Healthcare industry BW

Options for the food industry

The use of biotechnological methods is both common and standard practice. In this article, the author attempts to find out where biotechnology is used in a communication minefield, where many people are still of the opinion: biotechnology = genetic engineering = "gene product" and the application of biotechnology ≠ bio ≠ conventional food production.

"We are increasingly striving to use greater quantities of unmodified regionally grown raw materials for our products. All these raw materials are totally standard agricultural products that have not been biotechnologically altered. In our factories, they are processed with traditional methods such as heating.... Therefore, we have no need for biotechnological methods." (Head of development of a food company)

Biotechnology has since found its way into the food industry, and in fact into the entire value creation chain from raw material production to food processing to the sale of the final product. According to estimates from the Fraunhofer ISI Institute (Nusser 2007), biotechnological applications generated about 9 to 23% of total turnover in the food sector in Germany in 2004/2005 and in the area of agriculture between 11 and 20%. A relatively small number of small- and medium-sized biotechnology companies with a total of around 19,000 employees supply the preliminary products. However, the actual value creation is achieved by the processing companies, say the scientists.

Today, the food industry employs the largest number of employees of all industries using biotechnological methods, processes or products. The total number is around 193,000 to 493,000 people. This sector is followed by the agricultural sector with about 113,000 to 206,000 employees. Global climate changes are noticeable in the altered revenues of farmers and food processing companies as well as in the changes in the sales to the public. All these changes happen slowly and imperceptibly. Many things are taken for granted, in fact they have become so much a part of standard practice that they are scarcely worth mentioning. The milk industry and the different steps associated with it is a particularly impressive example of these changes.

Climate change and nutrition

Helmut Maucher, Honorary President of Nestlé AG
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In 2007/2008, the dairy market in Germany benefited from the fact that countries that normally

produce a surplus of milk were unable to export large quantities as a consequence of drought, for example, and that also, in particularly in East Asia, there was an increased demand for dairy products. The milk payout in 2007 reached a record high unequalled in the last 18 years. “Even though milk prices are currently decreasing rapidly, this is only a temporary situation,” said Helmut Maucher, Honorary President of Nestlé AG. He knows what he is talking about. He started his professional career in a small cheese dairy in Eisenharz, a village close to the Lake Constance and was, at the end of his career, the head of a global food group. The expansion of arid areas, the growing world population and an increase of income in previously poor regions continue to broaden the gap between supply and demand. In addition, agricultural production uses about 70 percent of available drinking water. Maucher believes that new agricultural methods could potentially reduce drinking water consumption to about 50%, adding: “I am sure that we will be capable, with biotechnology and genetic engineering methods, of using decreasing drinking water supplies more efficiently, obtaining higher yields and feeding everyone – despite climate change."

Dairy industry – from bioreactor to the production of udder secretions

The legal definition (Milchverordnung 2000, milk directive 2000) of milk is: “unmodified udder secretion obtained by daily milking.” These “udder secretions”, in other words milk, have not remained unchanged over the last decades. It is a fallacy to think that the cows can simply be put in a field and they will produce the required quantities of milk. As one field is very different from another in terms of soil, region and climatic conditions, farmers need to supplement cow feed in order to ensure a balanced nutrition for their cows. Farmers can make a living by increasing the quantity of milk through feeding the cows mixed feeds. As a general rule, 1 kg of concentrated feed gives 2 kg of milk. Rape, soya and corn contain a lot of protein. According to expert estimates, about 190 kg soya is fed to a dairy cow per year in Germany, which amounts to a total quantity of soya of between 0.8 and 1 million t per year. Soya is far cheaper than any other protein-rich crops, despite the fact that it needs to be imported from the USA, Brazil or Argentina, all typical growers of GM (genetically modified) field crops. The milk of cows that are fed on such mixed feed, is nevertheless GMO-free. Reliable scientific studies confirm that natural and recombinant genes taken up with the feed are degraded into small pieces by both animals and humans, thereby having no negative effect.

Energie- und Nährstoffgehalte der einzelnen Maisprodukte

(Angaben je kg TM)

Maissilage

Erntejahre 04/05/06

	Isogene Gruppe	Transgene Gruppe
Energie (MJ NEL)	6,74	6,67
Rohprotein (g)	80	84
Nutzbares Rohprotein (g)	134	134
Rohfaser (g)	176	190
Rohasche (g)	28	29

Maiskobs

Erntejahre 04/06

Isogene Gruppe	Transgene Gruppe
6,99	7,01
82	83
138	138
170	164
33	32

Körnermais

Erntejahre 04/05

Isogene Gruppe	Transgene Gruppe
8,75	8,81
102	98
169	168
23	21
15	15

Long-term scientific studies have shown that feeding bt-maize to cows had no negative effect on feed consumption, quantity of milk, metabolism, health and fecundity - not even at relatively high quantities. 19,000 datasets were compared.

Long-term scientific studies have shown that feeding bt-maize (even high quantities) to cows had no negative effect on feed consumption, milk quantity, metabolism, health and fecundity. 19,000 datasets were compared, including data on transgenic as well as isogenic maize. It is worth noting that German agriculture is unable to achieve the high milk quantities required without importing feedstuffs.

More competitive thanks to biotechnological research

in 1.000 t		Exporte (▼)					
		But-ter	Käse	Mager-milch-pulver	Voll-milch-pulver	Kon-dens-milch	Insgesamt in Milchäquivalent
Neuseeland		364	323	281	680	.	13.600
EU-25[1)]		**211**	**594**	**196**	**364**	**215**	**13.000**
07/01 in %		*+27*	*+27*	*+37*	*-24*	*-32*	
Australien		66	217	134	116	.	4.200
USA		41	99	258	21	28	4.000
Weißrussland		50	92	60	27	67	1.900
Argentinien		19	47	11	115	.	1.600
D		**94**	**880**	**195**	**48**	**260**	.
NL		153	592	46	140	278	.
F		61	605	109	105	70	.
B		137	136	89	89	61	.
DK		57	258	16	75	0	.
IRL		143	136	68	59	1	.
I		13	245	9	3	0	.
PL		32	133	75	17	8	.
GB		32	96	39	66	6	.
Welt-handel	2001	787	1.292	1.040	1.494	670	.
	2007	**800**	**1.530**	**1.100**	**1.580**	**1.000**	.
	07/01 in %	*+2*	*+18*	*+6*	*+6*	*+49*	.
EU-25-Anteil	*2001 in %*	*21*	*36*	*14*	*32*	*47*	.
	2007 in %	***26***	***39***	***18***	***23***	***22***	.

1) Drittlandsexporte

Quelle: ZMP-Marktbilanz Milch

Global trade with dairy products
© LLM 2009: 48f and 195f.

Scientific research gives farmers more options to break free from government subsidies as well as to be better able to exploit supply fluctuations of the international raw material markets, to increase their revenues and to sustainably secure their existence. In 2008, there were 4,218 million dairy cows (EU-25 2007: 22,266 million) in Germany. Every cow produced around 6,944 kg of milk (EU-25 2007: 6,350 kg). Nevertheless, the quantity of milk obtained from a single cow is higher in other countries. For example, an Israeli cow produced about 65 percent more milk in 2006, amounting to 11,506 kg of milk per cow per year. Milk is no longer a regional product. Although competition cannot yet be called global, there is nevertheless competition from beyond the German borders.

One has to discover nature in order to use it

At present, the food industry only exploits a small proportion of the raw materials nature has on offer. This starts with animal feed products, concerns production with microorganisms and enzymes (e.g., aromas, enzymes) and includes ready-to-eat foodstuffs and their ingredients. Prof. Christine Lang is the head of OrganoBalance, a biotechnology company that specialises in using natural biodiversity for production and products. Using genetic methods, OrganoBalance selects lactic acid bacteria and yeasts from thousands of different strains. The company selects strains that show the best biological activity for the requirements of individual producers. "We are initially looking for the most promising strain for the functionality desired. The technological challenge is then to select those strains that are suitable for industrial application, meaning strains that can be reliably cultivated in large quantities and which grow well on culture media that are suitable for use in the food industry," explained Lang. The selected strains are not genetically modified.

OrganoBalance has developed Lactobacilli (L. brevis, L. pentosum, L. fermentum) from several thousand strains that have been clinically shown to prevent gastritis and gastric ulcers by destroying Helicobacter pylori in the human stomach and intestines. In addition, the company has developed a method that enables the addition of living lactic acid bacteria to dairy products in quantities that are able to achieve the physiological effect desired. "I bet any dairy technologist," said Lang smiling, "that we will soon find a strain that is much better than those he has tested for many years and is currently using for the production of cheese or yoghurt."

The nutritional value shown on food packaging does not provide information on how the consumer metabolises the ingredients. This is information that is more vital to know than how much protein or how many vitamins a specific type of food contains. Knowing how the ingredients metabolise is important and is an issue when undesired health effects occur. For example, 2 to 3 percent of all small children in western industrialised countries are allergic to cows' milk. Others develop allergic reactions to milk proteins (whey, casein, soymilk, etc.). "Only a small proportion of children immediately develop rashes after having consumed one of these products; the allergy remains invisible in the majority of children," said Jean-François Biry of DBV Technologies, a company which received the Siemens Innovation Award in 2006 for its molecular diagnostics test that is able to detect delayed-onset milk allergy. DBV Technologies markets the test in association with NUMICO (Danone) for baby food.

Something that looks like a biotechnology success story, is standard in the food industry. Today, it is mainly the big companies that invest in R&D. Other companies use what is available on the market and carry out research that receives public funding, said an industry insider. The majority of SMEs tend to carry out "research of practical relevance" (see article on MLF). Eckhart Heuser, CEO of the German Dairy Industry Association and General Secretary of the European Dairy Association estimates that the dairy companies (including the big ones) invest on average just 3 to 5% of their sales revenues in research and development. This investment, where it exists, is aimed mainly at the development of methods that enable the preservation and safety of dairy products and takes into account health- and nutrition-related aspects.

Keeping promises: biotechnological methods make it possible

Typische Unterschiede zwischen pharmazeutischen Nahrungsmitteln und Functional Food-Produkten

Functional Food	pharmazeutische Nahrungsmittel
Anwendungen sind präventiv	Anwendungen sind medizinisch indiziert und therapeutisch
Einnahme: unregelmässig, entschieden vom Konsumenten	Einnahme: regelmässig, nach engen Vorgaben des Herstellers bzw.
enthält nicht notwendig aktive Moleküle	enthält notwendig aktive Moleküle + Hilfstoffe
niedrige Konzentration aktiver Moleküle	hohe Konzentration aktiver Moleküle
aktive Moleküle sind typisch aus Pflanzen- oder mariner Biomasse extrahiert	aktive Moleküle sind typisch synthetisiert oder biotechnologisch
Produktvolumen ist signifikant	Produktvolumen/-gewicht ist niedrig
sensorische Eigenschaften sehr wichtig	sensorische Eigenschaften zweitrangig
Kunden: Verbraucher, breites Spektrum an Wiederverkäufern (inkl. Handel)	Kunden: Verbraucher, Handel, medizinisches Fachpersonal,
typischer Ausbietungspreis: niedrig – mittel	typischer Ausbietungspreis: hoch
frei zugänglicher Kauf über Einzel- und Großhandel sowie Gastronomie	Vertrieb an zugelassene, eng überwachte Verkaufsstellen mit

Typical differences between pharmaceutical foods and functional food products
© Stefan Palzer (2009): Bioactive ingredients – Maximising stability, solubility and bioavailability. Presentation at Life Science Forum, Garching March 18

Under pressure from European authorities (EC No. 1924/2006), food producers are increasingly required to substantiate their nutraceutical health claims. Information on the safety of the food as well as its efficacy is required. How or how many of the vitamins and minerals (e.g. calcium) consumed are taken up by the body? How many consumers really know that the 'vitamin' often relates to a combination of different individual substances. Vitamin E is regarded as an antioxidant, but only four (the tocopheroles) of the eight vitamin E types have an antioxidative effect. Great care has to be taken to select the substances that have the promised/desired effect. Another example is probiotic bacteria. It is not sufficient for yoghurt to contain probiotic bacteria (e.g., Lactobacilli, Bifidobacteria) in order to suppress pathogens in the intestines. "Another decisive factor is also how many, where and for how long the encapsulated probiotic cells are released," said Stefan Palzer of the Nestlé Research Centre in Lausanne. It is also necessary to modify the bioactive substances in such a way that they can be transported in the blood. Therefore, product development depends very much on the processing of the nutrients and bioactive substances following their extraction from plant cell material and marine biomass. Other important aspects are the product modifications, method of encapsulation and integration into the food matrix. Innéov, jointly owned by Nestlé and L'Oréal, has launched a food product, providing scientific proof that the product has positive dermatological and cosmetic effects. The company combined lycopin molecules with milk proteins and spray dried them. Lycopin is a carotene that has an antioxidative effect. In order for the product to exert the desired effect the formulation and the special mixture of the ingredients (it also contains soya isoflavones and vitamin C) is of particular importance. This neutraceutical, which also has cosmetic effects, has a long storage capacity and also a very high bioavailability.

Nestlé and Danone are not the only companies to develop functional food products. In 2005, Yakult Honsha, a Japanese producer of probiotic milk drinks (sales revenues in Europe in 2004: 67 million euros/567,000 bottles), opened a research centre in Belgium, where research is undertaken into how Caucasians metabolise probiotic microganisms. Yakult hopes to increase its market shares in

Europe. Its goal is to reformulate the milk drinks, which are developed specifically for the Japanese market, so that they will also have a positive effect on the health of Europeans, and in addition have an effect that can be proven scientifically. Companies investing in research and not relying on public funding, have greater freedom, say the developers of the aforementioned companies: financial freedom allows us to determine the agenda and milestones ourselves, chose our partners more specifically and we do not need to share the results with potential competitors. That is also the way the retailers do it.

Retailers sell and bioanalytics secures quality standards

Genetic technologies have nowadays become an indispensable part in controlling the hygiene and quality of food. DNA analytics and rapid tests in particular (AFNOR 2008, German 2009) are key to ensuring the hygiene and quality of raw materials, foods and processing steps and are used to continually monitor the steps involved in production. Big commercial enterprises, as well as the food processing companies, have own laboratories for product analytics and product control. This also enables them to determine the authenticity of the product's origin. Is the wild salmon from Canada or Ireland, or is it not wild salmon at all and bred in aquaculture instead? Is "Original Feta Cheese" made from cows' milk? The nutritional values given by the factory and other health claims can be verified. The common paddock (Pholas dactylus) was used to develop a biotest which is nowadays used by shopping chains to determine how many of the antioxidants (e.g., tocopheroles, selenium) mentioned on the package leaflet still remain in the delivered batch (Knight/Knight 2005).

In contrast to discounters, big trading firms are developing backwards in the value creation chain. They do not just sell products, but also process them. For example, Migros has own dairy factories where it develops yoghurt or milk products for lactose-intolerant people. TESCO, a company that, along with EDEKA and Walmart, is one of the largest trading houses worldwide, has recently gone a step further. TESCO finances a National Dairy Centre (NDC) at the Faculty of Veterinary Medicine at the University of Liverpool. This centre has the task of supporting TESCO's British suppliers in providing milk (in particular drinking milk) according to the desired specifications. This is an iterative optimisation process. The NDC supports the farmers with specific research projects, the results of which are made available to participating farmers and to TESCO. The participating farmers do not only receive purchasing guarantees, but also obtain a higher price for their milk. However, the biggest advantage is that the dairy farmers are slightly ahead of their competitors. The dairy farmers obtain the results earlier and in a way that enables them to implement the results more quickly. "The Liverpool-based institute was chosen because the institute had long-standing experience in providing advice on dairy-related issues (e.g., the treatment of lame cows, prevention of zoonoses)," said Prof. Robert Smith, head of the NDC.

Ludwig Rupp, Head of Development of Europe's biggest soft cheese producer located close to the city of Bregenz (Lake Constance), does not want biotechnology to become some kind of competitive crusade. For him, the most important thing is to produce safe and high quality products for partners like Krafts Food and for consumers.

The company (2007 revenues: 61.9 million euros) uses the entire range of biotechnology for the production of soft cheese: from the use of original calf chymosin for the production of the biological "Bregenzer Wald" cheese, to the microbially produced chymosin used for the production of soft cheese. The company has customers worldwide. "A spirit of openness is required in order for companies to be able to look beyond the end of their own noses", says Ludwig Rupp. In the end, biotechnological applications as well as other methods and products have to prove their value. And this means that biotechnology is standard practice in the food industry, and often "not worth making

a fuss about".

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Literature:

AFNOR Validation Symposium (2009): European Certification for Microbiological Test Kits. Brussels, June 19.
Behr HC, Bien B, Engelhardt H, Kasbohm A, Loof S, Schaack D, Thielen M (2009) Ökomarkt Jahrbuch 2009. Verkaufspreise im ökologischen Landbau 2007/2008. ZMP Zentrale Markt- und Preisberichtstelle.
Buchardi H, Block HJ (2007): Die Situation der Milchforschung im benachbarten europäischen Ausland. October. Berlin: Milchindustrie-Verband. www.milchindustrie.de/de/infos/wissenschaft/milchforschung_ausland/.
EG (2006): Verordnung über nährwert- und gesundheitsbezogene Angaben über Lebensmittel. 20. December, Official Journal of the European Union: https://www.gesundheitsindustrie-bw.deeur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:012:0003:0018:DE:PDF
German JB (2009): Research on personalizing foods for health: Milk as a genomic example. Presentation Life Science Forum, Garching March 18.
Knight J, Knight R (2005): Quality assurance of nutraceutical health claims: The case for antioxidants. BioWorld Europe December: 10-13.
Kroner W (2009): Welternährung 2020: Die zweite "Grüne Revolution" hat schon begonnen. DIB-Nachrichten 30 January.
Landesanstalt für Entwicklung der Landwirtschaft und der Ländlichen Räume LEL (2009): Agramärkte 2008. March, Schwäbisch Gmünd: www.landwirtschaft-bw.info/servlet/PB/show/1242023/Agrarmaerkte 2008 BW_1.pdf.
Knight J, Knight R (2005): Quality assurance of nutraceutical health claims: The case for antioxidants. BioWorld Europe December: 10-13.
Nusser M, Soete B, Wydra S (2007): Wettbewerbsfähigkeit und Beschäftigungspotenziale der Biotechnologie in Deutschland. Düsseldorf:
Hans-Böckler Foundation. https://www.gesundheitsindustrie-bw.dewww.isi.fraunhofer.de/t/projekte/wettbewerb_beschaeft_pot_bt.pdf.
Steinke K, Paul V, Gürtler P, Preißinger W, Wiedemann S, Albrecht C, Spiekers H, Meyer HHD, Schwarz FJ (2009): Effects of long-term feeding of genetically modified maize (bt-maize; MON810) to dairy cows on performance and metabolic parameters. Proceedings of the Society of Nutrition Physiology Band 18: DLG Publishing House.
Wiedemann S, Lutz B, Kurtz BH, Schwarz FJ, Albrecht c (2006): In situ studies on the time-dependent degradation of recombinant corn DNA and protein in the bovine rumen. Journal of Animal Sciences 84: 135-144.
Verordnung über Hygiene- und Qualitätsanforderungen an Milch und Erzeugnisse auf Milchbasis (Milchverordnung). Bundesgesetzblatt Year 2000 Part I Nro 36. 31 July 2000: www.bgblportal.de/BGBL/bgbl1f/b100036f.pdf.
Zika E, Papatryfon I, Wolf O, Gómez-Barbero M, Stein AJ, Bock AK (2007): Consequences, Opportunities and Challenges of Modern Biotechnology for Europe. Sevilla: European Commission Joint Research Centre. https://www.gesundheitsindustrie-bw.debio4eu.jrc.ec.europa.eu/documents/Bio4EUsynthesisreportEUR22728EN.pdf

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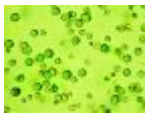

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