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Genomics in the agrofood sector

An overview of social questions and dilemma

by Rinie van Est, Rathenau Institute, and Lucien Hanssen, Deining Consultancy for Social Communication

Genomics is a relatively new field of research in which governments and companies will be investing significant sums over coming years. The specific application of genomics in research pertaining to agriculture, food processing and food consumption we name food genomics. To review social and moral aspects that are or will be involved in food genomics research, the Rathenau Institute last year (2002) set up the project *Towards a Social Agenda in Food Genomics* (*Naar een Maatschappelijke Agenda van Voedingsgenomics).* Within this project a study was done on the current state of affairs of food genomics research in the Netherlands and five social scientific essays were written about possible social impacts of food genomics. Besides these research activities, an expert meeting and a working conference were organised. Based on the research and debate activities in the Rathenau project, this article suggests a provisional framework for further consideration and discussion of the social aspects of food genomics.

1 Possible applications of food genomics

The application possibilities of food genomics are diverse and cover the entire food chain.[1] The agricultural domain shows us continuing upgrading of characteristics such as vitality, disease resistance, and drought and salt tolerance to increase yield, reduce loss during storage and transport and optimise processing procedures. Also, transgenic plants and animals are being created with entirely new characteristics. For instance, plants and animals are being enriched with (micro) nutrients that have a positive effect on human health. During food processing new biomarkers are being used to increase food safety and quality. We are seeing strong growth in the production of auxiliary substances and food ingredients by micro-organisms, such as colourings and flavourings, but also substances that are essential to our health. These biologically active substances such as vitamins, essential fatty acids or antioxidants are being used in neutraceuticals and functional foods. With respect to food consumption, genomics research is focusing on obtaining greater insight into the effects of food components in the body and substantiating health claims of new enriched foods. This field of research is named nutrigenomics. There is also a development towards a

completely new type of high-quality food that meets consumers' individual genetic profiles.

2 Starting the discussion on social aspects

To provide initial understanding of and start a discussion on the possible social and moral aspects of food genomics research, the Rathenau Institute asked five social scientists and philosophers to write an essay. The essays discuss the following themes:[2]

- socio-economic organisation of food production;
- globally sustainable food security;
- animal use;
- socio-economic organisation of food consumption; and,
- wishes and concerns of citizens and consumers.

The essays were discussed during a working conference that was held in June 2002 with policymakers, scientists, business representatives and social organisations. At this conference participants were also asked to put on paper the social and moral issues with respect to food genomics they thought were of most importance. The five essays are collected in the publication *Genes for your food – Food for your genes*.[3] Based on the essays and the discussions during the working conference, this collection finishes with a conclusive chapter enumerating social questions and dilemma. This article summarises our findings and suggests a *provisional*[4] framework for further consideration and discussion of the social aspects of food genomics.

3 Socio-economic organisation of food production

When it comes to seed production and the use of chemical manure and pesticides, industrial agriculture depends ever more on the life sciences and agrochemical companies. At the same time, the agrarian basis of food production is gradually being replaced by industrial biochemical systems. Consequently, the agricultural product is serving less and less frequently as a food product but rather as an industrial semi-manufactured product. In the long run synthetic industrial products might even replace food products. As a consequence, the power in the food chain is shifting ever more towards the food industry. Current food genomics research reflects a view of agriculture and food production with key words such as industrialisation, economic rationalisation, technical efficiency, scale increase and globalisation. Farmer autonomy is declining and the influence of international life sciences companies on food production is gaining the upper hand.

This view, also dominant in Dutch politics, increasingly forms a point of discussion in the current debate. There is a movement against globalisation visible and especially against the industrialisation of food production, and in favour of the maintenance of cultural (regional) diversity of traditional food products. Current genomics research is very weakly directed towards such alternative development directions. Besides this, the interests and views of Dutch farmers play only a marginal role in food genomics research. This is a remarkable blind spot because possible applications such as bioplastics, energy crops or the production of proteins through micro-organisms may have drastic consequences on Dutch agriculture and its functions such as land use and landscape management.

4 Worldwide sustainable food security

The problems regarding food supply are urgent. At the moment it is estimated that more than 800 million people around the world are undernourished. The target of the recent World Food Summit in Rome (2002) was to cut by half the number of undernourished people by 2015. However, it will take more than technological developments to solve the world food problem. Agricultural protection politics of the European Union and the United States, worldwide food transport and political stability are also significant factors. Food genomics research will not get off the ground in many Third World countries and will only enlarge the knowledge gap between the rich West and the Third World countries.

This does not apply to some "countries in development" such as China and India that are taking control of the technology into their own hands. In April 2002 for instance, Chinese researchers surprised the scientific world by an

nouncing the genome sequence of an important rice variety. According to some genomics research can and should contribute to solving the food issue. They want to use genomics know-how to upgrade local crop varieties in developing countries. The problem, however, is that this type of research cannot be carried out in those countries. Therefore they want to dedicate part of Western genomics research to local crops, the so-called orphan crops, in the Third World. Other parties do not welcome this idea and prefer the use of (low-tech) local alternatives that are already available.

5 Animal use

Today's meat production draws heavily on the use of energy, water and land. Due to a growing and richer world population, combined with Americanising food patterns, large new markets (e.g. China) are continuing to develop. Genomics might help solve this challenge in several ways. For instance by improving food conversion from vegetable to animal protein or by developing transgenic livestock or aquaculture for food production. One alternative route that does not use animals is the industrial production of high value proteins by (transgenic) micro-organisms. A shift from agrarian to industrial production of high-quality proteins might have major consequences for the agrarian sector. For instance by inventing protein-rich products for which the origin of the raw material no longer matters (soya beans, palm kernels, peas or alfalfa) food companies become less dependent on the choices of their raw materials. Such freedom of choice for the food industry might make farmers a plaything in the world market.

Another theme regards the effect of genomics on laboratory animal use. On the one hand food genomics is meeting the trend for functional foods. These innovations go in parallel with extensive effectiveness and safety tests, including many tests on animals. On the other hand genomics research can be used to develop alternatives (*in vitro* or *in silico*) to help reduce the number of animal tests. In social, economic and innovation terms, developing alternatives for animal tests means benefits and should thus be encouraged. The Dutch Lower House has already taken up this point. Within the budget for genomics research € 900,000 has been politically earmarked for research on alternatives for animal testing.

6 Socio-economic organisation for food consumption

Food consumption does not only mean taking in essential nutrients. It means a lot more: the pleasure we experience when we eat, the agreeable character and the ease of food consumption. In today's culture food also means the consumption of *lifestyle* symbols, of moral meaning. Cultural and political factors are essential to the meaning of products. That meaning is obtained through the way in which food is produced, the reputation of a brand or company, the environment in which food is consumed, or the social networks in which consumers operate. Consumers react in different ways: they may embrace high-tech functional foods or indeed resent the rationalisation and "scientification" of the food production process, and show an entire range of reactions in between. Both these trends and combinations of them are already visible. Besides the growth of the functional food market, there is clearly a movement against globalisation and industrialisation of food production and in favour of the maintenance of cultural (regional) diversity of traditional food products. Coalitions of farmers, consumers (think of the *slow food* movement), environmentalists and antiglobalists are making people more aware of this.

Besides its symbolic value, the functional value of food is a supplementary and useful starting point for discussions about the social effects of genomics research on food consumption. Knowledge of biological active components has experienced explosive growth over the last decade. That knowledge represents the basis for the development of new functional foods, and the public's revaluation of the health value of existing foods. A promising development is "tailored functional foods" and personalised foods.

Food genomics research supports the development of new knowledge about the relationship between food and health, and about new functional foods, and will speed up these developments. As a consequence genomics research will lead to a number of social questions being posed that dovetail with existing discussions on

Consumers' trust in food genomics

With regard to the acceptance of gene technology there is a clear distinction between 'red' applications such as medicines and diagnostic systems, and 'green' applications such as transgenic crops and genetic foods. One optimistic assumption is that by the time we reach the second generation of genetically modified food with substantiated health claims, the discussion about gene technology will be a thing of the past. Thanks to direct personal benefits, consumers will accept the products without much fuss and be prepared to put up with possible risks. Another scenario is also possible: Since genomics brings food and pharma closer, food genomics might face both green issues (naturalness, safety, power of the distribution chain, etc.) and red issues (genetic privacy, insurance, nutritional diseases, etc.). A crucial question therefore is how will consumers actually use the new food products and services? The themes below relate to this question:

Food is more than health

When it comes to their health, people do not act rationally. People base their choice of food not only on health aspects, but also on price, taste and the social and moral meaning of food. Notwithstanding this, researchers expect genomics to encourage conscious and healthy food consumption.

Risk perception of new food

When people use medicines they accept possible side effects, but they expect food to be very safe. What will happen if and when the boundary between food and medicine fades? Will consumers be willing to accept the risks of new food products, and if so, to what extent? Will the perception of the consumer move from need for food safety to the evaluation of the *risk-benefit*?

Fear of being pushed in

Some people fear that the consumption of healthy foods will develop an obligatory character in the future. One possible scenario is that insurance companies may threaten to raise insurance policy costs if people do not stick loyally to their personal diet, which has been determined on the basis of their genetic sensitivity to certain diseases.

Eating as social activity

The new trend to the individualising of eating patterns, which will only continue thanks to food genomics and the development of *personalised diets*, might devalue the meaning of eating together as binding social mechanism.

Genetic privacy

A genetic passport can have its negative sides. Genetic screening for instance might lead to confirming that a person has a high chance of developing a serious disease while they may not wish to know this. Genetic privacy, which means control over personal genetic information, is an important theme for consumers. Will consumers want to be screened?

functional foods. One should think of issues like health claims, the fading boundary between food and medicine, as well as the medicalisation of eating behaviour. Genomics research is even arousing hopes that food will be adaptable to individuals' genetic profiles. Genetic susceptibility to disease and medical complaints can range from intestinal cancer to food infection. Genomics research is helping us map these phenomena and tune food advice to the personal genetic constitution. Several genomics researchers believe that consumers will be choosing food on the basis of their own genetic constitution within ten to twenty-five years. By then people will have a genetic passport that allows them to use *personalised nutrition*, personal food with a preventive function. In this scenario food consumption has been individualised and "scientified" largely. There are people who find this something of a doom scenario. A crucial question therefore is: will consumers actually use these new food products and services? (see Box "Consumers' trust in food genomics").

7 Wishes and concerns of citizens and consumers

Genomics researchers hope that the "neutral" term genomics will not be confused with the "contaminated" term of genetic manipulation. Others, especially social scientists and representatives of social groupings emphasise the importance of discussions about gene technology and food, and food genomics taking place together. There is a number of reasons for this, because genomics and gene technology are strongly interrelated in technological, infrastructural and organisational terms. Due to this interrelationship a number of social aspects that are involved in the current debate about genetically modified food will also be involved when discussing food genomics. It is extremely important that the social debate about food genomics relates to the content of the running debates in the agrofood sector. Besides, lessons should be drawn from the way in which these controversies have developed within society.

The Dutch government and Parliament have expressed their wish to take social aspects into consideration in all genomics research. It seems evident, therefore, to allow all relevant parties to be involved. Many social parties are wondering to what extent genomics (in its current form) will be able to contribute to solving problems such as food security, environment and animal protection, "welfare diseases" and such like. The input of social groupings to (the debate on) genomics research is still very limited. Current Dutch food genomics research strongly supports industrialised and biochemical food production. The research agenda seems to reflect and perpetuate the central position of power of the food industry in the food chain. There is yet no effective counterweight.

The regular research programme should be enriched with varied social viewpoints. It is important to give other opinions equal rights because it is not clear how the food production and food consumption will develop in the future. Diversity in social views is the best key to a socially and morally robust research agenda. Analogous to the belief in political pluralism in our democratic order, food genomics research should pursue *innovation pluralism*.[5] This means:

1. That the contribution genomics research can make outside the dominant context of industrialised agriculture should be mapped;
2. That a sum of money will have to be put aside for alternative research: for less laboratory animal use, knowledge about health effects of traditional foods, knowledge for biological ("approved") agriculture;
3. That parties with different views, knowledge and interests will have a say in defining the research programme.

It will only be possible to broaden the research agenda if the parties that now dominate the genomics programme, will be open to other arguments, views and interests. The wish for openness is an important lesson we can draw from the debate on gene technology. In this debate the companies involved did not for many years realise that parties holding different values and opinions doubted the benefits of gene technology they sketched. Being receptive to opposing voices means choosing for a painful and uncertain, yet in the long term purifying and stabilising process. To have people trust food genomics, openness is the best policy. After all, confidence is based on honesty and openness. In this way a situation will be created in which scientific and technological developments, and their imbedding in society, will encourage and inspire each other.

Notes

1) This section is based on the study by Enzing, C. & A. van der Giessen (2003): *Voedingsgenomic-sonderzoek in Nederland. Mogelijke producten en maatschappelijke aspecten.* (Food Genomics Research in the Netherlands: possible products and social aspects.) Working document 89. The Hague: Rathenau Institute. This publication contains an English summary.
2) The authors of the essays are G. Ruivenkamp, B. Gremmen, L. Paula, H. Zwart and H. te Molder & J. Gutteling, respectively.
3) Van Est, R., L. Hanssen & O. Crapels (eds). (2003): *Genen voor je eten – Eten voor je genen. Maatschappelijke vragen en dilemma's rondom voedingsgenomics. (Genes for your food - Food for your genes. Social questions and dilemma regarding food genomics).* Working document 90. The Hague: Rathenau Institute. In May 2003 an English translation of this publication will be available.
4) It is important to stress the proverb "provisional", because at this early stage of genomics research statements made by scientists and other parties involved are often of a speculative nature. Expectations regarding applications that genomics know-how might serve are diverse. Especially the terms in which products and services will be introduced to the market vary widely. Expectations with regard to possible social effects show similar high uncertainty and unpredictability. This makes it very difficult to indicate the urgency of certain issues. It is a snapshot of the interaction between science, technology and society.
5) Rinie van Est (1999): *Winds of Change. A comparative study of the politics of wind energy innovation in California and Denmark.* Utrecht: International Books.

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Szenarien einer liberalisierten Stromversorgung

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Der vorliegende Beitrag beschreibt in komprimierter Form die Vorgehensweise und einige prägnante Ergebnisse des 2001 an der Akademie für Technikfolgenabschätzung in Baden-Württemberg durchgeführten Projekts „Szenarien einer liberalisierten Stromversorgung“. Als spezielle diskursive Methode zur Erstellung möglicher Szenarien für den deutschen Strommarkt im Jahr 2010 wurde das Cross-Impact-Verfahren eingesetzt. Mit dieser Szenario-Technik, die in ihren Grundzügen beschrieben wird, lassen sich die Wechselwirkungen der wesentlichen Systemgrößen des Strommarktes untereinander analysieren. Die Szenarien wurden in Zusammenarbeit mit Experten aus zehn wissenschaftlichen Einrichtungen und unter Einbindung relevanter Akteure unterschiedlicher Interessensgruppen entwickelt.

1 Einleitung

Durch die Binnenmarktrichtlinie für Strom hat die Europäische Union die Voraussetzungen für die Öffnung der Elektrizitätsmärkte im europäischen Binnenmarkt geschaffen. Somit ist die Versorgung dieses leitungsgebundenen Energieträgers unter Wettbewerbsbedingungen gestellt. Seit dem Inkrafttreten der Richtlinie befindet sich die Stromwirtschaft in einem dynamischen Umbruch, der mit erheblichen Veränderungen verbunden ist. Teilweise handelt es sich hierbei um Übergangserscheinungen, teilweise werden die entstandenen Neuerungen auch in Zukunft bestehen bleiben. Mit der grundlegenden Reform des Ordnungsrahmens für die europäische Stromwirtschaft verändern sich die Marktstrukturen, die relevanten Akteure, die Strompreise, die angebotenen Produkte, das Nachfrageverhalten und nicht zuletzt die Einflussmöglichkeiten und Aufgaben des Staates und der Kommunen.

Der Wettbewerb und die Lenkung von Angebot und Nachfrage über den Markt sollen dazu beitragen, die Effizienz der Stromversorgung zu verbessern. Dies führt zu völlig neuen