

A highly dynamic, self-organized, bio-economy; it's becoming a serious game

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Where do I come from? The research domain of IATE





MISSION: integral & well-balanced use of available plant- and microbial resources for food & bio-molecules, bio-materials and bio-fuel





Viable planet and reduction of fossil fuels

>>> transition towards
 a bio-based society

Food security: the rich versus the poor AND the food versus fuel 'battle'

>>>> transition to a fair, ethical and wellbalanced society

It is becoming a serious game























We are facing extremes, that tend to become more extreme







Growth rate of obesity in different BMI categories % increase (1986 = 100%)







Pays du Sud – Pays – du - Nord We are facing extremes







We are facing extremes

According to the U.N., a child dies from a water-related disease every 15 seconds.



te

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These are the consequences Of our way of living

En moins de huit mois, elle a déjà consommé toutes les ressources naturelles renouvelables que la planète peut produire en un an(Le Monde, 13/08/2015, Global Footprint Network).

> Combien de planètes pour subvenir aux besoins de l'humanité ?

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Combien de Chine faut-il pour subvenir aux besoins des Chinois?

So we can pose the question: Where are we currently heading to?

We are currently **extending the expiry date** of our planet.

We are not heading towards a sustainable, circular bio-economy >> better: spiral!

We are not able to take away the uncertainties about a well-balanced society

http://www.worldometers.info/

Aprill Oct-11 Aprill Oct-04 Aprill 000-97 Aprill 000-00 Aprill 001-00 Aprill 001-00 Aprill 001-08 Aprill 001-08

Concentrations of Greenhouse Gases from 0 to 200

Growth rate of obesity in different BMI categories % increase (1986 = 100%)

From chaotic back to self-organized, dynamic systems

We need to get better insights in our complex system(s)

technologies émergentes

We need to get better insights in our complex system(s)

Interactions between (external) constituents (in e.g. biomatter) /factors/...

And in our bio-economy transition?

In a transition towards a biobased economy

We are dealing with numerous highly complex systems (questions)

We have to deal with (only some examples given)

- What are the relationships between structure-functionenvironment in the plant and the bio-based product stages?

(natural rubber has superior quality as compared to synthetic rubber; after decennia of research no clue !?)

- How to design sustainable ways of utilizing 100% of our resources, including all its (functional) constituents?

(local, competitive small-scale bio-refinery concepts, ..)

What new business concepts are needed for that?

(industrial ecology, agriparks, ..)

- Do we understand the perception of consumers/users?

(products based on current waste streams, accepted? > a neurophysiological approach needed)

- How to deal with the paradox 'using a sledgehammer/elephant to crack a nut'?

(our engineering actions are in general at a scale that is 100.000 higher than of the action required (e.g. opening a sulphur bridge in a molecule, or over-dimensioned storage facilities, or cooking with water) > how to understand the impact of changing processing conditions on biomatter)

Deepen our insights in the complex systems

Trying to recognize features of rigid, dynamic and chaotic behaviour

'Steering' systems to become self-organized and dynamic

Some examples from functionalization of molecules, towards functional fractions, combined fractions (incl co-products), via development of new product-structures and diverse products, towards full business parks and global systems

Functionalizing biomolecules Reduction of number of modifications and energy use

SYSTEMES D'ETUDE Emulsions, liposomes, bactéries, cellules

PHENOLIPIDES

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TOMORROW: grass not only for cows

Prof. J. Sanders, 2010, Wageningen UR

Figure 3. The wheat grain and its components (adapted from Surget & Baron⁵⁴ and Hernery *et al.*⁵⁵).

Bio-refinery: a variety of Cereal Products:

From functional molecules towards functional fractions and their utilization

EcoBioCAP will provide the EU food industry with **customizable**, **ecoefficient**, **biodegradable packaging solutions** with direct benefits both for the environment and EU consumers in terms of food quality and safety.

Relations structure /transfer

Alternative resources and products

'meat alternatives on basis of new plant and insect protein sources

> Developing new fibrous foods utilizing new processing tools and process intensification pathways

>>> here is a real opportunity, also for developing countries?

Stabilization of products and Down-scaled novel technologies

STEW COOKED IN MINUTES THE SUSTAINABLE BREAKTHROUGH IN FOOD PREPARATION

With the Nutri-Pulse® e-Cooker® stew can be prepared in a few minutes, with better retention of the original nutrients and an exquisite taste, e-Cooking® technology is also ideal for preparing other types of meat as well as fish, vegetables and potatoes.

IDI. Netherlands B.V. developed this technology which uses Pulsed Electric Field (PEE) to cook food. Stew does not need to simmer for hours, but is instead ready after only a few minutes within the a-Cooker

The origin of the technique lies in research for mild preservation techniques for fruit luices and other liquids, whereby cold pasteurisation'with pulsed

VOLDINGSINDUSTRIC CORMANNA

electric fields is used to better preserve the flavour. smoll, colour and tasta of the Juice in comparison with traditional heating processes. Govert van Oord, Owner-Manager of IXI, Netherlands B.V., wondered whether this technique could also be applied to the preparation of solid foods (uniform heating and controlled) and his idea proved to be a big success.

OMVE NETHERLANDS B.V. DIL Netherlands B.V. is business partner of OMVE Netherlands B.V. OMVE is a leading company specialised In high-quality, small-scale liquid process equipment for laboratory and pilot applications. The advanced processing equipment simulates both existing and new industrial processes at the highest level and a large number of trials can be carried out in less time

of meat, fish and vegetables chewable, edible and digestible. The disadvantage of this method is that during sustained heating this can cause the loss of some valuable nutrients. The Nutri-Pulse e-Cooker ensures a homogeneous preparation process; this means that no heat is brought from the outside to the inside of the food, but instead the necessary heat is created in the food itself. Electrical pulses pass through the food and cause electroporation of the cells. In combination with pulsed ohmic heating, the food is cooked eventy on the inside and the outside, and prepared very quickly at a relatively kny temperature and with low energy usage The pulse duration, number of pulses and pulse

strength can be adjusted very accurately so that the

'Advantages are low energy usage, nutrient preservation, improved quality, and significant time and space savings'

very gently, in addition, it increases the quality of

the food by preserving more nutrients, more initial

moisture of the product, more smell, colour, structure

and tasts. The food enables fresh produce to be pre-

pared in a very short time (just a few minutes) and

opens up opportunities for the development of new

dishes. The preparation process with the Nutri-Pulse

homogeneous heating, the food is also microbiologi-

Hans Roelofs, Innovation Director at IXI. Notherlands

B.V., reports that the leasibility study on the use of

PEF technology for cooking painted a very positive

e-Cooker is safe (no hot surface) and, because of

cally safe to make.

APPLICATIONS

Innovation by Cees Goettsch/Hans Roelofs

picture, IXL has received good comments from the culinary world including from Jonnie Boer from restaurant Librije in Zwolle (NL). With the e-Cooker, 1XI has wan the Cooks innovation Trooby in 2011 Together with Top Sport Restaurant and InnoSport Lab* Papendal (NL), which has expertise in the fleid of nutrition and sport, IXL is working on the project "e-Cooking-Voeding-Sport".

This project examines the possible impact e-Cooking* can have on the sporting performance of individual athletes. Practical tests are soon to be carried out in the Top Sport Restaurant's open kitchen. Caterers, hospitals and companies in the food Industry have already shown an interest in this new technology which, in addition to its benefits such as low energy usage, nutrient preservation, improved quality and time savings, can also deliver significant space savings.

HERE AND NOW

IXL Netherlands B.V. develops surprising technological concepts from idea to the market. The company's guiding principle is People, Planet, Prosperity; and It chooses to focus on technologies that add real value to society

Meanwhile IXI, has applied for and teceived several patents for e-Cooking. Van Oord sees a great future for the technology: "The principle of e-Cooking is in line with all the focal points of the agrifood sector such as sustainable food and energy. Consider the growing world population and the impending food shortage. It is important that whatever people eat contains as many nutrients as possible." Roelofs adds: *e-Cooking can also provide a solution to mainutrition for patients in hospitals and care homes. They will get tastier food, which can be offered at any time thanks to the guick cooking time. Also looking across borders at developing regions, where there is often food available but not enough power to prepare It property. The Nutri-Pulse e-Cooker uses so little energy that, in the near future, it should become possible to nower it with a truck bottory"

www.innovation-xi.com

VOCDINGSINDUSTRIC INTERACTORY Q

Sustainability >> also in the kitchen?

http://www.innovation-xl.com/en/nutripulse.html

Agri-business parks

At larger scale, a group/cooperative of a wid SMEs could be competitive in valorizing bion most efficient ways for multiple products <u>THUS creating value on site</u>

- Greenport concept: profit by integration of agricultural production, processing & trade
- Local/regional clustering of different production chains, to utilize waste, residuals, heat or other streams

Ecologie industrielle : de nouveaux flux de matières et de biens

An energy-zero transport container concept?

We have the means to better valorize and improve our quality of life

There is a market!

Improved competitiveness by biowaste feedstocks & bioprocessing

Sales of biobased products

2007:48 bil € (3,5% of total chemical sales) 2012:135 bil € (7,7% of total chemical sales) 2017: 340 bil € (15,4% of total chemical sales)

G. Festel (EFIB 2009, Lisbon, October 2009; OECD workshop, Vienna, January 2010)

There are multiple, combined, options!

We can make use of the real value of biomass?

e.g. lignin is nearly not valorized, proteins in grass idem, brewer spent grains idem, co-products for cereals idem, etc. etc.

Only for some we have substantial residues to valorize, for others not!

Of course we need to take into account the overall PPP impact!

Figure 15. Impacts of bio-based vs fossil-based value chains

Pesitive impact
 Negetive impact or risk

	Raw material sourcing	Chemical production	Product use and end-of-life options
Environmental effects	 No hazards in raw material sourcing Decrease in the consumption of non- renewable resources Reduction in biomass-related waste Risk of eutrophication due to use of fertilizers and plant protection products (not applicable to by-product streams) Potential contribution of imported biomass to biodiversity losses 	 Reduction in non-renewable energy consumption Reduction in GHG emissions Modernisation of process technology and energy concepts Increase in water consumption Increase in particulate emissions from feedstock preparation 	 Less toxic waste Less GHG emissions from waste incineration Biodegradability offers opportunities for composting Recycling possibilities of biobased products
Social effects	 Contribution to rural development Risk of involvement in the GMO controversy Potential contribution of imported biomass to food insecurity 	 Contribution to rural development Increasing sustainability and greening of chemical industry image Reduction in VOC emissions improves workforce health and safety Risk of involvement in the GMO controversy 	 Decrease in human toxicity Contribution to sustainable development Risk of involvement in the GMO controversy
Economic effects	 Utilisation of wastes and by-product streams Contribution to rural development Competitiveness of raw materials compared to fossil fuels; possible need for subsidies Need to develop the logistics of raw material sourcing 	 Contribution to innovations and European competitiveness Creation of jobs and maintaining production in Europe In some products, savings in production costs Investment costs Risks of up-scaling 	 Possible green premiums Market entry in environmentally sensitive markets Reacting on increasing consumer awareness New innovations and products with superior functionality Savings in waste charges

And our quality of life!

We also need to take Into account perceptions:

... and dillemmes:

Which approaches to reach really breakthrough innovations

(not a factor 10% improvement but a factor 10!)

What are we doing or should do?

We need radical innovations based on better understanding of the needs, new scientific ideas, creativity, joint forces, ...)

(technological, organizational, social, economical)

Next to optimization Real innovations

Optimisation: climb mountain where one's base camp sits

Re-orientation: climb a higher mountain in the neighbourhood

Innovation: reshape the landscape

Tackling complex systems means:

Acknowledged and Adapted from Hans Schepers

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Lessons for teaching and research:

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We need to go from bricks to an integrated picture

My lessons learnt

It is possible, but not easy

If I should be Kasparov, we should learn the scholars and students to play chess

Lessons learnt, especially regarding the bio-based transition

- 1. Be passionate by the heterogenity and not homogeneity of renewable resources: exploit the richness of nature (while maintaining a viable planet)
- 2. Bio-based society IS NOT (only) a focus on bio-energy from biomass
- 3. Use the value piramide & quality of life
- 4. Step away from a synthons approach but start with the functionality and complexity of biomolecules (or functional fractions)
- 5. Don't think about a single output product but about multiple products and markets (biorefinery)
- 6. Down think about up-scaling only, also down-scaling counts
- 7. Include all (side-)effects of a new eco-product
- 8. AND we should be the research entrepreneurs of tomorrow

Thank you very much for your attention

Some of the French institutions involved in the transition towards the bio-based economy'

« CEPIA » division

Science and engineering For food and bio-products

Monique Axelos Michael O'Donohue

Genetics and breeding

Science and processing

VariabilityPlant engineering

Foods, Materials, Polymer, Molecule, Energy

Consumers

• Health Benefits

- Food Safety
- Sensory Quality
- Sustainability of a biobased economy

Integrated approach to construct quality

- Variability
- Plant engineering

Different spatio-temporal scales Modeling → risk assessment → novel technologies

Topics of interest (1)

Nanotechnology: application for biobased applications

Design of natural polymer-, protein-, or lipids-based nano devices for smart delivery

Development of *food* **nano-composite**

Nanosensor to detect allergen (high throughput screening)

Nano-particles in packaging

Topics of interest (2)

Biocatalysis & (Dry) Bio-refinery

Complexity of process-structure-function relationships

Vegetable proteins for food and non-food applications

.... And many more

AGRICULTURAL RESEARCH FOR DEVELOPMENT

> Working together for tomorrow's agriculture

Research on the appropriate scale

Three research fields

•Biological systems

Understanding biological systems, from molecule to ecosystem

•Tropical production and processing systems

Analysing farming practices and farming system performance, from plot to farm level

•Environments and societies

Supporting players in rural areas, from a local to a global scale

Fruit and vegetables

Sugarcane

Cocoa

Coffee

Rice

Cotton

Banana and plantain

Oil palm

Animal production

Animal production

Forest species

3BCAR : une offre de compétences en Carbone bio-sourcée

L'institut Carnot 3BCAR (www.3BCAR.fr) est un réseau structuré de laboratoires de recherche, proposant des compétences pour les entreprises intéressées par la production et les usages du carbone bio-sourcé (**bioénergies, biomolécules et biomatériaux**) selon les principes de la chimie verte et l'analyse de la durabilité.

Une offre large :

Plus de 500 chercheurs dans 11 unités de recherche et 3 centres de ressources technologiques. une dizaine de plateformes techniques et un démonstrateur pré industriel, jusqu'à TRL 6. trois pôles géographiques en synergie.

Spécificité : mobiliser des approches multi-disciplinaires, des végétaux aux propriétés d'usages dans une démarche d'éco-conception:

Les marchés

Les producteurs de biomasse et produits agricoles intermédiaires

Les gestionnaires de biens publics

Les entreprises de biotechnologies vertes et blanches

Les producteurs d'énergie

L'industrie chimique

Les axes de développement des activités

1- Analyse systémique des impacts des modifications liées à l'usage du carbone renouvelable

2-Adaptation de la biomasse à ses nouveaux usages (biotechnologies vertes)

3- Substitution des procédés existants par des procédés biotechnologiques (biotechnologies industrielles)

4- Complémentarité des procédés chimiques et biologiques pour obtenir des fonctions d'usage définies