

Transition pathways towards circular greenhouse horticulture

NVTL 2023

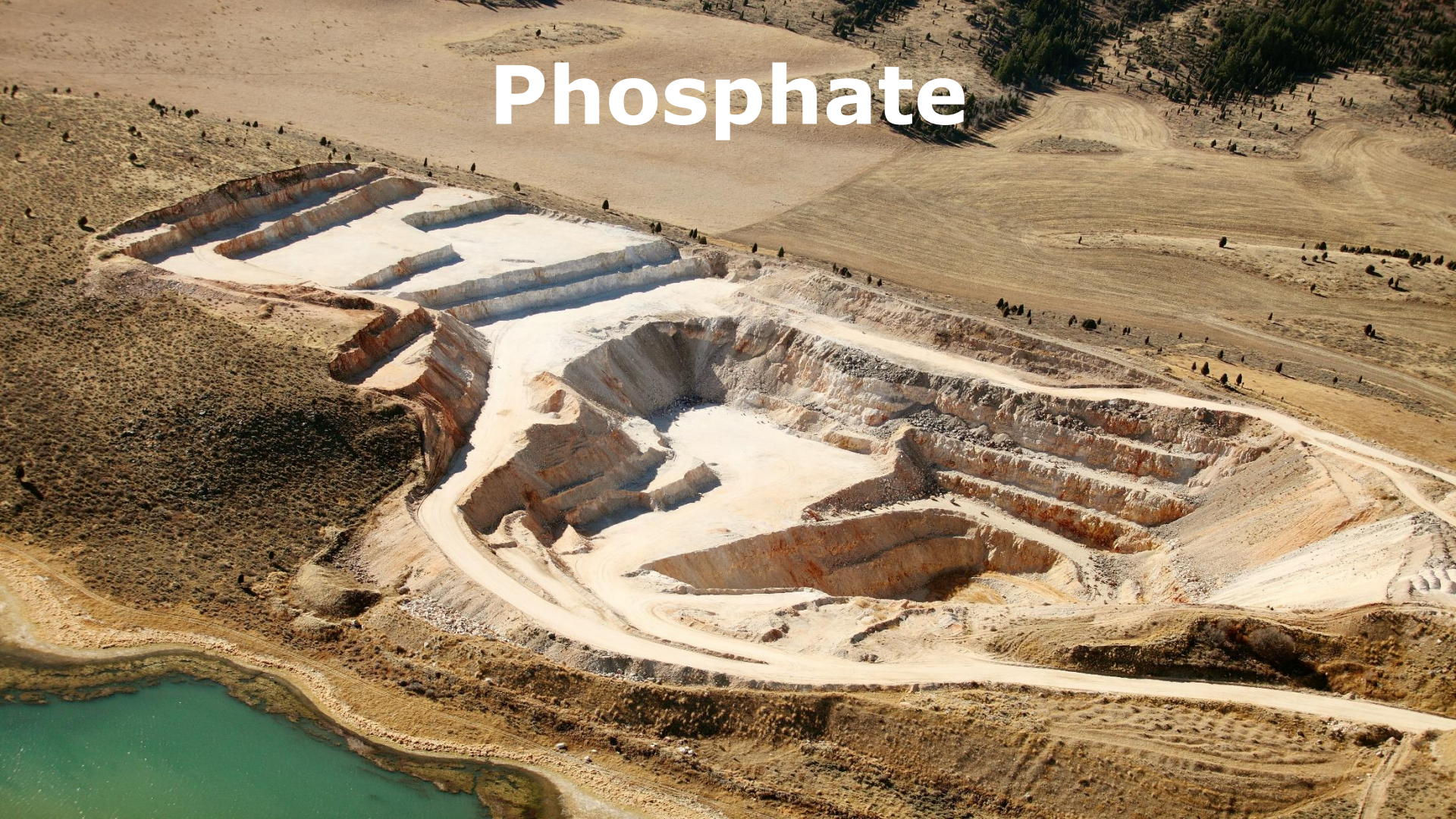
Alexander Boedijn



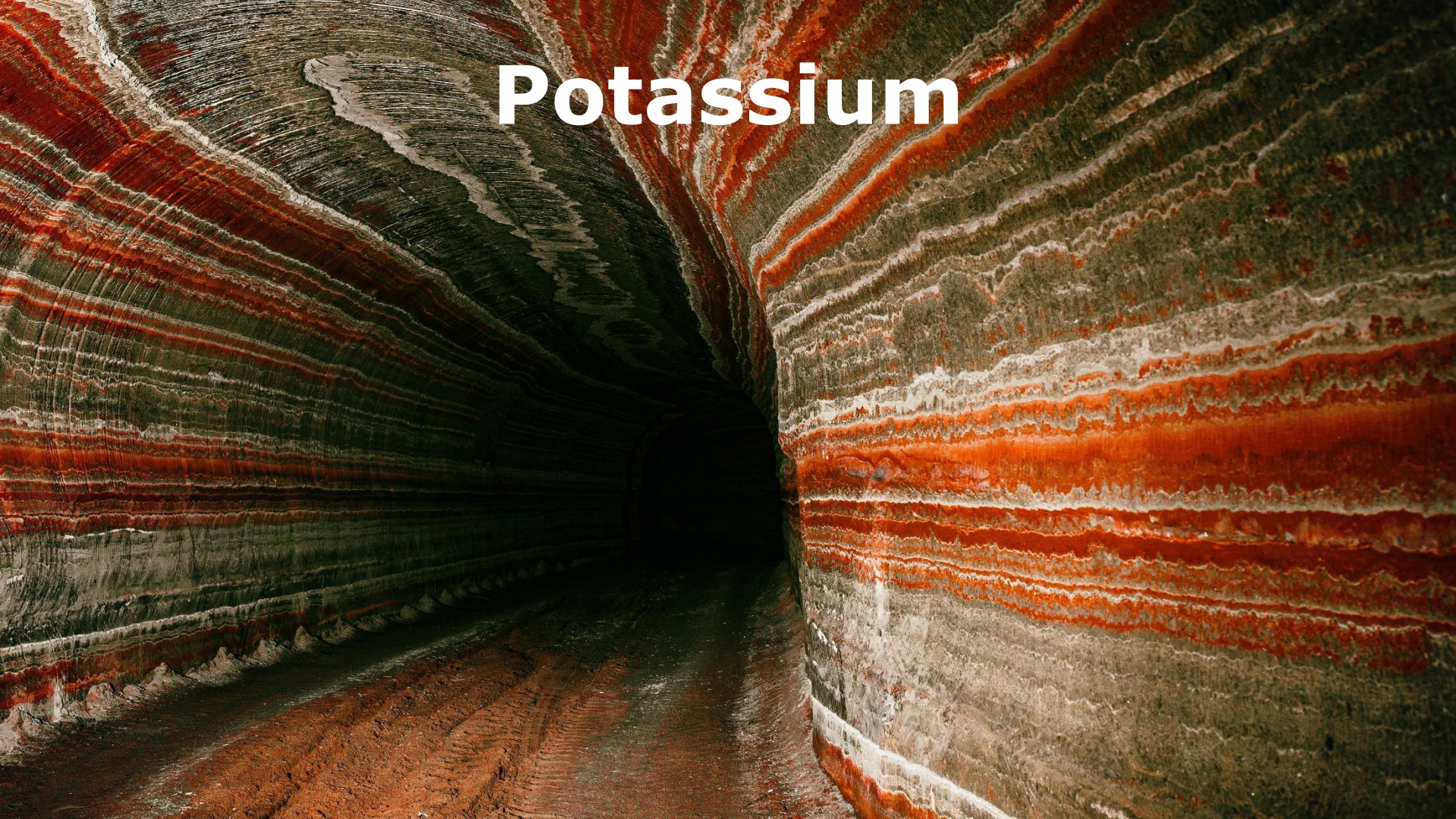
Greenhouse Horticulture Metabolism

- Water
- Fertilizers
- CO₂
- Growing media
- Biomass
- Plastics
- Plant protection products
- Cleaning products
- Removable coatings
- Paper products
- . . .

Phosphate



Potassium



Natural gas



Basalt



Peat



oil



Groundwater



Biomass

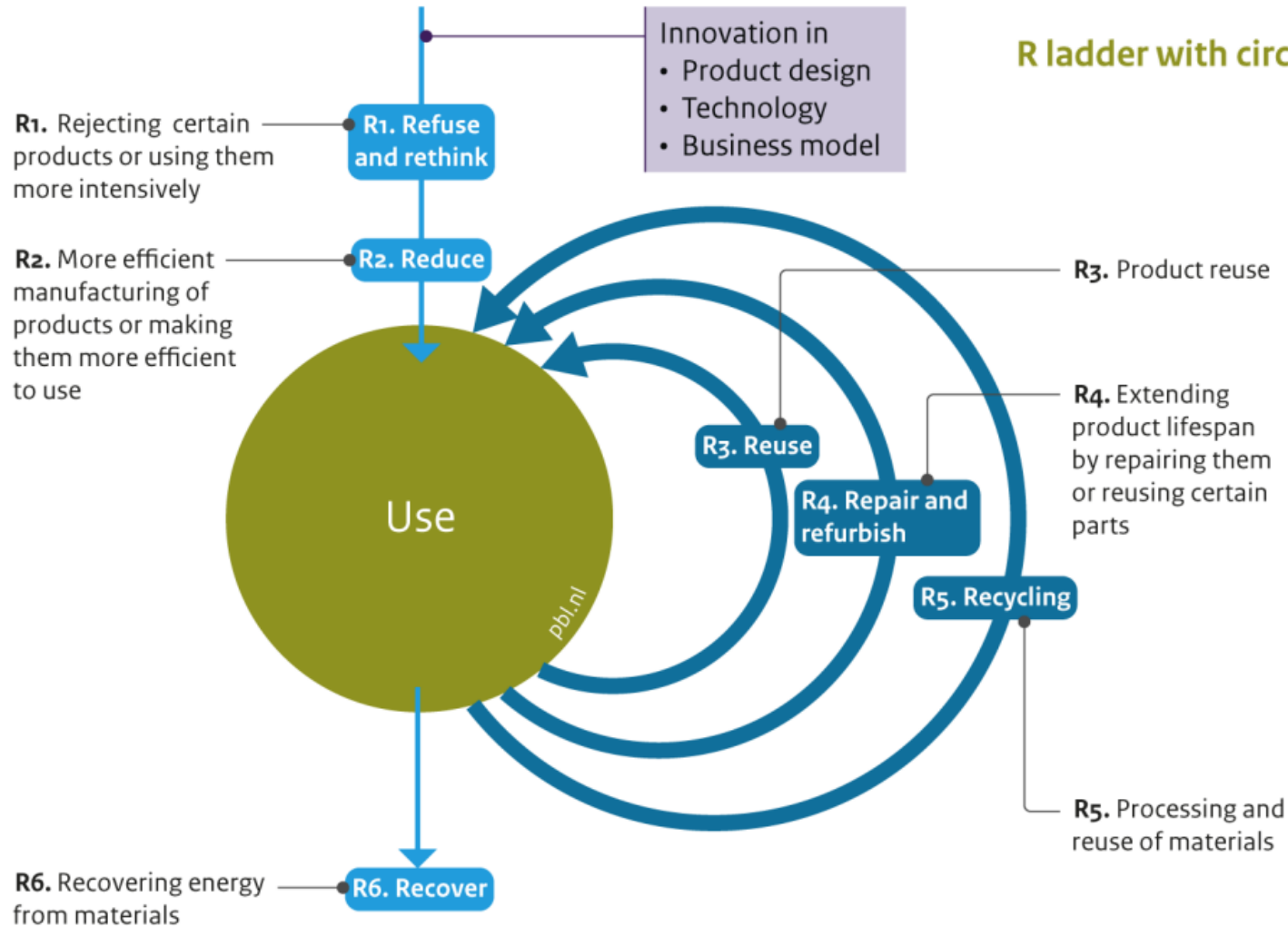


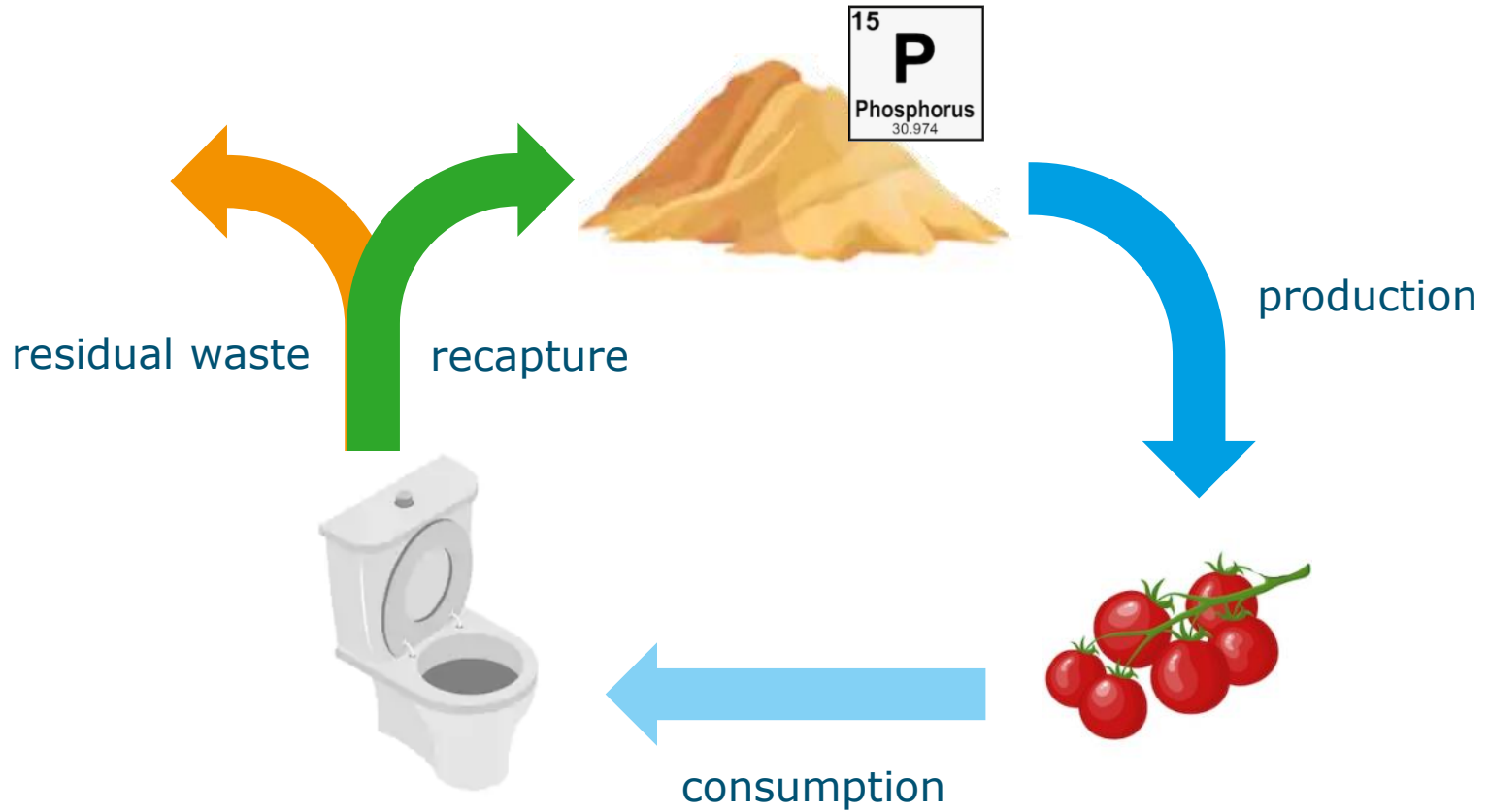
GREENHOUSE HORTICULTURE IN THE CIRCULAR ECONOMY

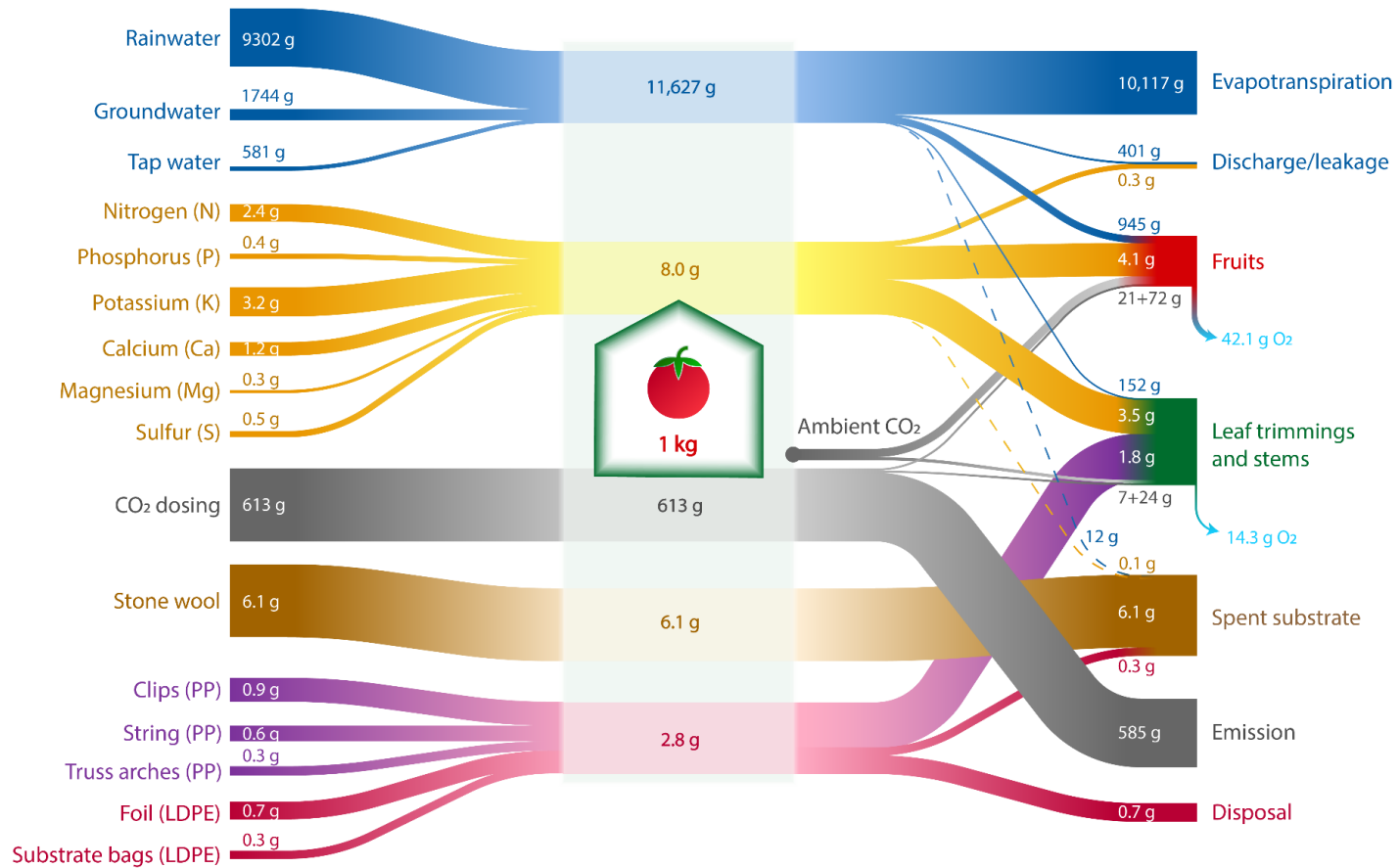
EFFICIENT, CLEAN AND CONNECTED



R ladder with circularity strategies







Source: Van Tuyl et al. (2022)

In case of tomatoes...

Several plastic products are used in a tomato greenhouse that have an important function but at the same time cause a plastic pollution and create a bottleneck for biomass valorisation





A stakeholder challenge!

- Growers (past behaviour, risk perception and economics)
- Government (regulations, social dilemma's, risk perception)
- Waste processing companies (economics, resources, regulations)
- Supply companies
- Innovative 'biomass' companies

Solution is definitely not (only) technological...



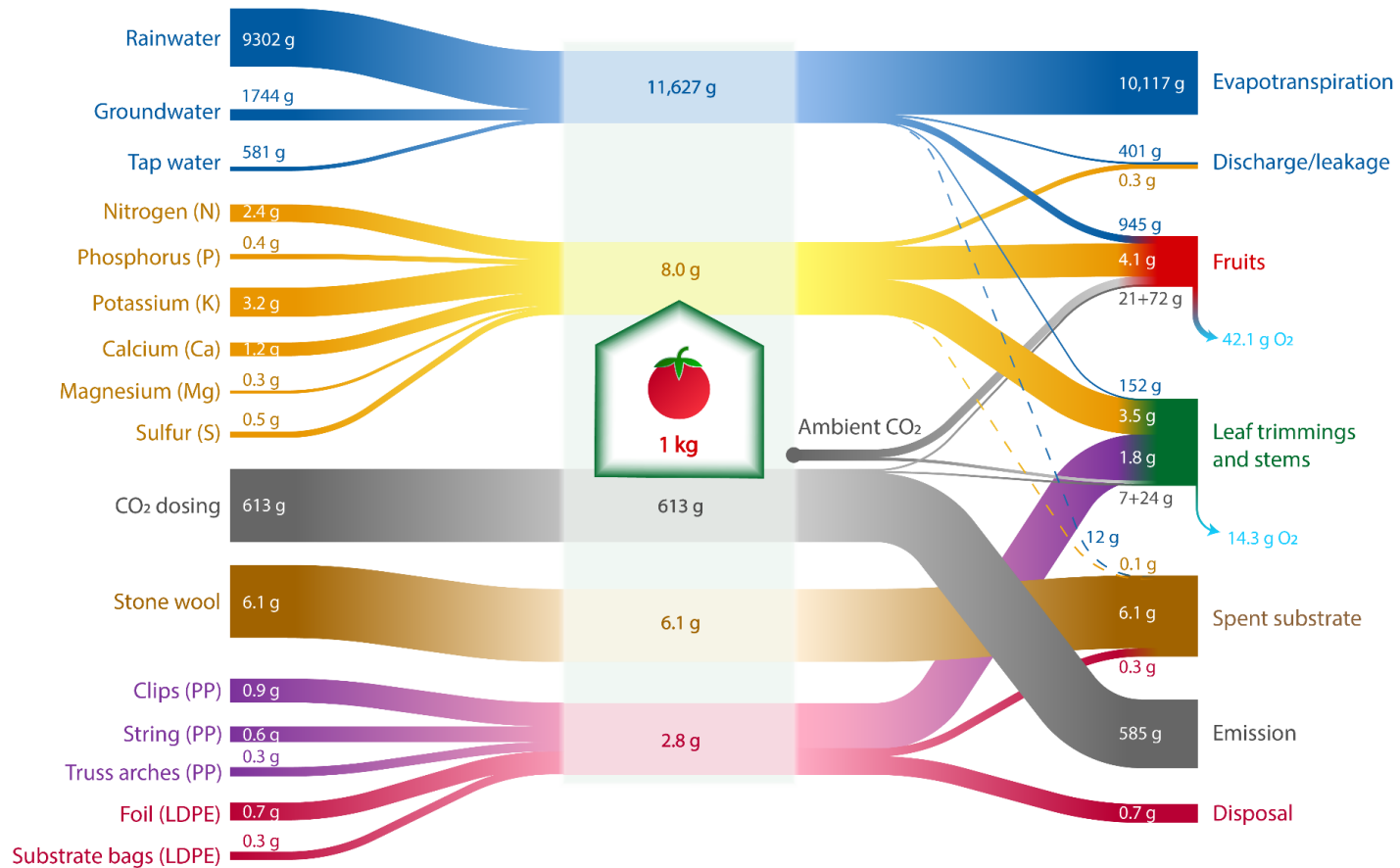
Plastics

- **Refuse:** Stop using plastics when a product function has little added value or can be easily replaced by something durable.
- **Rethink (Return logistics and –design):** Avoid single-use product design and keep products in use.
- **Substitute (Biobased & Compostable):**
Depending on function and EOL fossil based plastics can be replaced by biobased and/or compostable alternatives.
- **Recycle:** Designing mono-material products and organizing mono-material waste flows.



Biomass

- **Setting up total-use value chains:** Cascading from high- to low value products. For instance extracting protein (rubisco), then minerals for fertilizer and then using the fibers.
- **Change in system design & grower practices:** a grower does not only produce tomatoes but also high quality and 'clean' biomass: stems and leaves.



Source: Van Tuyl et al. (2022)

Afvalverwerker steeds meer grondstofleverancier

Circulaire glastuinbouw: substraatmat wordt grondstof voor bakstenen

Onder Glas | VAKBLAD ONDER GLAS | 25 oktober 2018

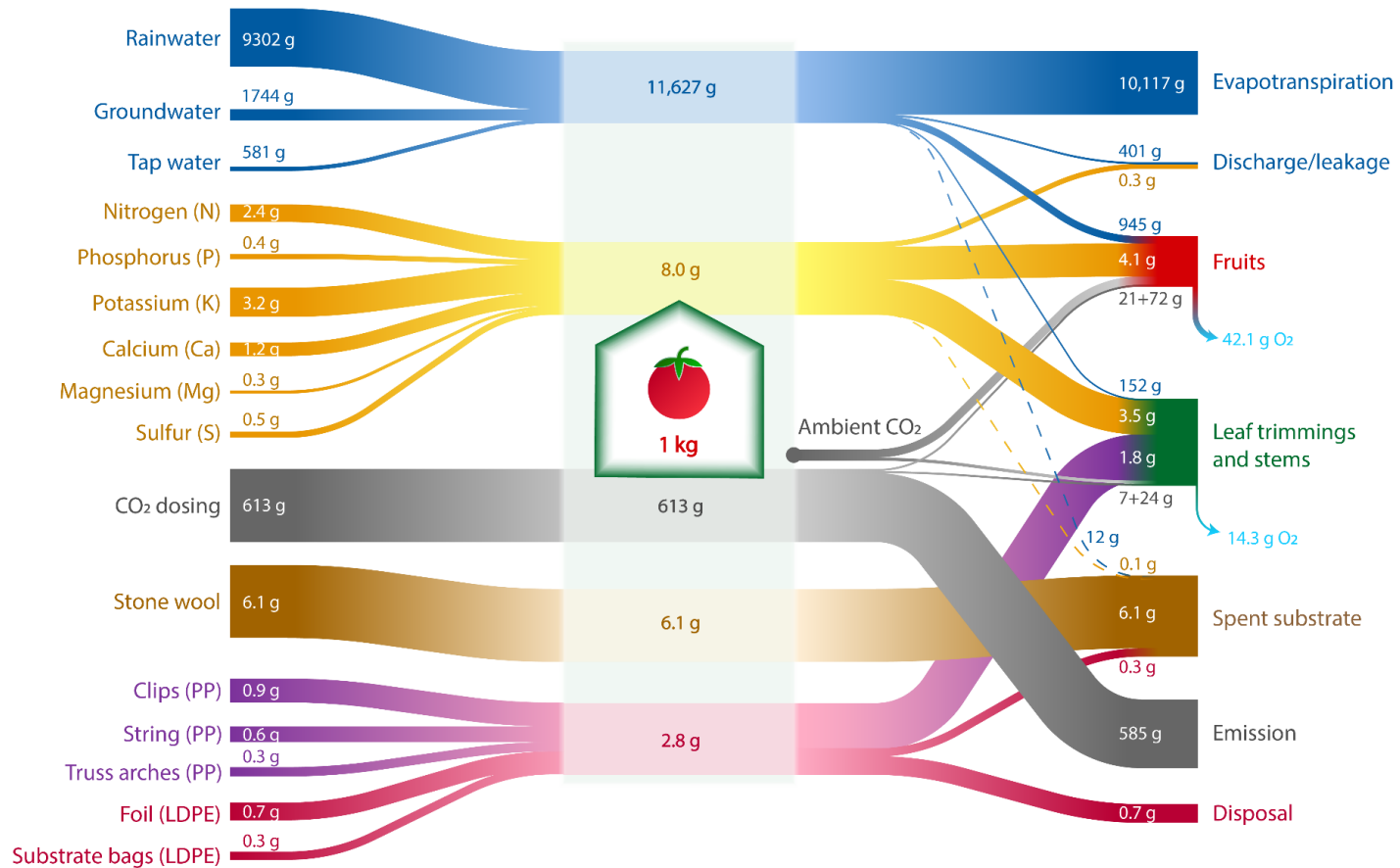


Tekst: Roger Abbenhuijs, beeld: LD Photography



Growing media

- **Refuse:** Designing growing systems that do not require any growing media.
- **Reduce:** Increase product lifespan.
- **Recycle:** From residual flow to new growing media; improving the grade of recycling.
- **Substitute:** Shifting towards alternative (raw) materials that have a lower environmental impact and/or have a higher potential for (local) reuse.



Source: Van Tuyl et al. (2022)



- **Reduce:** Increase resource use efficiency in the greenhouse; currently >90% of dosed CO₂ leaves the system as GHG emission.
- **Reuse/Substitute (short term):** utilize CO₂ from existing fossil sources (industry, waste incineration, container ships).
- **Reuse/Substitute (longer term):** utilize short-cycle CO₂ from non-fossil sources: DAC and biomass

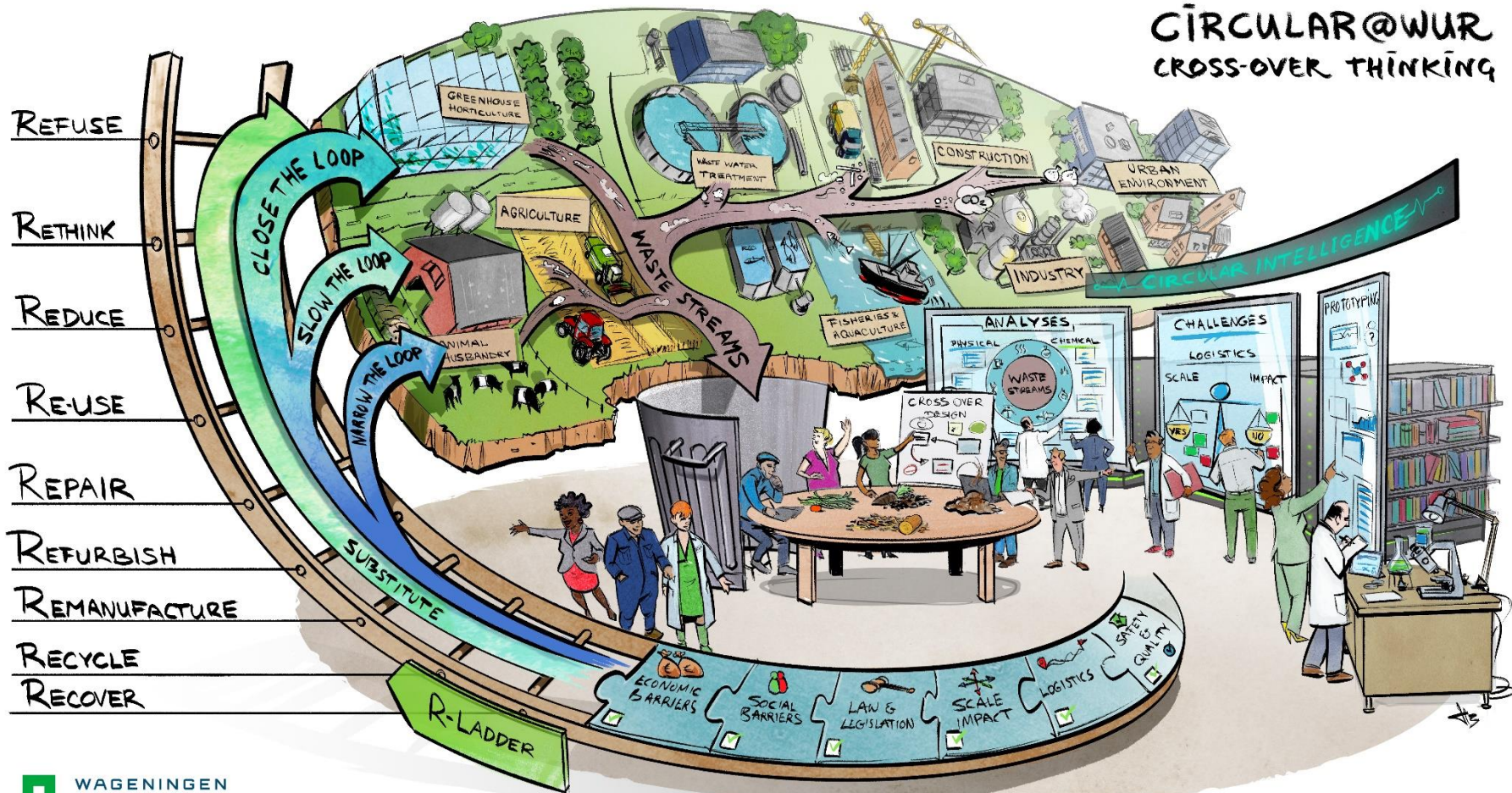
Check out: *Carbon Dioxide Enrichment for Greenhouses in a Decarbonised Future* by Van Tuyl et al. (2022)

What are Cross-overs?

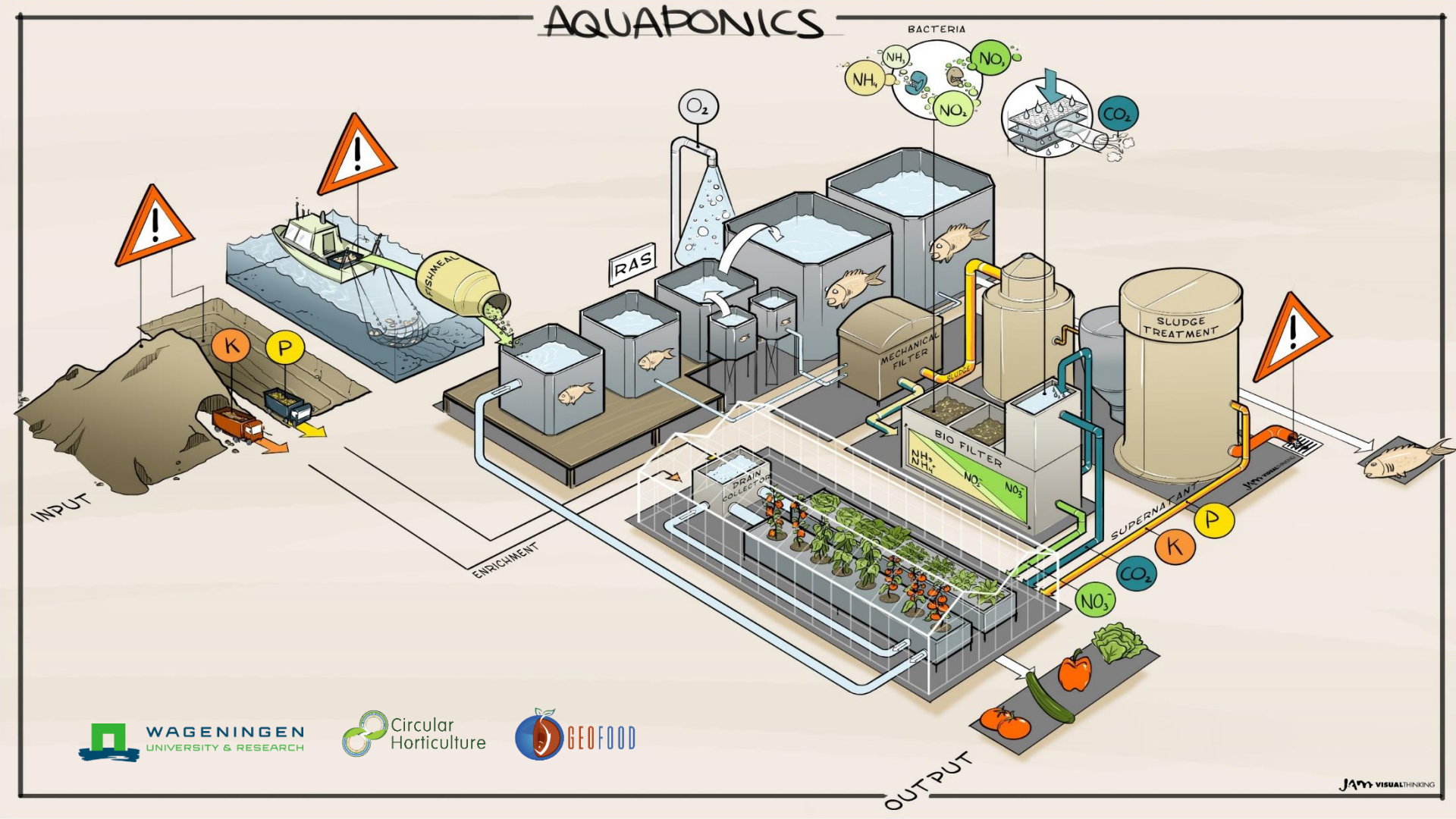
Cross-overs are (new) connections between two or more sectors based on the exchange and reuse of material flows in order to decrease the input of raw materials and/or to decrease the production of waste.

Basically: The residual- or waste flows of one process should become resources for other systems.

CIRCULAR@WUR
CROSS-OVER THINKING



AQUAPONICS



Cases we worked on

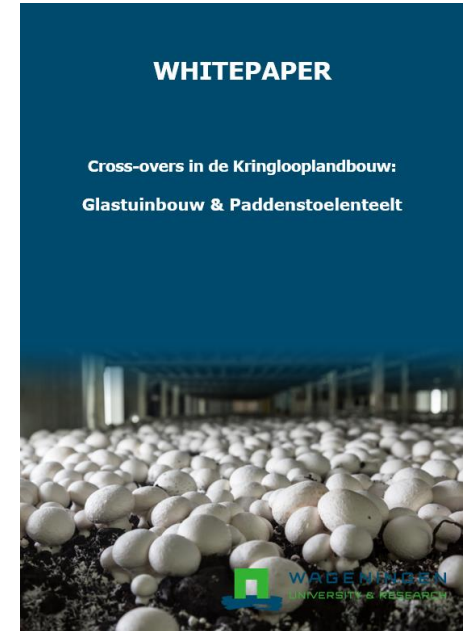
Horticulture & Aquaculture



Horticulture & Pig farming



Horticulture & Fungiculture



Questions?

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and many more...

CIRCULAR ECONOMY



Sources

"Tunnel, multicolor fragment of potassium salt mine's wall, Belarus" by Sergejus Michalenko/Shutterstock

"Aardgastank in de raffinaderijindustrie" by tonton/Shutterstock.com

"Ruwe olie uit oliebron" by Anan Kaewkhammul/Shutterstock.com

"Verschillen tussen lineaire, keten- en circulaire economie" by Raad voor de leefomgeving en infrastructuur from the report Circulaire Economie: van wens naar uitvoering (2015)

"Fishing boat on green water, aerial drone view" by Sergey Muhlynin/Shutterstock

"An aerial view of an open pit phosphate mine" by B Brown/Shutterstock.com

"An agricultural digger on a mound of peat which has been extracted from the Somerset Levels in the UK" by cparrphotos/Shutterstock.com

"The water flowing artesian well from the land when the ground water hole drilling machine installed for the water supply" by Theeraphong/Shutterstock.com

Sources

“Modern greenhouse with tomato plants. Beautiful background” by Roman Zaiets/Shutterstock.com

“Greenhouse horticulture in the circular economy” by Wageningen University & Research in collaboration with JAM Visual Thinking

“R ladder with circularity strategies” by Hanemaaijer, A. et al. (2021), Integral Circular Economy Report 2021, Assessment for the Netherlands, The Hague: PBL Netherlands Environmental Assessment Agency

“Deep water culture hydroponic system close up” by Ivan Karpov/Shutterstock.com

“Cannabis Cultivator Transplanting Baby Marijuana Plant in Rockwool Cube” by OpenRangeStock/Shutterstock.com

“Plastic pellets . Plastic raw materials in granules for industry. Transparent polyethylene pellets by StanislauV/Shutterstock.com

“Cross-overs by design” by Wageningen University & Research in collaboration with JAM Visual Thinking

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“Aquaponics” by Wageningen University & Research in collaboration with JAM Visual Thinking

“Various tanks from a biogas plant” by Wolfgang Jargstorff/Shutterstock.com

“Champignons growing on a mushroom farm. Mushroom production industry” door
Kartinkin77/Shutterstock.com