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EU-based Production and Exploitation of Alternative Rubber and Latex Sources

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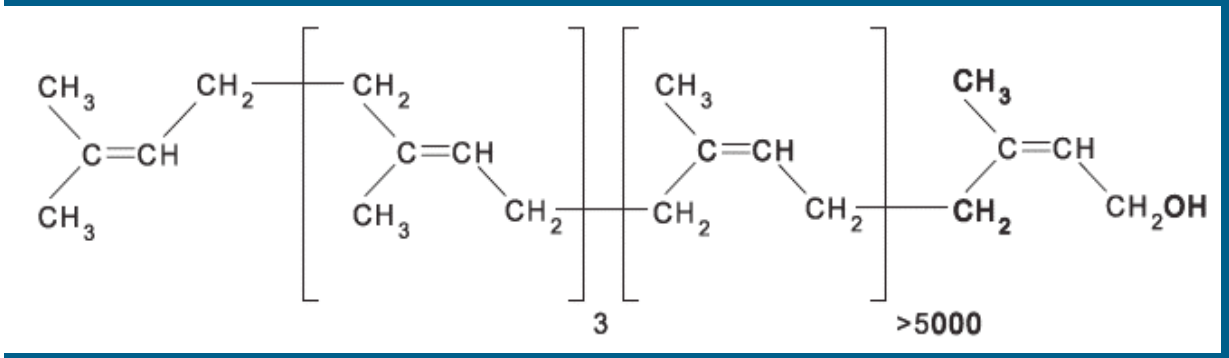
Natural rubber = *cis*-1,4-polyisoprene



- Monoculture of *Hevea brasiliensis*
- Over 8 million Ha, mainly in Southeast Asia
- Over 10 million labourers
- 7 years growth to first tapping
- Rubber yield: 1-2 tonnes / ha . year

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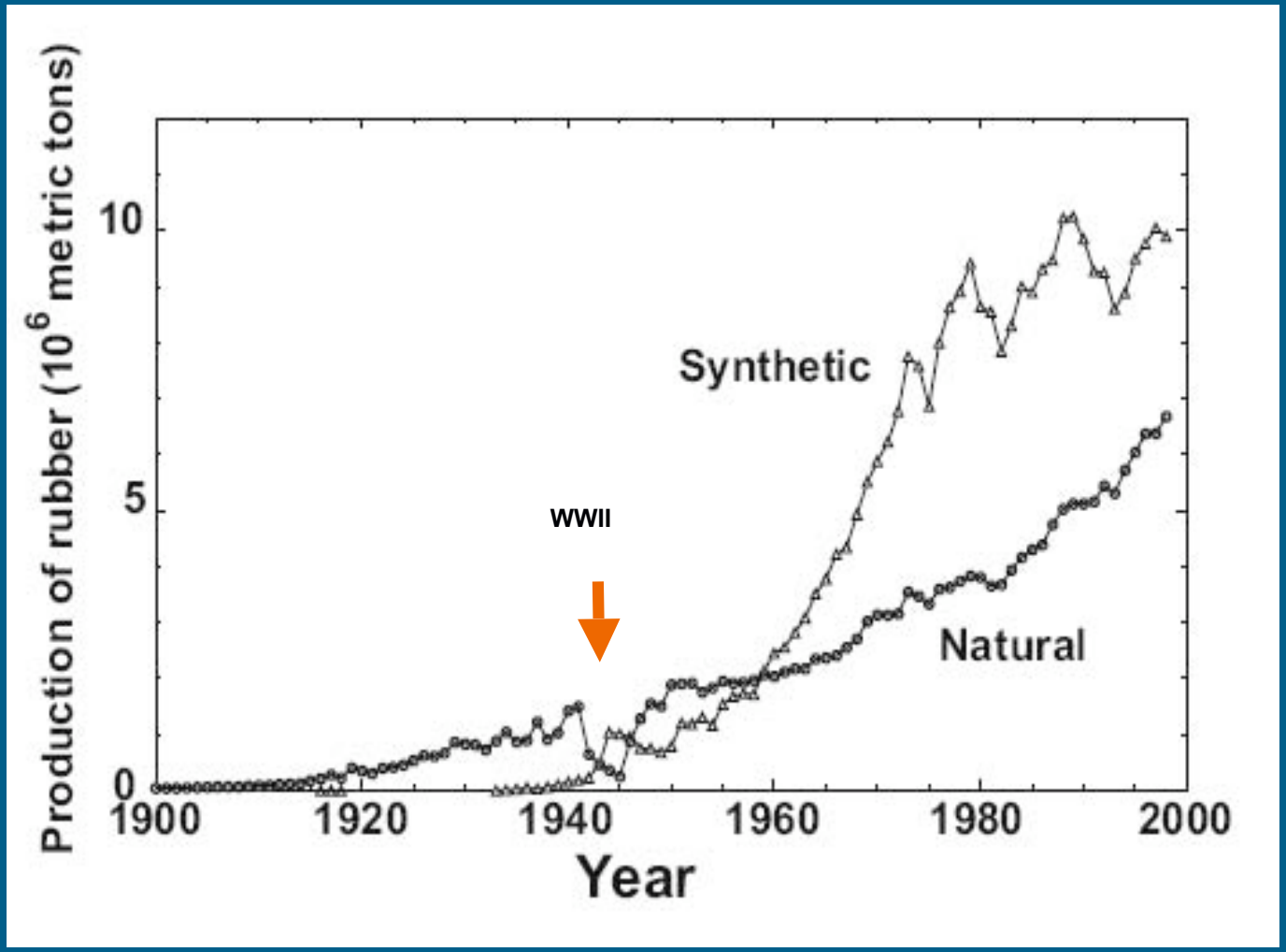
The market share of natural rubber increases



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because NR latex is superior to synthetic products..

- Latex applications: gloves, tubing, contraceptives
  - Thin, flexible films, good dexterity
  - Good physical properties
  - Low cost
  - Environmental benefits

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and because NR is superior to synthetic rubber..

- Dry rubber applications: heavy duty tires for airplanes, trucks, agricultural equipment, side-wall of car-tires
  - Heat-tolerance, low heat-buildup
  - Resistance to break
  - Resistance to shrinkage
  - High tear and tensile strength
  - Long shelf life

- In many of it's most significant applications, NR cannot be replaced by synthetic rubber!

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THE RUBBER INDUSTRY'S BIOLOGICAL NIGHTMARE

The day that haunts the rubber industry will dawn like any other. As tappers fan out among the plantings, the sea wind picks up, scattering foliage that falls unnaturally from the branches. The leaves are withered and dry, blackened with lesions. The dark eruptions mean only one thing: The South American leaf blight, a fungal pestilence so virulent as to have thwarted all efforts to cultivate rubber in its native Amazonian homeland, has reached the shores of Asia.

On the scattered family farms, source of 80% of the production, the disease proves impossible to control.

So fearful have Malaysian officals been of this potential calamity that they have never permitted a commercial airline to fly directly to their country from any South American nation known to harbor the fungus.

The outcome: the end of the natural-rubber industry as we know it.

(Wade Davis, Fortune Magazine, 1997)

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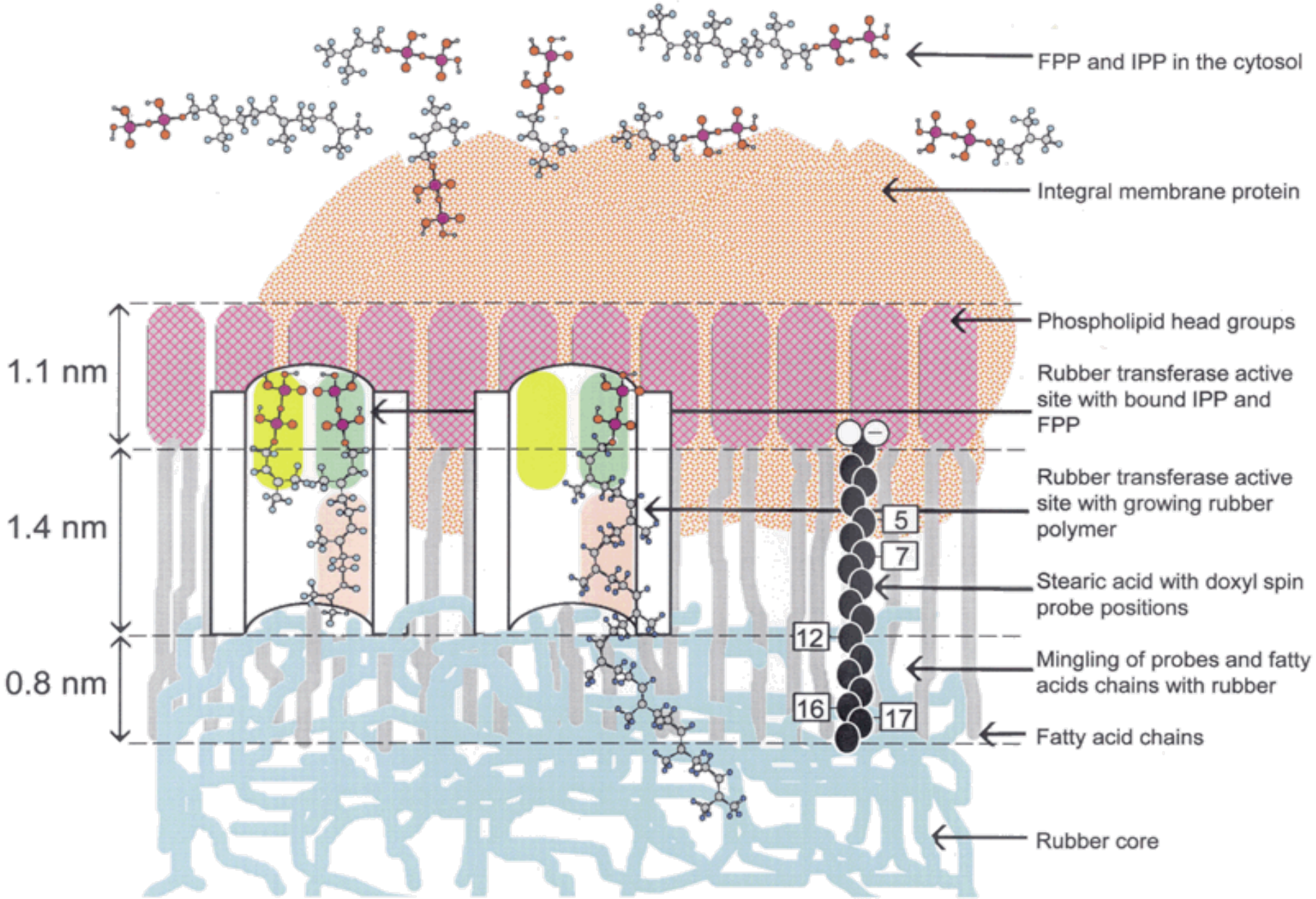
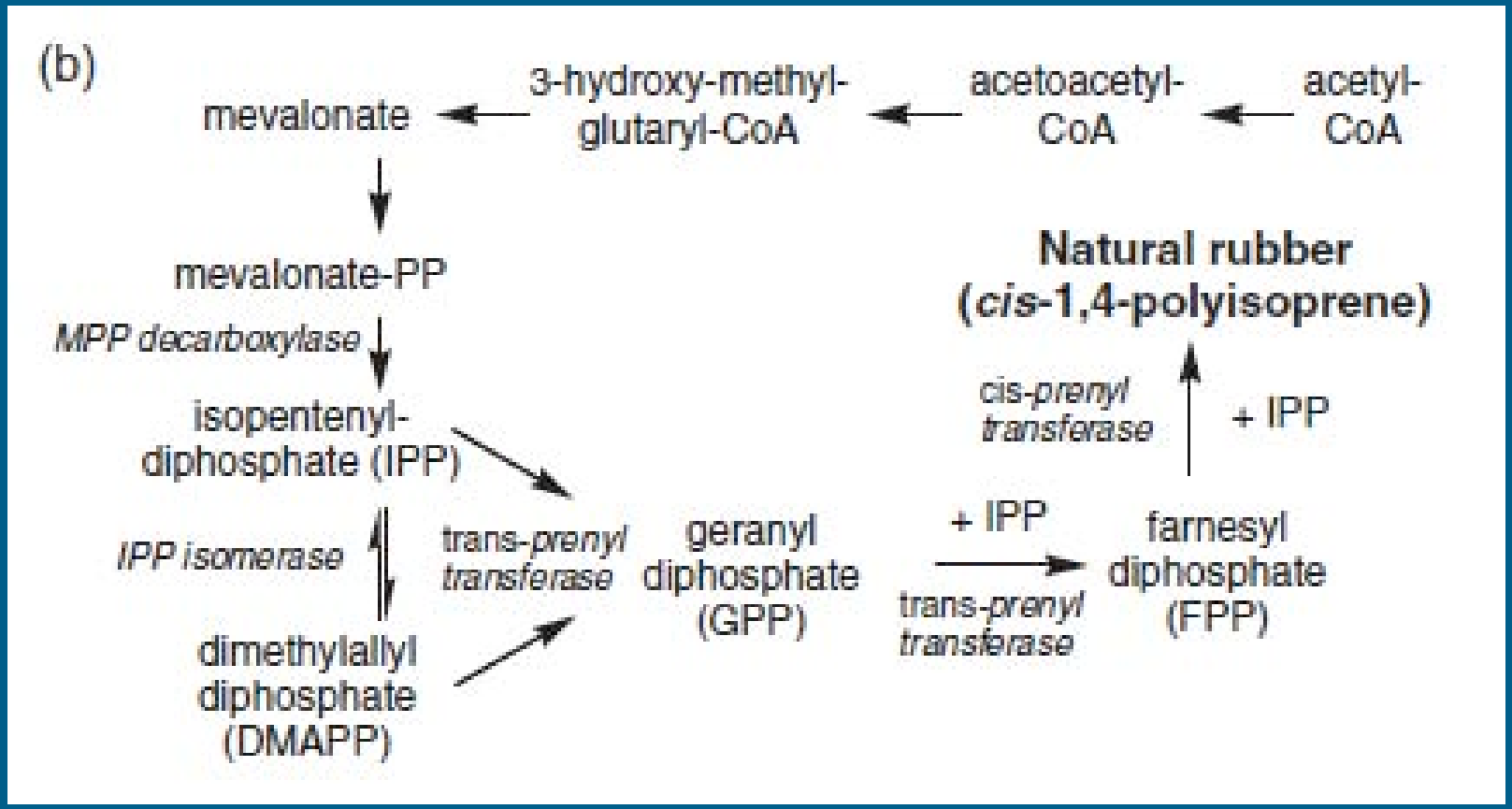
Why work on natural rubber in Europe?

- Strategic issues
  - Emergency crop should be available
- Scientific issues
  - Neglected compared to other biopolymers
  - Identity of rubber polymerase (*cis*-prenyl transferase) not certain
  - Links between genes and functions not established

Enzymes / proteins involved in synthesis?



Modification of rubber synthesis?



Why work on natural rubber in Europe (II)?

- Commercial opportunities
  - Life-threatening, IgE-mediated *Hevea* latex allergy
  - Alternative sources providing added value through new functions (hypoallergenic latex, high MW polymer)
  - New “marginal” supply under tight market conditions
  - Peak-oil: threat to synthetic rubber

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Why work on natural rubber in Europe (III)?

- Social / environmental issues

  - Rubber tree tapping is laborious, poorly paid, and often involves child labor
  - Competition for land by palm oil plantations
  - *Hevea* plantations replace natural forests

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EU-PEARLS: project details

- Call FP7-KBBE-2007-1 in Food, Agriculture and Fisheries, and Biotechnology
- 12 Partners: industry, SMEs, academia, research institutes
- 8 Countries, 8 M€ - ~6M€ subsidy, 2008-2012
- Disciplines/activities: Entire chain from new varieties, molecular breeding, agronomy, by-products, extraction, modification, applications
- Objective: Establishment of new production and application chains for latex and rubber in Europe

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EU-PEARLS: partners / coordinator

- Wageningen UR Biobased Products (WUR, Coordinator: Hans Mooibroek)
- Plant Research International B.V. (PRI, NL)
- Keygene (NL)
- Yulex Co. (USA)
- Vredestein (VRB, NL)
- Westfälische Wilhelms-Universität Münster (WWUM, DE)
- Université de Lausanne (UNIL, CH)
- Czech Academy of Sciences, Institute of Botany (CAS-IBOT, CZ)
- Basque Institute for Agrarian Research and Development (NEIKER, ES)
- Establishment Center Ecological Reconstruction (ECER, Kazakhstan)
- Centre de coopération internationale en recherché agronomique pour le développement (CIRAD, FR)
- Extraction Unit Designer (Stramproy)

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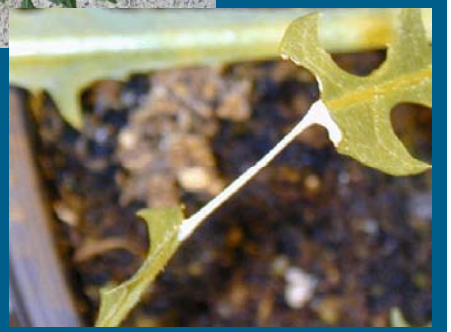
Target species for Europe

Partenium argentatum Gray, Guayule, Chihuahuan Desert (“wa-you-lee”)

Taraxacum koksaghyz Rodin, Russian dandelion, Kazakhstan



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Taraxacum kok-saghyz Rodin (TKS)

- Occurs in central Asia
- Superior rubber (high MW), up to 15% of dry weight
- Latex in laticifers
- Fast breeding: sexual diploids, several generations per year
- (Bi)-annual crop for temperate regions

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TKS bottlenecks

- No systematic breeding
- Limited germplasm available
- Critical properties
  - Vigor
  - Root size and morphology
  - Reliable rubber content

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TKS bottlenecks

- Agronomics
  - Vulnerable seedlings
  - Competition with other dandelions
  - Plant diseases
  - Rabbits!
- Processing technology
  - Limited information
- By-products
  - Butanol-acetone
  - Inulin (35% DW)
  - Leaf and root fractions for feed, ethanol or biogas

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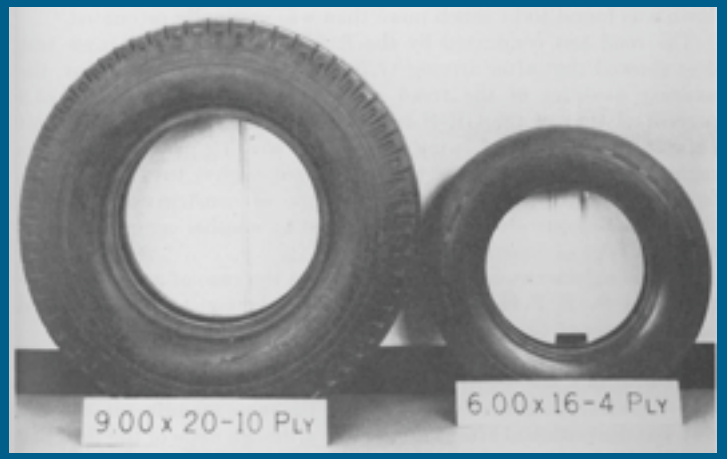
TKS future

- 1 ton of rubber per ha from improved TKS
- German rubber imports: 212000 tons in 2010, FAO
- Areas used for sugar beet and potato cultivation in Germany in 2007: 403 000 and 275 000 ha, respectively
- Cultivation costs similar to chicory



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Parthenium argentatum (Guayule)

- Occurs in Mexico, Southern USA
- Commercial in early 20th century
- “Manhattan project” type effort during WWII
- Partially domesticated
- Under development for high-value hypoallergenic latex
- Can be grown in Southern Europe, drought resistant

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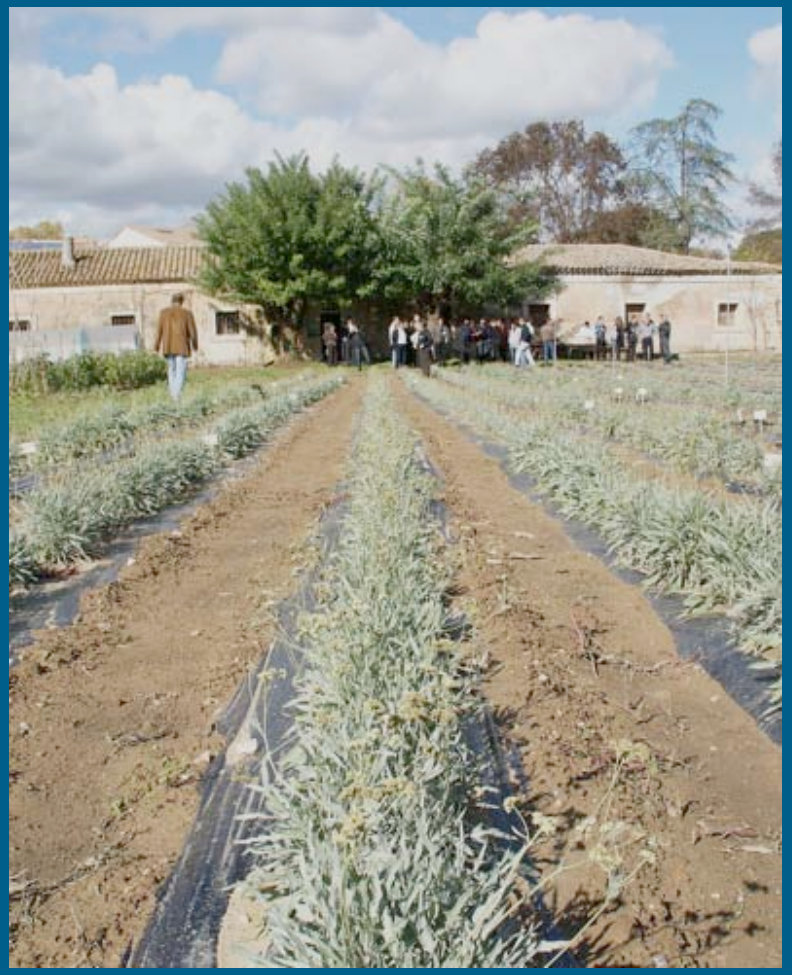
Guayule bottlenecks

- Germplasm
  - Suitable for Europe?
  - More breeding necessary
- Agronomics
  - Direct seeding is difficult, and seedling production is expensive
  - Harvest: various methods
- Difficult processing
  - Rubber in parenchyma cells: extraction is difficult and costly
- Marginal by-products
  - Resins (sesquiterpenes)
  - Low-MW rubber
  - Biomass energy



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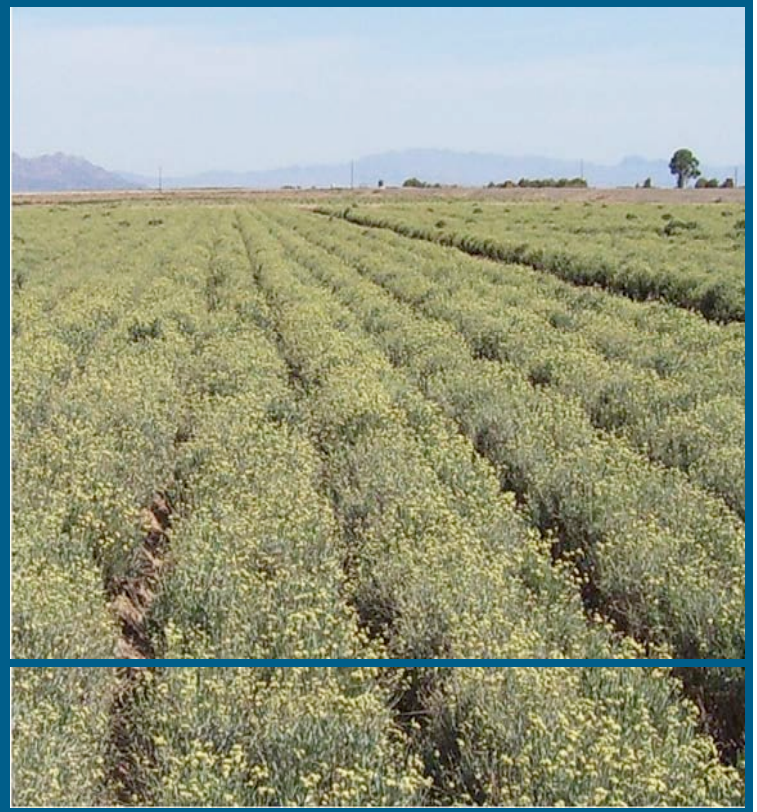
Guayule future

- Large scale cultivation in Southern Europe
- Rubber reserve *in planta*
- Processing facilities linked to cultivation (locked supply chain, similar to sugar beet)
- Initial market: high-value medical applications



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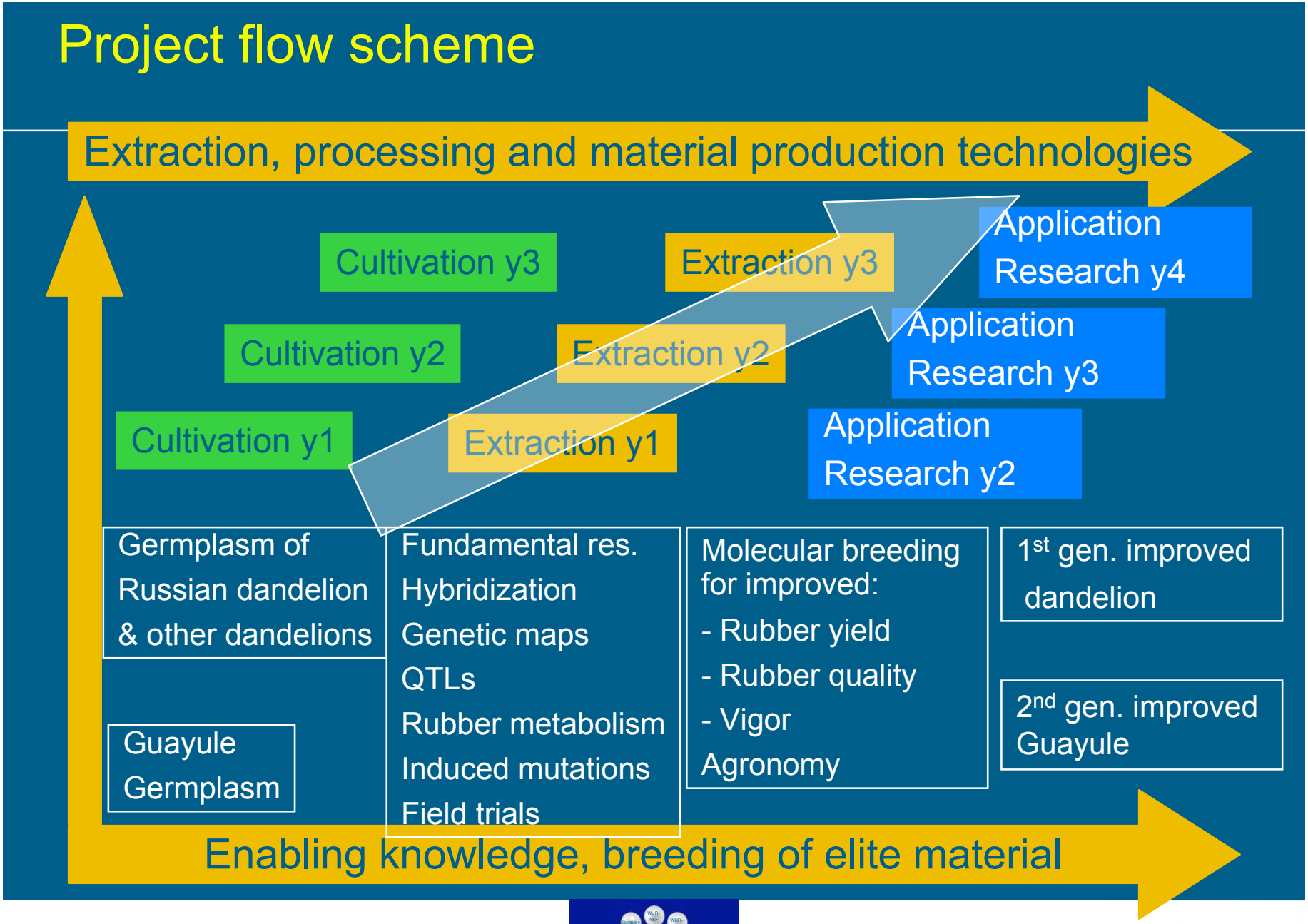
Project flow scheme



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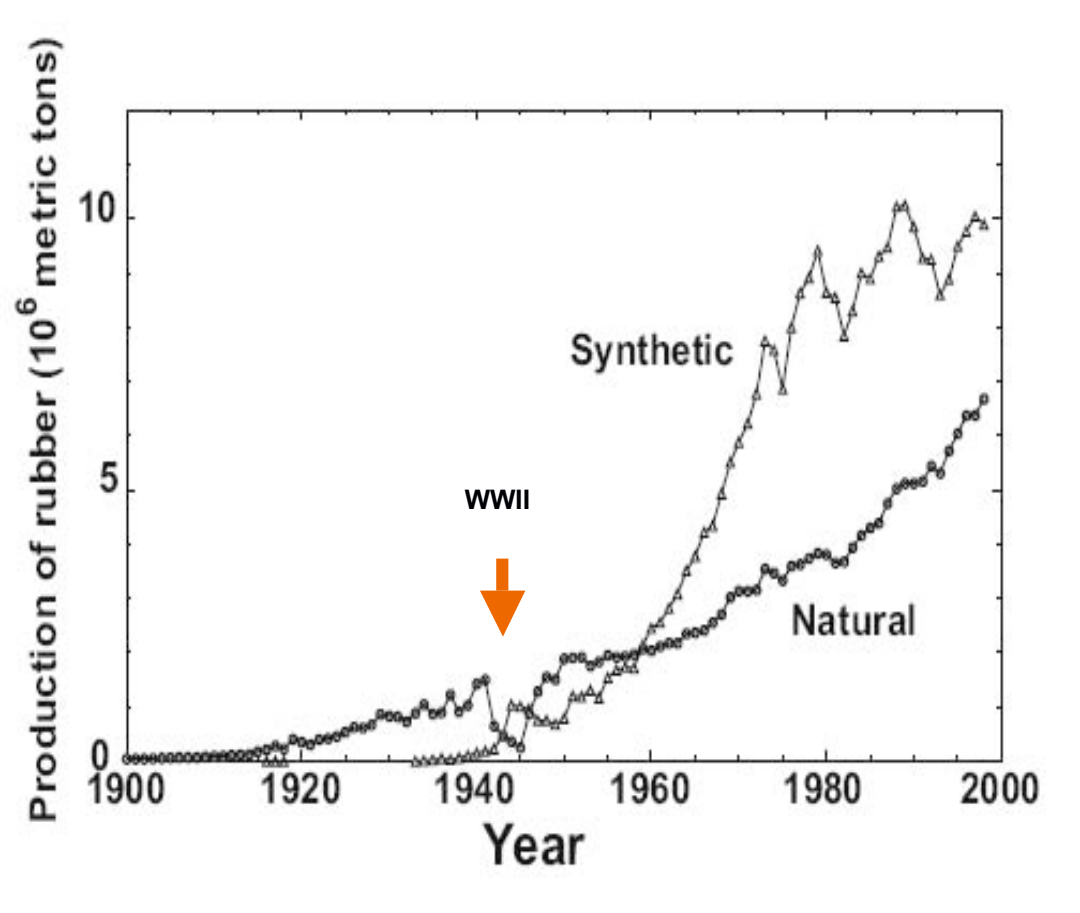
Economics (situation in 2007)



- Increasing market share for natural rubber
- Rapidly increasing demand from China and India
- Palm oil competition for land
- Great prospects!

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Current context

Commodity	demand	price
Natural rubber	- 18%	- 50%
Oil	- 5%?	- 65%
Petrochemicals	- 10%	- 35-60%
Synthetic rubber	- 20 %	- 70% (SBR, BR)
Tires	- 20 %	
Gloves	+ 10%	up? (flu, regulations)

- Peak oil: declining production soon
  - Less road and air transport, fewer and smaller tires
- Climate change: 80% CO_2 emissions necessary
  - Less road and air transport, fewer and smaller tires

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Long term vision

- SALB or other pests may decimate production
  - Strategic issue for the EU!
- Hypoallergenic gloves, medical rubber and latex products required
  - Commercial opportunity
  -
- Climate change and peak oil
  - Land transport electrification, lighter vehicles, less road transport, fewer and smaller tires
  - Less competition from synthetic rubber
  - Plants as sole source of carbon: chemicals, materials, fibers, plastics, rubber: opportunity for all sources of natural rubber

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Conclusions

- *Hevea* rubber production is low-tech and cheap (about 70% of production costs for labor)
- Guayule and TKS as strategic backup crops
- Guayule rubber is suitable for high-value applications (hypoallergenic products)
- TKS in case of “Emergencies” (plant disease, shortage, and for hypoallergenic products
- Farmer income (compared with e.g. chicory) highly acceptable

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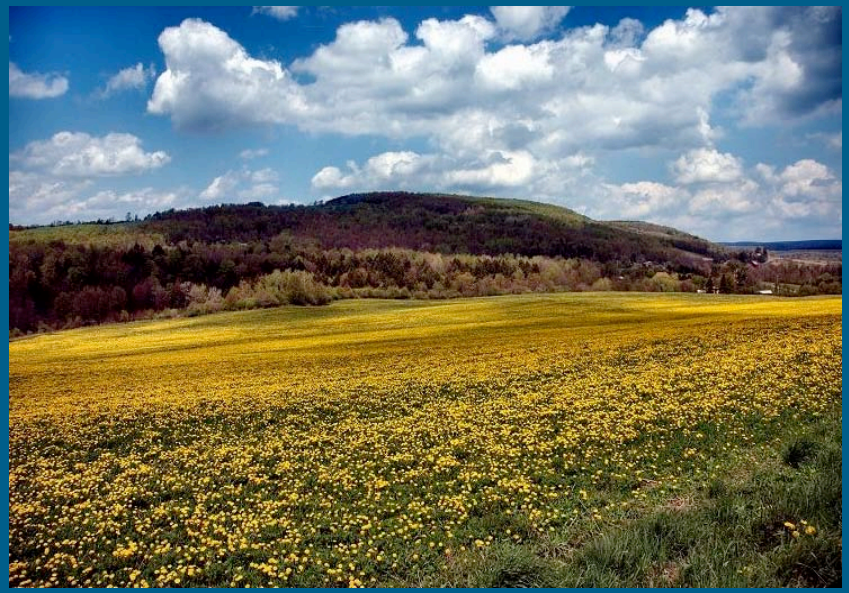
Thanks

Danke

Merci

Dzienki



Спасибо

Děkuji

Gracias

Dank

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