time that some authors (such as Popkin 2003; Dixon 2009) locate the transformation of a plant-based diet into a diet enriched with animal-based foods, fats and oils, processed sugars and carbohydrates, for which scholars coined the term 'nutrition transitions' that characterises much of the change of diet during the second food regime and after. The nutritional transition has taken place in two phases. The first phase includes an increase in the diversity of diets, high meat and lightly processed products; and the second phase involved a creation of diets specific for different classes: a working/poor class with a diet based on the relatively cheap, high calorie and highly processed food products, and a wealthy class with a diverse diet containing expensive fruits and vegetables (Dixon 2009; Hawkes 2009).[2]

A final point has therefore to be made about the advancement in technologies, which made the functionality of the two food regimes possible (Friedmann and McMichael 1989). It has been pointed out that distance between place of production and consumption relying on durable food products has caused adverse environmental impacts and the failure of first and second food regimes (Campbell 2009; Friedmann and McNair 2008). Food commodities which were produced as a results of technical and scientific advances typical of the years 1930–1970s helped the production and distribution of food and diets around the world during both first and second food regime (Dixon 2009). One last thing we want to note and which is not highlighted in the theory proposed by Friedmann and McMichael (1989) is the role of the military industry during this period of time. Truninger (2013:85) maintains that food innovation was pushed by this complex, as its technologies were then strongly applied for commercial use, as is the case of microwave ovens and plastic gadgets for storing food (e.g. Tupperware) or food irradiation for preservation. Zachmann (2011), though, notices that the perception of such food and its potentially dramatic effects on health put at risk the trust and acceptance among consumers

[2]This second regime, Friedmann and McMichael (1989) propose, was stable until mid-1970s – although for some authors such as Pritchard (2009) even until the 1980s – when rising trade wars between US and EU as a results of increase in agricultural surplus in Europe on top of crisis in US agriculture challenged the hegemony of US in food production system. As results, food and agriculture, until then excluded from international trade agreements, were included in the multilateral trade system and ignited the regulation of a global of food politics (Pritchard 2009).

and even some manufacturers. All in all, these technical scientific advances not only were quite different from those occurring during the first food regime but they were different also from the beginning of the second food regime. In fact, if the years after the war were the years of escaping hunger, the next 10–20 years became the years of modernisation, because technology had delivered what was promised. But it is also the moment in which the first signs of a cultural change in the attitudes towards this modern food and the technological innovations that delivered it, emerge.

1.6 Beyond the Second Food Regime

Although the second food regime was successful for a period of time to stabilize the political and economic system by which the world worked, it entered as well a period of crisis subsequently to main historical changes, as happened to the previous regime and as might happen to subsequent (if any) regime. During the 1980s the first signs of a negative impact of GR and intensified agriculture started to come into view (Pritchard 2009). The high yield new varieties were in particular responsive to the external input such as fertilizers or pesticides and, together with irrigation in the field, were at the centre of high productivity achievements. However, in accordance with a lack of proper policies, the consequence of intensified agricultural system has its negative impacts such as soil degradation, over-consumption of water resources, and leakage of chemicals into the ecosystem on the environment (Pingali 2012). This has manifested in the shape of lower productivity in mid 1980s as a result of degradation of agricultural resources such as soil, water and diversity of crops (Pingali 2012). Hence, the consequences of agricultural intensification are among the root factors of some of the global challenges currently experienced, including the ecological issue. Moreover, some of the current global health issues including the rise of obesity and type II diabetes have stemmed from the new diet forms which were globalized during the second food regime. Again Beck (1992, 1994, 1999) explains that if modernisation of a society happens through the process of innovation, then our present society has gone through two distinctive phases. The first phase includes the stages during which the consequences of innovations existed. However, these did not concern the public and political conflicts were not emphasising on them. And still, when the negative consequences or hazards of industrial society emerged to surface and concern the public, they became the centre of political and private discourses. This is the moment when, according to Beck, an industrial society transforms into a risk society. In a risk society the conflicts over distribution of hazards (or 'bads') produced are layered on the disputes over the distribution of societal 'goods' such as income, social security and jobs. This may be introduced as the foundation of conflicts in the industrial society over how the risk or hazards of production and capital accumulation of commodities such as the risk of application of novel technologies, use of chemicals and chemical technologies, and concern over environment, may be addressed (Beck 1996). This will

become increasingly important in the aftermath of the second food regime because such an over exposition to risks, without the safe net that science represented in the past, does not leave any escape, any alternative or offer any hope, because the saviour (technology) has transformed into the persecutor.

Now, if we have to assess the two regimes, the first and second food regime were functional when the global food relations were stabilized around the political and governance arrangement, trade trends, labour relations, farming systems, commodity complexes, consumer cultures; and were destabilized during the transitional periods or period of crisis (Campbell et al. 2017). Some researchers have identified the period from 1980s to the present time as a transitional period in terms of food regimes while others have proposed the emergence and existence of a third food regime by weighing in the ecological and cultural dynamics into account (ibid.). In this regard, the existence and emergence of a third food regime is highly debated. In agri-food circles, two main theoretical propositions have been credited: one named 'corporate industrial food regime' proposed by McMichael (2005), while other researches, including Friedmann, framed the current status of food relations under the name 'corporate-environmental food regime' as a possible third food regime in place (Burch and Lawrence 2009; Campbell 2009; Friedmann 2005; Holt Giménez and Shattuck 2011; McMichael 2009; Sage 2013).

The 'corporate industrial food regime' (McMichael 2005) would be a regime dominated by corporations and the whole political and legal apparatus for ensuring its domination; this structuration means that food technologies are heavily employed as foundational part of the working of the regime, specifically in terms of less labour presence and more and more automated, technology-based solutions for processing, transforming and creating meals. If this is the regime that currently exists, then it is inevitable to notice that it attempts to use green strategies for sustaining agri-food systems, for example by promoting production methods and systems which steer away from external inputs (e.g. chemical fertilizers and pesticides in the agricultural sector, and chemical additives in the food processing). It is to note that this move is proposed by McMichael as 'business as usual'. In fact, anything that is different from this industrial production organization is either subsumed or marginalised; in this regard, the so called 'alternative food networks' (Goodman and Goodman 2009), defined as networks of food production, distribution and consumption which try to escape the industrial logics and are so familiar to the average western consumer, are the proof of the ability of regimes to maintain their hegemony, because they pose no threat to a corporation-based regime (and likely will follow the same path of organic agriculture in becoming conventionalised). The existence of this regime exacerbates both the role of technologies as complementary with the evolution of such regimes, and the issues related to food security, as the strictures of this contemporary regime has its precedence in the colonial strictures typical of the previous regime, and on non-resilient agricultural and economic systems.

On the contrary, Friedmann (2005) and Campbell (2009) think that these same alternative food networks and the existence of other actors and trends (such as supermarkets, audits or organics) are evidence of the existence of a different configurations of relations, that is: a different regime named 'corporate environmental'

exists in which market transactions are fewer and of lower intensity (and therefore weakening capital accumulation is subsequent, as suggested by Friedmann 2005). The emergence of alternative food networks and their growth would therefore be a signal showing a growth of a new line of food production and consumption chain for capital accumulation by placing reliance on the environmental movements and emphasising concepts of fair trade, natural food, promoting health of consumers, and counting in the values of animal welfare (Friedmann 2005). These networks are the opposite of technology-intensive systems as long as they are characterised by a local, re-spatialised and re-socialised nature. More importantly for our argument, usually consumers participating in some forms in these networks are technology-sceptics, as is the case for biotechnology and nanotechnology, which Truninger (2013) believes underwent the same negative perceptions that had accompanied the technologies employed during the 1960s. In addition, concerns for food security assume a different perspective, as food provisioning which is not trapped in industrial and capitalist production is less rigid, and as such shocks (environmental, political, social or economic) can be absorbed without hitting as in the past or concurring towards evolution (and possibly shock reduction).

1.7 Novel Food Technologies

In this contemporary context, again Beck's concepts are useful, and specifically his proposed idea of a reflexive modernity (1994) is helpful to grasp some of the main issues around technology acceptance. Risk society, in fact, posited a division between nature and society and an overreliance on rationalism and progress as hallmarks of modernity. We were left in the previous sections with an over-pessimistic view of modern societies as being far and distant from nature, and with the delusion of rational solutions; there is nowhere to turn to because main institutions have left individuals alone and in risky situations. Beck came to the conclusion that this dynamic of risk develops in a dialectic way so that a modernity unfolding this way has to transform, and it does so trough individual reactions and initiatives. In fact, new risks posited by technological advancement are real and are clearly perceived in a negative way, which means that people are not blind to the risks and limits of technological advancement, and have to confront them -as well as confront themselves- in a reflexive exercise. In fact, the rise of so called alternative food networks during the past two decades may be evidence of this, and of such strategies put in place mentioned above. Take the establishment and growing of food supply chains such as organic food production systems, fair trade and local production and consumption in this regard as a proof of the attempt to escape the capitalist logics (Friedmann 2005; Levidow 2015). These 're-born' consumers advocate for less food processing and target environment friendly and healthy food, and lean on alternative forms of production. It has to be noted, though, as Dixon (2009) does, that the industry is happy to provide them exactly what they ask for, with enormous investments in the nutrigenomics and functional foods.

It is exactly here that food techs fit in this contemporary structure of food provisioning, as they are the tools that allow the industry to take advantage of the major global trends of healthy and sustainable food; for making sense of this, we leave now aside the double focus on both industrial and household level, and revert our attention to the technologies available in the industry only, as this is where the big changes are currently happening, and because they are not available at the household level for obvious reasons. As it is discussed in Chap. 3, various novel non-thermal food processing technologies including pulsed electric fields (PEF), supercritical CO_2, high pressure processing (HPP), radiation, and ozone processing as well as novel thermal processing technologies such as microwave, ohmic heating (OH) and radio frequency (RF) heating have been developed and regarded as alternative to conventional heat treatments in recent years. Moreover, in Chap. 3 it is noted that these technologies may be used for different food processing such as pasteurization, sterilization, drying, peeling, cooking, or extraction for a wide range of food products, while production lines in different food industries have been profiting from their advantages. Furthermore, according to recently published results, such as Jermann et al. (2015), in Europe and North America HPP, PEF, MWH, and UV are the four novel food processing techniques already commercialized or having a good chance to become commercialized in 5–10 years time. This shows that novel food technologies are already taking their role in shaping and stabilizing the present/emerging food regime as they respond to the needs of the industry.

Accordingly, the potentials of novel food technologies to enhance the status of food security, in the context of the “corporate-environmental food regime" will be discussed in the following sections of this chapter. In fact, it can be argued that to maintain food stability, the new food regime referred to as ‘corporate-environmental food regime’ might be based on local and seasonal food production systems (Friedmann 1993; Friedmann and McNair 2008). In this regard, the use of the novel food technologies might improve the stability of local food production while imposing less environmental impact and less energy consumption to extend the shelf life of locally produced food products. In addition, taking the example of HPP, this technology not only reduces the energy consumption and is operational using green sustainable energy, but it also makes the microbial decontamination of food products possible by using high pressure, hence increasing the shelf life and safety of food products with less impact on nutritional factors - in comparison to conventional thermal process (Rendueles et al. 2011; Wang et al. 2016). Same advantages may be pointed out for the other novel food processing technologies. Therefore, beside production of safe food and reduction of losses in nutritional factors of the product comparing to conventional food processes, such novel technologies are empowered by green and sustainable energy (Jermann et al. 2015; Pereira and Vicente 2010; Sims et al. 2003). Moreover, novel thermal and non-thermal food processing technologies has been evaluated as energy and water saving while they may reduce the emission of food processing (Masanet et al. 2008). Consequently, they may be used to improve the efficiency of food production systems in the framework of “corporate-environmental food regime” and help stabilize the relationships occurring, in favor of the corporate side.

Over and above that, in accordance with the recent argument of Campbell et al. (2017), the re-visibilisation of food waste in the current food regime is another significant factor at stakes in the present time. Food waste was not an issue before, in the configuration of previous regimes, because it simply did not exist in the form we know it today; shortages made impossible to waste anything, actually on the contrary they are arguably what enabled food habits and traditions to be created. The authors maintain that the problem of food waste emerged to the surface of food regimes as a result of several watershed moments including the growing concerns over climate change, rise in oil prices, rise in food prices in 2008, 2011 and 2012 which contributed to public awareness and the creation of specific policies about the future of food supply chains and their sustainability. The authors pointed at the environmental management frameworks such as EU Landfill directive (1999/3/EC) and creation of Waste and Resources Action Programme (WRAP) in the form of a non-profit company. Furthermore, WRAP contributed remarkably to bringing the food waste issue into public attention initiating the campaign "Love Food Hate Waste" (2006). Later, other organizations such as FAO took action to quantify food waste and food losses by investigating the whole food chain. The results of such investigations explained that the food waste in the Global North is a problem with its roots in the retailing sector and along the consumption chain, while in the Global South it is mainly stemmed from postharvest losses in the food production system as an outcome of technological failure and lack of efficiency in organisation management (Campbell et al. 2017). The valorisation of food waste is one of the strategies that may be used to reduce the cost of food loss and food waste (Mirabella et al. 2014) and in this context it is foundational to use technologies which are environment friendly and 'green' for waste valorisation. In this regard, the potentials of various novel thermal and non-thermal processes have been investigated by many researchers. For example, for the extraction of valuable phytochemicals such as phenolic constitute of waste of fruit and vegetables, the use of supercritical carbon dioxide extraction, microwaves, ultrasound, pulsed electric fields and high pressure has been introduced as an environment friendly process, as these extraction methods do not require organic toxic solvents (Putniket al. 2017; Mirabella et al. 2014). In this regard, take the example of banana peels as a waste of banana production. Thirty percent of a ripe banana is its peel. Banana peels are a valuable source for pectin production, micronutrients to feed cattle and poultry, wine and ethanol production, biosorbants for detoxification of feed, production and utilization antioxidants to be used in nutraceuticals (Mohapatra et al. 2010). To revive the valuable compounds waste of food processing, the extraction of the valuable compounds with enhanced yield and energy consumption using novel technologies such as MWH is a good example (Jia et al. 2005; Qiu et al. 2010). Back to the example of banana peels, the utilization of banana peels for production of biogas and removal of heavy metals and radioactive minerals from wastewater can be named as a good example to show the potential of such by-product to enhance food security by improving environmental conditions, reduce fossil fuels dependence and resuscitate water resources (Oyewo et al. 2016; Wobiwo et al. 2017). Food waste and novel food processing technologies, in addition, may be linked in a

further way, for example, the radiation of meat products is a non-thermal novel technique for their sterilization, although the irradiation of meat may affect its sensory quality according to the oxidative changes. Also, the study of Kannatt et al. (2005) showed the effective use of potato peel extract for retarding the peroxidative changes in radiated meat produced. Where does this leave us? Well, whether it is one or the other regime (or even none of them), it is undeniable that there is a coexistence of different and opposing trends which pull in different directions, corporates hegemony is strong and environmental issues are central. So, again, what is then the role of food technologies in this? Whether we embrace the understanding of current food provisioning as being corporate industrial or corporate environmental, one question emerges as to whether these food technologies can help in the making of more sustainable food regimes in which environmental and health related concerns are resolved. Although it is evident that the very formation and running of food regimes is characterised by technological innovations, the demand for more sustainable systems (instead of regimes) calls also upon the role of these technologies, and given the coexistence of both pro-technology organisms (corporations) and anti-technology ones (alternative food networks and the likes, to make a bold differentiation, although of course there is a good degree of acceptance almost in these networks) it is probably more helpful to make sense of them and see how they can adapt to one or the other, help running out of the strictures of food regimes, help in addressing food security and possibly contribute in the making of better systems.

1.8 Consumers' Attitude Toward Novel Food Technologies

Consumers' attitude and acceptance are crucial to make the commercialization of new technologies in food production chain possible, even more in the context of food regimes, as the regimes rely massively on legitimization, of which acceptance by the public is paramount. It has been noted that consumers are favouring food products which are minimally processed, contain fewer food additives, have less adverse impact on health, enhanced the health condition and produced sustainably (Bhaskaran et al. 2006; Jermann et al. 2015; Zink 1997). It has been stated that negative attitudes of consumers toward processed food products has its roots in consumers not trusting technologies, in the lack of knowledge about processing technologies, in counter-advertisement against food technology by food activists, in the concerns about heavy use of sugar and salt in processed food, and in the beliefs such as the lack of nutritional benefits in all food produced by big food companies (Floros et al. 2010; Williams and Nestle 2015). During the past two decades, a considerable number of studies has noted the guarded attitude of consumers toward novel food technologies (Cox and Evans 2008). It is worth discussing the roots of negative attitudes of consumers toward novel food technologies or in general novel technologies going back to Beck's risk society (1996) for a last rush. We have seen how after the strong belief in science and technology that characterize the second food regime we have moved into a period of distrust. The argument back then was that it is preferable to take some risks in a private and individual way that to trust

science and technologies, empowered by the political bodies, that have caused the environmentally dangerous situation we find ourselves in. From a consumer attitude perspective, our society is a risk society and in a risk society the hazards of industrial society are dominant (Beck 1996). Hence, in the risk society the individuals are concerned and critical over the application of technologies and science which are perceived as the roots of global challenges. So, the critical view and negative perception of consumers toward application of novel technologies in food production and consumption chain may be explained by the nature of the risk society itself. The negative consequences of trusting science and technology during the second food regime is contemplated as the main origins of current global challenges. Moreover, the level of mistrust in the application and use of novel technologies for food processing and caution may vary among wide ranges of consumers, with regard to a wide range of novel technologies (Cox and Evans 2008), so that it is not unidirectional and has to be faced from various perspectives, such as the different consumers in different place, the differnt food items and the different technologies applied. In this regard, risk can be divided into different categories in accordance with consumers' perception of risk (Slovic 1987). For example, if the risk is voluntary or involuntary, observable or hidden, immediate or delayed, fatal or non-fatal; and according to the consumers' degree of control over risk, and the degree of science and information about the risk itself (Cardello 2003). In this respect, the risk of using novel technologies may be regarded as an involuntary risk that individuals are exposed to by consumption of food which may cause irreversible changes in food products and lead to unknown delayed health risk (Oser 1978). Take the example of consumers who are favouring the green and alternative food networks and are resistant to technologies and, accordingly, show greater levels of concern over the application of novel food technologies. Contextually, there exists another group of consumers who put their trust in the science and regulatory authorities of food production and consumption, and are willing to consume food products which are manufactured using novel food technologies (Bord and O'Connor 1990; Bruhn et al. 1986; Bruhn et al. 1996; Cardello 2003; Sparks and Shepherd 1994). This means that acceptance of novel technologies and consequently some food products depends significantly not only on the perceived benefits of them but also on their perceived risks, and that this coexistence will likely pull in different directions, juxtaposing one to the other. Furthermore, many consumers have limited knowledge related to the novel technologies, and for these consumers trust is an important element, actually paramount. However, based on the failures of the food industry during the second food regime to secure and sustain the trust of consumers, the public may not be at rest about values that dictate how food is produced at the industrial level and by means of novel food technologies. In this respect, one of the key roles during the second food regime belonged to the policies in place. The policies in place back then may be blamed to a great extent for the adverse consequences of GR and, later on, for the expansion of industrial food and fast foods. In this sense, the lack of trust in the information made available to the public by or through the food industry is understandable. Respectively, providing the information toward benefits of novel technologies to public through independent consumer organizations or scientist are more welcomed by the public and might induce more positive influence toward their

acceptance (Siegrist 2008), but the industry has to be careful to avoid the perception of green washing. It is essential to present the correct and understandable information about the food produced by means of novel technologies to secure their acceptability by consumers (Liu and Lopez 2016) but even more to work towards reconstruction of trust. Some old issues, such as acceptance of GM for example, can re-emerge even stronger than before as it may be extended to other novel food technologies (Siegrist 2003, 2008).

1.9 Conclusion

Food security is indeed not only a global challenge of our time, but also an imperative to ensure a healthy human society (Augustin et al. 2016). Since prehistory time, humans started using food processing for extending the useful life of food materials and their safety as a part of primitive food production and consumption systems. Specifically, at this point of our history, the food production and consumption system is summoned to respond to a very complex demand for food. It is not only about fixing the hunger and/or nutritional inadequacy, but also about doing so with sustainable approaches to ensure the survival of our ecosystem as a whole. Therefore, food production is not only about the call to increase the production to meet the demand in consumption at any cost. Here, sustainability is a prerequisite to all sectors of food production and consumption system including the food processing and technologies. As discussed in this chapter (and as will be seen in Chap. 3), research and food techs development have been focusing on innovative food technologies to be able to adapt to the growing demand for sustainability in terms of energy and water consumption, preservation of nutritional value of food products, reduction of food waste and ensuring food safety. In addition, the existence of global megatrends (namely, 'more from less', 'planetary pushback', the 'silk highway', 'forever young', 'digital immersion', 'porous boundaries' as proposed by, e.g, Augustin et al. (2016) or Hajkowicz (2015)) will affect the way food products are designed and produced. Such trends are originated from political, economic, social and ecological situations which consequently will alter the lifestyle of the earth population. Hence, the food consumption patterns will also be influenced by such trends (Augustin et al. 2016; Hajkowicz 2015). The backbone of these mega trends is accommodating and coordinating the elements of innovation in terms of technologies, promoting health, protecting the environment and cultures, reducing waste, and enhancing consumers trust. In other words, the characteristics of the 'corporate-environmental food regime' is evidenced and reflected in these trend. For examples, in the context of 'more from less,' attempts to minimize the waste of food processing or use of waste of food processing in other industries may be made (Hajkowicz 2015). The novel food technologies may play a significant role in solidify such trends.

Although, according to information and knowledge available, the novel food technologies may be able to adequately respond to the requisites of sustainability

and food security in the framework of a 'corporate-environmental food regime', the negative attitude of consumers and nature of risks are among the most significant factors standing in the way of benefiting from the novel food technologies to their fullest potentials. In their investigation over GM products and related fears, Campbell and Fitzgerald (2001:218) have noted that "fear over food technology is a complicated subject requiring further analytical thought and empirical investigation. [...] not all new technologies are subject to continues stigmatisation and not all scares are effective in reducing access to the stigmatised product within a society". Therefore, at the current time, one of the outstanding confrontations is to coordinate consumers' acceptance of the currently available novel technologies. Concerns have become evident to the public as a consequence of trusting innovations and technologies blindly during the second food regime, and mistrust of consumers in innovations and novel technologies are direct result of that. Consequently, in-depth studies into consumers' benefit and risk perception of novel technologies may be among the most decisive. This may result in development policies for productive communication of information to effectively gain the trust of consumers (Bearth and Siegrist 2016).

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