



**800
researchers
and engineers**
at INRA work in areas
related to food and nutrition

EDITORIAL



The field of human food and nutrition has evolved considerably in developed countries during recent decades: the explosion of agricultural and agri-food yields and their economic consequences, an abundance of supply in a constantly changing sociological context, the development of concerns with respect to health and environmental safety, and the globalisation of trade and dietary habits, etc.

There is a marked contrast in the world today between those who are malnourished and those suffering from nutritional diseases due to excessive intake. The research challenges converge in both cases. At INRA, we are convinced we can play a leading role in this area and we must continue to promote our ability to generate scientific knowledge and sponsor institutional research.

To achieve this, we are developing partnerships in France and throughout Europe with other actors in public and private sector research, working in our areas of competence. We are thus doubling our efforts to achieve the coherence, visibility and competitiveness of research in food and nutrition, and continue to manage the networks which have gradually built up over the past twenty years with our national, regional and industrial partners.

Marion Guillou
President of INRA

€ 183 M
or 27% of INRA's overall
budget is devoted to food
and nutrition

**100 patents
80 licenses
managed by INRA**

SOME KEY FIGURES

The agri-food industry in France

€128 billion turnover. France thus ranks **1st** in Europe ahead of Germany and **2nd** in the world behind the USA.

3rd leading industrial employer.

10,841 companies, mainly SME, 70% of which have fewer than 20 employees and 90% fewer than 250.

(source : ANIA)

In 2005, the **National Programme for Research on Human Food and Nutrition (PRNA)** commissioned by the French National Research Agency and managed by INRA, funded 22 projects to a value of €14.3 million (private-sector research: €7.03 million, public-sector research: €7.2 million).

UNDERSTANDING DIETARY HABITS

The economic and social sciences can help us to understand dietary habits. At INRA, for example, we are studying the factors which act on changes to consumption and can explain differences in consumer behaviour. This has led us to focus on social inequalities with respect to food consumption. For example, we have shown that food pricing structures do not encourage compliance with nutritional guidelines, and that the poorest households may find it difficult to achieve a balanced diet. More generally, we are looking at the mechanisms of consumer choice related to household incomes, prices and the information available on foods. Experimental economics approaches have shown how this information determines the value placed by consumers on the different products they are offered.

The economic and social sciences also address the industrial and commercial strategies of companies in a market context with the dispersal of agricultural suppliers and consumers on the one hand and a limited number of agri-food operators on the other. Furthermore, links must be made between agricultural, industrial and nutritional policies, at both the local and planetary levels. To achieve this, we are analysing how political instruments – taxes, subsidies, regulations, nutritional guidelines – are integrated by companies and affect consumer behaviour. Finally, we are assessing the efficiency of policies for collective risk management. This will result in government responses regarding standards and traceability, and the clarification of the effects of food-related concerns on consumer behaviour.

Pierre Combris and Bertrand Schmitt
Research Director and Deputy Head of the Social Sciences Department (SAE2)

GLOSSARY

Experimental economics

A branch of the economic sciences which applies observational methods in the laboratory to studying individual decisions and interactions between individuals in a clearly-defined context.

Intestinal flora

All bacteria living in the digestive tract.

Xavier Lerverve: “A global approach needs to be adopted towards food and nutrition”

Food and nutrition is an eminently complex field, involving a variety of disciplines ranging from socioeconomic and behavioural sciences to biology, toxicology and mathematics. The breadth of skills available within INRA means that a global approach can be adopted regarding the food chain, from the origin of agricultural products to the effects of diet on health. We can thus rely upon different types of know-how regarding breeding, production and processing in order to develop foods which will be the best suited to consumers. Creating and maintaining strong links between research and society around questions which concern all of us – such as food safety and quality – requires not only a sharing of knowledge but also an ability to listen to questions from society. The emergence and formulation of new scientific questions constitute major challenges in this research area. At INRA we approach the field of food and nutrition from

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Xavier Lerverve at the Salon de l'Agriculture in 2006.

three directions: taste, pleasure and behaviour; health and wellbeing; and safety (see page opposite). ▶▶

Xavier Lerverve, Scientific Director
Human Nutrition and Food Safety

Four Centres for Research in Human Nutrition

Research involving human beings imposes highly specific conditions and constraints with respect to ethics, safety, competence and regulations. INRA has associated itself with INSERM and different hospitals and universities to set up four Centres for Research in Human Nutrition (CRNH). These centres, which can carry out highly complex analyses of biological parameters, body composition and energy expendi-

ture, propose their services to academic and industrial research. Linked to various research or clinical units, the CRNH constitute a novel, high-performance, technical and thematic approach to research in nutrition. The Paris-Ile-de-France CRNH will be opening in 2006, alongside the three centres which have existed elsewhere in France for several years.

Clermont-Ferrand

Protein and energy metabolism, ageing and health

Lyon

Energy metabolism, insulin-resistance, obesity, diabetes

Nantes

Digestive tract, digestive physiology

Paris

Dietary behaviour, nutrition, public health



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Genome

All genes which constitute the gene pool of a living organism.

Metabolism

All chemical and biological transformations which occur in an organism. A metabolite is a molecule produced by metabolism.

Intestinal metagenome

Genome of all bacteria comprising the intestinal flora.

Typicality

Characterisation of a product, based on physical and biological factors and know-how.

OUR DIET IS A QUESTION OF...

SAFETY



Claude Gaillardin
Head, *Microbiology and the Food Chain Department*

In terms of food safety, research is carried out from three angles: the first explores the microbial world in order to understand the diversity of pathogenic agents. The second identifies how these pathogens adapt to different steps in the food production chain. The third tries to understand how pathogens become integrated in the bacterial ecosystem of foods. Traditional methods are able to preserve milk or meat in the form of cheese or sausages by seeding them with bacterial flora which, through their presence, constitute a barrier against pathogenic flora. It is at this point that safety and quality converge: the hundred or so bacterial species which colonise the rind of a cheese do not just protect it, but endow it with its specific features. We have recently discovered that bacteria exchange chemical messages which may or may not cause a pathogen to produce a toxin. These scientific elements are crucial if we want to ensure an economic future for raw milk cheeses, in the same way as they may become key to preventing certain risks of food poisoning. The bacterial flora in our intestine, whose genome we are currently seeking to elucidate, plays the same role as a barrier against pathogens.



HEALTH



Béatrice Darcy-Vrillon
Research Director, *Food and Human Nutrition Department*

NRA is exploring the links between diet and health. We are focusing on nutrients, not only as essential nutritious elements but also as signals to regulate the biological functions which keep us in good health. For example, we have shown that leucine, an amino acid found in muscle proteins, constitutes a signal which intervenes to limit muscle loss in elderly subjects. Similarly, it has been observed that the major benefit of certain vitamins or antioxidant compounds results not solely from their individual properties but also from their natural association in foods such as fruits and vegetables. It is therefore necessary to move on from studies on nutrients to more wide-ranging work on foods and diets in a longer term context. Collaborations between biologists and bioinformatics specialists, supported by increasingly high-performance information systems, are enabling us to understand the complex metabolic phenomena which are triggered in response to our diet. These new approaches, using high-throughput biology, open extremely interesting perspectives in terms of toxicology and the chemical safety of foods.

TASTE



Patrick Étievant
Head, *Food and Human Nutrition Department*

Taste is not just a question of the flavour of a food, but also its odour, appearance, texture, commercial context, our education and a combination of all these parameters. It is a multidimensional notion which requires a multidisciplinary approach. Determining the components responsible for the typicality of a product and studying their chemical origin enables a strengthening or masking of certain aspects of its taste. In partnership with the CNRS we are, for example, trying to understand the sensorial image of a food. We are focusing on the antagonistic or synergistic effects between flavours and analysing the volatile molecules released during mastication through the use of novel devices: a mass spectrometer linked to the nose of an individual, a chewing simulator, etc. In addition, with our colleagues working in the social sciences, we have observed that appreciation of the taste of a food is markedly dependent on the information provided to consumers (label, price, brand, etc.). Finally, understanding and improving taste is a crucial lever to encourage consumption, for example of fruits. INRA has bred some new fruit varieties which respond to different taste criteria: Garigette strawberries, Ariane apples and Angelys pears are meeting with considerable success.

CLEANER AND MORE RESTRAINED TECHNOLOGICAL SEQUENCES



Paul Colonna
Head,
Department for Science and Process Engineering of Agricultural Products

A technological sequence covers the succession of operations undergone by raw materials to turn them into foods. Even products which seem to arrive directly from a farm undergo industrial processes which are transparent to the consumer (e.g. stored vegetables are ripened before being sold by undergoing ethylene stress). The technological sequence establishes a compromise between sensorial, nutritional, safety and practical characteristics and the cost of a product, each being independent of the others. Research is not involved in this compromise, but focuses on understanding the process-



The industrial building at the INRA Laboratory for Food Processing Engineering and Technology, Villeneuve d'Ascq.

es implemented. It can thus explain why the raw material is transformed, provide technical solutions, study how micro-nutrients can be preserved in the final product, etc.. But above all, research addresses the integration of choices so that operatives can benefit from decision-making tools, preferring cleaner and more

restrained sequences (which generate less pollution – including by gases – and consume less water and energy). This research requires complicated measuring and experimental tools, and technological facilities which enable a simulation of the characteristics of a material after it leaves the factory.

ONE UNIT, THREE TEAMS



From left to right: Philippe Langella, Valérie Gaboriau-Routhiau and Gérard Corthier, three of the scientists who led the "Intestinal flora" workshop on the INRA stand at the Salon de l'Agriculture, 2006.

INRA CLUSTERS SPECIALISED IN FOOD AND NUTRITION

At the INRA centre in Jouy-en-Josas, the three teams in the Unit for Ecology and Physiology of the Digestive Tract, headed by Gérard Corthier, are studying the microbial flora present in our intestines. This flora, which develop as soon as we are born and remains with us throughout life, protects us against numerous bacterial diseases.

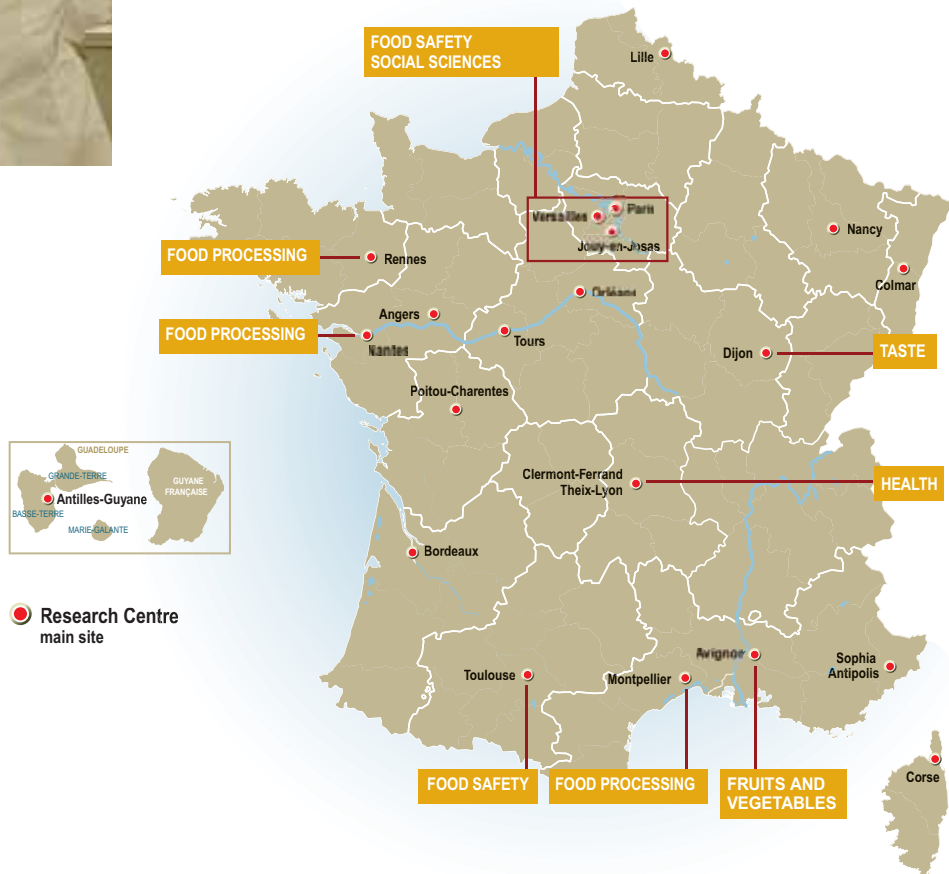
One team is trying to determine the genetic diversity of bacteria in our intestinal flora. Scientists are constantly identifying new bacteria, but only 20% of them can be cultured in the laboratory, hence the problem with clarifying their functions. This team is currently involved in organising the international Metagenome project (see below).

The second team is focused on the lactic acid bacteria present in dairy and fermented products, particularly those which have beneficial effects on health. These modest but real effects are born of the permanent dialogue between these bacteria and (through the intestinal mucosa) our entire body.

The third team is working on the metabolic functions of intestinal flora: the ability of bacteria to transform dietary constituents into molecules with a positive action on the body, which will have favourable or harmful effects on health.

THE METAGENOME PROJECT

A major scientific challenge, the international Metagenome project consists in creating a consortium of research agencies which will pool their results of sequencing the genome of digestive tract bacteria. This sequencing, which represents around 10 times that of the human genome, opens new perspectives regarding our knowledge of the intestinal flora and the mechanisms it employs to metabolise foods or the active substances in medicines. It is hoped that this programme (which requires funds of €100 million) will be launched at the end of 2006. Via INRA, France will be playing a central role in the management of this research.



Competitiveness clusters involving INRA

- **Angers**
 - specialised plant sciences, horticulture, seeds (world cluster)
- **Avignon**
 - European innovation cluster on fruits and vegetables
 - management of natural risks and regional vulnerabilities
- **Bordeaux**
 - Innovative products and

- processes for health (Prod'Innov)
- Timber industries and maritime pine for the future
- **Clermont-Ferrand**
 - Meat and meat products
 - Innovations in cereals
- **Dijon**
 - Taste, nutrition and health innovation cluster (Vitagora)
- **Lille**
 - Agricultural industries and resources (world cluster)

- Materials for domestic use
- **Montpellier**
 - Sustainable agri-food systems and quality of life in the Mediterranean region (Q@LI-MED)
- **Nancy**
 - Natural Fibres, Eastern France
- **Rennes**
 - Foods for tomorrow (Valoral)
- **Toulouse**
 - Cancer-Bio-Health

RESEARCH PROJECTS

- a method to evaluate the crunchiness of maize flakes
- a diet which limits muscle loss in the elderly
- a bacterium which is beneficial in meat preservation
- the identification of truffles to combat fraud
- consumer choices: the case of organic, fair-trade chocolate

www.inra.fr/presse

RECENT PUBLICATIONS

- La fermentation au service des produits du terroir, 312 p.
 - Fruits et légumes – caractéristiques et principaux enjeux, 116 p.
 - DVD La vigne et le vin, 30 min.
- Éditions Inra - 01 30 83 34 03

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