Food, Facts and Fiction

A Story about Science and Perception

Prof.dr M.A.J.S. (Tiny) van Boekel

Farewell address upon retiring as Professor of Product Design & Quality Management at Wageningen University & Research on 20 June 2019

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Dear Mr. Rector Magnificus, esteemed colleagues, family and friends.
Ladies and Gentlemen

When it comes to food, everyone is an expert because we all eat. So, I can ask you the following question. What, do you think, is the state of our food supply these days? Do you think it is better than it ever was before, or rather that it was much better in grandmother's time? What, do you think, are facts, and what is fiction in this respect? To find answers to these questions, I would like to take you with me in a somewhat personal story about what has happened in the past 50 years or so, in relation to food. Why a story? Well, I think that as scientists we may need to do some more storytelling to reach the public. So, this is my attempt at it. The words in the title are the guidelines for the story. I start with the last word 'perception'. I use it in the sense as I found it in a dictionary: "perception is the way in which something is regarded, understood, or interpreted." In this lecture, I refer especially to interpretation, please keep that in mind.

Food

Then I move to the first keyword, Food. Next to be a daily user of food, like every one of you, the topic also kept me off the street during my professional life. Since I learned about Wageningen, Food science has captured me. At secondary school, I came to know Wageningen from our chemistry teacher, who himself had studied agricultural chemistry in Wageningen. He took us on an excursion to Wageningen in 1969, 50 years ago now, and I was immediately captured by the atmosphere here. I wanted to study something with the possibility to combine chemistry, biology, physics, mathematics but I was also looking for the possibility to apply knowledge that would be societally relevant. And what could be more relevant than food? So, I started as a young, perhaps a bit naïve, student here in 1970, as you can see in Figure 1 with a picture from the early 1970s.

Figure 1. Picture from the registration card at the then Landbouwhogeschool Wageningen, early 1970s.

Figure 2. Book cover about Food in the Netherlands, 1975

I grew my hair and beard even further, lost some hair on the way, but I gained in knowledge and learned about science. Around that time, many things were changing in terms of agriculture and food systems, without me being aware of that then, to be honest. The investments made in agriculture after World War II paid off in the 1950s and 1960s in an unprecedented way: food became abundantly available at low cost. Sadly, the first signs of problems with overproduction and overconsumption started also to appear. Already in those days in the 1970s, we had big discussions as students about food production, the world food problem, food additives, the upcoming diseases of civilization like cancer, coronary heart disease, diabetes, now called non-communicable diseases. Figure 2 shows the cover of a Dutch book that appeared in 1975: "Voedsel in Nederland. Gezondheid, bedrog en vergif".

In translation, it reads "Food in the Netherlands: health, cheating and poison", not a very cheerful title. It led to heavy discussions, also in Wageningen, between nutritionists and technologists: technologists were framed as the bad guys who produced junk food and nutritionists as the people who were going to save consumers from the wicked activities of technologists: talking about perception. Of course, there was evidence coming up, with the already mentioned overproduction and overconsumption, that all was not well with our food system, but balance in discussions seemed to become a bit lost. And, that is still the case in our time, I am afraid.

First, I would like to highlight some of the benefits of food technology, see also van Boekel et al (2010). We have been able, due to scientific research and technology

development, to build an efficient and effective food supply system, the available food nowadays is, in general, of high quality, it is safe, attractive, and produced at relatively low cost and convenient to use. This is unprecedented in human history. Let me discuss with you some examples of food science research over the years as done with my colleagues; the focus was (and still is) especially on how food behaves chemically, physically, microbiologically, as a result of processing. How can we optimize quality and safety by adjusting processing, by studying properties of raw materials and characteristics of the resulting foods. The first example is related to modelling. Personally, I started a career in modelling some 25 years ago, as shown in Figure 3.

This was the start and the end of this type of modelling, I am afraid. OK, you understood, of course, that I meant a different type of modelling. I am referring to the use of mathematical models to describe food quality, more specifically kinetic models. That looks more like the one in Figure 4..

I will not bore you with the mathematical details, I am not even going to explain this Figure, it is just to give you a flavour. Kinetics is derived from the Greek word kinesis, which means speed. With such models we can make predictions about how fast things happen, for instance, at what temperature and time a food must be heated to kill bacteria while at the same time preserving nutrients such as vitamins. Or, with such models we can predict how long a food will remain safe and stable, and at what point it may become dangerous, or simply not tasty anymore. With quite a few PhD students, we could apply this concept, among other things, to the topic of the Maillard reaction (see van Boekel, 2008, for an overview).

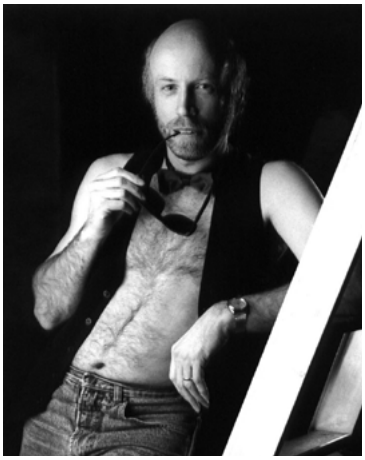

Figure 3. Picture of a model, 1994.

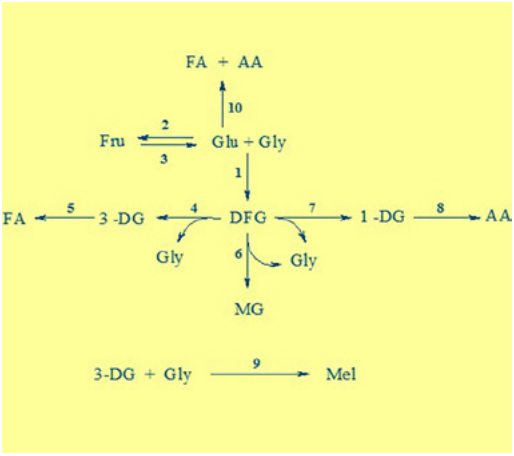

Figure 4. Schematic representation of a kinetic model.

The Maillard reaction is an extremely important reaction in foods, leading to desired colour and flavour in many foods, like bread, beer, chocolate, meat, coffee, baked potatoes, and many more. It also leads to undesired reactions such as the loss of nutritional value, formation of acrylamide, a suspect carcinogen that can be formed in French fries and in bakery products, and carcinogenic heterocyclic amines formed during BBQ. It has an effect on allergenic responses to proteins, which is still under investigation. Optimization in the sense to maximize the desired effects and minimize the undesired effects is an important and relevant activity in food technology. Mathematical models are then very helpful to explore various scenarios from behind a computer, without having to explore it via trial and error, to choose the best setting for delivering high quality food (van Boekel, 2008).

Another research topic in which our group was active was that of proteins in foods, which culminated in a very large, multidisciplinary research project called PROFETAS (an acronym for Protein Foods Environment Technology And Society) (Aiking et al, 2006). The topic of PROFETAS was to investigate alternatives for meat, because also 20 years ago, it was already clear that the anticipated increase in meat production worldwide is not going to help the environment, to put it mildly, and so the idea was to investigate the possibilities for meat alternatives based on plant proteins. The results were published in a number of PhD theses, publications and in a book that was ceremonially handed over to the then Minister of Agriculture, Nature and Food Quality, Cees Veerman. The topic is still very relevant today and will remain relevant in my view. PROFETAS was the nucleus and set the agenda for interdisciplinary research in this and other fields. That interdisciplinary research is not always easy, became apparent from a quote that I took from one of the PhD students, cited here:

"Profetas brought me both joys and frustrations, for which the source of frustration was perfectly depicted at the Heidag (Retreat Day) when we had to draw our image of Profetas. The technologists drew processing machines, food, money and happy consumers. The social scientists drew pigs under a black stormy sky, and children eating pea burgers in a meadow of wild flowers under a blue sky. What a marvellous eye opener it was to the great divide that has to be crossed to achieve integration in scientific research."

After 5 years, the PROFETAS project ended, but it sparked a lot of new research later, for instance with insect proteins and other sources, and it also sparked entrepreneurship on meat alternatives. And it makes me proud to see that the Netherlands is now one of the leading countries in this field.

Another type of research that our group became involved in was, to some extent, a logical continuation of PROFETAS, namely in multidisciplinary research projects,

where we worked together with plant breeders, agronomists, nutritionists, economists, ecologists, sociologists. It was about food sovereignty (the TELFUN project), about Quality in African Food Chains (the CoQA project), projects about the effects of climate change on safety of fresh produce (VegiTrade project), about the effects of satiating foods (the Sensory Satiety project), and several more. Really a multitude of different types of projects. This cooperation between natural and social sciences was very inspiring, and indeed relevant to understand what goes on in the food chain. We became involved in food and nutrition projects, also in developing countries, notably West Africa, but also India and Ecuador. As a personal experience, I was captivated by the enthusiasm and hunger for knowledge from students in those countries, and the work we did there together, broadened my scope and it helped me to put food technology in a broader, global perspective.

Perception

The story so far was about developments and achievements in food science research, about which I am quite proud, as you noticed. Yet, the perception of the general public is that all is **NOT** well with our food, so there seems to be a discrepancy here in perception of the general public on the one hand and scientific insights on the other hand. The notion how it was in the earlier days seems to have been forgotten, with food shortages, deficiency diseases, food poisoning and infections; the achieved benefits are not recognized anymore and the present situation is taken for granted. Earlier times are considered with some sense of false romanticism that everything was much better in grandmother's day. There is this quote from the American food writer Michael Pollan: "Don't eat anything your great-great-grandmother would not recognize as food" (Pollan, 2009). Well, I tend to disagree with him. There is enough evidence from historic accounts that the food situation was not so good, say, 100 years ago, and most grandmothers would have been quite happy with the present situation. This attitude bears some resemblance with the present discussion on vaccination, people seem to have forgotten how dangerous infectious diseases can be and how that can ruin lives. Because vaccination was such a success, the need to continue with that is not seen anymore. A similar reaction seems to have happened with regards to food: the quality is so good that people do not see any more how much worse it was, or still is at other places in the world, so the perception of the public and scientists is definitely not aligned.

I became confronted with such different perceptions after my inaugural lecture in 2001 (van Boekel, 2001). The statement I made there that organic food needs processing and that processed food is not worse than what people consider as natural food was headline news, with some examples in Figure 5.

Vers voedsel niet beter dan uit blik

door Kaspar Kloijn

WAGENINGEN, vrijdag

Telegraaf 21-9-2001

deVolkskrant

Voorpagina | Nieuws & Achtergrond | Columns & Opinie | Video | Wetenschap | Mensen | De Gid

Leve de Pizzakoerier

Studenten hoeven niet te wanhopen als ze niet elke dag vers, ambachtelijk en natuurlijk koken. Er is niets mis met eten uit de muur, meent hoogleraar Tiny van Boekel....

tekst Mac van Dinther 25 september 2002, 0:00

EEN STRIKVRAAG. Wat is gezonder: een rijpe tomaat, vers van het land, of een blikje tomatenpuree? Simpel. De verse tomaat natuurlijk, sappig, zongerijpt en barstensvol vitaminen. 'Mis', zegt Tiny van Boekel, hoogleraar bij het Departement Agrotechnologie

Figure 5. Some headlines from newspapers after the inaugural lecture in 2001

It marked the start of a totally unexpected career in the media, with interviews in journals, TV, radio, and it also resulted in invitations to speak at all kinds of meetings with consumers. I actually enjoyed this a lot because of the opportunity to share expertise with the general public. However, the phenomenon of the then upcoming internet and social media caused a sort of alternative counter force, opposing the belief that we had made great progress in the past 100 years thanks to food processing. In 2016, another interview was published in which I basically said the same thing as in 2001: there is nothing wrong with processing. This time hell broke loose. The reactions on social media were heavy. Here I show you two in Figure 6:

dick soek @dicksoek · 14h

@foodlog_nl Wij noemen dat een oetlul !!!

3 4

Harmen Ligthart @HarmenLigthart · 13h

@dicksoek @foodlog_nl iedereen in dit land heeft toch recht op een mening?!?! Nou ik ook: ophangen zo'n vent!

1

Figure 6. Two reactions on twitter after an interview in 2016

"Oetlul" means something like "dickhead", and the second tweet reads: 'everyone in this country has the right on his opinion, don't we? Well so do I: hang this guy!" And another reaction was that I was bribed by the food industry to tell such a story, as displayed on a website (Figure 7).

Figure 7. Headline on the internetpage http://supermarktgeheimen.nl/. In translation it reads: bribed professor: "Natural food is unhealthy"

So, the transformation from a shy student in 1970 to an alleged criminal professor in 2016 (see Figure 8) is a remarkable shift, to say the least.

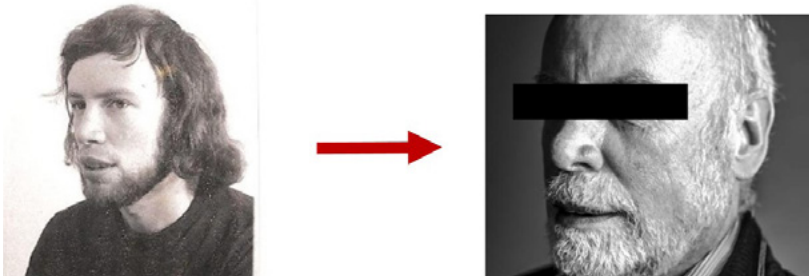

Figure 8. Transition from student to professor

Going from this personal experience to a more general observation, it is clear that the perception of people about food is rather different from scientists like me. What strikes me most is that people dare to make statements without any proof, or any attempt to at least discuss the difference in opinion. It looks almost like a religious belief about food, a belief that cannot be questioned anymore and everyone who dares to do that anyway, needs to be excommunicated, at the least.

This, Ladies and Gentlemen, is all about perception and framing. Facts and fiction seem to mingle and it results, apparently, in dogmas. Ok, now I mentioned the word fact, time to discuss that aspect of the title.

Facts

What are facts? Nowadays, thanks to President Trump, we are confronted with facts and alternative facts, rather confusing, but a fact, I would say, is something, a phenomenon, that is accepted by everyone. So, if someone drops a pencil, it will fall to the floor. We can safely call that a fact. Why? Because everyone can see that it happens and everyone can repeat it, so reproducibility and being able to check facts is an important factor. Now, let's make it a little bit more complicated. If foods are consumed containing a lot of saturated fat, blood cholesterol levels will change, that is a fact because you can measure that and if you repeat it with many people, you will see, by and large, the same thing happening. But, and this is important, it will not happen in exactly the same way. In other words, there will be some variation between people, but a general trend may still be observable. It is important to realize that this variation causes uncertainty, so now we talk about facts but apparently with a bit of uncertainty. Let's continue with this example. Is it now also a fact that consumption of saturated fat will affect health? Well, that may not be so clear anymore, one of the reasons being that health is not only depending on saturated fat, or depending on how much saturated fat people eat, or perhaps the effect depends even on the food in which the saturated fat is present (Astrup et al, 2019). So, these kinds of facts make the situation rather complicated and it adds to the uncertainty. So, how do we deal with that in science?

Science is about proposing theories and hypotheses, searching for evidence for such a hypothesis (or for evidence against it, if we follow the philosopher Popper), but anyway, combining a hypothesis with evidence leads to conclusions. Some people call such conclusions scientific facts but, personally, I do not like that so much because these conclusions are definitely not carved in stone. They only reflect what we think is most plausible with our current knowledge. At this point, I would like to introduce to you the Bayesian concept, which was also addressed in my inaugural lecture in 2001, but let me refresh your memory. Figure 9 shows a picture of Thomas Bayes.

Figure 9. Picture of Thomas Bayes.

Thomas Bayes was an English clergyman living in the 18th century, who put forward a theorem, now known as Bayes' theorem, about probability:

$$P(hypothesis|data) = \frac{P(data|hypothesis) \times P(hypothesis)}{P(data)}$$

Don't bother about the mathematics, but to me, philosophically this equation puts science and facts in perspective. The reason I am showing this equation is to make clear that probability is an important concept in science. Let's analyse this equation in plain English. You see two keywords here, data and hypothesis, while the P stands for Probability or Plausibility, if you like. So, when we start an investigation with a hypothesis, we are not sure that our hypothesis is correct. Think of it: if we were 100% sure, we would not need to investigate it any further, it means we know everything there is to know. But this will usually not be the case, so, there is some uncertainty when we start, expressed in probability. It is the same type of probability that we use in our daily life when we say that the plausibility that it will rain tomorrow is 60% or so. Let's take up the example of the falling pencil again. We all know now, of course, that an explanation for the falling pencil is the law of gravity, described by Isaac Newton. But we cannot see this law of gravity, it is unobservable, we can only see the dropping pencil. The beauty of Bayes' theorem is that it allows us, quantitatively, to state something about the plausibility of a hypothesis / theory that we cannot observe, by connecting the probability of the data and the hypothesis as shown in the equation. If the measured data do not correspond to what the hypothesis predicts, it means that the confidence in the hypothesis will decrease. If, however, it corresponds largely with what we measure, then the confidence will increase. In this way, we can update our knowledge. With a high probability, given the measured data, we tend to say that it is scientifically proven, but please realize that there will always be some doubt. And this is how you should interpret scientific facts: it is a probability statement about a theory or a hypothesis. A new theory using the same data can lead to a higher probability than an older one. That the pencil falls is a given fact, so the data does not change. However, the theory with which we explain that phenomenon may change. The probability of the theory of Newton can thus be compared to that of Einstein's law of relativity. Such comparisons happen all the time in science, and that is how science progresses, with a lot of debate and discussion as it should be. The pencil example is of course a metaphor for other theories, like the cholesterol hypothesis we talked about earlier, I hope you get the picture. This updating of knowledge is the reason why nutrition advices change over time: new hypotheses are proposed and may lead to new insight. So, in my view, this is how we should interpret scientific facts, considering the plausibility of theories. Moreover, application of Bayes theorem forces scientists to make their assumptions explicit about their hypotheses and this opens up room for discussion, even about what scientists call a paradigm, a framework in which some assumptions are accepted without discussing them anymore. But let me be clear: assumptions are not the same as fiction.

Fiction

It is high time to talk about fiction, one of the words in the title of my lecture. The essential part that makes science different from fiction is the combination of a hypothesis with evidence from data. And I should add: the use of reproducible evidence. In science there is the obligation to state your assumptions so that everyone else can repeat what you have done, and allowing to disagree with the assumptions made. What then is fiction in the scientific context, you may ask? I would say that if you propose a hypothesis, or a theory, or a statement, but you do NOT provide reproducible evidence for it, then it becomes fiction. To illustrate my point, I show an example that I found from a Dutch website about the effects of chitosan, a compound that is present in the skeleton of shellfish and insects (Figure 10).

A brief translation in English from the Dutch website reads: "Chitosan binds fat in the stomach and intestine, so that the fat cannot be used anymore by the body. It also has a positive effect on cholesterol." This is a clear hypothesis, well done I would say. But what about the evidence? The website gives a scientific source on which this statement is apparently based, also well done. However, when I looked up that scientific reference I read in its conclusion:

"The limited information currently available indicates that chitosan is not effective in weight management without concurrent lifestyle and dietary modifications. in maintaining weight loss. (….) Similarly, chitosan's impact on serum lipid levels, if any, needs to be confirmed by large and rigorous clinical trials. The studies performed thus far suggest that cholesterol benefits are linked more to subjects' weight loss than to chitosan." Source: Am J Health-Syst Pharm—Vol 60 Jul 1, 2003 1315

So, there is absolutely no evidence for this hypothesis; in Bayesian terms, the plausibility that "chitosan is a fat eater" is extremely low, which makes me conclude that this statement is fiction. This is just one example of the many you can find on the

Figure 10. Picture taken from the website http://slankr.nl/afvallen-met-pillen-top-5-wetenschappelijk-bewezen-supplementen/

internet, mostly not supported by any evidence, let alone a source to look up the details. They usually have a simple message and that makes it probably appealing to the general public, and not the much more complicated story that science has to tell with associated probabilities that are hard to grasp. And that is what makes it troublesome: people tend to believe this kind of nonsense because of the simple message and turn away from science with its complicated message. Fiction seems to rule at the expense of facts!

Another type of fiction that bothers me comes from the food industry, especially about marketing and advertising food. There, the suggestion is made that food is produced in an artisanal way, like in the old days, with grandma's busy preparing food. In reality, of course, it is high-tech production. Maybe it is obvious that advertisement is fiction but nevertheless, fiction it is and I am afraid that in the long run it will have a negative effect when consumers find out what the truth is. Why not be proud of technology? As long as an honest story is told, I think consumers will understand that high-tech is there to ensure food safety and food quality. Yet another type of fiction is the so-called clean label policy where the industry is responding to the fear of consumers for additives, called e-numbers. The response of the industry is to search for alternatives that do not need to be labeled. However, e-numbers have a function in food, they act as preservatives or as gelling agents, or as anti-oxidants, or as flavourings. A striking example is MSG (E621, mono-sodium glutamate), which is probably the most hated e-number. It can be replaced by yeast extract. There is nothing wrong with yeast extract but it does contain MSG, but needs no MSG labelling anymore. The label is clean but the fiction is the suggestion that it is free of MSG, which is not true. These kind of actions will not regain trust, maybe in the short run, but not in the long run. In my view, the food industry is shooting in its own foot.

Yet another point that comes close to fiction is the present discussion about ultra-processed foods in relation to obesity. Let me explain why. What is meant by ultraprocessed food? Some Brazilian nutritionists have made a classification into 4 groups, called the NOVA classification (Monteiro et al, 2018):
It proposes 4 classes:

1 Unprocessed or minimally processed foods. Examples are edible parts of plants and animals, frozen and cooled products, dried fruits
2 Processed culinary ingredients. Examples are salt, sugar, honey, oils
3 Processed foods. Examples are canned fruits and vegetables, salted nuts, cheeses, bread
4 Ultra-processed foods. Examples are carbonated drinks, energy drinks, breakfast cereals, pizzas, infant formulas, cookies, cakes, pastries

My criticism to this classification is that it puts the blame on processing, and also leads to very strange classification results, for instance, that products like infant formulas are classified as ultra-processed, with the advice to avoid them. Some scientists embrace this concept and advocate its use, leading to debate in the scientific literature (Gibney, 2017, 2019, Hall et al, 2019). Some nutritional guidelines are even to avoid processed foods as much as possible. To me, that sounds like throwing away all the benefits that we have achieved in the past century. The problem, of course, is confusion about the word processing. If people cook, they are processing, basic products as bread and cheese are processed foods, and whether it is processed at home or in a factory does not matter too much in terms of nutrition. The problem is not in processing, but in the composition and marketing of certain products that do not contribute to a healthy diet. One type of criticism on processing that I take seriously is that we may have gone too far in refining raw materials; lack of fibers in the diet is causing problems, also in relation to the microbiome in the gut, and we know now very well that the microbiome is extremely important.

I am not denying that there is a link between obesity and industrialization of food production over the past decades. Thanks to food technology, we have the means of producing enough, safe and high quality food, but it has also led to the situation that the market is literally saturated with food, at least in the Western world. The abundance of food, the marketing of it, and the distance between production and consumption, has led to a situation where people have lost the connection with food, and even worse, it has led to an obesogenic society, meaning that people are tempted to eat at any time and at any place at low cost. It is difficult to resist this temptation, and people tend to overeat themselves, and make wrong choices in their diet. The result is that obesity is now one of our main nutritional problems, which is very sad, considering the situation where we came from 100 years ago. And, by the way, another important factor that stimulates obesity is the drastic change in lifestyle over the past 50 years or so, it is not just the food. But people are blaming the food industry as a culprit for this situation. It is not my job to defend the food industry, I actually criticize them a lot, but I don't think our nutritional problems are mainly caused by the food industry as such. In my view, it is a much broader societal problem, partly caused by our economic system, in which also consumers and citizens have an important role to play. And it is not just the food industry that leads to an obesogenic society, it is also the presence of snack bars, food at petrol stations and train stations, etc. The marketing of products that do not contribute to healthy diets is a consequence of the free market that we have. One cannot blame industries for making profits as long as we want this economic system as a society. Obesity has become a multifaceted problem that will not be solved by blaming processing. In fact, I do not think we can blame anyone particularly for that, it is an undesirable

consequence of our affluent society. It has become more of a societal problem than a technological problem. So, here you see my development from a technologist to some sort of a sociologist.

My criticism towards the food industry is mainly the lack of transparency in telling an honest story to the consumer about what is done with the food and why it is done in that way. The result is distrust on a large scale and a consumer perception of an industry only wanting to make money at the expense of the consumer. If an honest story would be told, and if consumers would be much more involved in what they really need, then this distrust will gradually disappear. I mean a real dialogue. For example about e-numbers, why not be open about why e-numbers are needed, and explain what will happen if they are not used. If consumers don't want preservatives anymore, fine, but tell them then that the risk for food poisoning increases; in other words, show the costs and the benefits of using e-numbers. Transparency about these matters is badly needed. Nutrition education starting already at primary schools is also important in this respect.

The focus on presumed unhealthy products has led to development of, for instance, low-fat or low-cholesterol products. But this has clearly not solved the obesity problem, it might have even worsened it because the focus on fat reduction has led to an increase of carbohydrate consumption (Giugliano et al, 2018, Smith et al, 2017, Astrup et al, 2019). The presumed unhealthy effect of (saturated) fat is not so clear anymore, as recent research shows that the health effect may well depend on the product, and the composition of the total diet (Deghan et al., 2017, Feeney et al, 2018). This is called 'the matrix effect', by which it is implied that nutrients are present in a matrix and do interact, and as a result of that, the effects on health are not straightforward to predict, based on the presence of nutrients and calories. A calorie is not a calorie, it really matters where calories come from (Mozaffarian, 2018). Much more attention should be given to the complexity of food with all its interactions between nutrients, in the food but also in the body. In my view, there are no unhealthy or healthy products but there are healthy and unhealthy diets. Apparently, it has become difficult for people to go for healthy diets. Of course, we have learned a lot about nutrients in the past and we should not throw away that knowledge. Rather, it is time to update our knowledge. In this respect, I would like to make a plea for much stronger cooperation between food scientists and nutritionists. Dear nutritionists, let me be clear: processing does have an effect on nutrition and health, but not necessarily in a detrimental way, it can actually be quite beneficial in terms of safety, digestion, of producing foods that fit in a healthy diet, and sustainability. Ever since I was a student, I have been amazed about this divide between food technology and nutrition, fortunately I see the two coming closer together nowadays.

It is time for a paradigm shift from thinking about nutrients and calories as the explanation for everything, to a paradigm where composition of diets is much more important (Mozzafarian, 2018). Working together on that paradigm shift with technologists and nutritionists is necessary while taking the general public with it in a societal discussion about how we want to organize our society in terms of food production. New insights following from this approach may have large consequences for the food industry on how to develop and design food, going from a reductionist approach to a more holistic one.

My message is that processing of foods should not be avoided. Optimal processing should be the keyword in relation to food safety, prevention of food waste, sustainability, affordable, bioavailable products that contribute to a healthy diet. The focus should be on food processing in relation to the quality of the diet, and the food industry should not be made a problem but part of the solution. And this becomes pressing because we are faced with many challenges the coming decades: how to produce sustainably produced healthy diets. That brings me to the topic of sustainability.

About sustainability

The big challenge coming up is how to feed the world in a sustainable way, perhaps the biggest challenge mankind is facing now, even though this does not seem to have overwhelming political attention. The recent Lancet paper "Food in the Anthropocene" drew some attention but not too much (Willett et al, 2019). A quote from this paper reads: "A global transformation of the food system is urgently needed". The challenge is actually twofold: how to produce healthy diets and how to do that sustainably? We do not have clear-cut answers to these challenges, I am afraid. The Lancet paper analyzed the situation quite well, I think, but it also does not really provide a way out. The current attempts of the Dutch Minister of Agriculture, Nature and Food Quality to go for a circular agricultural economy are strongly linked to this.

If I put on my pessimistic hat, I am inclined to think that the problem will solve itself over the years: with our scarce resources, we will have less food available, and as a result the obesogenic environment will disappear by itself, because there will not be enough food worldwide. If that happens, however, I think this will happen with a lot of societal turmoil that may even lead to wars in the fight for scarce resources. But now I am very pessimistic. If I put on my optimistic hat, I am inclined to think that we can find science-based solutions, provided that there is political will to go for a global transformation. Social innovation is badly needed,

next to technological innovation: it requires an agricultural and food revolution, as mentioned by the Lancet paper. We will need all actors involved, farmers, processors, consumers and governments, we will need to connect local and global scales.

Summing up

Ladies and Gentlemen, in the beginning of my lecture, I asked you the question about what you consider facts and fiction, what your perception is of the situation. Let's see if we have a glimpse of some answers now. To sum up this story about food, facts and fiction: let us not throw away the many beneficial developments that we have seen in the past century; I would consider it a fact that over the past 100 years or so we have greatly improved on food security, food safety and food quality, in short on nutrition security. This was achieved by applying science and technology. I consider it fiction that processing is the cause of our present problems with food. However, let us not close our eyes for the new problems we have created. The abundance of food, leading to an obesogenic environment, resulting in the worldwide rise of non-communicable diseases, the impact that food production has on the environment, the need to feed 9 billion people, maybe more, in just a few decades: these are enormous challenges. It is my perception that we have the tools to face all these challenges, but it is also my perception that the key is not only in technology, but also in social innovation. As a society, we really need to rethink our current way of food production and we need to do that from a societal perspective: what do we strive for as societies with our food systems. When I started this journey in 1970 as a young student in food science and technology, I could not have predicted what I am stating now: social innovation is equally important as technological innovation. Social innovation is also much more challenging, but for that very reason, technologists need to be engaged in the societal debate, perhaps at the risk of being hanged for their viewpoints.

Last words

Saying farewell to my position at WUR is not my strongest point, that has not gone unnoticed. Retirement is not something I was looking forward to and I managed to escape initially. In education, this is called procrastination (uitstelgedrag in Dutch). I admit that I suffered from that. I cannot express it better in words than in a song from the Band, the refrain from The Last Waltz:

It's the last waltz
The last waltz with you
But that don't mean
The dance is over
It's the last waltz
The last waltz was through
But that don't mean
That the party is over

The Last Waltz refrain, ©Robbie Robertson, The Band

Yes, today is my Last Waltz, but I find some comfort in the lyrics that the dance and the party is not over. I did some soul searching as to why do I find it so hard to say goodbye? One answer is: because the WUR is such a fantastic place to work. It is about science and education and about things that matter: food, environment, livelihood. Another reason is that it is fantastic to work with young, enthusiastic and motivated people, called students. I am definitely going to miss that. It has been great to work with so many inspiring people, inside and outside WUR. It's an impossible task to mention all of them, many of them are present here today and I am grateful for your presence. Let me mention just a few, my promotor, the late Prof. Pieter Walstra has been a great source of inspiration, I actually learned to do science from him, it was a situation where we grew from a master-student relation to friendship. I also want to mention Wim Jongen, who really boosted my career in many ways but especially inspired me to go for the societal debate since I became full professor. The former Rector Bert Speelman was so brave to appoint me as professor back in 2001, for which I owe him thanks. His successor, Rector Martin Kropff had an important effect on my career by taking me away from my chair after 11 years, to become Dean of Education, a decision I found very hard to take but has eventually given me great pleasure because it opened up a completely new world for me, a world that I liked a lot because I saw so many people so committed to making sure that Wageningen University is the best in education, the first and foremost task of a university. And I would like to thank also his successor Prof. Arthur Mol who gave me a lot of trust and responsibility as Dean, and who did not kick me out immediately at retirement age but made it possible that I could continue for some time as a special professor in Dairy Science & Technology. Then, I would like to thank all my coworkers from my previous chair group PDQ, Product Design & Quality Management, now FQD, Food Quality & Design. I do realize that the success that we had was due to your hard work, ideas, commitment and perseverance. It gives me enormous pleasure that I could come back to the chair group after I retired as Dean of Education, I will never forget the warm welcome back that you gave me, and still give me to this day. By thanking the current chairholder, Prof. Vincenzo Fogliano, I actually thank all of you for an inspirational and enjoyable

working environment. Vincenzo, I was very happy that you were willing to take over my position as chair holder when I became Dean. We knew each other already since the early 90's when we worked together on several EU Maillard projects and I knew that the chair group would be in good hands. I also would like to thank you for your hospitality, that I can stay as a guest worker at FQD, after the university said that I really had to retire last April. So, officially I am retired but unofficially I can still continue thanks to your gracious hospitality, so the last waltz is through but the party is not over yet. I also would like to thank the students I worked with, especially the PhD students, far too many to mention them by name, but let me assure you that working with you has been the highlight of my career. I learned a lot from working with you, it was very inspirational and it also led to close friendships, thank you for the trust you gave me. Colleagues from the cluster of Food Science, from the Science Group Agrotechnology & Food Sciences, also you were a pleasure to work with, in a friendly and cooperative way. In fact this is true for the whole Wageningen University & Research community, I had the privilege to work with many of you in quite a few interdisciplinary projects, and that was a great joy. I am definitely going to miss that!

Then there is my family and family-in-law that I would like to thank, for families get together in Brabant and beyond. You kept me with both feet on the ground with your humor and hospitality. And last but not least, my wife Corrie. Again, I would like to play a song fragment, Girl from the Beatles:

Is there anybody going to listen to my story?
All about the girl who came to stay

Girl, ©Lennon-McCartney, The Beatles

Well, you came to listen to my story, thank you for that, and Corrie was the girl who came to stay. I met her on the 21 February 1971, around midnight, so we know each other already for more than 48 years. She has been my companion over the years, and a critical one I may add, she told me what to do and what not, I admit that I did not always listen to her advice, but she was very supportive, also by the way, in giving useful suggestions for this lecture. I realize that she has given me a lot of freedom to do what I wanted to do. My dearest Corrie, I also realize that you had a different perception of retirement than I have. You sometimes wondered whether I was married more intimately with the university than with you, but let me tell you here in public: you are my first and only love, and that is a fact, not fiction. Ladies and gentlemen, thank you for kind attention. Ik heb gezegd!

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Prof.dr M.A.J.S. (Tiny) van Boekel and his wife
Corrie van Boekel-Tholen

'Nutrition security has improved substantially over the past 100 years or so. Even though, people seem to be worried about the current industrial food production and there is distrust. Meanwhile, new challenges arise because of increasing obesity and sustainability issues around the food production system worldwide. Social innovation appears then equally important next to technological innovation. The role of science and technology in distinguishing facts from fiction should be seen from a probabilistic perspective: what is the most likely explanation for observed phenomena.'

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