**DRIVE4EU was coordinated by**

**Dr. Ingrid van der Meer**

Wageningen University & Research,
Wageningen Plant Research

ingrid.vandermeer@wur.nl

+31 (0) 317 481363



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DRIVE4EU

# Dandelion Rubber and Inulin Valorization and Exploitation for Europe

to develop a European production chain of natural rubber and inulin from Rubber dandelion


**www.drive4eu.eu**

**Wageningen University & Research**
Ingrid van der Meer,
ingrid.vandermeer@wur.nl
Wageningen Plant Research, Wageningen,
The Netherlands

**Wageningen University & Research**
Frans Kappen,
frans.kappen@wur.nl
Food & Biobased Research,
Wageningen, The Netherlands

**Keygene N.V.**
Rolf Mank,
rolf.mank@keygene.com
Wageningen, The Netherlands

**Institute of Botany ASCR**
Jan Kirschner,
jan.kirschner@ibot.cas.cz
Průhonice, Czech Republic

**Tereos Starch & Sweeteners Europe**
Capucine Bouckaert,
capucine.bouckaert@tereos.com
Aalst, Belgium

**GEA Westfalia Separator Group GmbH**
Steffen Hruschka,
steffen.hruschka@gea.com
Oelde, Germany

**Apollo Tyres Global R&D B.V.**
Nico Gevers,
nico.gevers@apollotyres.com
Enschede, The Netherlands

**QEW Engineered Rubber B.V.**
Peter Stello,
peter.stello@qewrubber.com
Hoogezand, The Netherlands

**Independent Expert Consulting Board to Promote Scientific Research Activities in Kazakhstan**
Kamila Magzieva,
kamila.magzieva@inexcb.kz
Almaty, Kazakhstan

**Trelleborg Wheel Systems Czech Republic a.s.**
Jiří Brejcha,
jiri.brejcha@trelleborg.com
Prague, Czech Republic

**The foundation Stichting ter exploitative van de proefboerderij "Rusthoeve"**
Charlotte van Sluijs,
cvansluijs@proefboerderij-rusthoeve.nl
Colijnsplaat, The Netherlands

**JOANNEUM RESEARCH Forschungsgesellschaft mbH**
Maria Hingsamer
maria.hingsamer@joanneum.at
LIFE - Centre for Climate, Energy & Society,
Graz, Austria

**Institute for Agricultural and Fisheries Research**
Hilde Muylle,
hilde.muylle@ilvo.vlaanderen.be
Merelbeke, Belgium

**NETZSCH Feinmahltechnik GmbH**
Alexander Rossmeisl,
alexander.rossmeisl@netzsch.com
Selb, Germany



## What is DRIVE4EU?

- A European Research Project partly funded by the 7th Framework Programme of the European Commission with a total budget of 7.1 M€.
- Start of project: 1st February 2014, end of project: 31st July 2018.
- The project was coordinated by Dr. Ingrid van der Meer, Wageningen University & Research.

## The aims of DRIVE4EU were…

…to set up a European chain for the production and processing of natural rubber and inulin from Rubber dandelion.

…to enable the EU to become less dependent on the import of natural rubber.

…to respond to the threat of a global natural rubber shortage.

## To achieve these aims, the main objectives of DRIVE4EU were:

- breeding of plant genotypes with high root biomass, high rubber and inulin yield,
- production of seed batches for agronomic tests and large scale demo field trials,
- optimized cultivation and harvest methods for Rubber dandelion,
- ecological analysis of the gene flow between Taraxacum koksaghyz (TKS) and other, wild, dandelion species,
- scaled-up and optimized extraction and refinery protocol for natural rubber (NR) and inulin from Rubber dandelion,
- testing and application of NR and inulin from Rubber dandelion in end product uses, and
- demonstration of the economic viability of the DRIVE4EU production chain for NR and inulin.

# Results and lessons learnt

## New dandelion hybrids with optimized characteristics

A sophisticated system of crossing and selection techniques was used in DRIVE4EU to develop Rubber dandelions with a high rubber yield. Several novel strains were evaluated as most promising ones with the potential of a relatively high rubber producer (up to 18% rubber on dry weight). Selected lines have the desirable attributes of high biomass and a high percentage of rubber in the roots. Some have additional attributes such as; agamospermy, permanent hybridity and polyploidy of the alloploidy type, no need for pollination. The breeding process is still ongoing to improve rubber yields even more. A higher production can be achieved by improved agronomy and by breeding bigger plants with more rubber and inulin.

## Agronomy

In order to achieve the best agronomical, sustainable and economical production, several trials were conducted to obtain experience with the agronomy of Rubber dandelion in Europe and Kazakhstan. The following steps in general root crop production were explored and demonstrated: sowing (bed preparation, densities, sowing date), fertilization, herbicide treatments, harvesting (harvest machines, harvest date) and storage. Different planting systems (ridges versus flatbed) were explored. Planting in flat fields resulted in high plant densities and higher yields, but root morphology was more optimal from planting on ridges. Ridges resulted in longer roots, but a lower plant density and a lower yield per hectare. The field germination was improved by priming and pelleting the seeds. Sowing conditions were optimal in late spring or early autumn if sufficient moisture was available. Herbicides, which can be used in the cultivation of Rubber dandelion, were identified. Further, several harvesting technologies were tested to harvest the roots as clean as possible, with minimal damage to the roots and minimal harvest of the leaves.



## Information on the interaction between cultivated and wild dandelion, conservation of wild dandelion

Crossing experiments between *Taraxacum koksaghyz* (TKS) and related dandelion species indicated that hybridization is possible under controlled conditions. To determine whether 66 years after the end of seed production of TKS in the Swedish county of Skåne still traces of TKS were present in the environment and TKS genomic fragments could be detected in dandelion relatives, a detailed large scale population genetic study was performed. This study showed that not a single TKS-specific allele was found. TKS represents an economic plant, an alternative rubber producer, with a potential of world importance. Conservation of TKS is needed because its natural occurrence is confined to a small geographical range in Kazakhstan, and there are many factors with negative impacts on TKS. A current dominant threat is drought (i.e. the lack of ground and rainwater). Another threat is the gradual intensification of sheep grazing that leads to soil degradation and erosion. The expected trends in future include the agriculture intensification, cropland expansion and new irrigation plans. If applied to the TKS region, each of these plans could directly or indirectly threaten the TKS localities. To minimize these threats, it is recommended, primarily, a formal landscape protection (as a Protected Landscape Area) with some activities blocked at and near the TKS localities, with management of TKS sites limited to a sparse horse grazing.

## Biorefinery design

A biorefinery process was designed and used to extract natural rubber and inulin from Rubber dandelion. For the biorefinery design of rubber and inulin extraction a patent is pending. Depending on the quality of dandelion roots the biorefinery process is easy to operate. However sand is very bad for the process, leading to abrasion of equipment; lower separation efficiency (loss of rubber); and lower purity of rubber. The biorefinery process is a scalable process, low manual labour is needed and the efficiency in rubber recovery is high. Inulin is available in a solution, which has to be processed further. Inulin can be used to produce Polyethylene furanoate (PEF), which could substitute fossil-based Polyethylene terephthalate (PET).

## Prototypes made of dandelion rubber

A first bicycle tyre with dandelion rubber was produced. These tyres are made with natural rubber extracted from Rubber dandelion grown and harvested in The Netherlands. Furthermore, a series of car tyres were produced containing natural rubber from Rubber dandelion that have been analyzed and tested for their performance in driving experiments. The tyre prototype provides better grip than traditional compounds, which is directly related to a higher concentration of natural resin in this particular variant of natural rubber. Also prototypes of rubber goods for building industry were developed and tested, and finally dandelion rubber was tested in off road prototypes. Further prototypes of other rubber products were made. Further improvement of dandelion rubber with higher purity is necessary. The mixing cycle of compound and/or reformulation of recipe to compensate for the initial resin content was made. In comparison to natural rubber from Hevea trees; rheological behaviour of dandelion rubber is similar; the compression set is significantly higher; ageing properties are comparable; and processing is much easier.



## Economic analysis and life cycle assessment

An economic analysis and environmental life cycle assessment was successfully applied to the DRIVE4EU value chain. The main factors influencing the economic and environmental performance are the cultivation and harvest process steps especially the use of fertilizer, plant protective agents and diesel. The assessment showed that the economic viability and environmental sustainability of the DRIVE4EU system could be reached with future improvements. The following future improvements would improve the economic and environmental performance: e.g. higher yield, higher rubber content, less use of fertilizer and protective plant agents and lower energy demand in refinery. Knowledge on the application of the assessment methodology was gained and this will be used in future research collaborations.