Z15 NANOMATERIAL USED IN WASTE WATER TREATMENT PLANTS

Presented by Costina Avirvarei

Trainee KNOW Unit

Z15: the first nano-scale flocculant used in Irish wastewater treatment industry

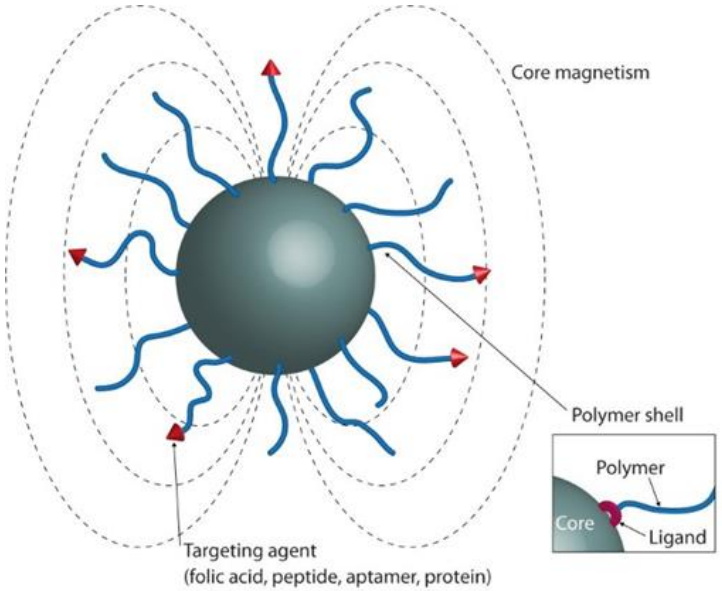
Reportedly used in 5000 WWTP across the EU and 30 plants in the UK and Ireland.

Innovation and increased population.

CURRENT STATE

What is Z15?

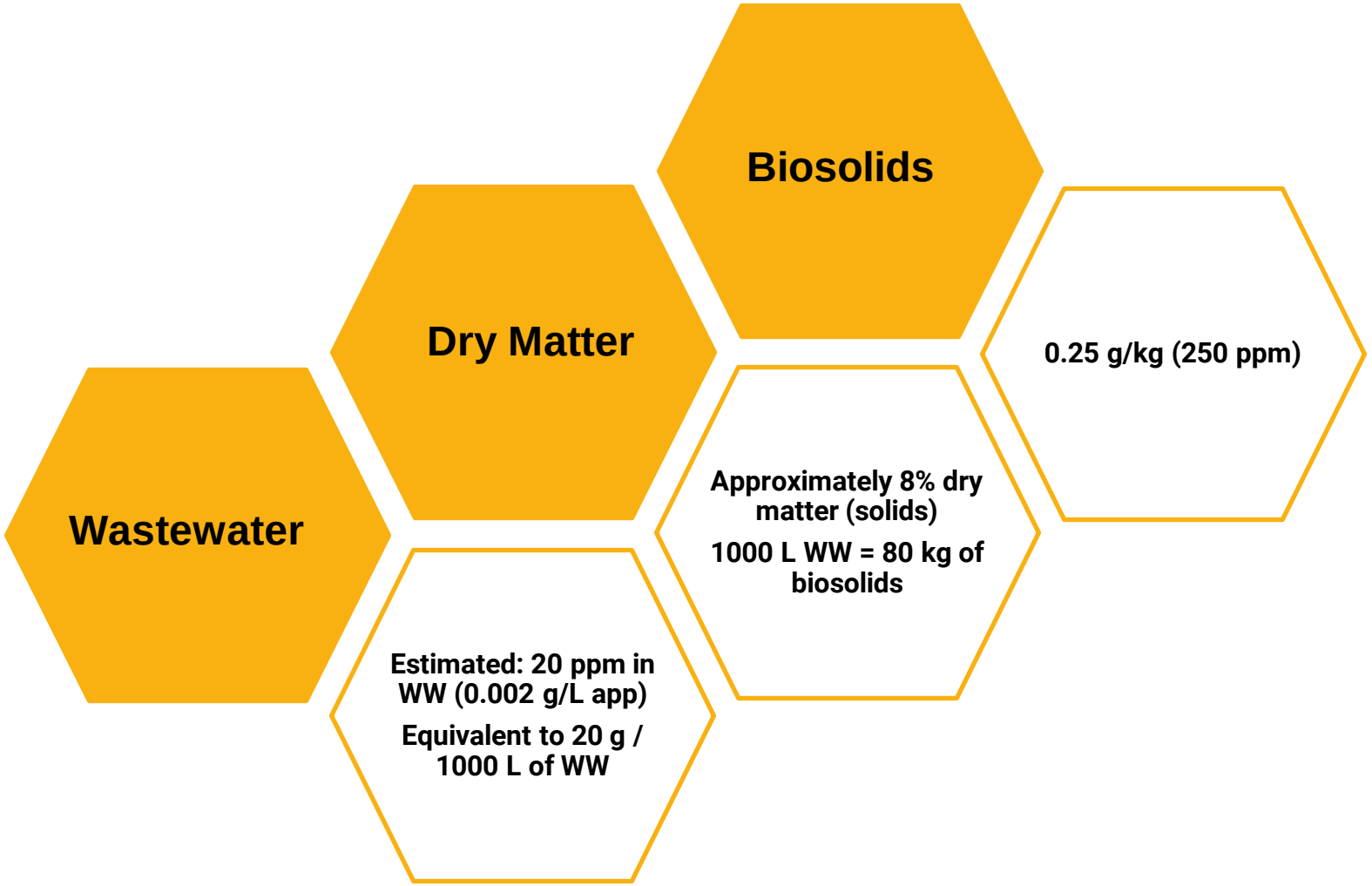
- Iron Oxide particles coated with folic acid
- **Produced by**: VTA Austria GmbH as Nano-floc
- **Particle Size:** Nano-particles ranging from 1-60 nm
- **Packaging and Application**: Sold in 1000L IBC tanks and applied at a rate of 4-20 ppm
- **Surface Area:** One drop of Z15 has a surface area similar to that of a football pitch



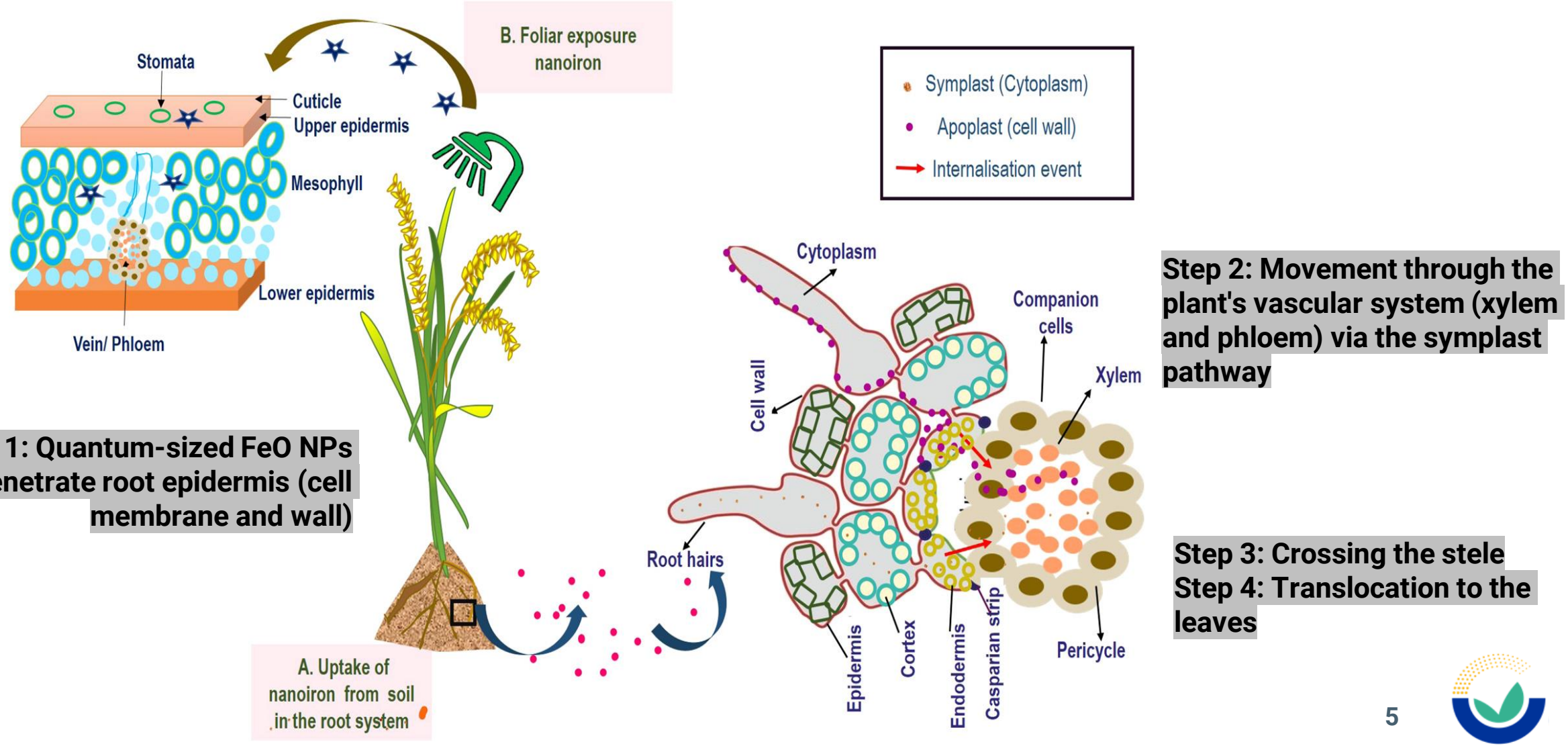
Biosolids

- **Reuse:** Most biosolids reused as soil conditioners and fertilizers in agricultural lands
- **Approval:** Z15 contains land-spreadable nano-particles of Iron and Folic acid “approved by environmental protection agencies globally”

APPLICATION RATE EXAMPLE



MIGRATION OF Z15 INTO THE FOOD CHAIN



Step 1: Quantum-sized FeO NPs penetrate root epidermis (cell membrane and wall)

Step 2: Movement through the plant's vascular system (xylem and phloem) via the symplast pathway

Step 3: Crossing the stele
Step 4: Translocation to the leaves

Figure 1: Uptake of nano iron in plants through to pathways (A) soil-root system and (B) Foliar spray (Rai et al., 2022)

TOXICITY AND APPLICATIONS OF IRON OXIDE NANOPARTICLES

Toxic potential of iron oxide nanoparticles

- Size, shape, structure
- Concentration, dosage
- Bio-distribution, bio-availability
- Solubility
- Immunogenicity
- Pharmacokinetics

2017 EFSA opinion re-evaluating the safety of iron oxides and hydroxides used as food additives

- Yellow iron oxide ($FeO(OH)\cdot H_2O$), Red iron oxide (Fe_2O_3), Black iron oxide ($FeO\cdot Fe_2O_3$)
- Red and black iron oxide, in nano- and micro-form, positive in vitro genotoxicity assays
- Genotoxicity evaluation limited due to database limitations and inability to read across different redox states of iron oxides
- No data available for carcinogenicity, reproductive, and developmental toxicity

Folic acid iron-oxide nanoparticles as target drug delivery

- Folate receptor (FR) over-expressed in certain human malignancies such as ovarian, liver, lung, and brain metastases
- Iron nanoparticles conjugated with folic acid used for targeted drug delivery in cancer cells
- High loading affinity for the anticancer drug doxorubicin hydrochloride (DOX) and is explored as a drug delivery mechanism
- Trialled for magnetic resonance imaging (MRI) of human ovarian cancer

Reference: 2017 EFSA opinion re-evaluating the safety of iron oxides and hydroxides used as food additives; Bonvin et al., 2017

OVERVIEW

Context

Retention of Z15 in biosolids and its potential entry into the agricultural food chain through the recycling of sewage sludges

Usage

Nano-flocculant in wastewater treatment to enhance the efficiency of solid-liquid separation and improve the overall effectiveness of the treatment process.

Uncertainties

Considering the lack of data and the fate of this product once it is applied in the field, the toxicity characteristics have not been thoroughly assessed.

Potential concerns

Due to the nano size characteristics of these compounds, the probability of them entering the food chain has not been considered and assessed.

Potential concerns

The ingestion of nanoparticles via the food chain poses an emerging risk.

Follow-up

A Life Cycle Assessment (LCA) will have to be performed at the request of Member States.

STAY CONNECTED

SUBSCRIBE TO
efsa.europa.eu/en/news/newsletters
efsa.europa.eu/en/rss
Careers.efsa.europa.eu – job alerts

LISTEN TO OUR PODCAST
Science on the Menu –Spotify, Apple Podcast and YouTube

FOLLOW US ON TWITTER
@efsa_eu @methods_efsa
@plants_efsa @animals_efsa

FOLLOW US ON LINKEDIN
Linkedin.com/company/efsa

FOLLOW US ON INSTAGRAM
@one_healthenv_eu

CONTACT US
efsa.europa.eu/en/contact/askefsa

efsa
EUROPEAN FOOD SAFETY AUTHORITY