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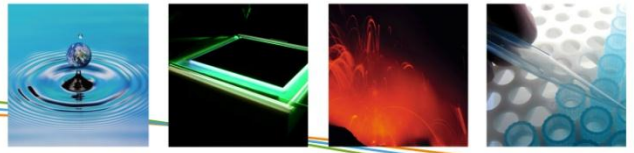


SAHYOG: Strategic Research Agenda

SAHYOG team

Delhi, Brokerage event EU-DBT, 3-4 February 2014

SEVENTH FRAMEWORK PROGRAMME

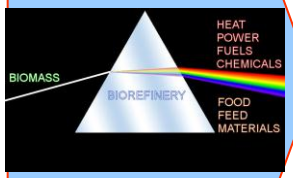
Department of Biotechnology
Ministry of Science & Technology
Govt. of India

The new Production oriented value chain

1st Agro logistics → Food pretreatment → Foodconversion → Food production → € ↑↓ → **Food**
Healthy, tasty, sufficient

Biomass sources
Agro-food productio
By products
& waste

Logistics&storage
Production
Imports



New production
Performance materials
Base&platform chemicals
Performance chemicals
Bio Energy

€ ↑↓ → **Biobased Products**
- Biobased materials
- Bio-based chemicals
- Bio-fuels
- Bio-energy

Existing conversion

Existing production

€ ↑↓ → **Existing non- food:**
- Feed
- Paper
- Additives
- Fibres/ clothes
- Wood for cooking

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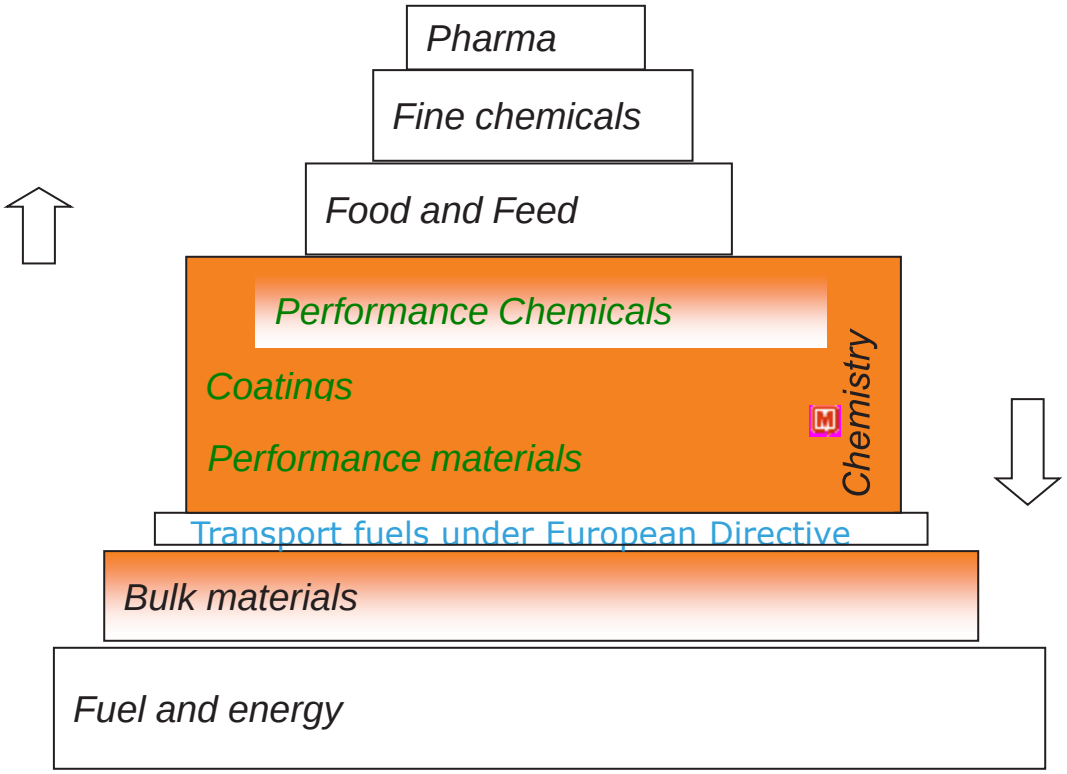
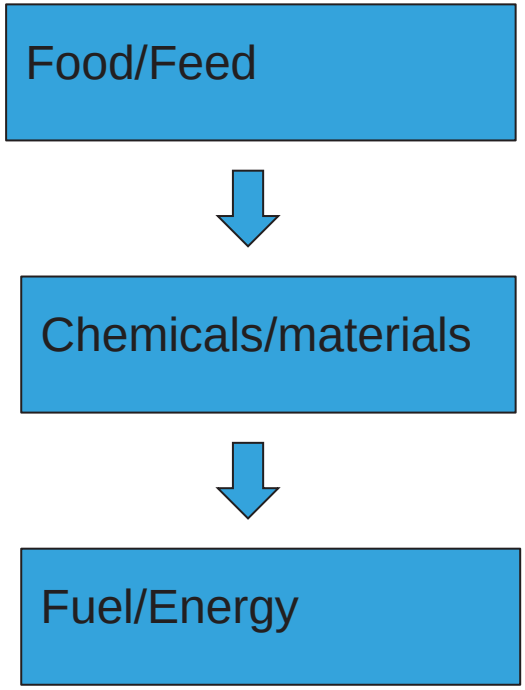
Value pyramid vs societal cascade of biomass



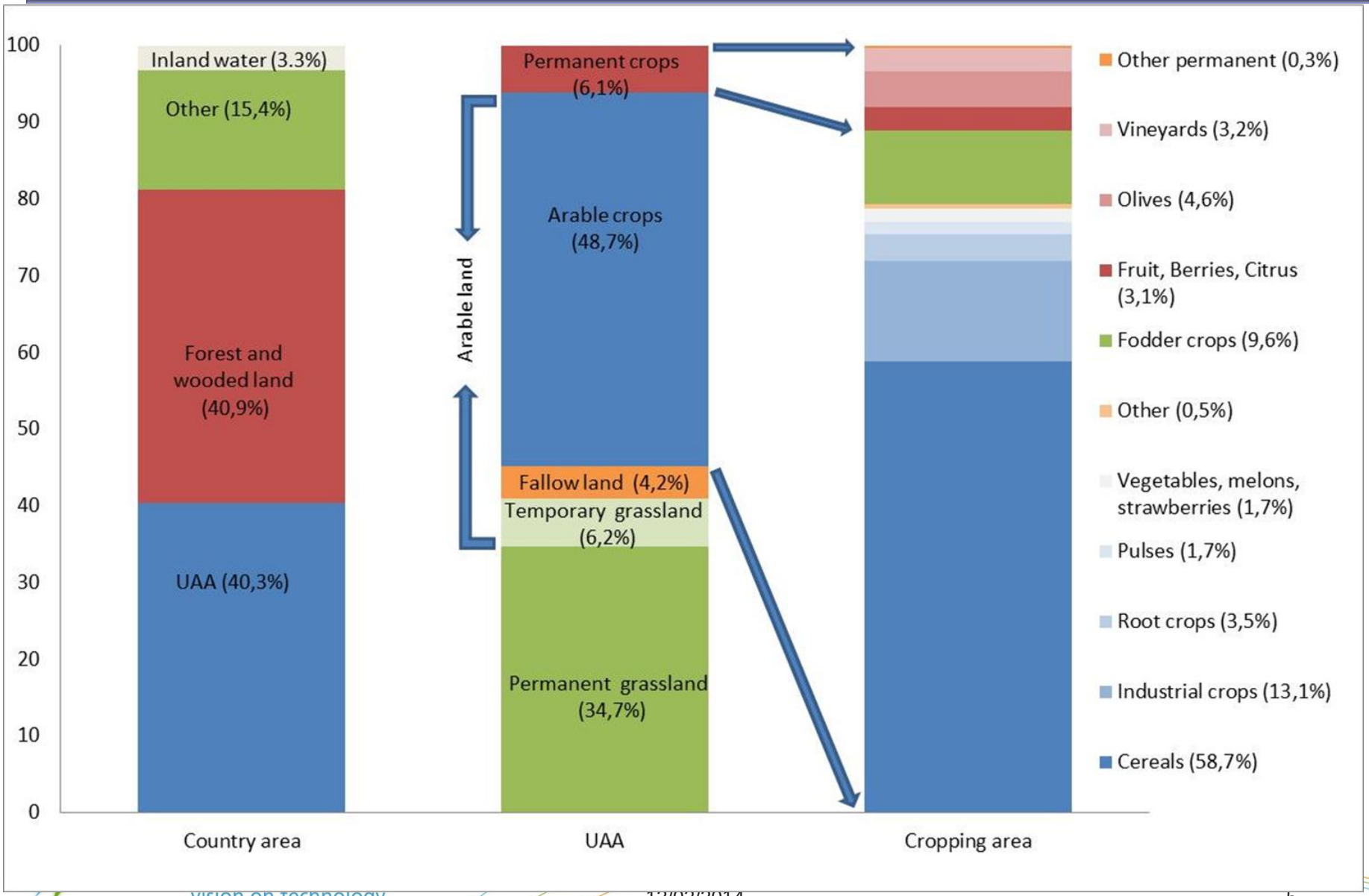


Inventory, R&D needs

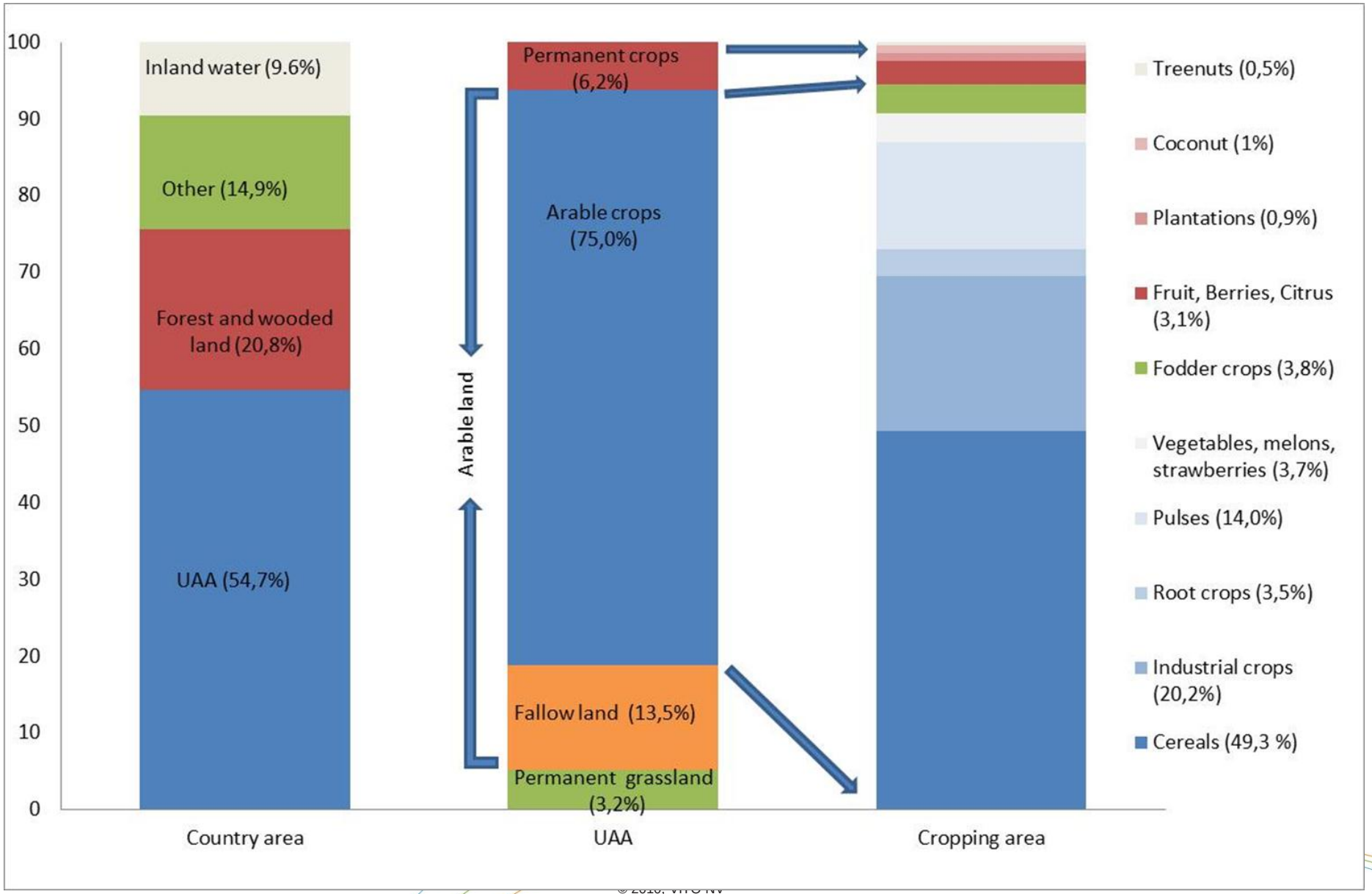
- Inventories of biomass
  - Surface – crops: geographical and climatological zones
  - Food part, straw part, processing part
  - Bulk vs high value
  - Potential: irrigation, nutrients, adaptation, manipulation,….
- Inventories of research projects (EU – ALCUE – INDIA) follow up of Star-Colibri
  - Competences of research
  - Problems to be solved
  - Future ➔ mind mapping
- Networking & exchange
  - Milestones in the inventories
  - Companies needs
  - Stakeholder meetings

Kolom1	projects	Funding
Cordis	605	€ 1.649.795.122
IEE	47	€ 41.833.612
StarColibri	294	€ 716.994.576
Total Europe	**946**	**€ 2.408.623.310**
India	**280**	**€ 350.000.000**

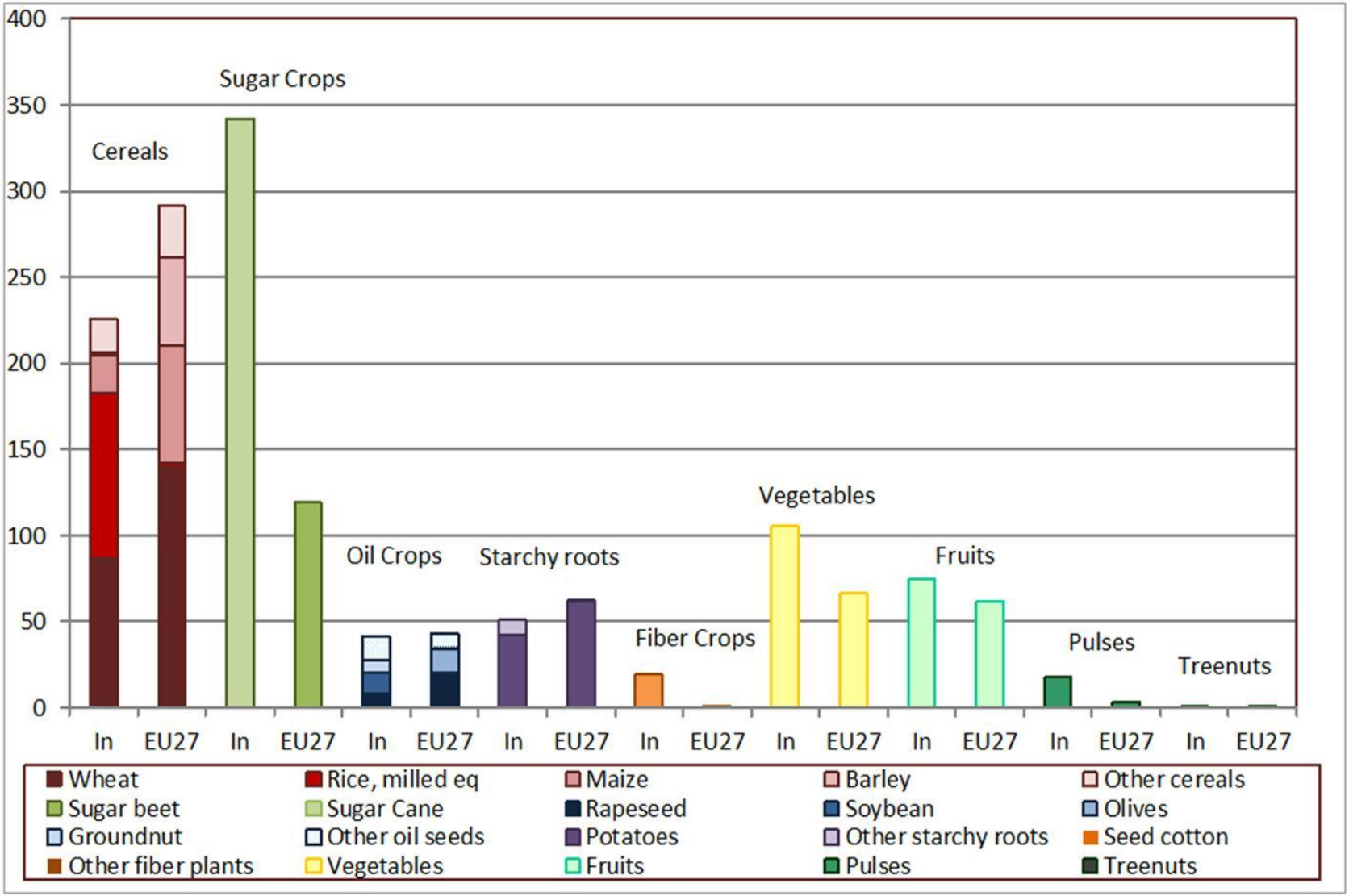
Land use in India: 330 M ha



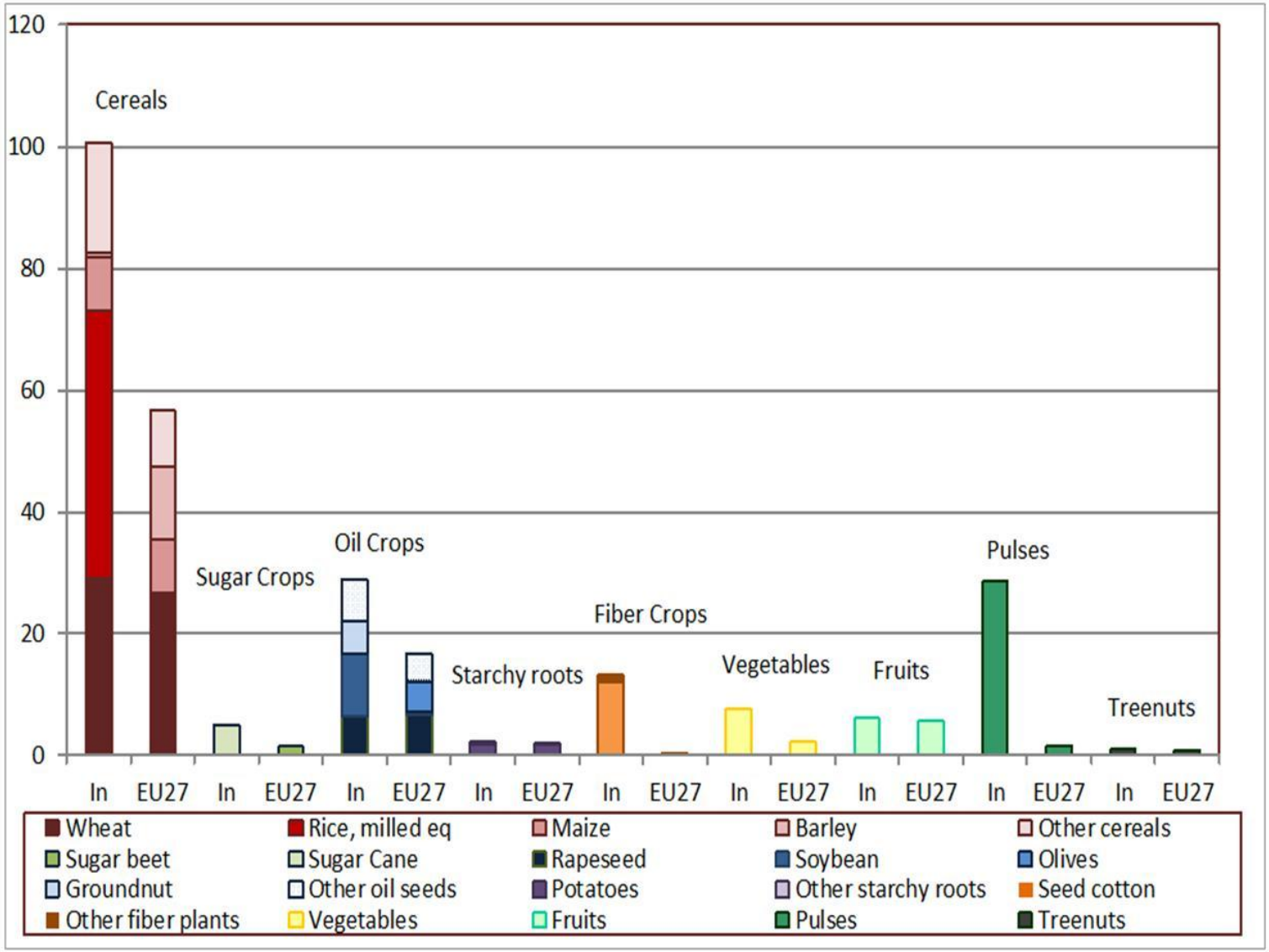
Land use in Europe: 430 M ha



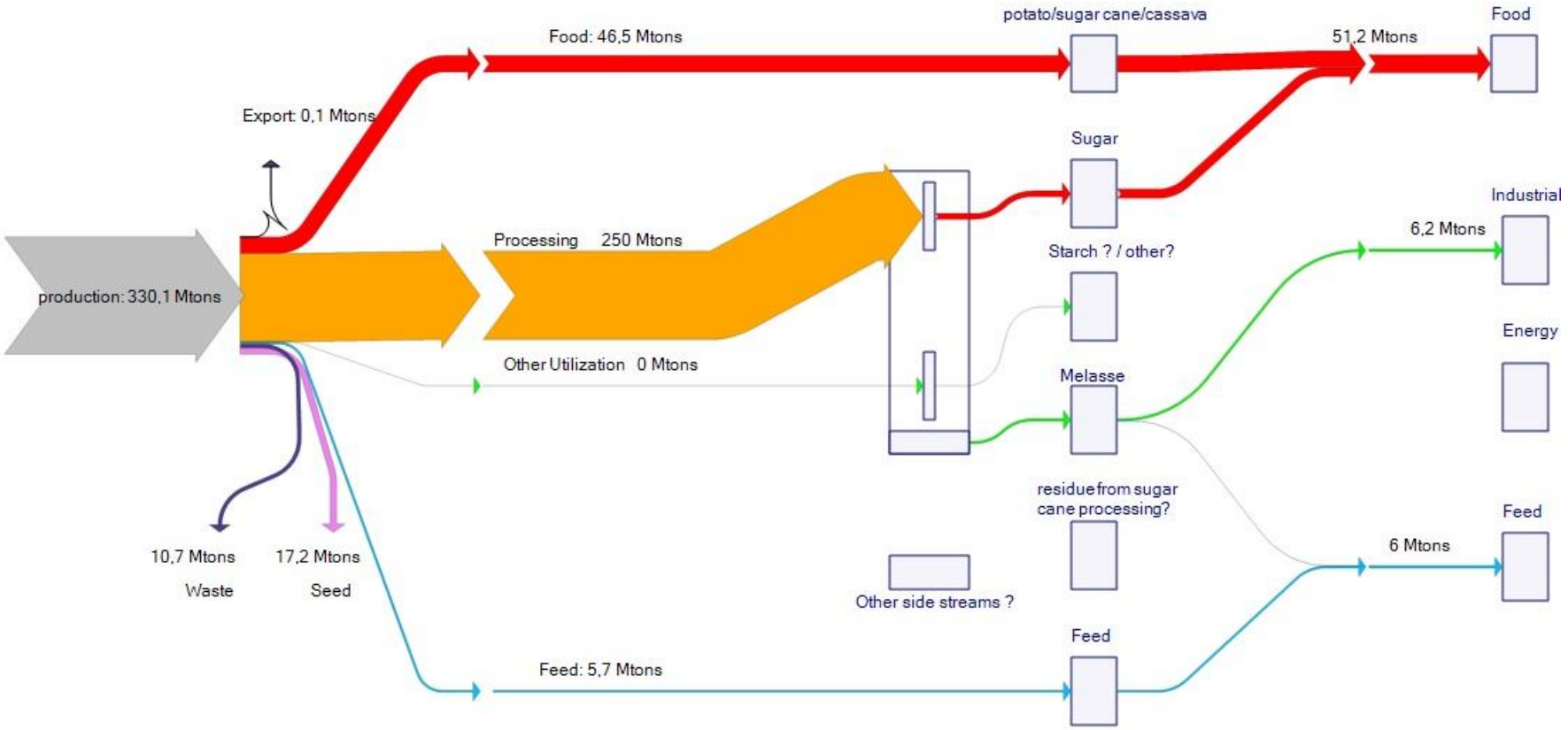
Biomass production (MT) in India/EU



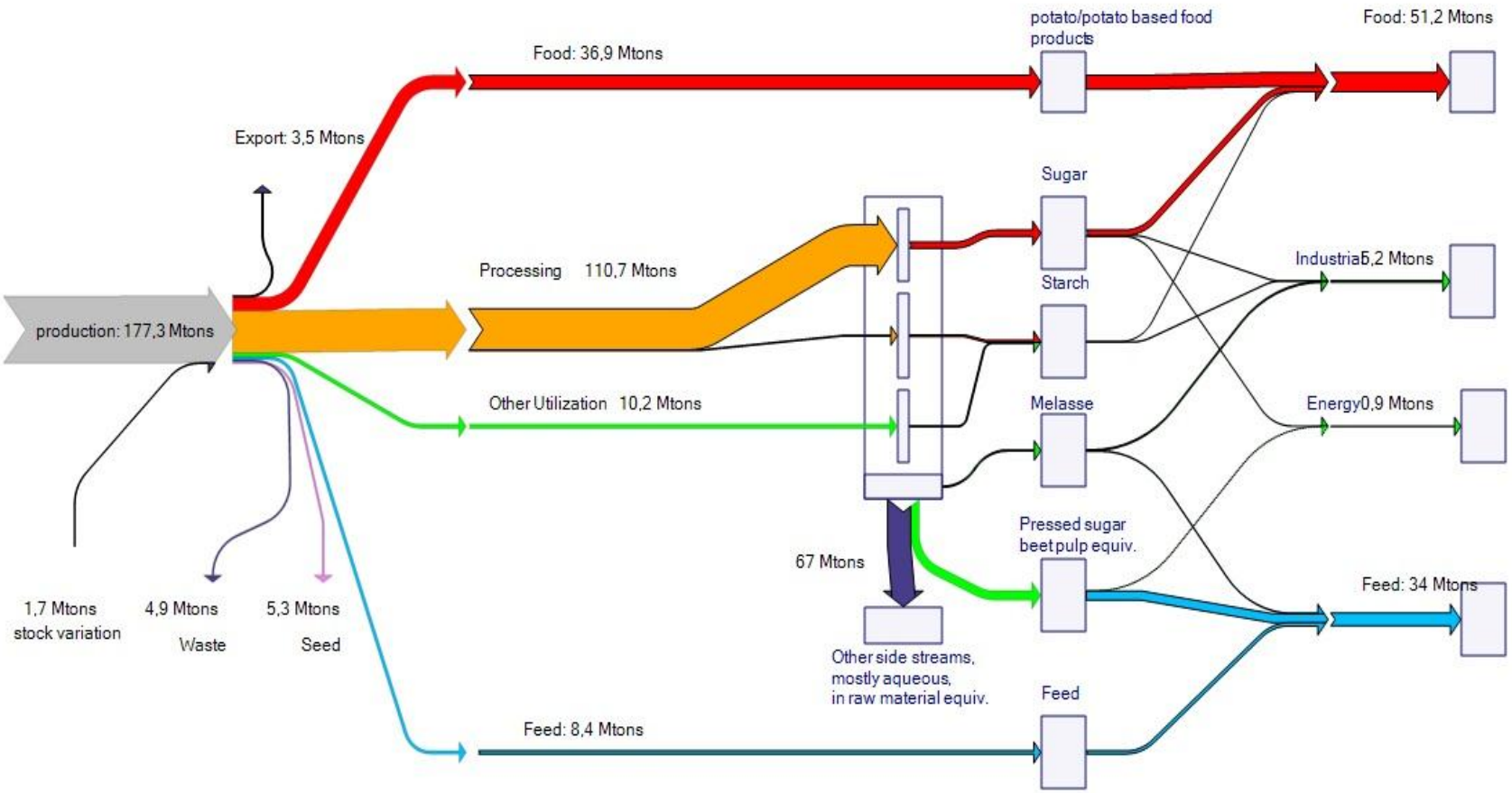
Land use (Mha) for biomass cultivation in India/EU



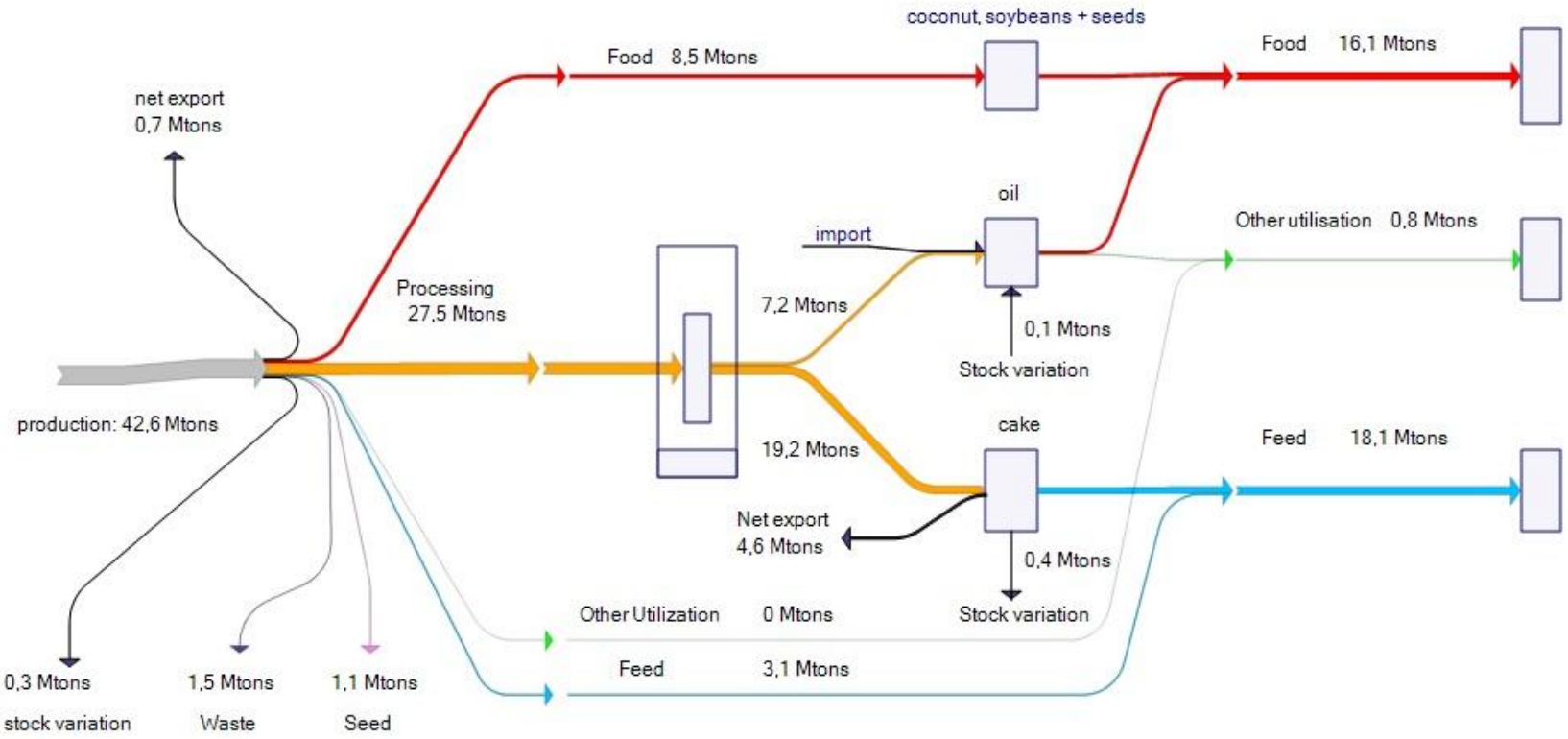
Domestic Supply and Usage of Sugar crops & Starchy roots in India



Domestic Supply and Usage of Sugar crops & Starchy roots in EU-27



Domestic Supply and usage of Oil seeds in india



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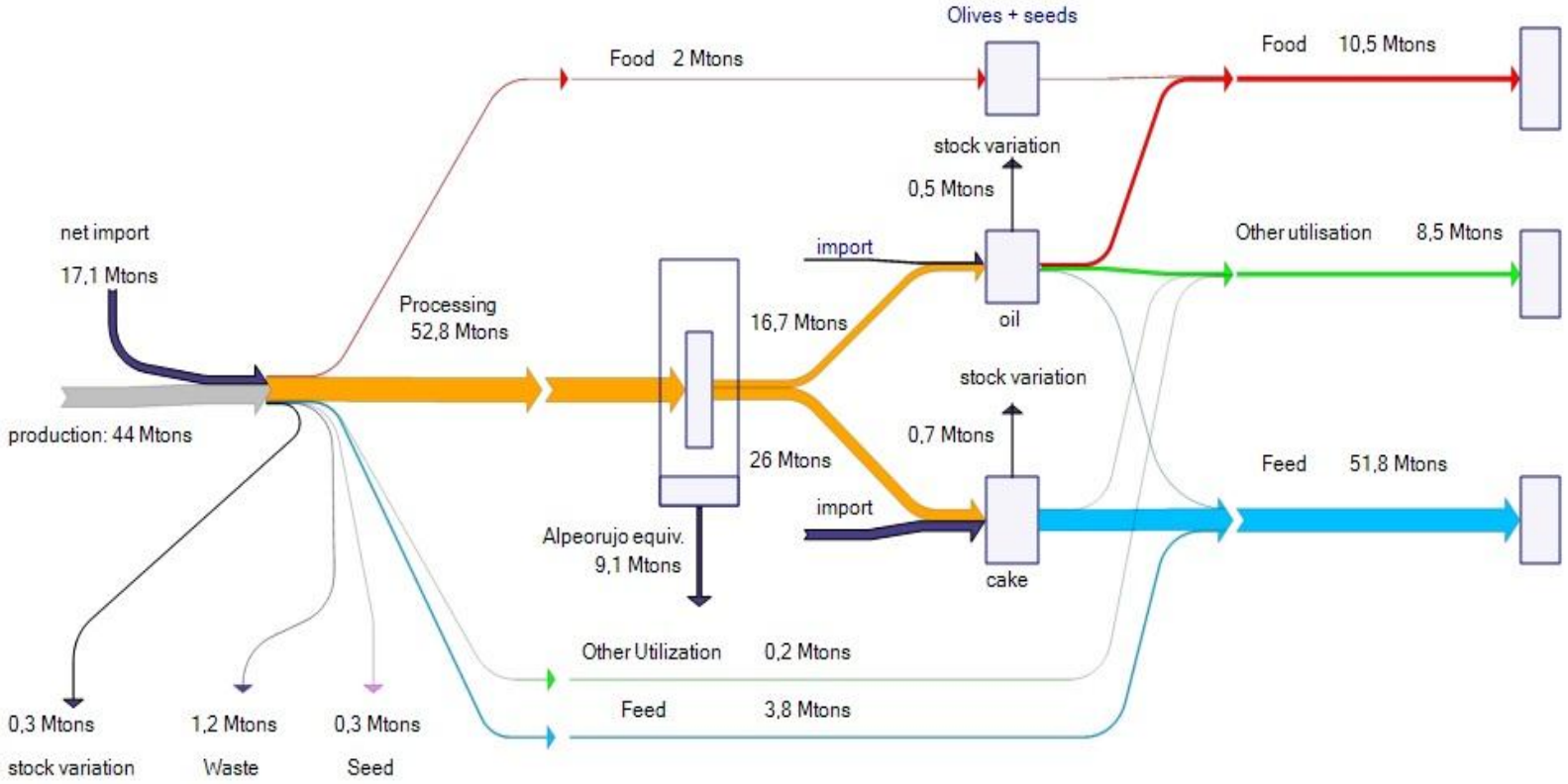
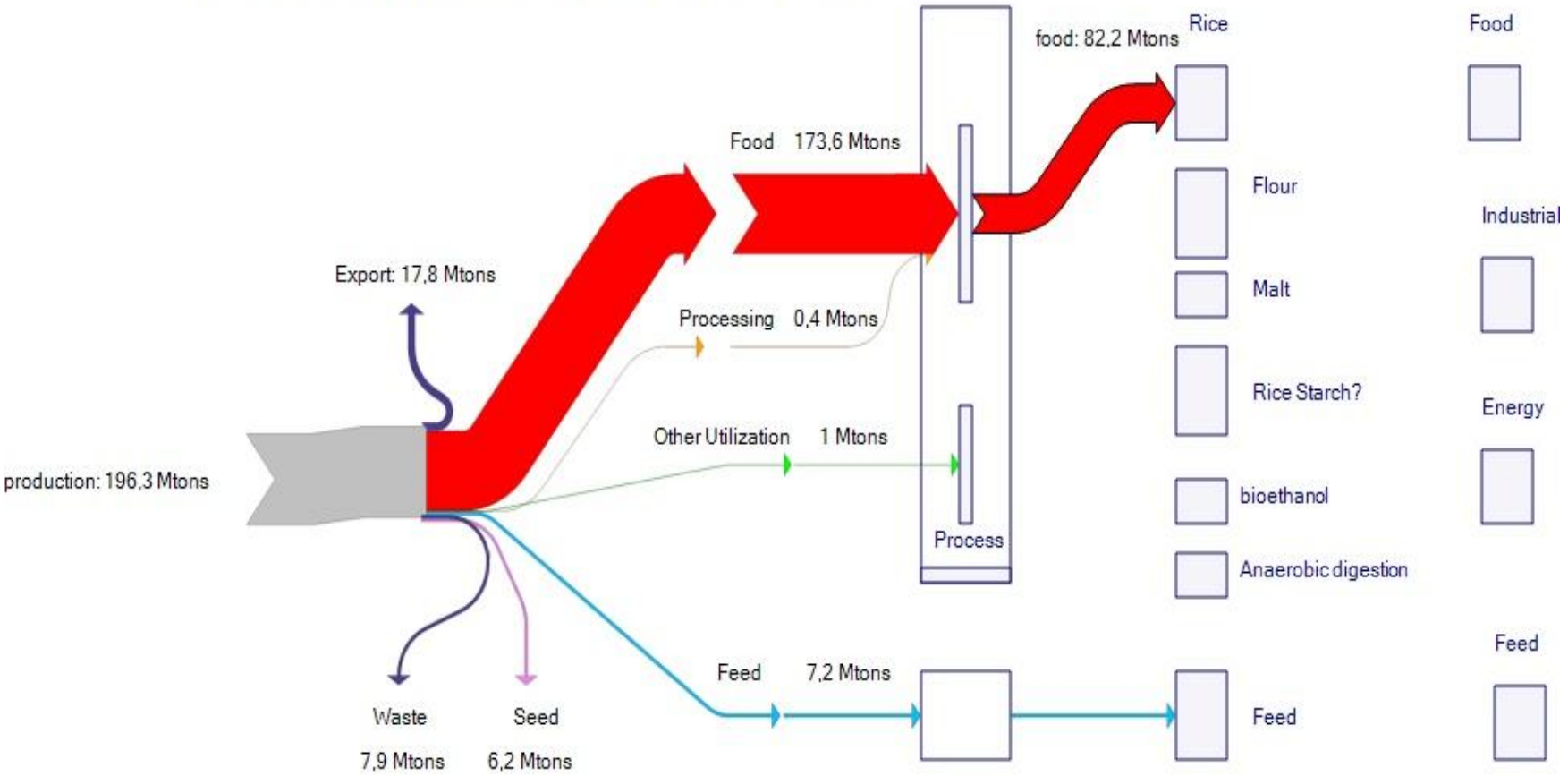
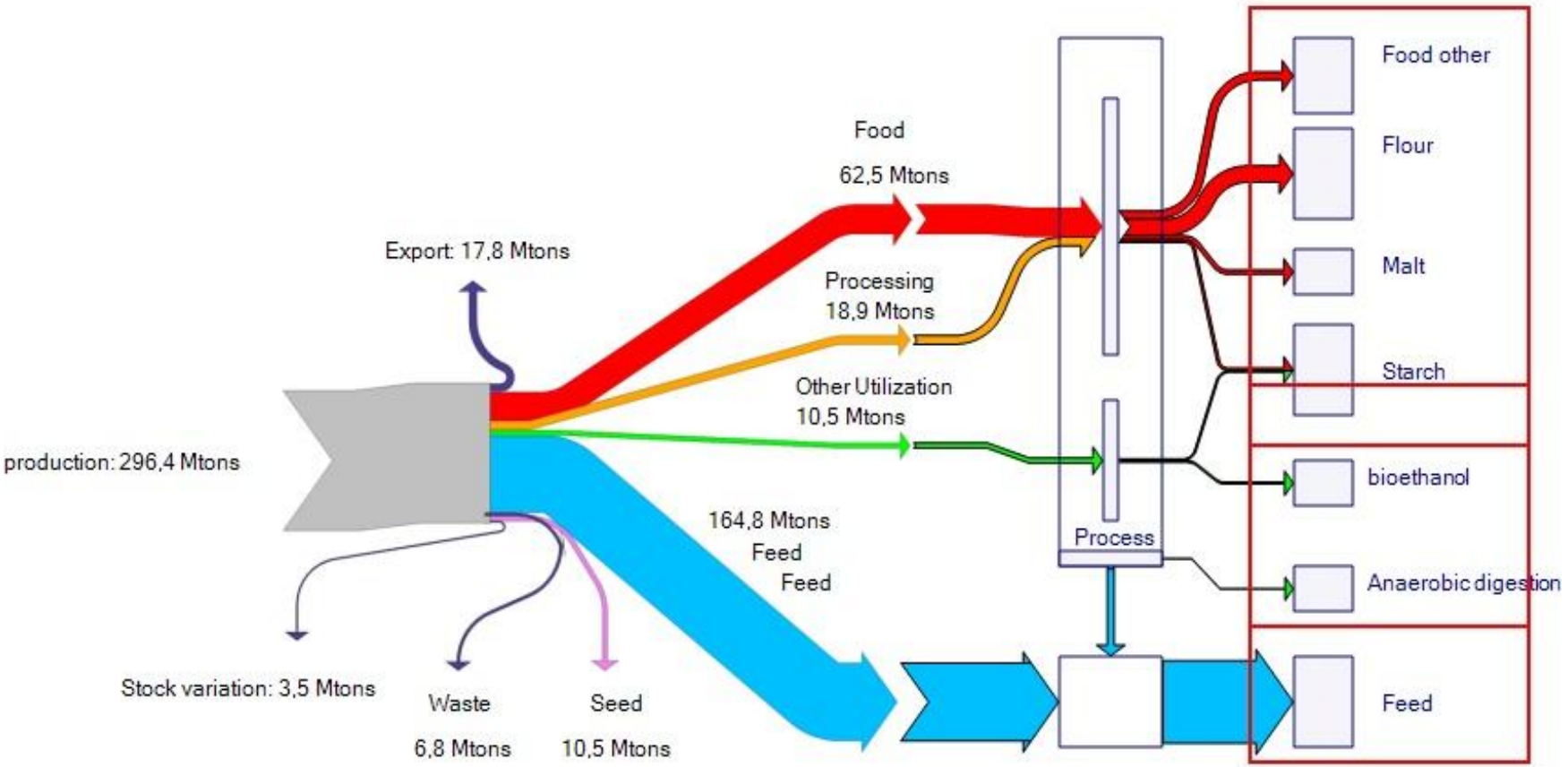
Domestic Supply and usage of Oil seeds in EU-27



Domestic Supply and Useage of Cereals in India



Domestic Supply and Useage of Cereals in EU-27



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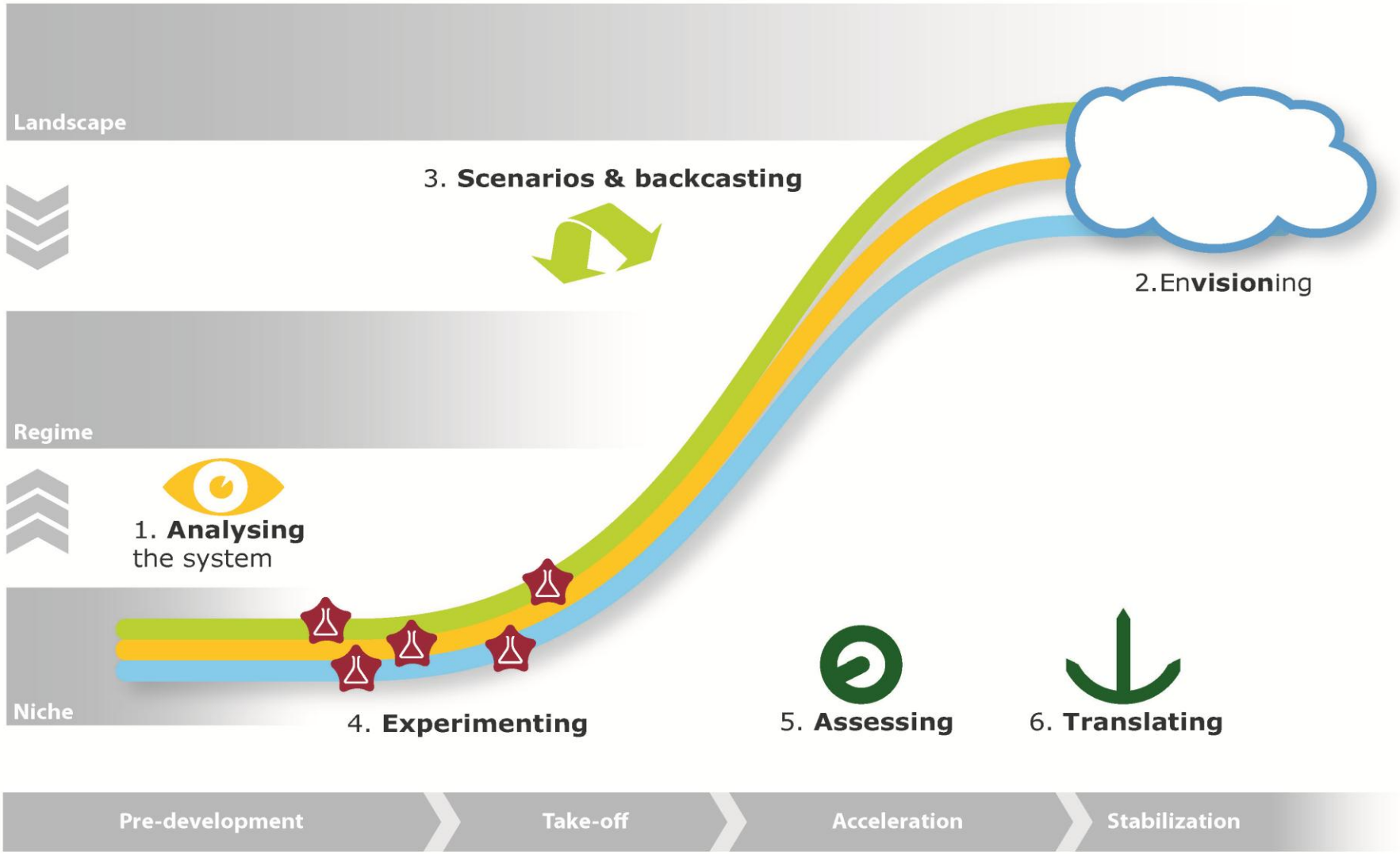
Still struggling with waste and residues

Europe	India
42 M tons waste + 18 M tons crops	> 623 M tons crop residues
109 M tons agriculture residues	461 M tons consumed
> 169 M tons	> 162 M tons (220 M tons)
57 M tons wood (16 M m^3 cuttings)	
41 M tons additional roundwood	980 M tons cattle dung
66 M tons Forestry residues (1, 2, 3)	150 M tons MSW (not used)
10 M tons sewage sludge	> 10 M tons sewage sludge (will come)
? M tons Food Processing Waste	
220 M tons biodegradable household Waste	

➔ Need for extra information and inventories

Road Map towards a new Bioeconomy vision



Strategic Research Agenda: Strategy !!!

- Starting from existing Road Maps
- Boundary conditions
- Strategy building on the cons and supps to a new vision
- Supporting actions to the road map
- Definition of needs and gaps
- Scenarios & backcasting
- Brainstorms ➔ Envisioning
- Experiments
- + assessing (e.g. LCA, twinning,…)
- + translating

Vision: Needs and challenges in Europe (1)

- Biomass production
  - High intensified agriculture
  - Extension to Eastern Europe
  - Multipurpose crops for biorefinery
  - Wood & forest based biomass
  - Limited biodiversity
- Biorefinery
  - Integrated biorefinery and value chain
  - Process intensification
  - Functionalised molecules with functionalisation/defunctionalisation
  - Waste and environmental management

Vision: Needs and challenges in Europe (2)

- Markets & products, legislation
  - Cascade
  - Certification/standardisation
  - Recycling
  - The improved inventories for Europe become an action or task for the European Biotechnology Observatory
  - We also need food processing data and data on sewage water and sludge

Needs and challenges in India (1)

- Biomass production
  - Agriculture intensification (seeds, nutrients, water, practices,…)
  - Logistics & storage
  - High biodiversity
  - 7000 km coastal zone
- Biorefinery
  - Food and processing
  - Waste – waste - waste
  - Energy application in order to convert environmental treaths
  - > 50 Mtons used for cooking
  - Strong sugar mill and bioethanol (old) infrastructure
  - Strong potential to set up a bio-ethanol infrastructure (based on bagasse)

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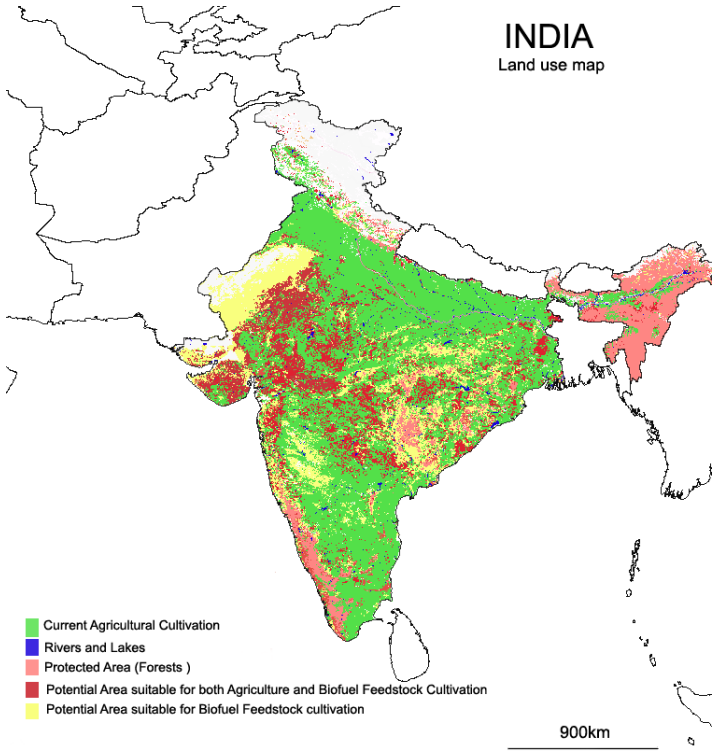
Needs and challenges in India (2)

- Markets and products, legislation
  - Processed food
  - Energy under all forms integrated with recovery of added value compounds
  - Rural development: small holder versus farmer cooperations producer companies)
  - Later on high added value molecules (medicinal plants)
  - Food price policy
  - Change use of biomass
    - Other energy sources or better coocking systems
    - Other or better fodder resources; better pretreatment of fodder will lead to higher nutritional value

Needs and challenges in India (3)



- > 500 M tons biomass available
- 32% from energy still derived from biomass
- 70% of population depends on biomass for its energy needs
- Thermochemical conversion:
  - Combustion
  - Gasification
  - Pyrolysis

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Research Recommendations: Biomass production (1)

- Agricultural production intensification
  - Low yields in India

	India	Flanders/EU
Wheat grains	2.7 ton/ha	8.3 ton/ha
straw	4.3 ton/ha	4.1 ton/ha
Maize grains	2.2 ton/ha	11.4 ton/ha
stover	3.6 ton/ha	34.4 ton/ha

  - Need for better plants/seeds
  - Water and nutrient management

Research Recommendations: Biomass production (2)

- Modelling of cropping scenarios
- Remote monitoring & GIS for plant production and prediction
- Investment plan for agro – ecological –climatological locations

  ➔ crops fit for land
- Technologies to harvest by-products + assessment of limits of crop removal
- Improved agricultural practices

- More resilient plants (draught, heat, salinity, acidity) => restore abandoned land
- Multipurpose plants for a bioeconomy (e.g. more straw producing)
- New crops allowing agricultural intensification

Research Recommendations: Biomass production (3)

- India and Europe have a large coastal area
- Different climatological conditions

➔ Blue economy/algae

- Cheaper microalgae and seaweed production & harvesting
- Integrated biorefinery of micro- and macro-algae (oils/fats, glycerol processing, proteins)

- Forest and grasses potential
- Fast growing trees and grasses
- Bamboo based biorefinery

Research Recommendations: Waste (1)

- Waste Reduction & monitoring
  - Methodologies to reduce waste production
  - Segragation of waste for better re-use
  - Survey of waste: landfill investigation
  - MSW and industrial waste inventories
  - ➔ Strongly experience from Europe to India

Research Recommendations: Waste (3)

- Waste conversion into added value products
  - Biomass in wastewater systems
  - Special attention to food processing waste
  - Strategy to apply waste as feedstock for energy and biobased products
  - Forestry residues
  - Waste conversion and enzyme development
  - Composting of waste?
  - Waste and wastewater valorisationthrough VFA platforms
- Circular economy development
  - Better and maximum utilization of biowaste
  - Carbon recycling via recycling of bio-based molecules and polymers

Research Recommendations: Biorefineries (1)

- Lignocellulosic biomass as a resource for energy/materials
  - Smart enzymes for lignocellulose and lignin hyrolysis
  - Robust yeast for saccharification and production
  - Process intensification for lignocellulosic biorefineries
  - Valorisation of lignin by conversion into bio-aromatics
  - Production & refining of food and non-food oil plants (Jatropha, Castor, Salicornia, cardoon,…)
  - Wet biomass refinery of algae, grass, waste (e.g. protein extraction)

Research Recommendations: Biorefineries (2)

- Thermochemical conversion processes
- Need for pyrolysis oil platform towards advanced biofuels and chemicals
  - Pretreatment for gasification, combination pyrolysis & gasification
  - Valorisation of pyrolysis oil and syngas
  - Treatment of non-biowaste (e.g. plastics) to syngas + fermentation to chemicals and fuel
  - CO2 conversion to chemicals and fuels

Research Recommendations: Biorefineries (3)

- Improved anaerobic digestion systems
- Improving overall efficiencies & reduction of costs
- Pretreatment, upgrading of biogas
  - Mono-digestion and multiple feedstock or co-digestion
  - Microbiology and enzymes for pretreatment
  - Integration of pretreatment with added value extraction
  - AD integration with multiple products (H2, VFA, fibres, nutrients, …)
  - Digestate as fertilizer (hygienic aspects)
  - Biogas upgrading (gas grid)

Recommendations: Policy, market, products (1)

- Society
  - Governance for societal acceptance of bio-economy
    - Communication and awareness creation: use of biowaste, waste disposal approach, segregation of waste
    - Education in ecology, environment, biobased economy
    - Technically qualified human resources for clean energy and bio-based economy (agriculture and industry)
  - Transition from largely fossil-fuel driven to clean and renewable energy
  - Capacity building of farmers to invest in bio-economy
  - Better sharing/involvement of marginal farmers in supply chain
- Legislation
  - Declassify residues from waste to resource (LMI)
  - Market driven pricing system
  - Waste transport legislation
  - Clear and transparant regulatory foundation

Recommendations: Policy, market, products (2)

- Market
  - Promotion of industry for transtion to bio-economy
  - Market and economical potential studies
  - Lessons learnt from failures
  - Public procurement of biobased products
  - Standards for biobased products
- Products
  - Agreement on GHG reduction performance of biobased products and energy
  - Specific markets exploration (bio-based plastics in addtion to paper)
- Logistics
  - Reduction of pre- and post harvest losses (development of sustainable systems)

Recommendations: Policy, market, products (3)

- Sustainability
  - Agreement on sustainable production and use of biomass
  - Sustainability and economic profitability assessment for full systems

- Research
  - Joint EU-IN study on markets: biobased polymers, aromatics, fibres, …
  - Research into development of performance criteria of biobased products, GHG reduction, land use etc.
  - Standards of biobased products
  - Pricing mechanisms of biobased products and supporting energy
  - Creation of level playingfield for biobased products and energy
  - Sustainability limitations
  - Optimisation of geographical locations for biobased products

What is missing?

- What are the needs of industry?
- What are the needs of the small holders (farmers)?
- What are the needs of the society?
- Public validation.
- What is the political will?
- …

What will be the road map?

- Which are the topics for common research? (limited number)

Bilateral (EU-India)

- Waste/wastewater to energy ➔ lead via India
- Wood biorefinery + bamboo ➔ lead via EU
- Lignocellulose 2G chemicals (which ones?) + bamboo ➔ lead via EU
- Algae, marine biomass ➔ lead via India
- Crop improvement ➔ EU-India

Unilateral (EU or India)

- Medicinal plants and biodiversity ➔ lead via India
- Sugar-based bioeconomy ➔ lead via Europe

Strategy (limited R & D)

- Agricultural practice, logistics, storage, …

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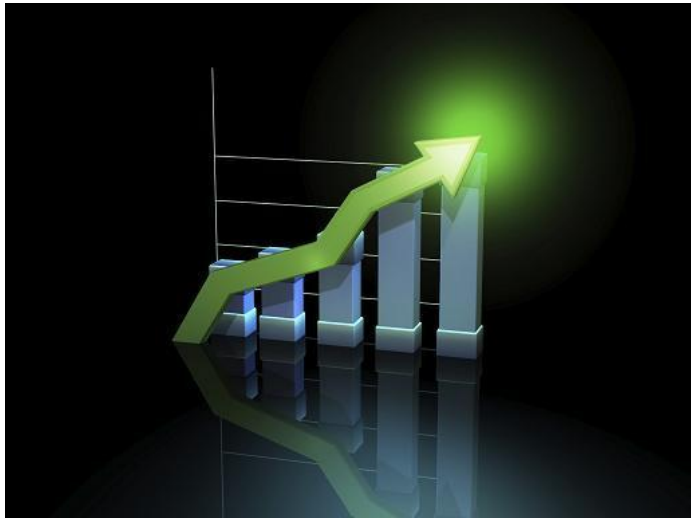
A bright future for bio-based economy in EU and India



For more information visit our web-site

http://www.sahyog-europa-india.eu/

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