25 years R&D for non-food products: towards present market demands

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4F CROPS, Bologna, 17/09/08

Renewable resources in non-food applications

Flax: 5000 B.C.

Hemp

Cotton

Sisal

Strings

Wood

Wool

Reed

Glues

Jute

Putty

Coir (coconut)

Rubber

Textile

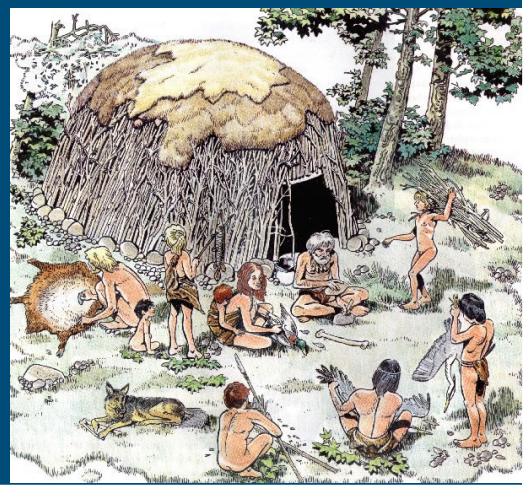
Paper

Leather

Linen

Paints

Linoleum



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As old as humanity!

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The origins of R&D for renewable resources (agrification)

- EU policy, treaty of Rome (1957)
  - Increase the production of food
  - Reach food self-sufficiency
  - Aim for stable and flourishing agricultural sector
- Instrument: price stability
  - Fixed price for agro products
  - Surplus is taken out of the market at guaranteed price
  - Surpluses are stored or
  - Exported with export subsidies
- The treaty was very successful

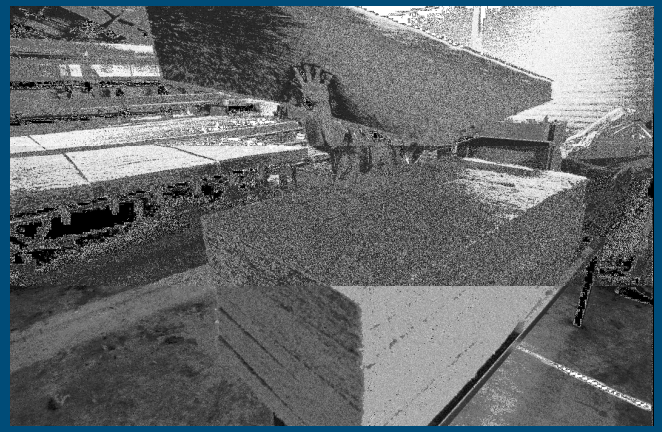
The origins of agrification

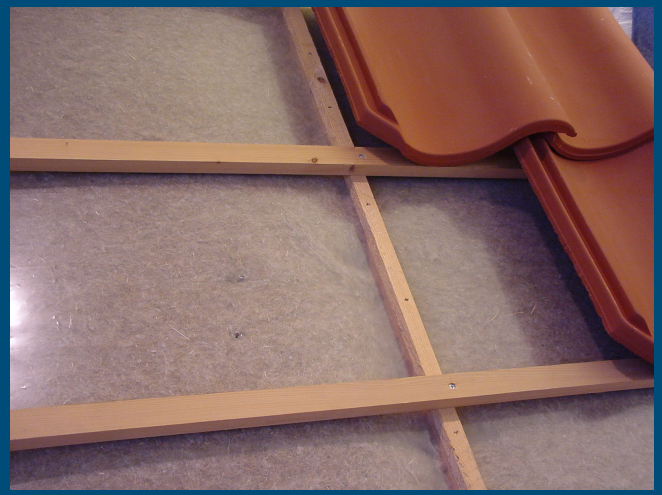
- Innovations in agriculture in the 20th century
  - Plant breeding, plant fertility
  - Crop protection
  - Plant nutrition
- This led to enormous, structural increase in production

- Early 1980s growing surpluses
  - Sugar, grain etc. needed to be taken out of the market
  - EU policy thus became very expensive
  - Subsidies needed to be diminished, crisis in agriculture
  - Need for alternative outlet for agricultural produce
  - Extension of the crop rotation scheme (finding a fourth crop in the crop rotation)

Characteristics of Dutch agrification policy in the 1980s

- Provide farmers with stable income
- Focus on substantial land use (bulk production)
- Strongly focussed on agrosector
- Primary production is leading
- Supply driven, does not take into account market demand
- Department of Agriculture is leading
- Government invests in development programs
- Flax, hemp, oil crops programs
- Industrial Carbohydrates, - Proteins





The situation in the 1990s

- Study “Ground for Choices” (1992, WRR)
  - 4 scenario’s
  - 12 EU countries
- At least 40 Million of the 127 Million hectare in use for food production would no longer be needed
  - Use of all available agricultural land leads to enormous overproduction

But.....

- Halfway the 1990s none of the agrification developments has reached the market!
- General notion: market parties should play leading role.
- Minister of agriculture:
  - Agrification should develop following the market
  - Aim for high value crops
- Public debate on sustainability

Characteristics of Dutch agrification policy in the 1990s

- The wish to improve environmental performance of agriculture and industry
- No bulk, but focus on crops and components with a high added value
- Focus on environmentally friendly end-products
- Market parties should lead the development
- Industry is co-funding and participating in the projects (PBTS, BTS)
- Government stimulates availability of basic knowledge
- Ministries of Agriculture and of Economic Affairs support

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First products: starch plastics, composites

At the turn of the millennium..

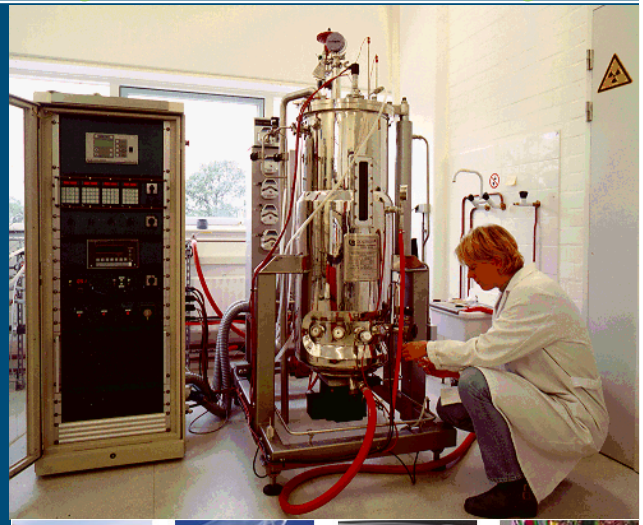
- Few new products reached the market
- Ministry of LNV spent a lot of money and is very unhappy
- Agrification is dead

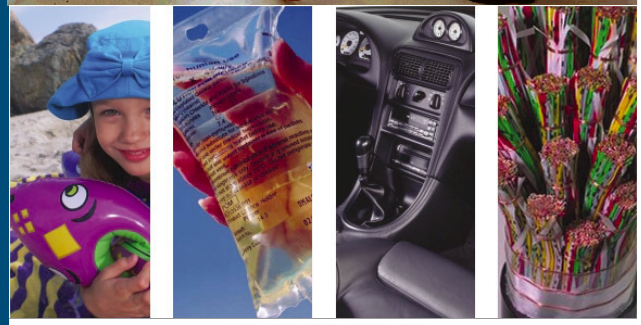
But then..

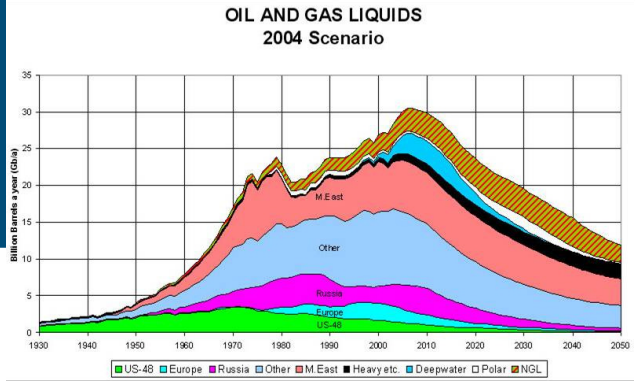
- Feed crisis
  - BSE, swine pest, foot-and-mouth disease
  - Dioxin in mother's milk
  - Manure legislation, animal welfare discussion
  - Shrinking livestock
- Side streams find less application in animal nutrition, alternative outlets needed
- Climate change (Kyoto protocol signed)
- Provisioned scarcity and security of supply of mineral oil leading to a search for alternative feedstock
- Leads to Biobased Economy policy

Characteristics of Biobased Economy policy 2000 - Today

- Renewable energy
- Side streams rather than crops
- Demand for new products and not crops is leading
- Focus on high added value end-products
- Focus on linking agriculture with other sectors (f.i. chemistry and energy)
- New technologies: white biotechnology, biorefinery
- Departments of Economic Affairs, of Environmental Affairs and of Agriculture.
- Chemical industry and Agrifood industry







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What was happening in the various sectors?

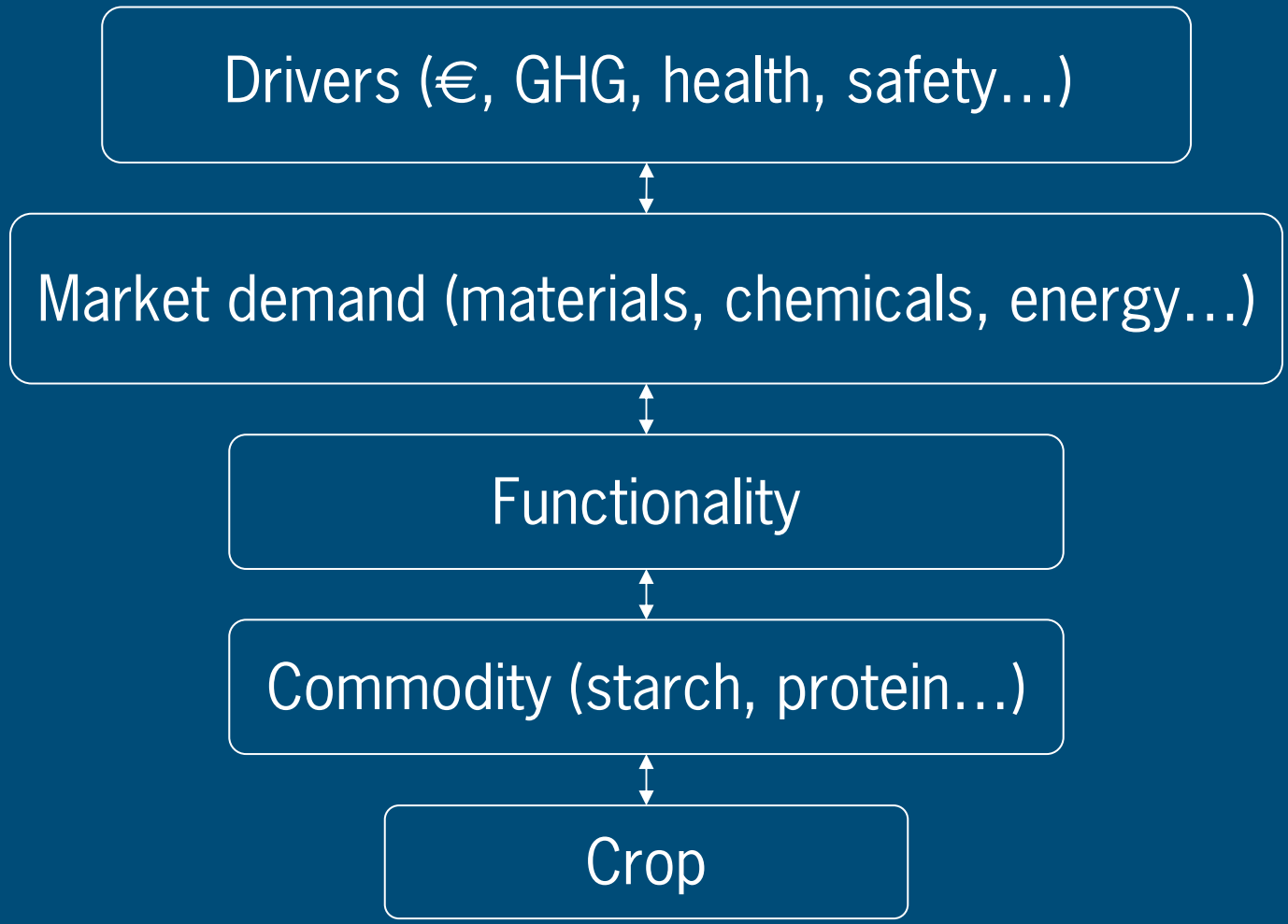
- First period, 80s:
  - Instability in agriculture regime
  - Target regimes (chemistry, energy, consumer market) not interested
- Second period, 90s:
  - Even more instability in agriculture regime
  - Chemistry regime becomes interested in sustainability
  - Legislation for sustainability (VOS, packaging)
- Third period, 00s:
  - Instability in agriculture, chemistry and energy regimes
  - Government sets target for renewable resources use

Lessons from the agrification era

- Market demand (needs to be created), entrepreneur takes the lead
- Successful new technology is not enough for a successful market introduction.
- Environmental benefits are not enough to sell a (biobased) product.
- Availability of suitable infrastructure helps (small investment).
- Spin-offs from existing chains: higher chance of success.
- Existing regulations can obstruct market introduction.
- In the Netherlands the price of raw materials is often so high that raw materials are imported from abroad. (hemp vs jute).

How can we determine present and future demand for non-food crops?

Our approach: “chain inversion”



Methodology

- Use the Eurostat production data of 2005 for EU-25
- EU-25 is representative for the global market potential for biobased products
- Estimate the percentage of biobased components in the manufactured goods (in €)
- Estimate the potential to increase the percentage of biobased components (in €)

Eurostat data on manufactured goods

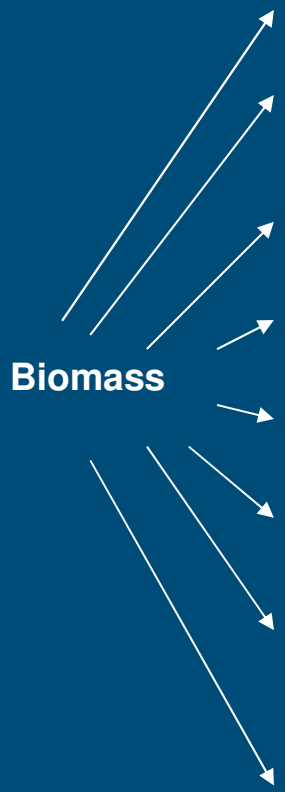
- In 1970, the «Nomenclature générale des activités économiques dans les Communautés européennes» (NACE - General Industrial Classification of Economic Activities within the European Communities) was compiled.
- It is a classification covering the whole range of economic activity.

Biobased products…

- NACE contains over 4000 Products in 503 Classes, 222 Groups, 60 Divisions
- Coarse selection: 936 potentially biobased products (Non-food and non-feed)
- Final selection: 780 products

→ Further divided into 3 groups

What can we do with biomass?



Free sugars

Starch

Natural oil

Protein

Cellulose

Lignin

Hemicellulose

Specialty ingredients

(1) Biomass -> food

(2) Biomass -> feed

(3) Biomass -> energy (heat, power, fuels)

(4) Biomass -> separation to materials

(5) Biomass -> separation to substances

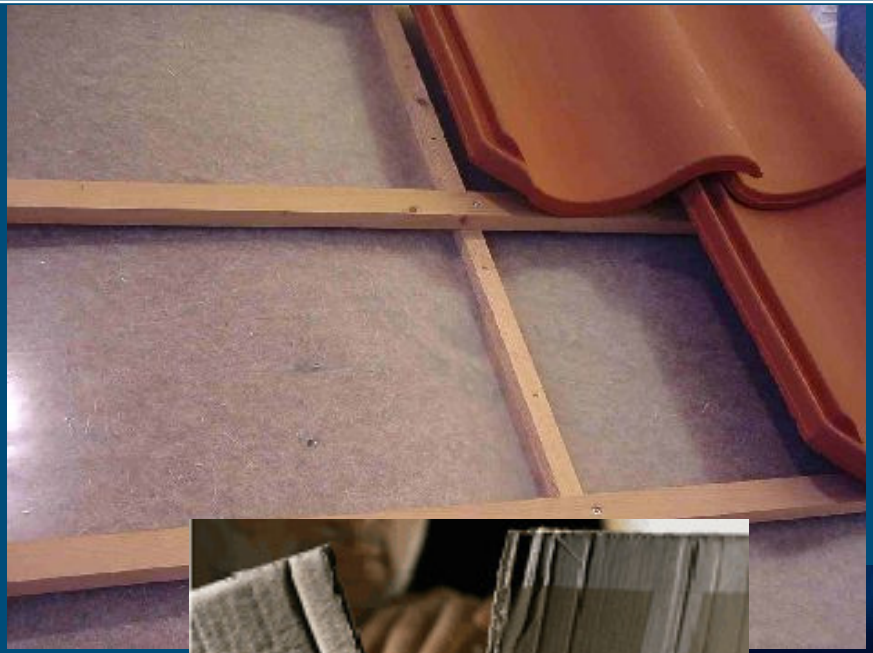
(6) Biomass -> fragmentation to building blocks

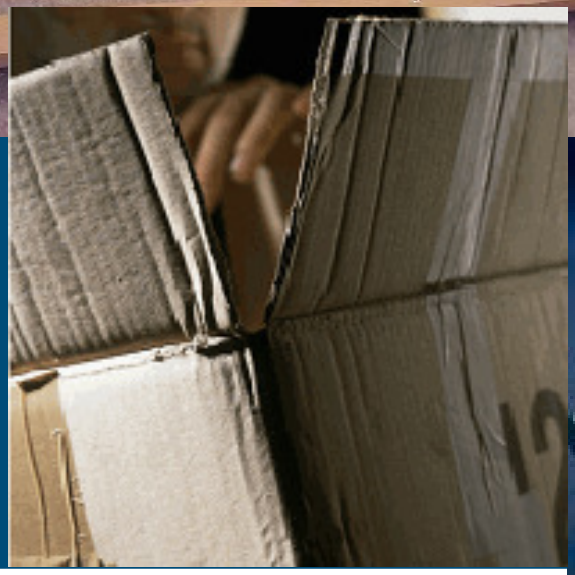
Classification non-food applications (Bos, van Rees, 2004)

Green resources supply us with:

- Materials:
  - fibres for paper, fabrics and composites
  - wood for timber and energy
- Substances:
  - starch for plastics, glues and additives
  - bio-oil for paints, inks and transport fuels
- Chemical building blocks:
  - lactic acid for additives and polymers
  - ethanol for fuel and plastics
  - furans for resins and fuels

Materials from biomass





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Substances from biomass

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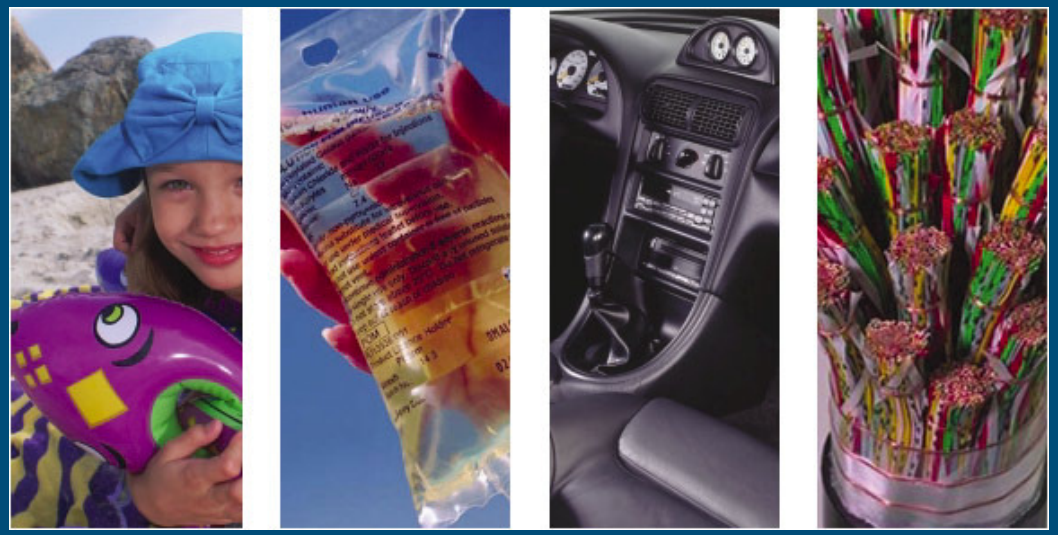
Chemical building blocks from biomass



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The logics of this classification

- Materials from biomass:
  - Mostly old established applications and relatively simple processes
  - Can be big (f.i. Paper industry), but also a lot of SME
- Substances from biomass:
  - Often using relatively simple chemical conversions
  - Partly in present food industry (f.i. AVEBE), also SME
- Chemical building blocks from biomass:
  - Mostly combination of white biotechnology and chemistry
  - New products and processes
  - Focal point of the chemical industry
  - Biggest potential for biomass applications

Different crop choice!!

Market potential based on present production data

(Eurostat 2005)

	Number of product categories	*Percentage product categories registered*	*Total registered value* (billion €)*	*Present share Biobased ** (billion €)*	*Commo dities*	*Crops*
Materials from biomass	**323**	78%	250.6	187.7	?	?
Substances from biomass	**101**	60%	47.9	23.2	?	?
Building blocks from biomass	**356**	33%	155.2	34.5	?	?
Totals	**780**	55%	453.7	245.3	?	?

* excluding the confidential data
** of the non-food, non-feed component, based on expert judgement

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Biobased products

- Present market size of biobased in non-food/non-feed products in EU-25

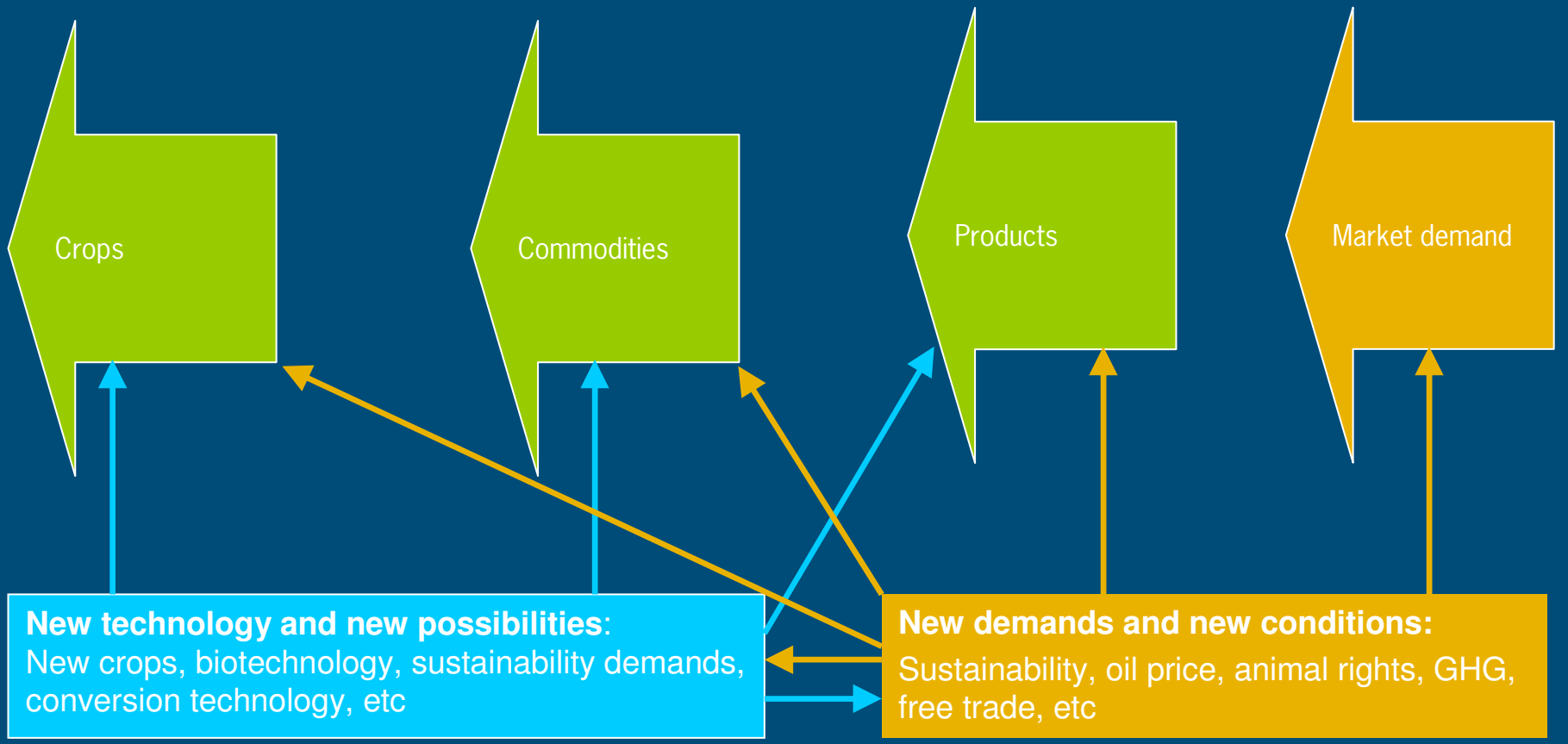
→ 250 Billion € (excl. confidential data)

- Present market size of food/feed products in EU-25

→ 460 Billion €

- Largest potential for growth in building blocks (240%)

WP 6. “Scenarios for successful establishment of future crops”



How do new crops fit – What new crops?

Challenge for 4F Crops

How are we going to build these chains?

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