

# Food, Nutrition & Behaviour



Research for healthy eating, healthy living



**WAGENINGEN UR**

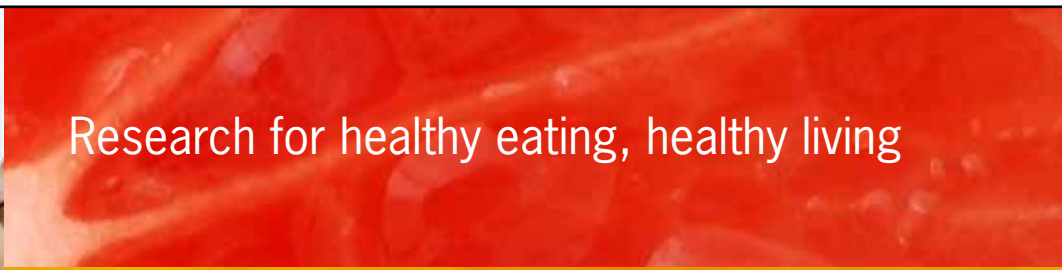
*For quality of life*



# Food, Nutrition & Behaviour



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*For quality of life*



Food consumption and lifestyle directly impact nutritional health and well-being in everyday life of today's consumers. This provides enormous challenges to both consumers and professionals. For consumers, food choice is determined by habits, lifestyle, preferences, taste, etc., albeit largely unconsciously. The professionalized food chain serves them with an abundance of plant and animal foods, provided by a world wide web of production, processing, packaging and distribution that simultaneously shapes the lives of the workforce involved. This not only affects well-being and life expectancy of individual consumers, but also the disease burden and health care expenses of societies in today's global village. In this context, our mission '*to explore the potential of nature to improve the quality of life*' translates into R&D that aims to improve physical, mental and social well-being, and that contributes to reducing the societal burden of disease. Ultimately, people must be enabled to make well-informed choices, consume nutritious foods and live healthier lives.

The challenges with respect to food and nutrition, health and behaviour, require innovations both in scientific knowledge as such, as well as its translation into societal practice. Knowledge and technology gaps between food technology, nutritional, clinical and behavioural research, inspire the development of innovative concepts; viable market concepts are identified by cooperation with partners from food industries, life science companies, medical universities, multinational food companies, etc. In the public domain, challenges in determining, advocating and implementing healthy dietary patterns require collaborative research efforts with public and private parties; this ranges from strengthening evidence-based national and European food and nutrition policies, up to evaluation and fine-tuning of dietary interventions in daily practice of hospitals and community health services.

# Preface

The physical proximity and close collaborations of Wageningen UR (University & Research centre), the Top Institute Food and Nutrition, Food & Nutrition Delta, the hospital Gelderse Vallei, governmental bodies, the academic collaborative centre Agora, and R&D intensive companies provide a knowledge infrastructure ready to face the challenges of the future. We call this the golden triangle of business, knowledge and policy, and it works.

This brochure illustrates this range of research activities in the domain of food and nutrition, lifestyle and health. It does so by providing examples of collaboration with our partners in the public and private sector. We hope it inspires to explore new roads, to renew knowledge, and to innovate products and practices.

Prof Dr Martin Kropff  
Wageningen UR





From the emergence of agriculture to today's global food chains much has changed in the way foods are made and reach our plate. The importance of food to nourish us, to comfort us and to bind our societies has not changed. Never before in history has the production and availability of safe and nutritious food been as high as it is today. Currently more than half the world population lives in cities, steadily growing to 65% around 2030, fully depending on a steady supply of food. Many developments has made this situation possible, from improved farming, processing and logistics technology to cheap oil and globalised markets. Wageningen UR research has played an important role in taking the agrifood chains to the next level of productivity and competitiveness, with a strong agrifood business in The Netherlands as one of the results.

However, everything comes with a price. While 75% of people in the western world have been or are on a diet, hunger has not been eradicated at all. In fact, in 2009 the overweight and obese population equalled the malnourished population. Today's challenges are found in the abundance of cheap, unhealthy foods on the one hand, and the environmental impact of food production on our planet's resources. This brochure highlights our research and innovation, our ideas, and our challenges in contributing to a world with healthy foods for healthy lives.

In three chapters we demonstrate that joining forces of academia, governments and private companies results in efficient and effective solutions for nutrition (chapter 1), food (chapter 2) and behaviour (chapter 3). Our research and innovation lines enable our partners and customers to develop their own strategy and realise their own business goals within the global challenges. The health care cost of poor nutritional status of elderly is estimated at 1 billion euros annually in

# Healthy eating, healthy living

The Netherlands. However, equally interesting are entrepreneurial food and food service companies that approach elderly people as an interesting and growing market and develop meals that are both tasty and nutritious.

Wageningen UR is in a unique position in the domain of Food, Nutrition & Behaviour with depth and breadth, multilevel approach, drive, ambition and the ability to bring stakeholders together in research and innovation programs that benefit all. We hope that the examples shown in this brochure as best practices inspire you to meet and join us.

Prof. Pieter van 't Veer

Charon Zondervan, PhD





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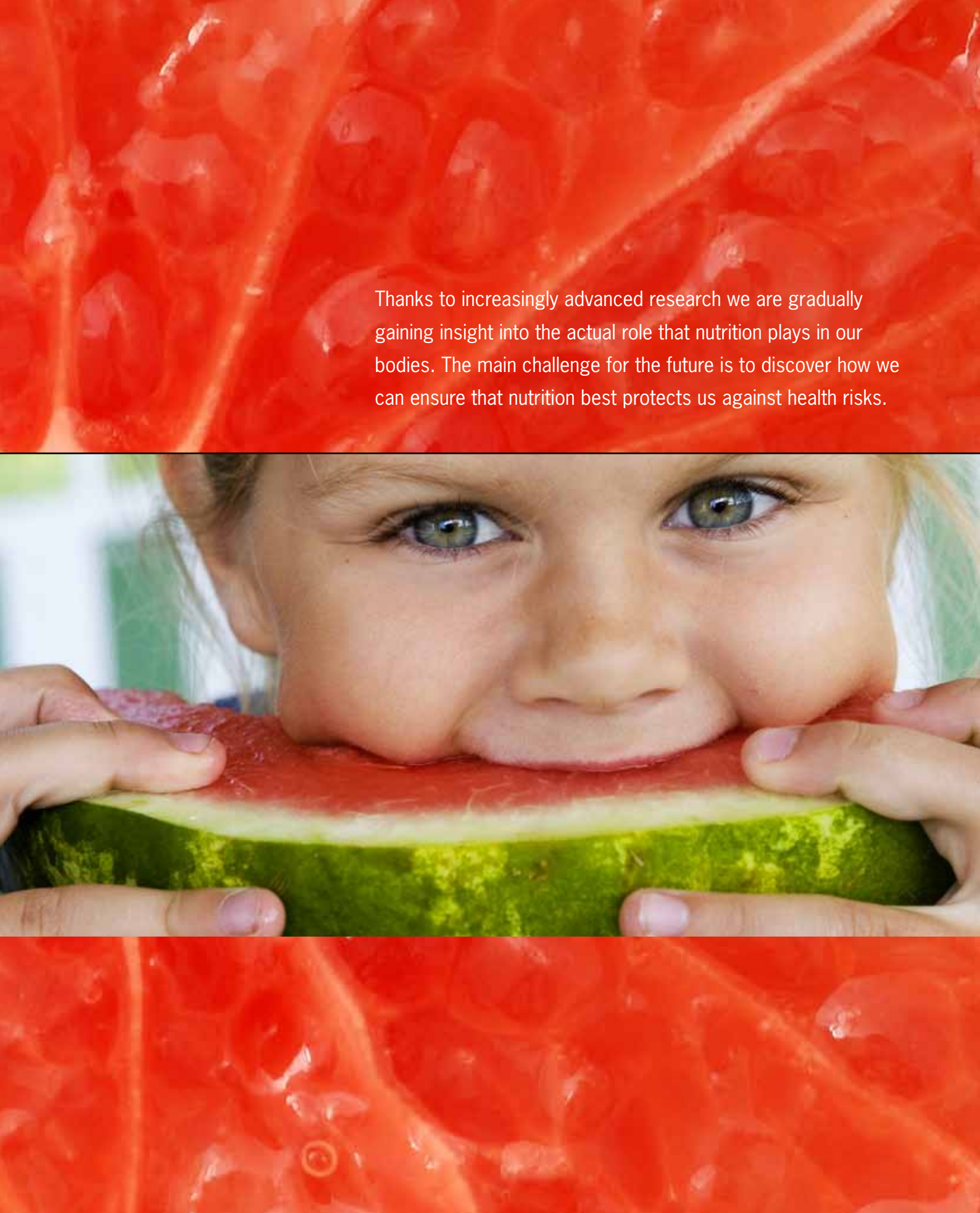


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A young child with light skin and green eyes is shown in a close-up, holding a large, thick slice of watermelon to their mouth. The child's hands are visible, gripping the edges of the slice. The watermelon slice is vibrant red with a green rind. The background is a soft-focus image of more watermelon slices, creating a sense of abundance and freshness. The overall composition is centered and visually appealing, emphasizing the child's interaction with the fruit.

Thanks to increasingly advanced research we are gradually gaining insight into the actual role that nutrition plays in our bodies. The main challenge for the future is to discover how we can ensure that nutrition best protects us against health risks.

# How does nutrition keep us healthy?

A healthy individual requires healthy and varied nutrition. While the availability and quality of food continues to be a major issue in developing countries, the Western world is facing the consequences of excessively calorie-rich nutrition. With food being available everywhere and at any time, Western people eat (far) too much. The combination of an unhealthy dietary pattern and a lack of exercise had led to an increasing number of people suffering from obesity, diabetes and cardiovascular diseases. Various types of cancer have also clearly been related to nutrition and lifestyle.

### **Nutrigenomics**

For more than 40 years Wageningen UR has been revealing insights into the effects of nutrition on health via multidisciplinary research. Over the decades, advanced nutrigenomics technologies have provided us with increasingly detailed information on which physiological processes are started by specific nutritional components and the 'derailing' reactions these components can trigger in cells and tissues. At the same time they have also taught us how nutrition can help the body recover its balance.

We are a world leader in the field of nutrigenomics and play a prominent role in the NuGo EU knowledge network. Nutrigenomics focuses on the effects of individual components and, increasingly of the total dietary pattern on gene expression. It is becoming ever clearer that nutritional components have a larger effect together than they do individually. The challenge is to find which dietary pattern offers the most protection against diseases. Wageningen scientists have drawn some interesting conclusions in this regard. An example is research into elderly people who stick to a 'Mediterranean' dietary pattern (lots of fish and vegetables, few meat and dairy products), which showed that they have a 25 percent lower chance of suffering a myocardial infarction.



### **Nutrition and prevention**

Thanks to nutrigenomics our scientists are discovering step by step the role of nutrition at the smallest possible molecular level. The resulting knowledge can have a major impact on the way we as a society deal with nutrition. In addition, the new technologies are very interesting to the food industry as they can be used to establish the functionality of specific nutritional components in their products. The question now is how nutritional science can be developed so that everyone is protected by eating the right foods. Specialists are already giving specific dietary and lifestyle advice to people from families that are prone to particular genetic diseases. It is expected that, in time, it will become possible to provide bespoke advice based on individual genetic profiles. As a result of this precision nutrition, the meaning of nutrition as a long term preventive measure is gradually shifting towards the effects that medication have in the short term.

### **Elderly people**

The elderly are the main target group within the Nutrition, Health and Behaviour domain of Wageningen UR. Due to the ageing of the population the number of elderly people in the Netherlands will increase considerably. And it is mainly this group that often suffers from nutrition-related diseases. One of the consequences of the ageing population is that a growing number of people will be turning to the health care sector, which is already approaching the limits of its capacity. We are studying how a combination of healthy nutrition and exercise can keep elderly people healthy for as long as possible. In addition to prevention, the research also focuses on the role of nutrition and exercise during and after an illness. There are, for example, various studies that research whether a specific combination of the right interventions might give a positive impulse to quality of life during and after cancer.

With food being available everywhere and at any time, Western people eat (far) too much

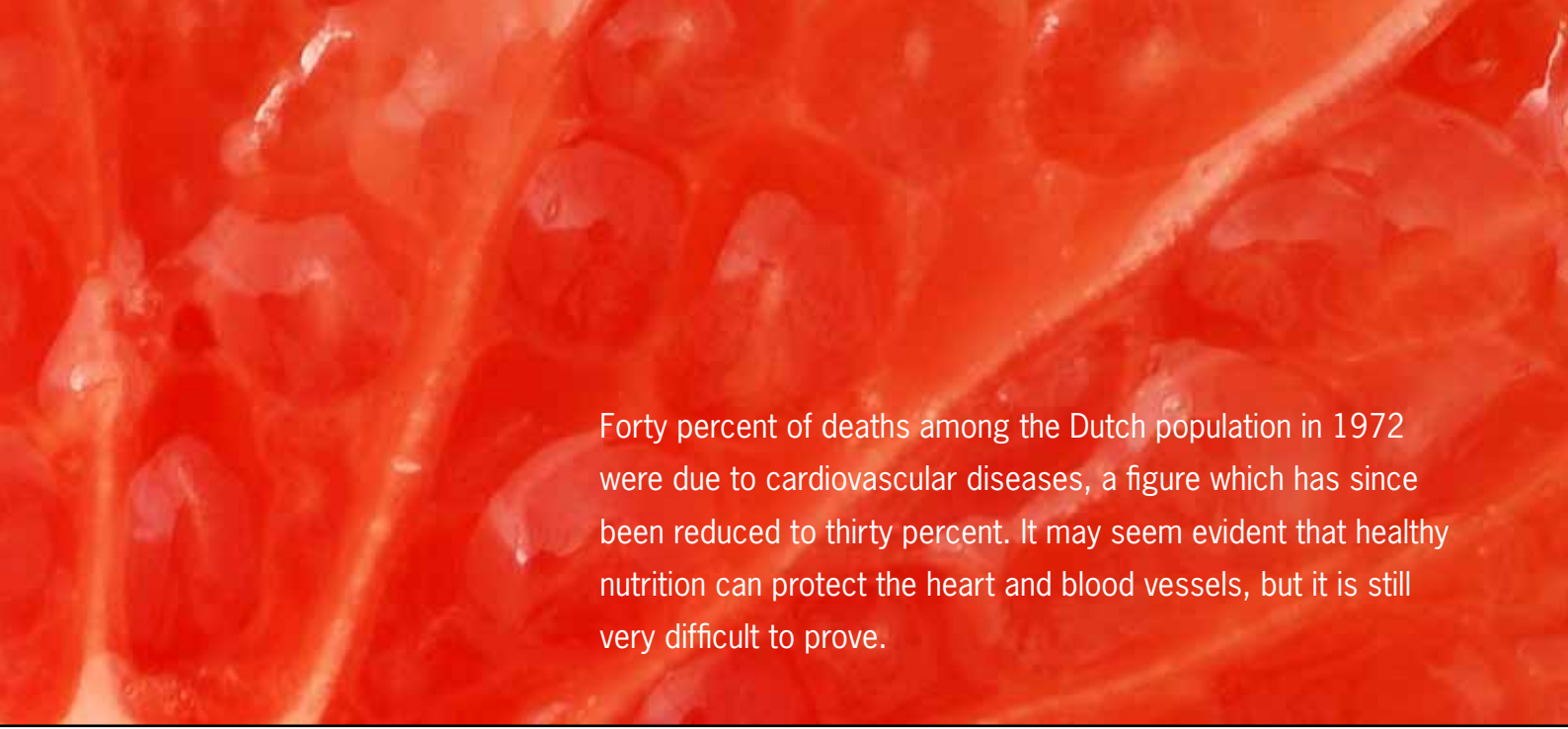
### Exercise

In the world of science, nutrition and exercise are still frequently treated as two separate disciplines. In Wageningen they are explicitly studied together. It is precisely this combination of nutrition and exercise that is necessary to deal with overweight and obesity, for example. A low-calorie diet only affects the fat-free muscle mass, which is harmful to health. By combining both disciplines we study, for instance, how nutrition can contribute to the recovery of the body during and after intensive exercise. Despite the numerous health claims stated on the packaging by the manufacturers, the world still has very little evidence-based knowledge on this subject.

### Nutrition and poverty

The food situation in developing countries is obviously very different from that in wealthy Western lands. Although Western diseases such as obesity and diabetes are also increasingly occurring in poor African and Asian countries due to the influence of Western dietary habits, malnutrition continues to be the major issue. The United Nations aims to have 500 million less people living in extreme poverty by 2015, and reduce the number suffering from starvation by 300 million. We are contributing to these goals via various projects, for example looking for varieties of basic crops with a higher nutritional value (biofortification) and enriching products with essential vitamins and minerals. A special focus is on projects that strengthen food security for children under two and their mothers.





Forty percent of deaths among the Dutch population in 1972 were due to cardiovascular diseases, a figure which has since been reduced to thirty percent. It may seem evident that healthy nutrition can protect the heart and blood vessels, but it is still very difficult to prove.

It is becoming increasingly clear that a combination of nutritional components can have a far greater effect than the individual components

The fact that cardiovascular diseases are less common today is partly the result of a continuous fall in the number of people who smoke. While smoking was the norm for 90 percent of the male population in 1958, now only 30 percent of men smoke. There are other factors involved in addition to the reduced number of smokers. Professor Daan Kromhout of Wageningen UR has been performing research into the relationship between nutrition and cardiovascular diseases for decades. The Zutphen Study, for example, followed approximately 900 middle aged men since 1960. The research showed that those who ate fatty fish every week were at a much lower risk of dying from a myocardial infarction. The research is part of the Seven Countries Study, which also confirmed what had been suspected for a long time: People who regularly eat fatty fish have a lower chance of a heart attack.

### **Alpha Omega Trial**

In 2010 Kromhout and his colleagues concluded the ten-year Alpha Omega Trial, which was aimed at excluding the possibly muddled results from previous epidemiological research and included one third of all Dutch hospitals and nearly 5,000 cardiac patients. It did not find rigorous proof that the Omega 3 fatty acids in fatty fish protect heart and blood vessels. This was partly due to the enormous contribution to public health made by cardiologists over the past ten years. Their percutaneous angioplasties and bypass operations have improved to such an extent that the effect of nutrition is almost impossible to establish. The pharmaceutical industry is also doing its job well: Medicine for high blood pressure, high cholesterol levels and thrombosis have had proven positive health effects. Research into specific risk groups does show, however, the protective effect of Omega 3 fatty acids. It was established, for example, that these fatty acids have a major positive impact on people who had suffered a myocardial infarction as well as diabetes.

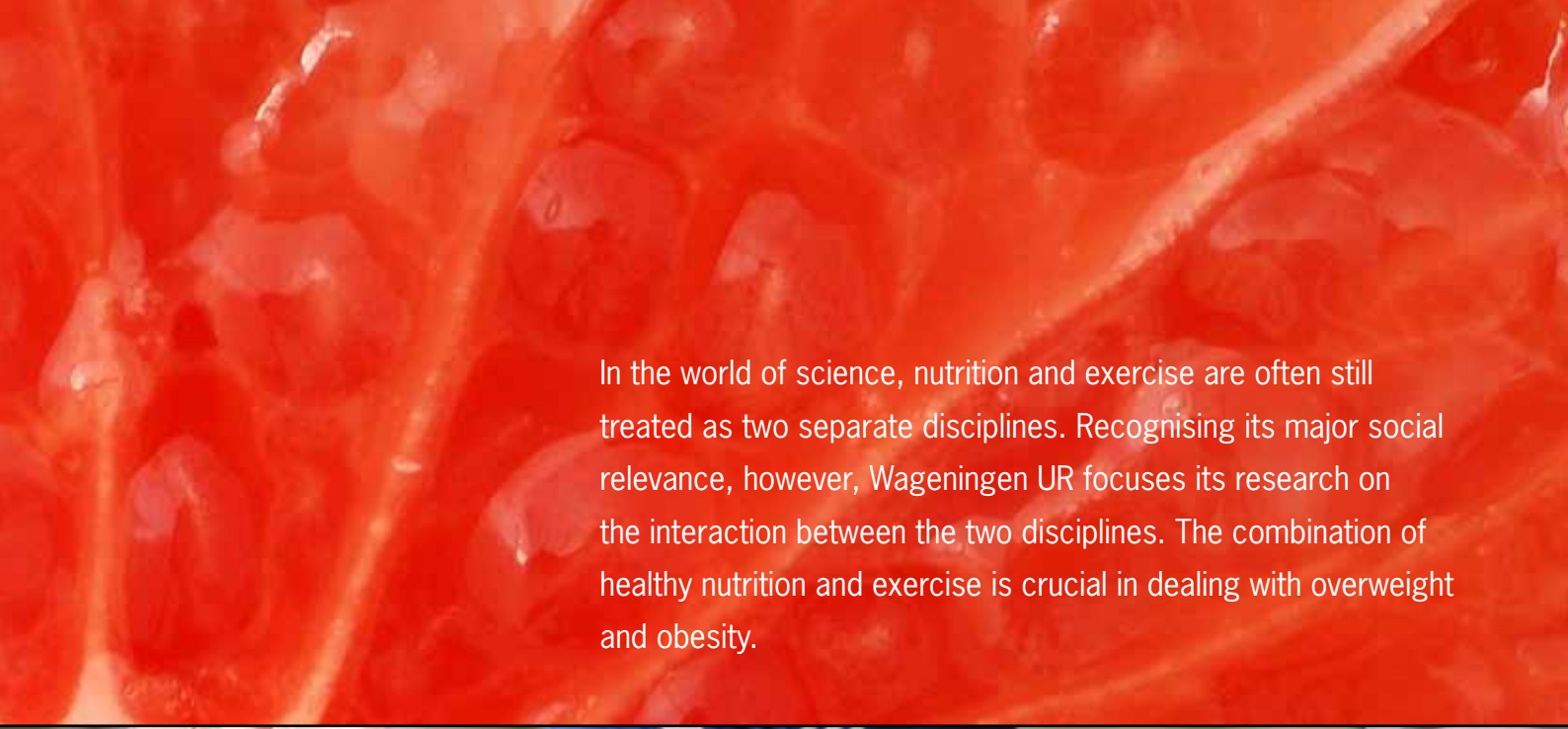
# Food as guardian of the heart and blood vessels



Another major research theme in the field of nutrition and cardiovascular diseases involves elements with a protective effect (flavonoids) that occur in vegetable food products, such as tea, cocoa, apples, onions and red wine. Recent meta-analyses show that these flavonoids reduce the risk of myocardial infarctions and strokes.

## **Dietary patterns**

Follow-up research should provide more certainty about the relationship between nutrition and cardiovascular diseases. Research at the level of individual nutritional components will remain relevant, but there should also be a focus on research into dietary patterns. It is becoming increasingly clear that a combination of nutritional components can have a far greater effect than the individual components. The question is, of course, which dietary pattern offers the best protection against cardiovascular diseases. The Seven Countries Study showed that a traditional Mediterranean dietary pattern reduces the risk of a fatal myocardial infarction compared to a Northern European dietary pattern. An international study among elderly people, the HALE project coordinated by Wageningen UR, resulted in an interesting conclusion: Elderly people with a Mediterranean dietary pattern had 40 percent less chance of suffering a fatal myocardial infarction. A traditional Mediterranean diet includes lots of vegetables, fish on a regular basis, and relatively little meat and dairy products.



In the world of science, nutrition and exercise are often still treated as two separate disciplines. Recognising its major social relevance, however, Wageningen UR focuses its research on the interaction between the two disciplines. The combination of healthy nutrition and exercise is crucial in dealing with overweight and obesity.



For example. A diet not only affects the fat-free mass, but also the muscle mass that can be harmful to health. We also perform research into the relationship between nutrition and more intensive types of exercise and sport.



# Nutrition and exercise


The Netherlands has experienced a major revival of performance-oriented recreational sports, with many people wanting to achieve a top performance at their own level. Running events such as the Rotterdam Marathon and the Dam to Dam run are unprecedentedly popular, and large cycling tours are fully booked within 20 minutes. Although the attention for nutrition among athletes is considerable, relatively little is known about the meaning – and consequences – thereof. Moreover, a lot of unproven opinions on the subject are exchanged on internet forums. For instance, people are often aware that carbohydrates provide ‘fast’ energy but not that the body has a limited absorption capacity. Too many carbohydrates at once can give athletes gastric and intestinal complaints.

## Combination of carbohydrates

There are indications that a combination of various types of carbohydrates can be useful. Wageningen UR is studying whether athletes can enhance their performance during intensive exercise via a combination of glucose and fructose. If this hypothesis is proven it could encourage manufacturers of sports drinks, for example, to change the composition of their products.

More research into the preventive effect of nutrition for athletes is required. Football and volleyball players and other intensive ballgame players run a greater risk of cartilage wear, for instance, which could be prevented by nutrition. And how about the effect of nutrition before, during and after intensive exercise? It is known that the immune function of athletes experiences a dip after an exertion peak. The dip is larger when people exercise on an empty stomach. As a result, it would seem feasible that athletes could make adjustments with nutrition, but it will be a while before the ultimate solution is found.





One in three Dutch people will get cancer, and with 30 to 40 percent of all cancer cases being the result of poor nutrition and overweight, there is a genuine need for knowledge about nutrition and cancer; before and after the diagnosis.



Globally more than 7,000 studies have been dedicated to the relationship between nutrition and cancer, including a prominent contribution from scientists from Wageningen UR. A large majority of these studies are aimed at prevention, and as a result, a relatively clear picture exists of what we should and shouldn't eat and drink: Plenty of vegetables, fruit and fibres, and a limited amount of alcohol and meat. Overeating should also be avoided: A high Body Mass Index (BMI) means an increased risk of cancer.

# Prevention and survival

Some afflictions can also increase the risk of cancer, such as the Lynch syndrome. People with this syndrome have a 60 to 80 percent chance of genetic bowel cancer (compared to the normal five percent). Is there anything we can do in such cases? A recent influential study by Wageningen UR shows that there is. Again, BMI plays an important part: People with Lynch who ensure that their BMI does not exceed 25 can prevent the cancer risk from increasing.


### **Nutrition during illness**

In addition to cancer prevention, our research is increasingly focused on nutrition for surviving cancer. Within this framework, a WCRF project group is looking at the relationship between nutrition and the return of and survival after colon cancer. Another example is an intervention study among women with breast cancer in the research programme of Alpe d'HuZes, which studied the effect of healthy nutrition and nutritional supplements in changing fat distribution after a course of chemotherapy. This changing fat distribution reduces muscle mass and thereby muscular strength. It would be of significant benefit if specific interventions could lead to an optimal quality of life. Moreover, it might possibly prevent other negative effects of changing fat distribution such as diabetes and cardiovascular diseases.

Our research is increasingly focused on nutrition for surviving cancer

### **Similar research, opposite results**

Research results are not by definition always applicable, as was shown by Wageningen research into the protective effect of folic acid against bowel cancer. After a similar study in the US indicated that the positive impact was substantial, folic acid was added as standard to our bread. Our scientists only confirmed these results, however, when they discovered a positive correlation between the protective effect of folic acid and high levels of vitamin B2, which is also added to food products in the US.



The good news is that the increase of obesity in children seems to be slowing down. Nevertheless, over half of the Dutch population is overweight, with 12 to 15 percent having a BMI above 30, with all the associated health risks. This group suffers from obesity, which is difficult to treat. Our focus is therefore aimed at preventing obesity in the first place.

We now know that nutritional fibres can play a major role in prevention. But which fibres?

A trip round the catering facilities of your average a train station in the Netherlands paints a clear, calorie-rich picture of the risk of overweight and obesity. It can be difficult to resist all these temptations - especially if your genetic makeup is sensitive to weight gain, another factor that plays a part in weight issues. What makes matters all the more difficult is that people get used to eating too much; it appears that the receptors in the gastric wall gradually become worse at registering the feeling of hunger and satisfaction. Learning to eat well, in appropriate amounts and at the right speed at a young age (eating fast means that the satiation signal comes too late) is especially important in the prevention of obesity; as is plenty of exercise. For, in addition to eating more, we have also been moving less in general. The solution seems relatively simple as it is only an excess of 100 unburned kcal a day that causes overweight.

### **SLIM, SLIMMER...**

One of the health risks sometimes related to obesity is diabetes mellitus (type 2). The SLIM study by Maastricht University and Wageningen UR showed that people with an increased chance of diabetes can prevent its actual onset by improving nutrition and increasing exercise. The SLIM lifestyle intervention reduced the risk by nearly 50 percent – evidence based, in an experimental setting. SLIMMER, the follow-up research performed by Wageningen UR and GGD Gelre-IJssel within the Academic collaborative centre AGORA, is aimed at developing a practice base that would allow SLIM to be implemented in daily life.

### **Nutritional fibres and protein**

A different branch in this field is the Wageningen research into specific nutrients and their relationship to obesity. As a result of these studies, we now know that nutritional fibres can play a major role in prevention. But which fibres? Proteins

# 100 kcal per day



may have a positive effect on metabolism. But do they? Wageningen UR can approach a subject from various perspectives within a single university and these joint studies have allowed us to acquire a unique position in the scientific world.

### **Pigs with diabetes**

Applicable research results on diabetes control are also achieved via a different discipline within Wageningen UR. Scientists from Wageningen UR have been researching the metabolism of pigs for many years, for instance. During this time they recorded which nutrients pigs need most in specific situations. A healthy piglet needs different nutrients than an adult pig with diabetes. The knowledge we are obtaining via this research can be used to improve the health of sick pigs via adapted nutrition and without medicine. Another benefit is that the metabolism of pigs is very similar to ours, and it is therefore plausible that the knowledge might also be applied to people.

New technologies are making it increasingly possible to chart the complete genome sequence of people and animals to give a new impulse to comparative research.

The Dutch population is ageing, and at quite a rapid rate. Meanwhile, the focus on nutrition and the elderly has also increased considerably over recent years. Wageningen UR has been a leading player in this field of research, which has had its own chair since 1988. The key question is: What should the elderly eat in terms of both quantity and quality in order to age healthily?



# Ageing healthily

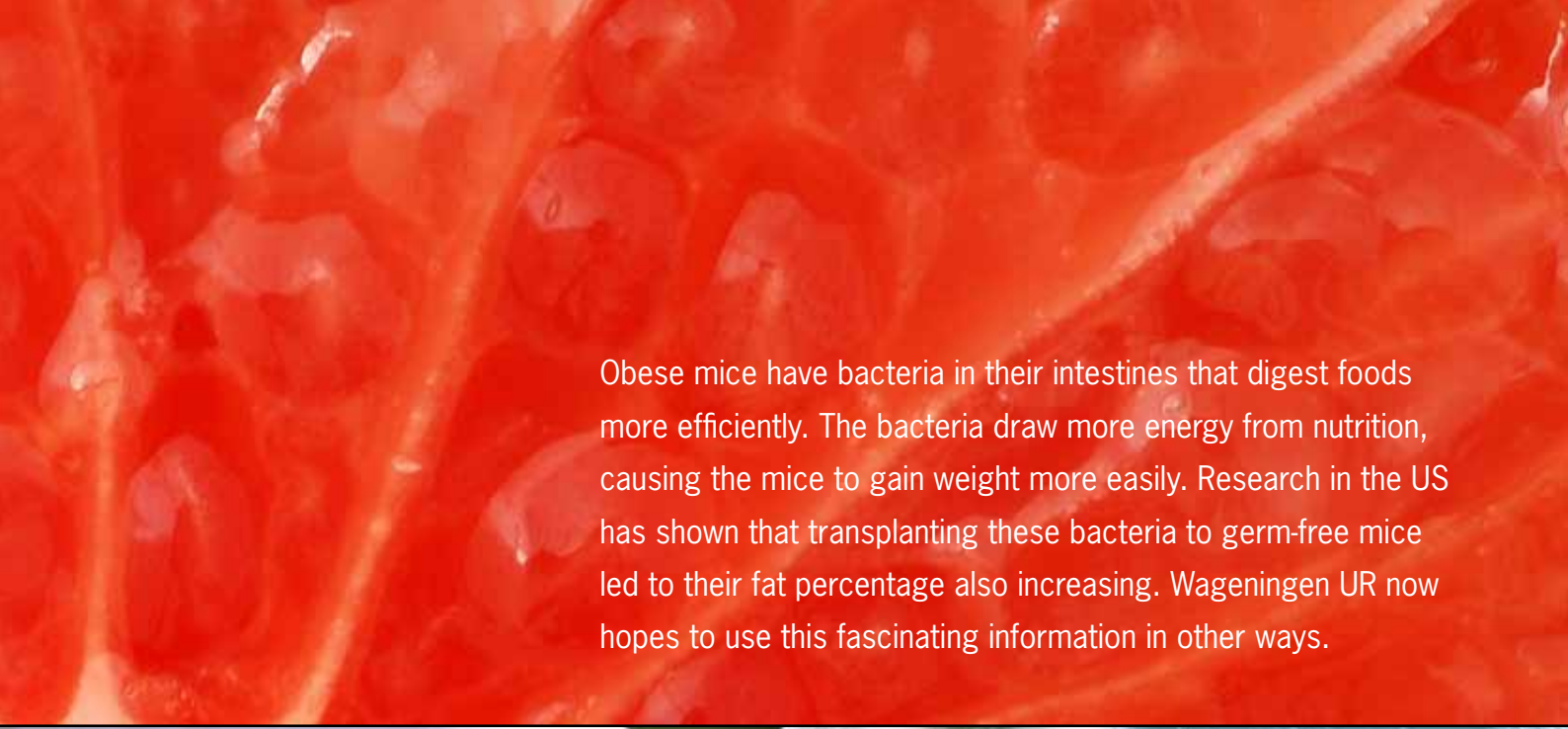
The fact that nutrition plays a part in ageing healthily has been proven by the extensive SENECA-HALE study into nutrition and health among elderly people in Europe, coordinated by Wageningen UR. One of the results of this research was that a healthy lifestyle, including good nutrition, can reduce the chance of dying by 65 percent, and can extend life by two years.

### **Preventive nutrition**

So what is the right nutrition for elderly people? It is acknowledged that vitamin D is essential in preventing osteoporotic fractures, but less well known is the important role of vitamin B12 of which approximately 25 percent of elderly people have a deficiency. Together with Erasmus MC and the VU University Medical Centre, we have started extensive research among 3,000 elderly people into the effect of vitamin B12 supplementation on the number of fractures. Another example of Wageningen research, in cooperation with Maastricht UMC+, is the Pro Muscle study into the – probably very positive – effect of protein-rich nutrition in combination with power training for muscle mass and muscle strength at an older age.

### **‘Caring’ nutrition**

In addition to nutritional value, we also research the value of food. For example: How does the company of other people and flavour help prevent malnourishment. The Lifestyle chapter on page 56 explores this subject further. The resulting information is especially important to institutions, where, according to the Dutch National Prevalence Survey of Care Problems (LPZ), a quarter of the elderly are malnourished. The Academic collaborative centre Agora, a cooperation with GGD Gelre-IJssel, studies healthy aging among elderly people who live at home, and combines knowledge from science, practice and policy to make this applicable for all parties.



Obese mice have bacteria in their intestines that digest foods more efficiently. The bacteria draw more energy from nutrition, causing the mice to gain weight more easily. Research in the US has shown that transplanting these bacteria to germ-free mice led to their fat percentage also increasing. Wageningen UR now hopes to use this fascinating information in other ways.



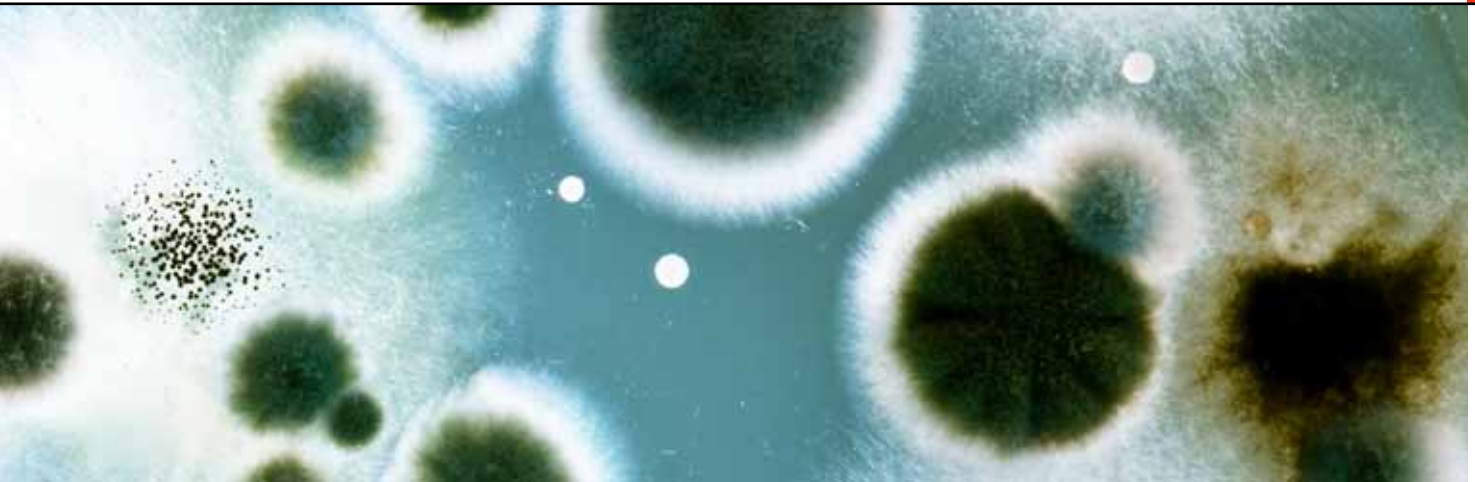
If people can be grouped by their microbiota, it should be possible to find group solutions

Wageningen microbiologists and their colleagues from the University of Amsterdam suspect that obese people also have more efficient intestine bacteria. It is still unknown, however, to what extent these bacteria are present, and, more importantly, whether they can be used to benefit the microbiota (intestinal flora) in favour of less efficient bacteria. The answers to questions in this undeveloped field can only be obtained step by step. The recent discovery by the MetaHit consortium (in which Wageningen UR is a participant) that people can be divided into enterotypes is a major step forward, however: If people can be grouped by their microbiota in the same way as with blood type, it should be possible to find group solutions.

Another significant breakthrough is the discovery by Wageningen UR and the top institute Food & Nutrition that microbiota cooperate with genes, with bacteria introduced in the small intestine having a clear effect on the genes. If this




# Of mice and men



communication was understood, it could be steered, for example by means of probiotics. This would make it possible to influence specific physiological processes, such as the immunologic response in the intestine.

### **Virtual laboratory**

With extensive experience in the field of microbiology, a massive collection of intestinal microbiota samples and an advanced chip methodology (HIT-chip) to analyse these samples quickly, the Laboratory for Microbiology of Wageningen UR is in a unique global position. Moreover, most data are freely available to the world in a large virtual lab. Wageningen UR has a clear focus: Less descriptions and understanding and more predictions and applications; for example in bacteria treatments or personalised dietary advice based on the bacteria present in the intestines.



Many chronic diseases are a direct result of an unhealthy lifestyle: Too much fatty food and too little exercise. Early intervention is required, and the best treatment is a combination of medicine and healthy nutrition.



The research discipline Nutrition & Pharmacology within Wageningen UR is the physiological bridge between the two sciences. It includes research into whether healthy nutrition can correct chronic diseases, which begins with studying exactly what nutrition does in the body. Above we mentioned research that shows the anti-inflammatory function of the *Angiopoietin-like protein 4*. Another example is a study of the so-called *endocannabinoids*, which is produced, among other things, from fats. To summarise: These chemicals are responsible for a happy feeling after copious eating, playing on the same receptors as cannabis. Lab research is looking for methods to artificially generate endocannabinoids and add them to food, enabling people to still feel satisfied without having to eat a large meal.

### Healthy people

The difficult thing is that the 'healing' function of nutrition in seemingly 'healthy' people is still hard to demonstrate. As a result, there is little urgency for changing the dietary pattern. This is why we are constantly working on the development of new, reliable measuring methods to scientifically establish the health-stimulating function of nutrition. The relationship between nutrition and improved health has

# The healing function of food




### **‘Hitting the engine’ does not solve the cause**

The top ten of Dutch medicines includes seven products that combat the negative health effects of an unhealthy lifestyle. This includes medication against heartburn, high blood pressure and high cholesterol levels. The downside of these medicines is that they are aimed at a single factor, while chronic disease is often caused by multiple factors. Additionally they often have unpleasant side-effects. Compare it to someone who hits a car engine with a hammer: It may help get the vehicle to run temporarily, but it does not solve the cause of the problem – an unhealthy lifestyle. It is better to turn multiple switches at once. Good nutrition and more exercise, possibly in combination with medication, is often more effective.

been shown for risk groups, for example in the aforementioned study into people who had had a heart attack and also suffered from diabetes (see page 12). The next step is establishing the function of nutrition in healthy people.

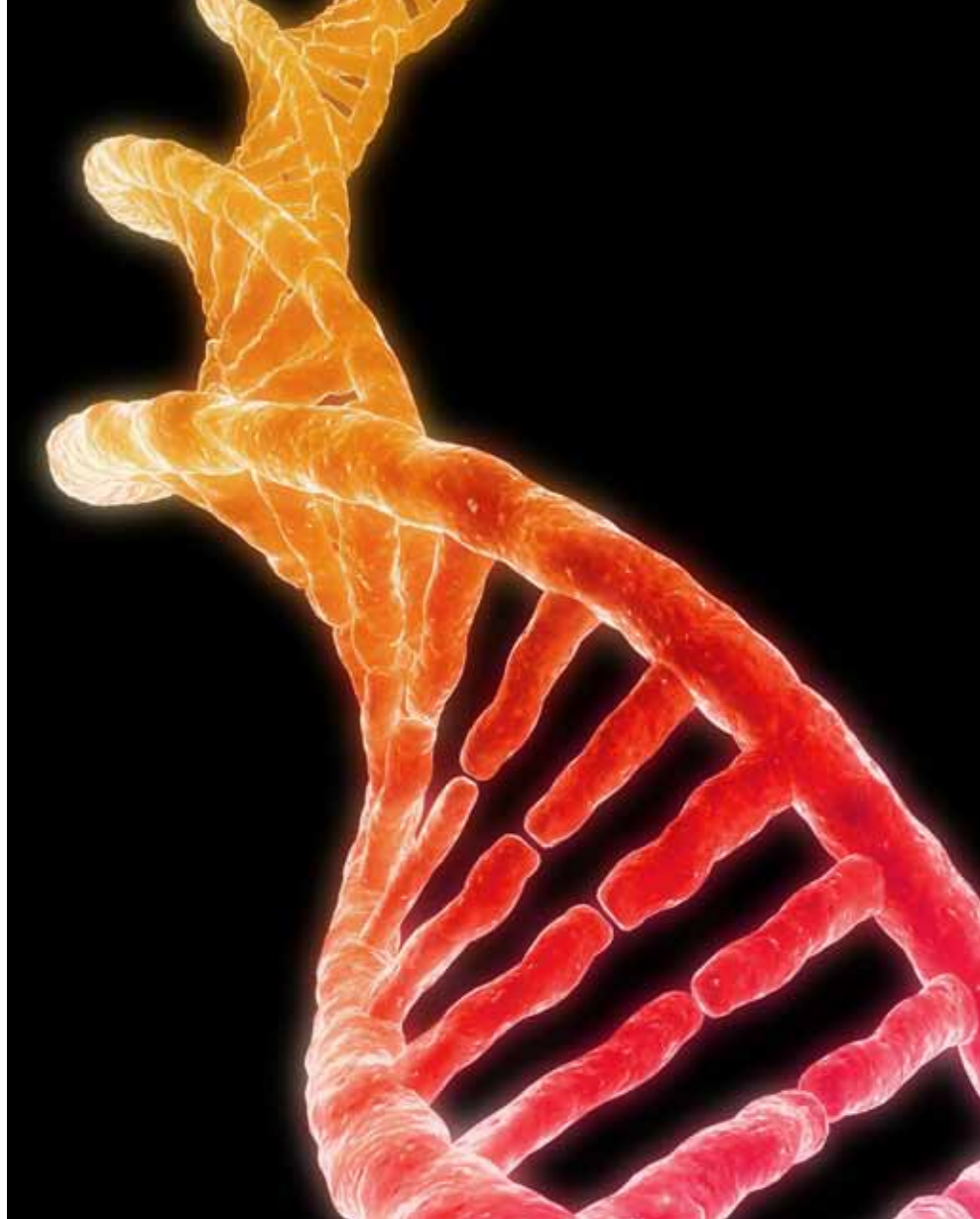
### **Pharmacology shift**

While medicine will continue to be necessary for acute health problems, pharmacology is shifting towards nutritional science. The principle of ‘one drug fits all’ is often ineffective and sometimes even harmful. An example is the drug rimonabant, banned in 2008, which blocks the cannabinoid receptor in the body but also has very serious side effects. More and more medicines are being developed that consist of a cocktail of active ingredients in lower doses. These products are coupled to the long-term effect of nutrition.



What exactly happens in the body when someone consumes fat?  
Our scientists are gradually working towards the answer by  
means of nutrigenomics technologies.

Saturated fat can cause  
serious inflammatory  
reactions in the body



# Protein protects body against infections

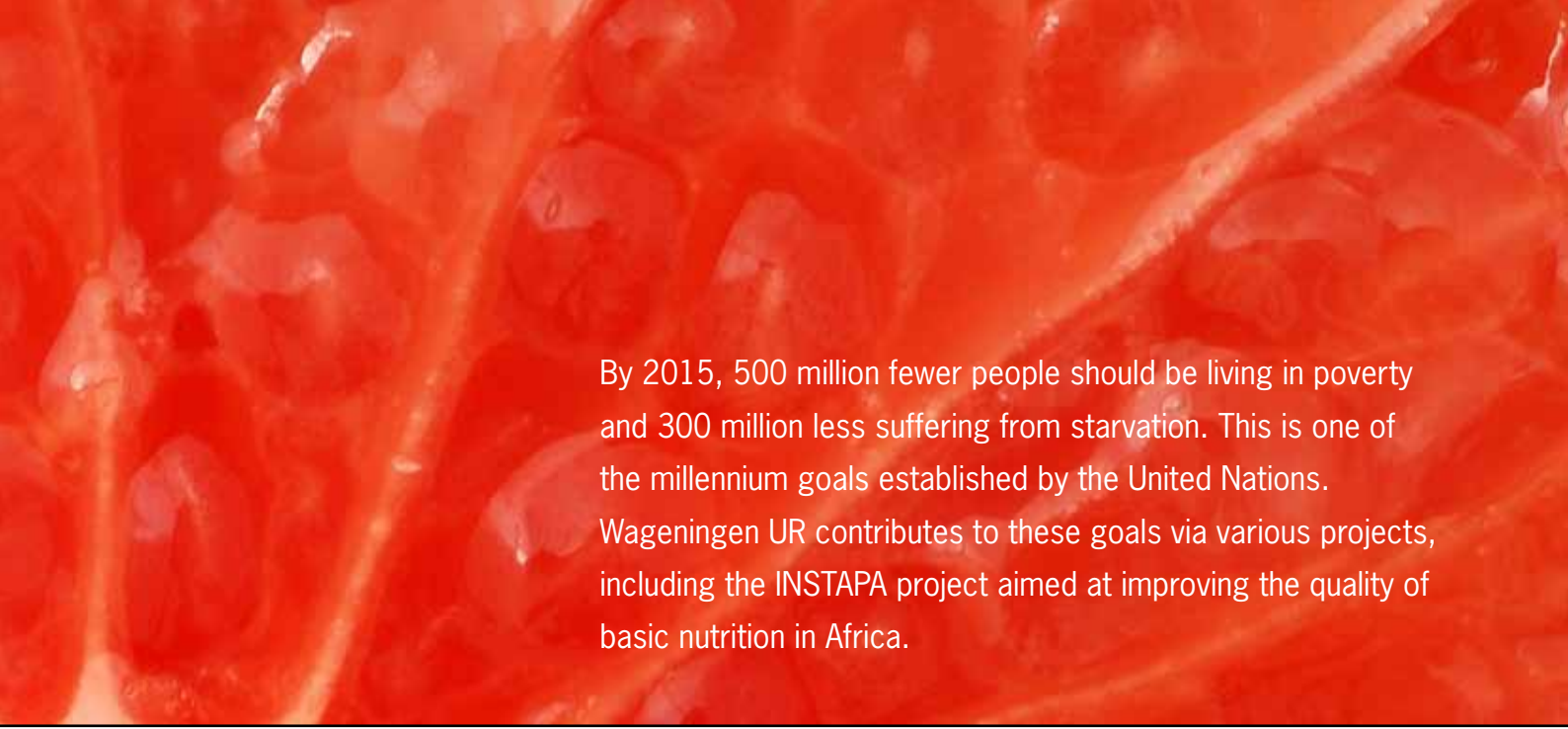
In late 2010 Wageningen UR published the results of a three-and-half year study into the effects of fat consumption. The conclusion was alarming: Saturated fat can cause serious inflammatory reactions in the body. The body tries to protect itself from these reactions by producing a specific protein: The *Angiopoietin-like protein 4* (ANGPTL4). Tests with mice showed that when a body cannot produce this protein, the saturated fat is stored in white blood cells in the abdomen. Eventually this resulted in a serious infection and an accumulation of abdominal fluid and peritonitis. The research also showed that eating unsaturated fat does not result in infections. Part of the explanation is that unsaturated fat strongly stimulates production of the protective protein.

## Human body

The fact that a gene is activated which produces ANGPTL4 is therefore essential in protecting the body against the major inflammatory function of saturated fat. Scientists suspect that this mechanism also occurs in the human body, but fails to function as it should in some cases. It is known, for example, that the fatty tissue of people who are overweight or obese displays inflammatory reactions.

## New evidence

Research is providing new evidence for the proposition that saturated fat is harmful to our health; not just because it increases cholesterol levels in the blood, but also because it can lead to infections. In addition, the research shows how the function of nutrition in our bodies can be determined all the way to the molecular level by using nutrigenomics technologies.



By 2015, 500 million fewer people should be living in poverty and 300 million less suffering from starvation. This is one of the millennium goals established by the United Nations. Wageningen UR contributes to these goals via various projects, including the INSTAPA project aimed at improving the quality of basic nutrition in Africa.

This research is performed in cooperation with ten international universities and research institutes. INSTAPA, which stands for Improved Nutrition through STAPle foods in Africa, is aimed at improving the quality of basic nutrition in Africa, especially in the region south of the Sahara. As a large part of the population in this region is too poor to afford a varied diet, they suffer from a major shortage of essential nutrients such as vitamin A, iron, zinc, iodine and folic acid (the so-called Big Five). They are also overly dependent on basic crops such as maize, millet, sorghum and cassava.

### **Three strategies**

INSTAPA has three strategies. The first is to find varieties of basic crops with higher levels of vitamin A, iron and zinc (biofortification). The second is enriching the existing products of these crops (fortification). The third is aimed at stimulating preparation methods to increase the levels of iron, zinc or vitamin A in the everyday diet. A promising project that follows up on the first strategy is the introduction of orange cassava in Kenya. This variety has a higher nutrient level than the white cassava that is commonly used in Africa. Question is, however, whether Africans will accept the orange variety. Data from qualitative research seems to indicate that they will.

### **Philosophy**

The philosophy behind INSTAPA is that reducing poverty in the world is only possible if the children that are born now can develop as well as possible. Malnourishment should be brought to a halt, which depends not only on food quantity but also food quality. INSTAPA is specifically focused on children under two and their mothers, recognising that a good start is essential to a child's development into productive adulthood.

Nutrition and nutrigenomics international

# Improving food security



# Prevention, healthcare and science: The financial benefits of nutrition

Unhealthy nutrition leads to 10 percent of the annual mortality rate in the Netherlands via cardiovascular diseases, diabetes and cancer. If everyone were to follow the nutritional recommendations, it is estimated that in 20 years, 140,000 less people would die as a result thereof, reducing the total healthcare costs for the chronically ill by 4.1 billion euros (three percent). The fact that healthy nutrition can result in major financial savings is the starting point of the Gelderse Vallei Nutrition Alliance.

The Gelderse Vallei Nutrition Alliance is a partnership between the Gelderse Vallei Hospital and the Human Nutrition department of Wageningen UR, and brings together medical specialists, dieticians, (nutrition) nurses, nutrition assistants, scientists, students and other experts to improve nutritional care. The combination of knowledge, skills, equipment, facilities and daily practice are leading to results that would otherwise not be achieved.

## Threefold objective

The objective is threefold, with three programmes reinforcing each other via mutual interaction:

- *Nutrition in Healthcare* – Improving patient health via transmural nutritional care, and focusing on nutrition before, during and after hospitalisation. This unique integrated combination of prevention and healthcare

will lead, among other things, to an improved nutritional position, less absence through illness, fewer complications, shorter hospitalisation and a better quality of life.

- *(Poly)clinical nutrition research* – Increasing insight into the interactions between nutrition and disease by facilitating and performing human (poly)clinical scientific nutrition research. The three research themes are: Malnourishment and clinical depletion, malnourishment and metabolic syndrome, and organ specific diseases and oncology.
- *The Nutrition Hospital* – Offering optimal, client-oriented nutrition to patients, visitors and personnel in accordance with the latest insights in nutrition, nutritional care and dietary treatments. In addition, the Nutrition Hospital aims to disseminate knowledge and function as an (inter)national role model.

## Underweight and overweight

Since the Alliance was founded in July 2007 it has established a wide range of special projects and achieved many positive results. 'Nutrition in Healthcare' is largely focused on underweight from a transmural perspective. As this issue requires treatment across the entire healthcare chain, it resulted in the setting up of the 'Malnourishment in Healthcare' programme. This trajectory should be implemented in primary healthcare at the end of 2011, and in tertiary care by the end of 2012 within the





Left to right: Inez Jans, dietician ZGV, Nicole de Roos, researcher at Wageningen UR, and Geert Feith, nephrologist

Gelderse Vallei region. ‘Cater with Care’ is focused on the development of ready-made and mainly taste enriched products to treat (the risk of) malnourishment and enable faster recovery. Experience at the Gelderse Vallei Hospital has shown that protein-rich snacks are valued positively

Another important aspect of ‘Nutrition in Healthcare’ is overweight in children, which has resulted in a multimedia treatment programme called ‘At the Table’ for parents with children between the ages of three and eight who are overweight or obese. In addition to group meetings, the programme offers parents a special, secure website where they can walk through all the stages of the treatment; an innovative and attractive concept, especially in view of the increasing shortage of healthcare personnel.

### **Nutritional Research Imaging**

Nutritional Research Imaging is an important theme within (poly)clinical nutrition research. The Alliance is especially proud of the 3-Tesla Magnetic Resonance Imaging (MRI) scanners, which can be used, for example, to measure brain activity related to hunger and satiation or to locate fat accumulation in the stomach. The scanners can also be used in the ‘Belly Fat Study’ among a group of overweight men and women.

Within the nutrition research programme, the Gelderse Vallei Nutrition Alliance stimulates innovative research with start-up

money. Examples of start-up projects are a study into reducing the direct pre-operative fasting stage – with a possible positive effect on post-operative recovery – as well as the establishment of the ‘double labelled water’ method to determine exactly how much energy people burn – and thus how much they should take in as a maximum.

### **What, when, where and with whom**

‘Good care tastes good’ is the motto of the Nutrition Hospital, indicating a significant focus on what patients eat. This includes, for example, the efforts of the Nutrition Hospital to put regional products on the menu. Another important aspect of good nutritional care is when, where and with whom. The pilot ‘At Your Request’ allows patients to make their own choice: Self-ordered meals are served in bed, in the room or in comfortable lounges within 45 minutes.

The Nutritional Hospital communicates extensively about its acquired knowledge and experience in the field of prevention and the role of nutrition in the development and treatment of diseases, including at conferences and via the website [www.voedingsziekenhuis.nl](http://www.voedingsziekenhuis.nl). The ambition is to become *the* knowledge centre for transmural nutritional care and enable other hospitals in the Netherlands and abroad to offer their patients optimal nutritional care – with substantial health benefits as a result.

## Academic collaborative centre AGORA

# Bridge between science and practice

One provides expertise, access to methodological knowledge and the latest state of affairs in scientific research; the other takes a more practical approach and poses specific questions that are in line with current social issues. They find each other at the 'market', the Academic collaborative centre AGORA, where Wageningen UR and regional health authority GGD Gelre-IJssel combine knowledge from practice, science and policy, forming a major bridge between the three disciplines.

AGORA is one of nine Academic collaborative centres in the Netherlands; structured regional collaborations between regional health authorities (GGDs) and university departments, often combined with other health stimulating institutions and/or knowledge institutes. The objective of these academic workshops is to structurally strengthen and embed demand-oriented research activities within public health practice.

### **Give and take**

"These Academic collaborative centres form a bridge between science and practice," says Annemien Haveman-Nies, Assistant Professor of Agro-technology & Nutritional Sciences at Wageningen University and coordinator of AGORA. "And both parties benefit; it is a matter of give

and take. Scientific education and research can be tested against and aligned with practice, while healthcare professionals gain access to the expertise and up-to-date knowledge of the university."

### **SLIM becomes SLIMMER**

A good example of a bridge between science and practice is the AGORA project SLIMMER: SLIM implementation Experience Region Gelre-IJssel. SLIMMER is the practical implementation of the SLIM (Study on Lifestyle Intervention Maastricht) intervention, in which Wageningen University also took part. In an academic setting, which means evidence based, SLIM showed that nearly 50 percent of diabetes type 2 cases can be prevented through healthy nutrition and sufficient exercise.

"SLIMMER is aimed at providing the SLIM intervention with a practical base," Haveman explains. "Lifestyle interventions that were effective in an academic setting should be translated to and tested against daily practice. This is not a matter of simply rolling it out. A lot of time is required and a great deal of cooperation between local parties such as GPs, dieticians, municipalities, sports organisations and health insurance companies." The pilot will be followed up by a study into the effects, after which SLIMMER will be implemented on a larger scale.



### **Applied methods for practice professionals**

That science and practice are not always on the same page is shown, among other things, by the commonly heard remark of epidemiologists that there is a hiatus between what they learn at university and the daily activities in practice. This was the inspiration for Haveman to write the 'Epidemiology in public health practice' textbook, published in cooperation with the Academic collaborative centres Limburg and Tranzo in Tilburg. "The book provides applied methods for practice professionals at a higher level which they can use as a basis for playing a larger consulting role in the development and implementation of new policies in the field of public health and evaluation of existing policies."

The publication of books on the interface of science and practice is not very common, but 'Epidemiology in public health practice' is read in both circles. "And that is an excellent development!"

# NuGO enables – more, wider, better – research

Nutrigenomics, research focused on the interaction between nutrients and genetic material and how this interaction affects health, is a relatively new science. However, thanks to the Nutrigenomics Organisation (NuGO), giant strides have been made in a short period.

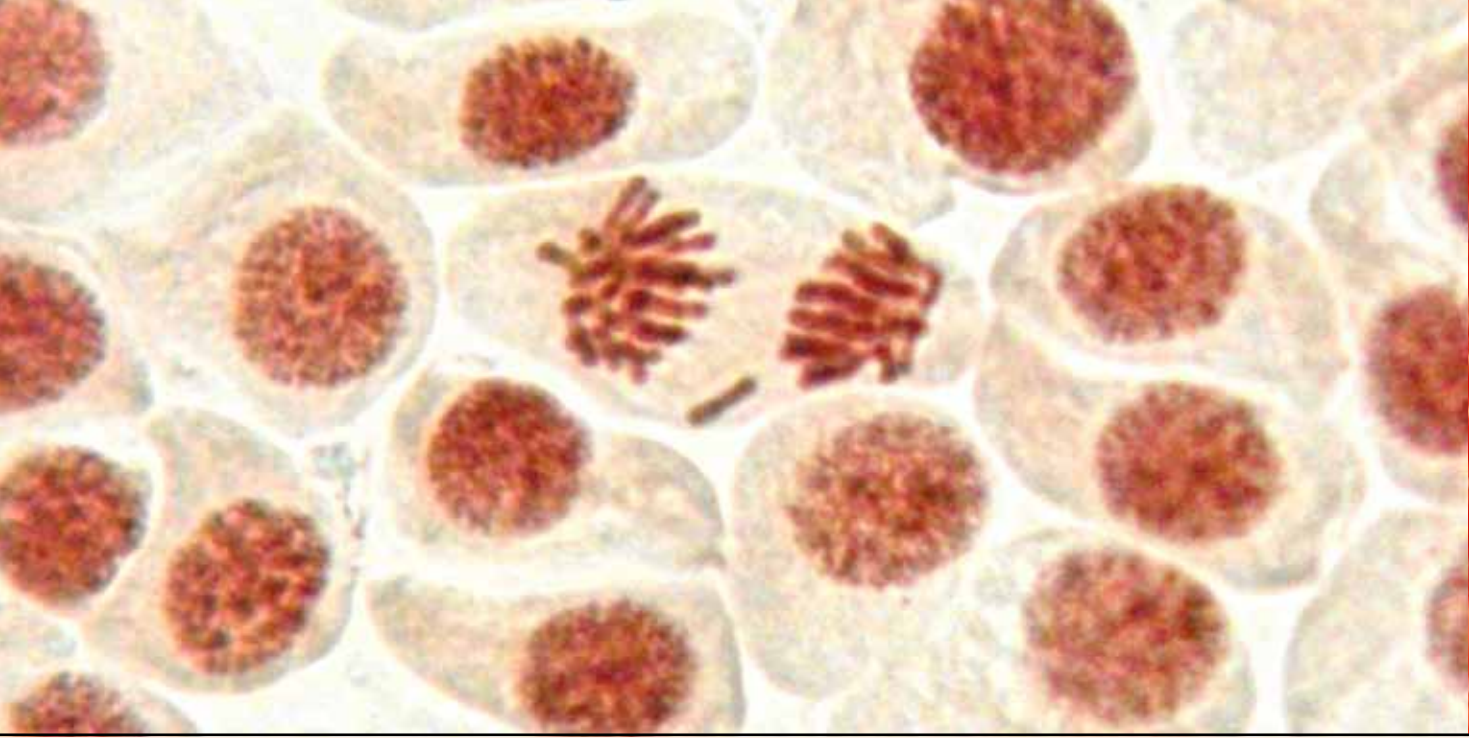
With Wageningen UR as coordinator and one of the most active and most renowned members, the NuGo collaboration enables universities and research institutes worldwide to exchange facilities, expertise, tools and data in order to make research easier, more efficient and more effective.

Michael Müller, Professor of Molecular Nutrition and Nutrigenomics in the Human Nutrition department of Wageningen UR, is a board member of NuGO and an active nutrigenomics researcher with dreams of 'Nutritional Science 2.0'. "The major challenge is developing nutritional science in such a way that everyone can stay healthy as long as possible and is protected against disease as a result of the right nutrition," says Müller. "Of course every person is different and we all react differently to various types of food. After all, we have tens of thousands of genes in our bodies including a plethora of unique variations and 'faults.' Nevertheless, we always have a choice between one way or another. Everyone can choose to lead a healthy life."

### Standardisation

These many individual genetic differences are exactly why standardisation plays such an important part within nutrigenomics. A major goal of NuGO is therefore the NuGO Nutrition Bioinformatics Infrastructure that includes standardised methods, protocols, instruments and data. Professor Müller: "No matter how complicated it may be (with everyone having their own way of doing things), attaining an effective cooperation and rapport is necessary. We use quite revolutionary software, and it is a new way of approaching science: People are no longer working in their own lab, chasing facts. We now have wide-ranging educational interaction, which also benefits students and research assistants who can now experience early on in their studies just how useful their work really is."

And useful it is indeed. While nutrition can have negative effects, it is on the whole positive. "The key question in nutrigenomics is: How can we make more of our genes? For example: How can we train our liver and intestines to have a temporarily increased capacity during Christmas dinner? How can phenotypic overweight people (due to external circumstances) be returned to their own, non-overweight genotype? Nutrition plays a central role in these issues. And, thanks to NuGo, this role is becoming increasingly effective."



As we have seen in the previous chapter, people with a diet that contains too many calories, saturated fats and salt have an increased risk of overweight, diabetes, cardiovascular disease and cancer. The issue of unhealthy nutrition can only be solved if the various branches within social sciences and nutritional science work together.



# Nutrition and lifestyle

The message that healthy nutrition is crucial to stay healthy has had a clear impact on society; partly due to government campaigns, consumers now know that vegetables, fruit, fish and variation in terms of meals are good for them, and aware of the risk of excessive calories, fats and salt. Dietary guidelines indicate exactly which components comprise a healthy diet. It is also becoming easier for consumers to make healthy choices in supermarkets and other food shops. At the same time, there are still plenty of opportunities within reach to make the opposite choice. Intake studies show that consumers still eat too few vegetables and fruit, and too many calories, fat and sugar. This is partly the result of the increasingly complex communication about nutrition, which does not always make it simple for consumers to eat healthily.

At Wageningen UR we are convinced that the issue of unhealthy nutrition can only be solved if the various branches within social sciences and nutritional science work together. The goal of these joint efforts should be to gain insight into the role and meaning of (un)healthy nutrition in people's daily life and discover which factors influence the purchase, preparation and consumption of food. We know that eating healthily is not just a matter of careful personal consideration. What we eat is also determined by other factors, such as flavour, habit and costs, while our physical and social environment also plays a part. How is the eating behaviour of children influenced if they eat with their family at the table at home? And what is the social meaning of food in schools? Wageningen research into the eating behaviour of Dutch people with a lower education has shown that other habitual behaviour also plays a part. This includes issues such as eating in front of the TV, eating irregularly, skipping breakfast and eating greasy food at night or at the weekend. It is possible that their everyday problems stand in the way of making healthy choices or that the information they receive about healthy dietary patterns cannot be applied to their specific situation.




One thing that the research shows for sure is that influencing how and what people eat is a complex process. For example, intervention via communication will only have an effect if it is in line with the perception of the target group. This was shown, for instance, in an evaluation of a Dutch TV series for teenagers called Roes, which showed youngsters the 'raw reality' of alcohol and drugs. An evaluation performed by scientists showed that the series made students in pre-university education (VWO) more aware of the risks associated with alcohol and drugs, while having an opposite effect on students in lower general secondary (professional) education (mavo and VMBO). It has also been determined that a wagging finger does not work; it puts people off, partly because the information quickly becomes too complicated.

The main social challenge is to make healthy nutrition the standard option, as the case of smoking illustrates. While it was fully acceptable to smoke at home, on the road and at work until the late 1980s, the current norm is very different. This huge turnaround was at a certain point started by a small group of people who were no longer prepared to accept the harmful effects of passive smoking. This group later brought into motion a whole series of changes at various levels, from stricter laws and regulations to the establishment of a new social norm. It illustrates the importance of consumers being allowed to play an active role. Healthy nutrition will not become the norm until consumers are allowed to play a central part in the change process. The discussion about healthy food should not be limited to the circle of scientists, politicians, marketers and other 'experts'. On the contrary, the everyday expertise of consumers, their neighbours and family members is vital in the search for successful behavioural interventions.



The discussion about healthy food should not be limited to the circle of scientists, politicians, marketers and other 'experts'





As vegetables are healthy it is important to eat them. And although most children don't really like vegetables, they can actually be taught to eat anything from a very early age.

Most appreciated were ways in which the food kept its crunch

It is understandable that children don't like vegetables. We are born with various flavour preferences, such as sweet, and the bitter or sour flavours that are commonly found in most vegetables are not among them. In addition to these evolutionary preferences, people develop their own penchant for food; often at a very young age. Babies experience their first flavours in the womb and later come into contact with a variety of flavours and smells via breast milk. Reasonably open to new smells and flavours in the first year, from the age of two children develop clear preferences and suddenly start to dislike specific foods, with a particular aversion to vegetables. The developmental phases of childhood – in which children discover who they are – also play a role here. Part of this process is trying to get your way by saying 'no' to everything your parents want (such as eating green stuff).

### **The crispier the better**

Wageningen UR performs a great deal of research into the flavour perception of various groups of people, including young children. One of these studies involved the question of how we can get children to eat more vegetables. It focused on the flavour aspect as well as other factors that influence eating behaviour, such as texture (how food feels in the mouth) and social context. The research provided valuable results. Various tests showed that children have a clear preference for vegetables that are naturally crunchy (carrots, raw vegetables, cucumber). We also studied per vegetable variety which methods of preparation children liked best. Most appreciated were ways in which the food kept its crunch, with slimy vegetables or puree with 'bits' in getting the lowest marks.

### **Parent power**

There are several ways in which parents can help their children learn to eat vegetables and see them as a tasty dish. First of all, serve the food as crispy

# Relating to children's experiences



as possible, without brown discolouration or a grainy texture. Secondly, offer children a choice in their vegetables. A third motivator is creating a positive context, such as a nice atmosphere at the dinner table. Finally, parents can serve vegetables in various ways to increase acceptance; in an oven dish one day, and boiled the next, for example.

### **Satiating vegetables**

In addition to the slightly bitter, sour flavour there is another reason why children dislike vegetables: They contain little energy, and eating them does not give a satiated feeling. Our scientists have shown that if we succeed in cooperating with the food industry to develop tasty vegetables that remove the feeling of hunger, children are more likely to eat them.

Teenagers often eat what they like or whatever their parents put on the table, hardly ever thinking about healthy or sustainable food. 'Unhealthy food is fine, as long as you don't get fat,' is their attitude.

The main motives given for buying specific products are 'tasty', 'hungry', 'habit' and 'convenience'




# Healthy eating is not an issue

Commissioned by the Dutch Ministry of Economic Affairs, Agriculture and Innovation (EL&I) Wageningen UR performed research into how youngsters perceive healthy and sustainable food. It is an important question as teenagers develop their identity between the ages of 11 and 18. How they perceive food is important to their eating patterns. The research, called 'Beyond the bread bin' (*Voorbij het broodtrommeltje*), shows how little the youth of today are engaged in what they and other people eat. At home parents determine what is put on the table. During school hours teenagers have more to choose from as they can buy food at school and in the direct surroundings. The main motives given for buying specific products are 'tasty', 'hungry', 'habit' and 'convenience'. More expensive snacks get high marks as they can be used to impress others.

### **Connecting with teenagers' perceptions**

It is difficult to get teenagers interested in 'healthy' and 'sustainable' food as this does not come naturally. Between the ages of 12 and 16 kids are still growing and often hungry. Their primary concerns lie with themselves, each other and the here and now. The Wageningen scientists concluded that if we wish youngsters to make healthier and more sustainable food choices, we must find a connection with their perceptions. They stress that this is a joint responsibility for all parties who have an influence over teenagers. Schools can enhance children's knowledge of food in classes and after-school activities, while school cafeterias can contribute by supplying the right products at the right time, without designating them as 'healthy and sustainable'. If parents were better informed about the importance of healthy and sustainable food, they could serve as a conduit at home. Finally, marketers have the vital task of translating the benefits of healthy and sustainable products in a way that is relevant to teenagers.



If we as a society wish to ensure that the food demands of future generations are met it will be essential to further increase sustainability in food production. Consumers can stimulate this development by purchasing sustainable products, but how can they be tempted to do so?



In the study 'Food with value' (*Eten van waarde*) we researched the motives of Dutch consumers when purchasing food products. It showed that their choice is mainly determined by subconscious processes. Consumers largely make decisions based on habit and do not like giving too much thought to what goes into their shopping cart. Flavour, health and affordability are the main quality values, and consumers only choose products that they feel meet these values. Those who attach importance to 'health and nature', for example, purchase more vegetables, fruit and fish, while people who place greater store on affordability

# How to tempt consumers

Communicating the associatious consumers find important, can help messages have a lasting impression

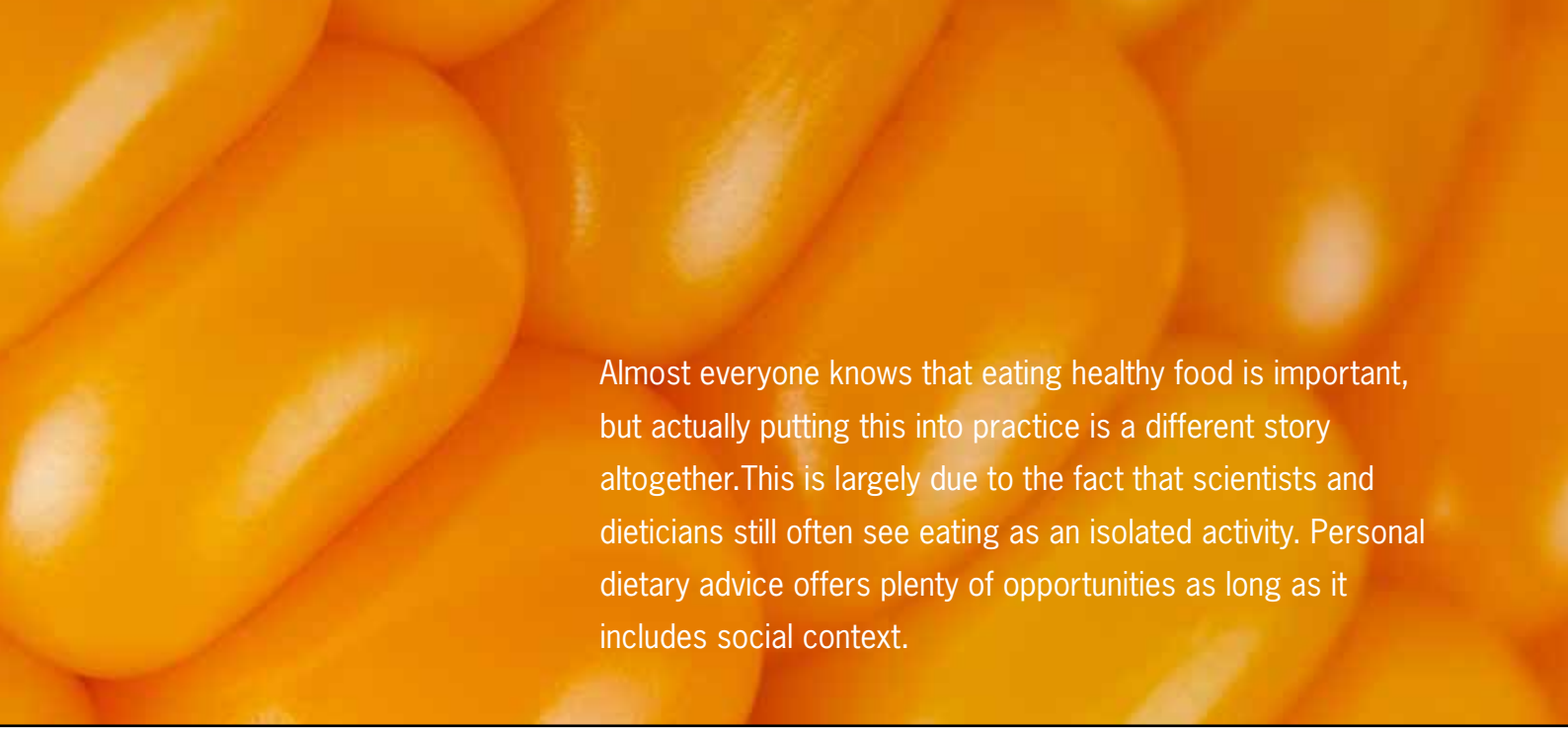
buy less of those products and are more susceptible to special offers. Values such as the environment, animal welfare and justice play an important part in the purchasing behaviour of a small group of consumers, but only if products that meet these values are also affordable, healthy and tasty.

### Priorities

By providing a clear overview of their priorities, the study sketches a good picture of the thoughts and actions of consumers. Various studies show that people attach great importance to animal welfare, but once they are in the shops other values apparently take precedence. The study does not provide a complete explanation for consumer behaviour as it is based on the classic theory that people initially become aware of a specific need, and then start looking for information. The majority of consumers indicate that they mainly shop out of habit, however. Additionally, some purchases cannot be ascribed to one specific food quality: Consumers often see multiple connections between the various values.

### Associations

Nevertheless, the study provides plenty of ways in which the agri-food sector can stimulate sustainable consumption. For example: Consumers have clear associations with the quality values they find important. Communicating these associations can help messages have a lasting impression. The consumer group that is susceptible to values such as the environment, animal welfare and justice (as long as they are combined with affordability, health or taste) can be tempted by claiming that a sustainable product is 'healthy and tasty'. Such a claim then justifies a higher purchase price.



Almost everyone knows that eating healthy food is important, but actually putting this into practice is a different story altogether. This is largely due to the fact that scientists and dietitians still often see eating as an isolated activity. Personal dietary advice offers plenty of opportunities as long as it includes social context.

Consumers should be actively involved in the composition of their personal dietary advice as an 'expert in daily life'

Fast developments in the fields of nutrigenomics and ICT have made it increasingly possible to provide people with personal dietary advice that is very much in line with their individual risks and characteristics. Although this sounds promising, the eventual goal of people actually applying these personal recommendations is where things usually go amiss. Dietitians often mistakenly assume that consumers mainly include health aspects in their eating decisions. And they often wrongly forget to include the social aspect of eating. Health is important, of course, but there are other issues at play such as there being little time to prepare a meal, the fussiness of the kids or the plans to go to the gym later that evening. Nor do people want to be labelled as health freaks when they throw a dinner party.

This is why the scope of dietary advice should be widened to focus less on nutritional components and products and more on the issue of how to organise healthy food in a social context. In concrete terms this means, for example, that the negative image of healthy food needs to disappear and that it should become the most obvious choice in everyday life. Consumers should be actively involved in the composition of their personal dietary advice as an 'expert in daily life'. This would prevent advice from not being followed up because it does not fit into the social context.



Eating behaviour on a daily basis

# Healthy eating is a matter of organisation



Wasps are a delicacy in Japan, while crickets are a popular snack in Thailand. A large part of the global population, some 80 percent, eats insects, but in the West we find a plate of mealworms or a pot of locusts unappetising. Insects seem to be a taboo in our food culture. Can that be changed? Wageningen UR aims to find out.



What stops us Westerns from eating insects and the related issue of how can this aversion be turned around?

Insects have a high nutritional value: They are rich in protein, healthy fatty acids, vitamins and minerals. One hundred grams of insect meat per person can provide our daily required amount of protein, iron and vitamin B, making it the ideal meat substitute. Insects could potentially offer the solution to the increasingly alarming global food shortage.

### **Species with potential**

There are far fewer objections to large-scale insect breeding than intensive cattle farming. Insects don't need antibiotics, require little space and thrive on waste and manure. Over the coming years, Wageningen UR will be studying which species have the most potential as nutrition. The Dutch government and the Dutch trade association VENIK see the likely benefits and have provided financial support for research into the sustainable production of insect protein for human consumption.

# Insects as main course

### Obstacles

A similar research challenge is to find out what stops us Westerners from eating insects and the related issue of how this aversion can be turned around. There are various factors at play, including cultural barriers, eating habits, lifestyle and precipitated risks. But there are also various obstacles in the field of food chain coordination and regulations that have to be overcome.


### European research proposal

Wageningen UR submitted a proposal for a European project to train scientists in how to participate in the introduction of food innovations. The project revolves around a case on insect-based ingredients in the food chain. How can we stimulate the acceptance of insects as food? What are the obstacles? How can the process be influenced? More knowledge is required to answer all these questions and Wageningen UR aims to obtain this knowledge by using the European project to combine expertise from universities in Belgium, the UK, Italy, Sweden and France.

### Multiple disciplines, broad perspective

This multidisciplinary project will see food technologists, agricultural specialists, entomologists, management specialists, psychologists, economists, sociologists and quality experts apply their general knowledge about the acceptance of (food) innovations to the possibility of introducing insect protein as an ingredient in Western menus. They will focus on both the consumer and other links in the chain such as parties which market food products, regulatory institutions and the food technologists that create innovations. The research issues and project approach have already been developed, and Wageningen UR is looking forward to dealing with them from within a unique international research network.





A healthy lifestyle is not easy to achieve as unhealthy nutrition is the standard option. While campaigns inform us about the importance of a healthy lifestyle, the intended effect often falls short as campaign makers overly focus on rational motives for decision making.

People in a good mood are more easily influenced by impulses than those in a negative frame of mind

Various research within and outside Wageningen UR shows the limited impact of lifestyle campaigns. The problem is not so much that the campaigns are not adequately tested beforehand, rather that the shots miss their target because they are aimed at the wrong goal. The goals – increasing knowledge, awareness and motivation – have little effect on people's eating behaviour as they make their decisions based on far less conscious reasoning. Easy snacks are readily available everywhere in Western society, while people have less and less time to eat. At birthday parties we enjoy a drink and a slice of cake. And how many people actually choose to take the stairs to the fifth floor rather than the lift?

### **Evolution**

When studying behaviour related to nutrition and lifestyle, our scientists do not only take into account the rational, intentional choices people make, but also the impact of impulses. There are various demonstrable circumstances in which impulses seem to prevail; initially, for example, in situations where there are major temptations with direct rewards, such as drinking alcohol in a bar. Secondly, it has been shown that people tend to choose the most logical option: They will sooner take the elevator that is nearby than the stairs that are further away. Thirdly, it is difficult to resist impulses if people have little energy and their self control is low; after a hard day's work it is tempting to stay on the sofa rather than going to the gym. A fourth example is that people are more susceptible to stimuli when they are distracted or act absentmindedly. Finally, people in a good mood are more easily influenced by impulses than those in a negative frame of mind.

Wageningen scientists studied the relationship between the need for satiation and the choice of snacks in a leading Dutch chain of express supermarkets. The research showed that the time when the test subjects were due to consume a complete meal (for example, one hour or four hours after eating a snack) had

# The impact of impulse

virtually no impact on which snack they chose. A slice of pizza was one of the favourite choices, regardless of the time remaining until the next meal. Another renowned study in this field is the soup bowl experiment performed by the American nutritional scientist Brian Wansink. Described in the book *Mindless Eating*, published in cooperation with Wageningen UR, the experiment shows that portion size largely determines how much a person eats. Wansink served half of the test subjects soup in a normal bowl, while the remainder were given soup in a bowl that was slowly being refilled via a hidden tube. The test subjects in the latter group ate 73% more soup without being aware of it.

### Social marketing

So what interventions do have an effect? Register the critical moments - when people make unhealthy choices or display unhealthy behaviour – and create more possibilities for healthy choices by adjusting their physical or social environment. The recommendation is to stimulate the appeal of a healthy lifestyle with specific marketing promotions. Successful examples are snack vegetables, such as the attractively packaged tomatoes, radishes and cucumbers in mini sizes, which make a healthy choice much easier to make. Moreover, the unhealthy option should be made less attractive to consumers. The preeminent example in this case is smoking: What was obvious behaviour two decades ago is now no longer acceptable in many situations in daily life.

Finally, campaign makers should no longer approach their messages from a rational point of view. Instead they should increase their focus on the perception and lifestyle of the target group and on the unconscious decisions people make. By subtly stimulating the negative associations with an unhealthy lifestyle, lifestyle campaigns may actually be effective.





The Netherlands throws away billions of euros worth of food every year. Supermarkets, restaurants and caterers squander approximately two billion, while consumers waste even more. Reducing this waste could save the agri-food sector raw materials, save companies and consumers money, and also be beneficial to the environment. Moreover, there are plenty of ways to achieve this.

The approach towards food waste is an important research issue within Wageningen UR. Our research shows that part of this squandering of food is hidden from the view of consumers. For example, we have to go to the market to buy curvy cucumbers as the supermarkets won't sell them. Meanwhile, consumers are even more at fault, buying 20 percent more than they need in shops and continuing to cook 30 percent more than they require for their meal. All this leads to between ten and 17 percent of the food purchased being unnecessarily thrown in the bin.

### **Smaller is better**

Although the costs of throwing food out are insufficiently considered when making purchasing decisions, companies are increasing their focus on the issue of waste. And logically so, as less squandering means lower costs. An experiment in Wageningen UR's Restaurant of the Future showed that catering companies can reduce losses on salads considerably if they serve salads in smaller bowls. Some 40 percent of the salad served in large bowls was thrown out. Served in smaller bowls, the losses were reduced by over five percent, while the number of sales remained the same. Conclusion: Smaller bowls benefit the environment and finances.

### **Cooking with leftovers**

The wasteful behaviour of consumers is difficult to break through, or so it seems. Yet, Wageningen scientists believe that there are plenty of ways to get people onboard, for example by introducing products that have a longer shelf life due to innovative packaging technologies, portions for single households or re-sealable packaging. Services such as a digital kitchen coach, advice on cooking with leftovers and better information about the actual shelf life of products can also stimulate consumers to waste less.

# Effective solutions aplenty



## Minimal food waste at Máxima Medical Centre

Patients who choose their own meals in hospital tend to finish their plates – this was the result of a study by Wageningen scientists in the Máxima Medical Centre in Eindhoven and Veldhoven.

The Max à la Carte meal service enables patients to choose between two meals that consist of various interchangeable dishes. The meal service showed spectacular results: Only 2.2 percent of all meals ended up in the bin compared to the 36 to 48 percent that was thrown out before.

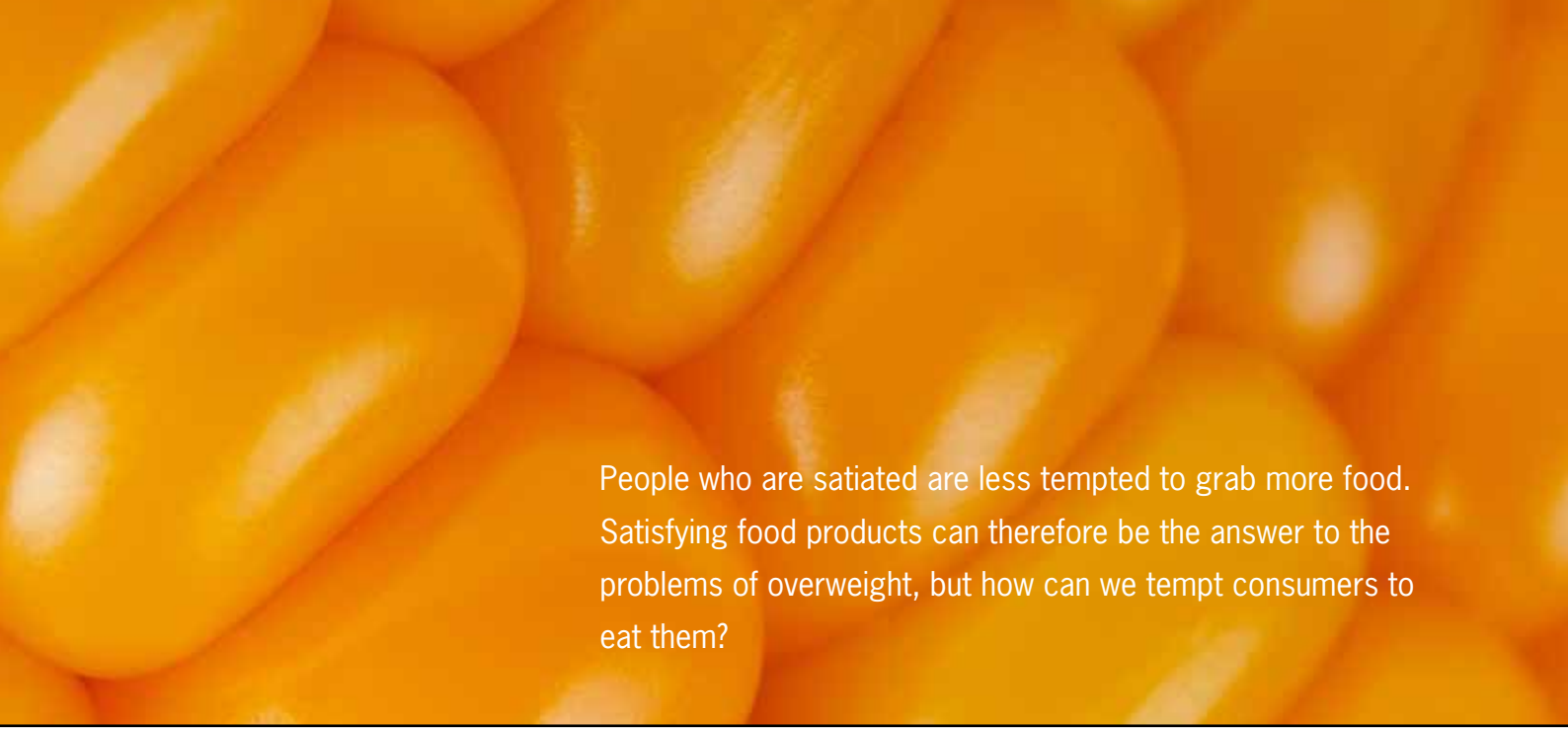
Allowing people to be served the portions that they want without having to choose what to eat several days in advance clearly had an effect.

The hospital annually saves around 400,000 euros and the figures may be even higher if the suspicions of the scientists that better food leads to a faster recovery are correct. Patients have given the new meal service an eight out of ten satisfaction rating, much better than the measly 6.3 given to the previous services. The fact that

the plates are garnished as in a restaurant and served by specially trained nutrition assistants also plays a part.

### **At your request**

A similar initiative with an emphasis on improving patients' food intake is taking place in the Gelderse Vallei hospital in Ede, which is in a knowledge alliance with Wageningen UR. Catering company Sodexo introduced the 'at your request' meal concept in this hospital – see page 30 for more information on this initiative.



People who are satiated are less tempted to grab more food. Satisfying food products can therefore be the answer to the problems of overweight, but how can we tempt consumers to eat them?

The satiation level of food is partly determined by the fibre it contains, and the average fibre intake of the Dutch population is half of what it should be. Additionally, many processed food products such as fast food, snacks and sodas have a high energy density which means they do not fill us up and we tend to keep eating. As part of the extensive research programme Satiety & Satisfaction we are studying which fibres stimulate a satiated feeling and how many are needed to achieve this. The results of this subproject may enable manufacturers to produce food that tastes good and has sufficient satiating effects, such as light dairy products with the same full flavour and satiating effect as the 'full fat' alternative. Scientists often use the sensory laboratory of the Restaurant of the Future in this type of research.

### **The right attitude**

Developing healthy, satiating food products is one thing – getting consumers to buy them is a different challenge altogether. This requires an effective communication strategy, one which engenders the right attitude without the negative associations of having a 'full belly'. This is a subject that is being researched by the behavioural scientists and communication experts at Wageningen UR.

### **Effect**


Another major subproject is aimed at measuring the effect in the market. This includes the development of a method to gauge the impact and market share of new satiating products in relation to total food sales in the retail sector. By linking this information to the so-called food consumption assessment, we can learn a lot more about the purchase and consumption of food products.



Satiation

# Tempting people to eat satiating products





National figures show that malnourishment is a major problem among the elderly. The number of elderly people who fail to eat sufficiently in hospitals fluctuates between 25 and 40 percent; in nursing and old people's homes malnourishment occurs in between 20 and 25 percent of residents, while 15 to 25 percent of elderly people living independently are malnourished.

### **Elderly living independently**

The Academic collaborative centre Agora, a cooperation between Wageningen UR and regional health authority GGD Gelre-IJssel, is researching healthy ageing among elderly people who live independently, combining knowledge from science, practice and policy to make it applicable to all parties. One of the issues studied by Agora is malnourishment. A study in 21 municipalities in the Dutch province of Gelderland showed that there is still much to be gained by the prevention and treatment of malnourishment. The research showed that two groups of elderly are most at risk of malnourishment: Elderly people who are still quite active but have an unhealthy lifestyle, and those with handicaps who are increasingly dependent on care. A large proportion of these groups do not come into contact with health care facilities such as home care, general practitioners and consultancy agencies for the elderly (CvOs) These CvOs can play an important preventive role, but currently mainly reach 'young' healthy elderly. If the CvOs were to succeed in reaching the risk groups they could make a considerable contribution to the prevention of malnourishment.

### **Set the table**

Another research programme focuses on elderly people in care institutions. During a symposium in May 2009, the former minister Gerda Verburg wondered if less medication would be used when care institutions paid more attention to nutrition. Her comment was the reason for a pilot study into the effects of good nutrition and a better ambiance at meal times to combat underweight. Care institution BrabantZorg and Phliss research worked with Wageningen UR in the pilot that was called 'Set the table' (*Dek de tafel*). Our scientists measured the food intake of the clients, how they experienced their meals, what diet products they used and how much care they needed, using camera observation technologies that were developed in the Restaurant of the Future. As part of the study the clients were

# Battling malnourishment



presented with meals that were made with at least 60 percent organic products plus products without artificial substances. There was also a focus on the ambiance: Meals were served by hostesses, the tables were nicely set, and the clients received personal attention from the nursing staff and the chef. In addition, the meals included an aperitif before and a cup of coffee after the meal.

## **Follow-up research**

The pilot showed that there is a deductible relationship between healthy nutrition and a positive ambiance on the one hand and weight gain among malnourished elderly on the other as the participants had more energy and gained weight. For the Ministry of Economic Affairs, Agriculture and Innovation (EL&I) it was reason to make funds available for a broad three-year follow-up study. There is a very good chance that more attention to meals could result in cost savings in other elements of the organisation of care institutions, such as medication, fewer diet products and a reduced need for care. If the effects of meal care and weight gain can be determined scientifically, this is sure to have a social impact. It would, for example, become interesting for healthcare insurance companies to contribute to initiatives such as 'Set the table'.

## Restaurant of the Future

# Experimental facility where scientific and applied research meet

The reformulation of products is an unstoppable development in the food industry. At the same time the market is hesitant to introduce reformulated products due to concerns over what consumers will like and what works in the market place and what not? The Restaurant of the Future offers manufacturers an experimental facility by providing them with consumer reactions to their product. Additionally it functions as a meeting place for scientific and applied research.

The Restaurant of the Future, part of Wageningen UR, is situated on the campus where everyone is welcome to lunch. On one 'condition': Visitors must first agree that every moment of their time at the restaurant will be recorded on camera. In the Restaurant of the Future visitors share a table with science. It serves as a facility where scientists can analyse consumer behaviour in conditioned circumstances, but still in a real life situation. Food industry companies can also have sensory and physiological testing performed in the laboratories of the restaurant. This unique combination makes the Restaurant of the Future interesting for a wide variety of clients.

### Classic and new methods

Stefanie Kremer has been working as project leader at the Restaurant of the Future since its opening in 2007 and describes it as a place where two worlds collide. "Within sensory research, classic sensory tests and consumer

research have always been two separate worlds. For a long time, there was a golden rule which said that complex sensory research could only be performed by trained panels. The disadvantage of this separated approach is that you know what an expert panel values but not what consumers will actually experience in the shops. For a complex product such as wine a certain amount of training can be useful when it comes to naming sensory attributes. Soup, however, has attributes that consumers can easily define without expert training. Working with consumers efficiently provides us with hedonistic and sensory insights that can later be used by marketers and product developers."

### Reducing salt levels

An interesting case in this context was reformulation with soy sauce as an ingredient. A soy sauce manufacturer wanted to know whether it was possible to reduce the amount of salt in products without losing consumer acceptance. The result was that although consumers did notice that the flavour profile of products had been altered, this change did not affect their appreciation of the product. In other words: The product tasted differently but wasn't any less tasty. This is an encouraging conclusion at a time when the food industry is actively reformulating products on the one hand, while being very hesitant to market reformulated products on the other.



Kremer understands the industry's dilemma: "When reformulating the question remains: Do you apply it to an existing product or will you add a reformulated product with a different flavour profile to the product range? The industry is wary of the latter option, but I think that many good concepts bite the dust at too early a stage because the flavour is too different from the old standard."

### **Introduction method determines success**

Is a different flavour profile really that terrible if it also means that a product contains less salt, fat or sugar? That depends, says Marian Geluk, Business Development Manager. "I have heard that in the industry there are barriers against introducing reformulated products. This is understandable as various launches of reformulated products have been unsuccessful. An example is the manufacturer of dry soup products who announced in big letters on the new packaging that they had seriously reduced the level of salt in the product. As a result sales went down because consumers apparently thought that less salt would make the product lose its good qualities. The company successfully recovered by changing the text on the packaging to just 'new'. Consumers who consciously buy a brand product with a health connotation would possibly have been fine with the change. A manufacturer that expanded its A-brand with bread containing 40 percent less salt did successfully introduce the new product. This example shows that in addition to sensory characteristics,

the way a product is introduced can determine its level of success. Studying the effect of communication in a real life context is therefore of great importance."

Kremer is convinced that the number of failed introductions of reformulated products can be reduced if manufacturers test their product concepts in sensory research and in real life at an early stage. "The Restaurant of the Future is an experimental facility that offers manufacturers the opportunity to try new things, and find out what the consumer likes. Take a good look at consumers and include them in the concept at a much earlier stage."

Real life research in the food industry is on the verge of a breakthrough, Kremer predicts. "Product liking has so many facets and it takes more than a single test to figure it out. An increasing number of clients are recognising this and looking to be guided by a partner that provides them with valid research data. Data that actually say something about the sensory characteristics of products and about consumer behaviour, which requires different tests to those currently being used. Tests in real life settings are naturally costly, which is why our consumer scientists is working on developing a host of tests that combine substantial external validity with an effective organisation."

Until the mid-nineteenth century, people supplied themselves and their nearest and dearest with food. Most people worked on, lived off and depended upon the land, and this often had dramatic consequences. The industrialisation of food production has brought the world many advantages. Food quality, attractiveness of food products and sustainability of global food production continue to be important themes. Wageningen UR works in an interdisciplinary way to address these major challenges.



# Food products and food production

The potato crisis that affected Northern Europe and Ireland in the 1840s was the final food disaster in a long list of events that led to the widespread prevalence of deficiency diseases and death from starvation. As people were not able to conserve food products on a large scale, failed harvests had catastrophic results.

As a result of the invention of canning, the nineteenth century marked a turning point in the history of mankind. The 200-year anniversary of the tin can which took place last year did not get the publicity as it deserved. After all, as food supplies became less dependent on the season, the amount of labour on the land was reduced. The newly available manpower capacity was used in factories, and facilitated the development of the industrial revolution. Agriculture also became increasingly industrial, as machinery enabled the large scale production, preparation and packaging of food products.

The twentieth century saw rapid developments in the field of food and food production. Science taught us about the ingredients of food and their functions, and we learned about beneficial and pathogenic bacteria. Thanks to both breeding and improved living conditions, we succeeded in developing better crops, while the industrialisation of food production allowed us to preserve food longer without losing too much flavour and nutritional value, and considerably increase food safety.

Today, most of the food products we consume come from factories and supermarkets offer a huge selection at relatively low prices. At the same time, preparation is much quicker than for non-processed foods. The downside, however, is that Westerners are becoming increasingly alienated from what



they eat. Many people worry about the quality of food, and equate the term 'processed' with 'unhealthy' and 'unappetising'. The paradox is that the food industry is encouraging this alienation by emphasising in its marketing and advertisements that certain products come directly from the land.

The research performed by Wageningen UR is strongly linked to the aforementioned social issues such as health and the attractiveness of food. An example in the field of health is the study into glucosinolates, chemicals that naturally occur in cabbage varieties and which are said to help prevent cancer. Other examples are *Milk genomics*, a study into the relationship between the genetic composition of cattle and the nutritional value of milk, or research into acrylamide, a harmful substance that is formed during baking or frying chips. Food safety is an issue that recurs in many studies, for instance in the research into how to prevent the growth of microorganisms in packaged fresh vegetables and fruit.

Another major research theme is global food production. Two of our main goals are to improve the quality of food products in developing countries as well as the economic conditions of farmers in these countries. One of the programmes we finance is TELFUN, an interdisciplinary research programme focused on quality improvement of local crops such as lupine (Ecuador), cowpea (West Africa) and mung bean (India), and on strengthening the local networks that produce these crops, which are at risk of disappearing due to the globalisation of the food market.

Sustainability is an issue that is a leitmotiv in all studies. The global food production is taking an extreme toll on the environment and relies heavily on increasingly scarce fossil fuels, land, water and phosphate. Intensive cattle



The global food production is taking an extreme toll on the environment



breeding is an especially energy-hungry sector that requires large amounts of fossil fuels and fertilisers. The production of meat will put an especially large claim on these products if the global population switches en masse to meat consumption. A major challenge is how to better utilise vegetable raw materials to bypass animal production.



Allergies are becoming increasingly common. In an ageing population the resistance is weakening of many people whose bodies become intolerant to certain nutrients that pass the intestinal wall.



Wageningen scientists are performing research into the causes and effects of food allergies, and working on the development of allergy-free products. This is one of the ways in which we are making a substantial contribution to the quality of life.

In allergies, the body reacts to components that the body produces itself or from substances from outside the body that would normally be harmless. One of the

# Looking for allergy-free alternatives

lesser known, but very serious allergies is mussel allergy. It is mainly caused by the tropomyosin protein, which occurs in the muscle tissue of almost all animal species. However, because this protein has a relatively minor relationship with the human variety, people can be oversensitive to it and suffer from allergic reactions, varying from skin irritation and tightness of the chest to acute cardiac arrest. Wageningen scientists are studying the exact effects of mussel allergy with the aim of breeding a new type of hypoallergenic mussel.

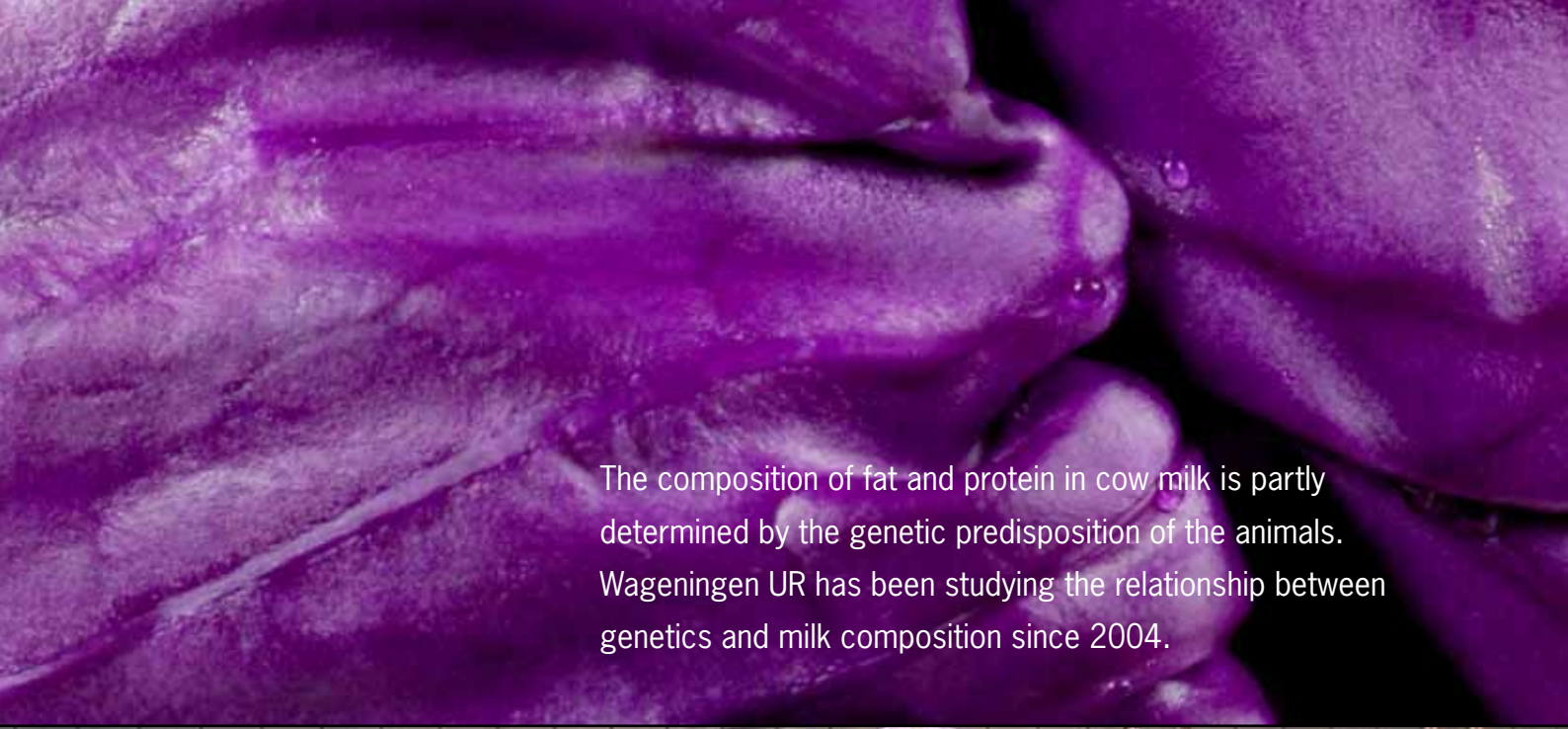
## Celiac

A more common allergy is celiac disease, or gluten intolerance. An estimated one percent of the Western wheat-eating population suffers from this allergy, often unknowingly. We have been carrying out research into an effective diagnosis, prevention and treatment of gluten intolerance in the Celiac Disease Consortium since 2004. A recent study into the cause of celiac toxicity shows that it should be possible to develop wheat varieties that are safe for people with celiac disease. One of the strategies applied by our scientists is directly selecting low-toxic varieties for production or developing new varieties via breeding programmes. The condition is that these new varieties have sufficient quality for agriculture and food technology.

Wageningen research resulted in a scientific breakthrough by replacing gluten in bread with small milk protein particles

## Bread

In early 2011 Wageningen research resulted in a scientific breakthrough by replacing gluten in bread with small milk protein particles. The result is a light bread with a crispy crust that closely resembles normal bread, and, more importantly, tastes like it too, unlike current gluten-free bread which is barely edible. Although it will be a while before this tasteful gluten-free bread reaches the shops, it is a major technological step in the right direction.



The composition of fat and protein in cow milk is partly determined by the genetic predisposition of the animals. Wageningen UR has been studying the relationship between genetics and milk composition since 2004.



Our scientists found major differences in composition, largely due to genetic causes. The resulting knowledge can be used to change breeding programmes so as to increase the amount of unsaturated fatty acids and suitable protein to the benefit of both producers and consumers.

Milk Genomics is the name of the project in which Wageningen UR works closely with the CRV and the Dutch Dairy Association. Via DNA research, the scientists determined precisely which genes cause the genetic differences between animals. As an international group of scientists had succeeded in mapping the complete bovine genome sequence in 2006, we were able to perform a specific search for those locations in the genome that house the genes causing variations in fat and protein.

# Improving milk via genetic variation




### **Fat composition**

Now that the natural variation within the dairy cattle population is known, it is time to utilise this by selecting those cows that produce milk with an adapted fat composition. By finding the right bulls, the scientists expect to increase the percentage of unsaturated fatty acids in milk by ten percent in ten years. This rise does not include any further increases as a result of improved animal fodder.

### **Higher cheese production**

In addition to the differences in milk fat, the scientists also found major differentiations in the milk protein composition, which could also largely be attributed to genetic variation. The milk protein mainly consists of so-called caseins. Milk containing a higher percentage of these caseins is of benefit to cheese manufacturers, enabling them to increase their turnover by around 25 million euros.



Although food technology has facilitated considerable improvements to food safety over the last century, risks still remain. It is known, for example, that meat products such as chicken are vulnerable to bacteria, while fresh vegetables and fruit are also prone to infection. Microbiologists from Wageningen UR continue to search for methods to prevent bacteria from growing uncontrollably and becoming a human health hazard.

### **Acrylamide**

One of the reasons that biscuits, crisps and chips are not very good for our health is that they contain small amounts of acrylamide. Animal testing has shown us that high concentrations of this substance, which is released during baking and frying, can cause cancer. Acrylamide cannot be completely eradicated, but scientists do expect to reduce the amount we ingest by 40 percent.

### **HEATOX**

Wageningen UR was one of the participants in the HEATOX project, European research that analyses the health risks of acrylamide. Our contribution initially focused on reducing acrylamide levels in potato chips. In this framework, our scientists developed a way to determine the acrylamide percentage in chips, and then studied whether they could reduce these levels in those cooked at home. The research showed that there are several suitable methods. A major reduction can be achieved by blanching the chips first and the ingested acrylamide levels can also be reduced by frying at a slightly lower temperature. Finally, a reduction can be achieved by selecting specific potato varieties low in glucose which are less susceptible to acrylamide formation. These findings have been put into effect by potato processing companies worldwide.

### **Salt**

Another way to reduce the risk of acrylamide is by replacing the leavening product ammonium bicarbonate, which is used in the production of products such as cookies and bread. While sodium carbonate is an alternative, this increases the amount of salt in products so scientists are continuing their search for other leavening products.

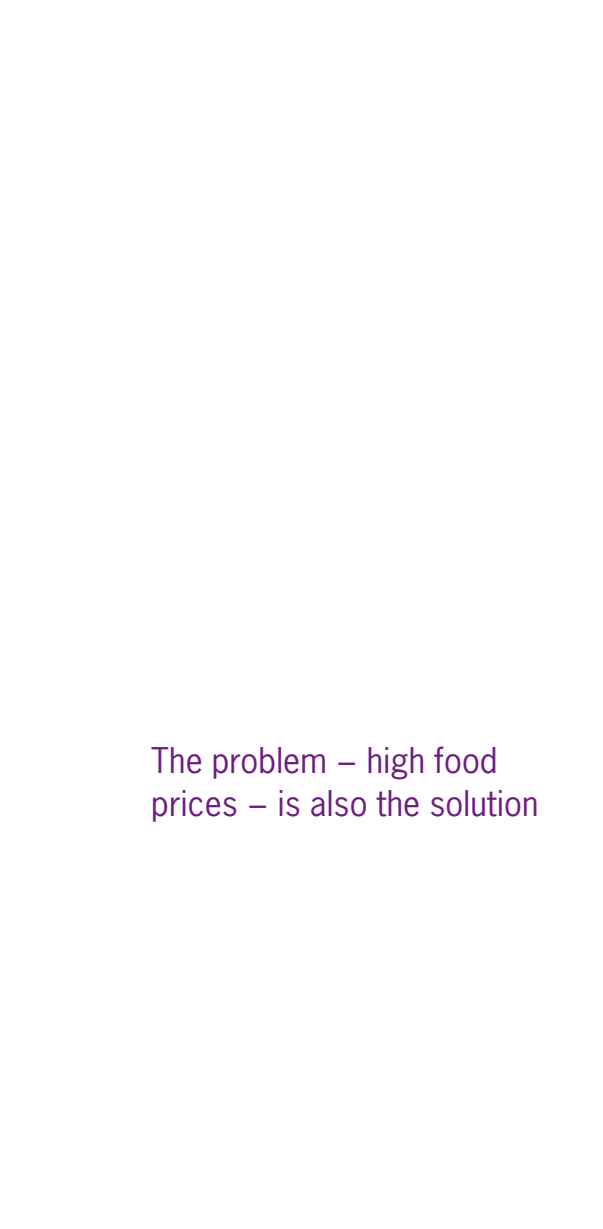
Product health risks

# Controlling the risk of acrylamide





Why are food prices rising? This was the question that Wageningen UR, sought to answer via a thorough analysis. Its conclusion was that the increases can be attributed to a combination of factors.



The problem – high food prices – is also the solution





# The poorest people suffer most from rising food prices

The major increase in food prices that has been seen since 2006 is related to the raw material prices of agricultural products such as wheat, soy, palm oil and maize. The prices of fossil fuels are also rising gradually. Although this is a global problem, the increasing prices mainly affect the world's poorest populations. This can mainly be attributed to the growing global population. Although the population rise is expected to slow down, economic growth will continue and so, therefore, will the demand for agricultural products. Moreover, some agricultural crops are being used for the production of biomass as a source for fuel rather than as food. And the supply of agricultural products has declined in recent years, mainly as a result of climate-induced failed harvests.

## Closed markets

The problem is made worse because some countries protect their markets from foreign producers, which also leads to price rises on the global market. Another factor is the value of the dollar, which has declined in recent years in relation to other currencies and made the price increases in dollars even higher.

## Solution

The problem – high food prices – is also the solution. As prices are high, the supply on the global food market is increasing, which in turn will cause prices to fall. At the same time, the extra demand for raw materials to produce bio-fuels is pushing up the price, as is the increasing oil price integrated in food prices. As mentioned, the problem is greatest in the poorest parts of the world. It is essential that the production capacity in these regions is considerably improved in coming years to strengthen the income position of poor countries on the global market. Our scientists are working on improving the opportunities for farmers and strengthening the food chains in these countries via various programmes.



Global food production is environmentally unfriendly and relies heavily on increasingly scarce fossil fuels. Intensive cattle breeding is a major contributor to these problems and yet meat is a great source of iron and vitamin D. Via a large number of studies we are researching whether vegetable resources are suitable for producing meat substitutes.

Food technologists have the task of developing fibre structures for substitutes that are comparable to those of meat

This issue has two main challenges, the first being to develop meat substitute that results in a similar intake of iron and vitamin D. The second challenge is to develop alternatives that have the same texture as meat, which would ensure they are also accepted by 'carnivores'.

### **Profetas**

Within the Dutch research programme Profetas (an acronym for PROtein Foods, Environment, Technology and Society), Wageningen scientists are working on various studies into meat substitute products. One of the conclusions is that these products still have a long way to go: The flavour of meat substitutes does not resemble actual meat and is deemed unacceptable by most meat eaters. The appearance, texture and satisfaction of these products also leave much to be desired compared to 'real' meat. Food technologists have the difficult task of developing fibre structures for substitutes that are comparable to those of meat. A possible interim solution would be to develop products that are part meat, part meat substitute.

### **Meals**

Another study is focused on determining the influence of a meat substitute in complete meals. The scientists tested various dishes with several meat substitutes. They concluded that the differences between meat and meat substitutes fade in complete dishes where it is less important whether the individual products taste good. This offers developers of food products new opportunities; for example to process meat substitutes in ready-made meals. To tempt the increasing number of people who are open to eating meat substitutes, it is wise, however, to develop products that have an appearance, texture and method of preparation similar to meat.

Sustainability and product development

# Meat substitutes have a long way to go





While cabbage varieties are high on the health ladder among vegetables, they remain relatively unpopular among consumers. Wageningen scientists are looking for methods to make cabbage more attractive.



A random sample of global research instantly shows the benefits of eating cabbage. American women who regularly ate broccoli, for example, were shown to have a reduced risk of a coronary event, while Chinese men who did the same had less chance of getting cancer. Wageningen scientists have a special interest in cabbage as a research subject. We have shown, for instance, that the protective glucosinolates in cabbage varieties are released more effectively when cabbage is chopped. Our scientists also discovered that the best way to prepare it in the microwave as this means no glucosinolates are lost when the cabbage is drained (as long as the microwave is not turned up too high).

# Cabbage deserves greater appreciation



## **Sprouted vegetables**

The problem is that consumers do not particularly value the current cabbage varieties. We are therefore looking for new varieties with plenty of health improving ingredients, such as glucosinolates, that will be sufficiently appreciated. A special focus is on the development of new varieties of sprouting vegetables such as bean sprouts and cress, which are already very popular in the US and increasingly so in the Netherlands. The benefit of sprouting vegetables is that they contain a much higher level of health-stimulating substances than 'adult' vegetables. A difficult aspect is that the percentage of these substances can vary substantially per variety. It has nevertheless clearly been shown that it is possible to further develop healthy substances in cabbage.



The invention of the tin can caused a revolution in food production two centuries ago, enabling people to store food safely for much longer periods. The technologies of storing food while maintaining quality have been further refined many times since then.



One of the latest innovations is High Pressure Processing, a discovery that is being intensively researched by Wageningen scientists. High Pressure Processing, or HPP, is a relatively mild conservation method for prolonging the shelf life of products while maintaining their flavour and essential nutrients. Food products are first quickly heated then placed under high pressure to block any loss of quality caused by micro-organisms. The high pressure also ensures that the products maintain the same shape and structure as the fresh product.

### **Extending storage life**

Various experiments have shown that it is possible to prolong the shelf life of products by pasteurising them under high pressure. In combination with other

# Improving conservation with higher pressure



factors (drying, freezing, heating), lower pressure also prolongs shelf life. The possible effects on product flavour have been shown to depend on the type of product. HPP does not cause the heat damage that normally occurs when products are heated, which has an impact on the flavour of some products.

### **Further research**

Further research is required to obtain greater certainty about the effects of HPP. An important question that has to be answered is how consumers feel about it. Another is whether the improvements make the necessary investment worthwhile as high pressure systems are expensive. Scientists are therefore also looking to see whether the costs of HPP can be reduced.



The food supply in most developing countries is extremely vulnerable. Wageningen UR is participating in various programmes, supplying its knowledge and expertise to help strengthen local food markets. An example is TELFUN, an interdisciplinary research trajectory that gives the local population greater control over its own food supply.





# Strengthening local population

Within TELFUN (Tailoring Food Sciences to Endogenous Patterns of Local Food Supply for Future Nutrition) Wageningen scientists work with food experts from Africa, Asia and South America. The work encompasses four countries – Benin, Ghana, India and Ecuador – where Western food products have gradually been replacing traditional food products as a result of globalisation. This has led to a decrease in the people's knowledge of how to grow local crops successfully, which in turn causes problems for the local food supply.

## **Interdisciplinary teams**

The Wageningen scientists in the four countries partner with teams that include a plant breeder, a food technologist, a nutritionist and a sociologist. They work on a local level to ensure all the aspects needed to create new opportunities for the local crops receive the attention they require. The plant breeder, for example, looks at crop yield and nutritional value, the nutritionist studies the health of children before and after the introduction of the crops, and the food technologist gives advice on how local people can prepare the crops for consumption. Finally, the sociologist looks at the consequences of the introduction of the crops for the local community.

## **Cowpea, mung bean and lupine**

In Benin and Ghana, TELFUN is focused on the cowpea, a long bean variety; in Ecuador on lupine and in India on the mung bean. In the latter country, the project resulted in a new modern food product prepared with a local crop: The mung burger. In Ecuador one of our scientists developed a new method for removing a toxic substance from lupine. These glycoalkaloides were traditionally removed by washing the lupine in flowing water for five days, which has now been reduced to two days. In addition to time savings, this has substantially reduced water consumption.

## Celiac prevention

# Multiple perspectives, a single goal

Wageningen UR has been working with other universities in a major research programme aimed at the prevention of celiac (gluten intolerance) since 2004. The cooperation is part of the Celiac Disease Consortium, which includes several universities as well as the Dutch celiac patients' association (NCV) and various companies. Joining forces has proven to be highly productive, unlocking several new research directions.

Luud Gilissen is senior researcher and allergy coordinator at Wageningen UR's Plant Research International and closely involved with the celiac research. "The research is based on many different perspectives," says Gilissen. "The Human Genomics department of UMC Groningen is looking for genetic traits connected to the development of celiac. Food Genomics aims for the development of food products that are safe for people who suffer from celiac; this mainly takes place in Wageningen. And Leiden UMC is studying the interactions between gluten and the immune system, in addition to coordinating the consortium. Several other universities joined the consortium in 2010: VUMC is focused on diagnostics and serious cases of the disease, while Erasmus MC is developing an animal model. More companies have also come onboard."

### Gluten protein

Celiac is an allergic reaction to gluten that occurs in approximately one percent of the population. Gluten is

a large group of proteins that is found in the seeds of wheat, barley and rye. The research programme has considerably increased knowledge about the gluten protein responsible for the immunological reactions. This knowledge is now paving the way for the development of celiac-safe wheat varieties.

### Safe oats

One of the research trajectories focused on by Wageningen UR is the development of gluten-free oat products, as Gilissen explains: "Oats are a very interesting and healthy grain mainly common as a food product in Scandinavian countries, Scotland and Canada. Current production and consumption in the Netherlands is but a fraction of what it was 50 years ago. As oats are related to wheat there has been a lot of discussion as to whether they might be safe for people with celiac. It has now been shown that oats do not contain any toxic gluten so long as they have not been contaminated with wheat, barley or rye during production, harvesting and processing."

### Gluten-free chain

With this in mind, the search has been on for companies that could help form a gluten-free oat chain; from initial production to end product processing. "We were successful," continues Gilissen. "The collaboration with various companies in the chain has resulted in a small-scale production of celiac-safe oat products, the first of which



have already been introduced to the market. We are now talking to various manufacturers about the production of oat bread as a new type of bread that is suitable for people with celiac. It is quite a challenge because it is the gluten in wheat that enables bread dough to rise, and that is exactly what we cannot use.”

### **Healthy characteristics**

During the research it became increasingly clear that oats are beneficial to other people besides celiac patients. They also contain so-called beta-glucans, specific nutritional fibres that can lower cholesterol levels. “Oats can play a role in the prevention of cardiovascular diseases,” Gilissen explains. “Additionally, their nutritional fibres and other healthy ingredients appear to make a significant contribution to the fight against obesity and diabetes. The increased knowledge about oats is resulting in new joint ventures. Patients’ associations, for example, are taking the lead in promoting oat products as healthy nutrition. This is a great motivation to continue research and ensure that R&D initiatives strengthen each other, both within and outside of Wageningen UR. What varieties are most suitable for processing, and in which food products? How can we maximise harvests? Can oat products serve as a protein substitute for people and animals? How can we further utilise the good traits of oats? What health claims can be made for oats? There are still many questions left to answer.”

## Cooperation leads to major breakthrough

# Less salt, same flavour

Markus Stieger, Assistant Professor of Food Technology and Sensory Science, led the project on behalf of Wageningen UR. “It started as research into the interactions between food structures (texture) and flavour. We also wanted to link the study to health issues to support our industrial TIFN partners in developing healthier products while maintaining the full flavour. As a result we increased our focus on salt, one of the main flavourings in our everyday diet of which we ingest far too much.”

### Partners

An average of eight people worked fulltime on the four-year research project, which in addition to Wageningen UR also benefitted from the knowledge of NIZO Food Research and Dutch research institute TNO. The research direction that proved to be most successful was the study into flavour contrasts, with the scientists applying the principle that people mainly use their senses to detect differences. Stieger: “By distributing the salt in a product differently, for example in layers with more and less salt, you ‘taste’ more salt, even if the product actually contains less. It doesn’t even require a conscious perception of the flavour variation.”

### Patents

After the scientists had shown that a different distribution of ‘salt’ (as well as sweet and umami) could strengthen flavour

intensity, a second key step in the research was required: The application of the principle in actual food products. Although the knowledge institutes in TIFN usually only provide their industrial partners with guidelines, this project took the cooperation one step further. “To patent our findings we needed examples of applications,” Stieger continues. “The laboratories of the manufacturers developed products such as bread, meat and cheese with less salt, which were then subjected to taste tests by the knowledge institutes.” The patent applications were successful, and are now in the hands of a consortium of several commercial TIFN partners.

### Public health

The industrial partners (Unilever, DSM, CSM, FrieslandCampina, the Dutch Dairy Association (NZO) and VION) are currently working independently on the development of ‘real’ food products with less salt for market purposes. In a number of products it appears possible to reduce salt by 25 percent without losing any flavour. This would make a substantial contribution to public health. In the Netherlands alone excessive salt intake results in thousands of lethal cardiovascular diseases every year. And there is more good news: The technology developed at TIFN can also be used to reduce the amount of sugar, and possibly even fat, in food products.



# Colofon

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## Human health

Continuing advancement in research allows scientists of Wageningen UR to unravel the workings of food in our bodies. The ultimate challenge remains: What are nutritional needs for healthy life and succesful ageing?



## Nutrition and lifestyle

Sticking to healthy eating habits is not as easy as it sounds. Temptations are everywhere. Social and food scientists from Wageningen UR interact with society, striving to make healthy food the standard option.



## Food products and food production

The industrialisation of food production has brought the world many advantages. Food quality, attractiveness of food products and sustainability of global food production continue to be important themes. Wageningen UR works in an interdisciplinary way to address these major challenges.

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