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Interactions between engineered nanomaterials and agricultural crops: implications for food safety

Key words:

Engineered nanomaterials, Uptake, Trophic transfer, Food safety, Toxicity and impact

Application of Nanomaterials

The annual increase of ENMs in sludge amended EU or US soil was predicted to range from 1 ng/kg for fullerenes to 89 µg/kg for nano-TiO_2 (Gottschalk *et al.*, 2009).

Exposure scenarios

Intentional Application

- Agrichemicals for crop protection: nano-silver in pesticide
- Agents for soil remediation, e.g., nano-zero-valent iron (nZVI).

Accidental Release

- Soil amendment, biosolids application
- Atmospheric deposition and ENMs persistence through water treatment plant

Uptake of ENMs into agricultural crops

Details in uptake and translocation are discussed under following sections:

- Surface contamination
- Size-based selection by plant cell wall
- Apoplastic route
- Symplastic route
- Foliar uptake
- Transportation in vasculature

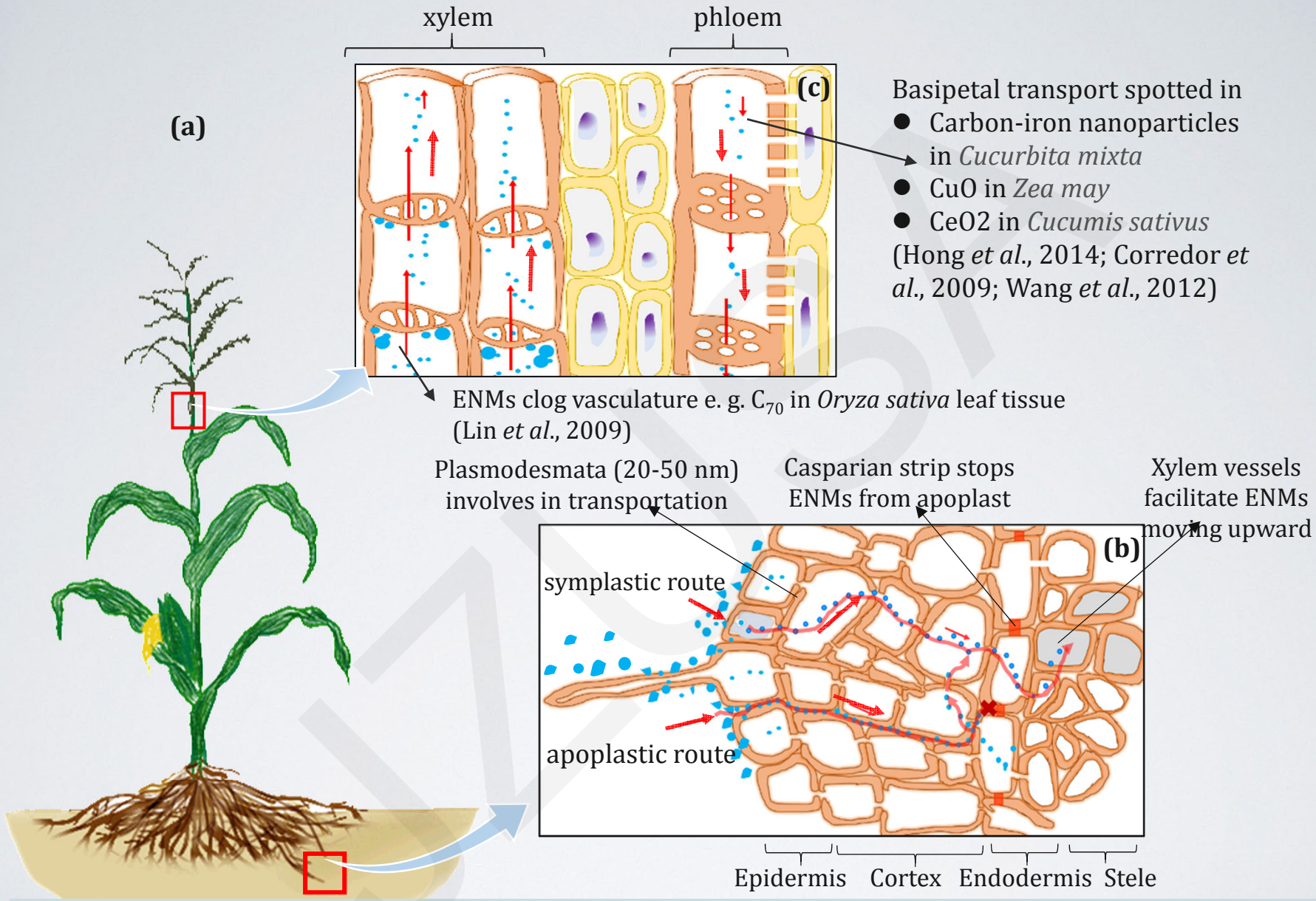

Figure 1. Schematic diagram of uptake process and routes, a) a model crop plant, b) root uptake processes and translocation into vasculature starting from root surface accumulation, symplastic/apoplastic flows into cortex and then traverses endodermis into xylem vessels; c) upward movement in xylem and downward transportation in phloem in both root and foliar uptake scenarios.

Trophic transfer and potential risks to food safety

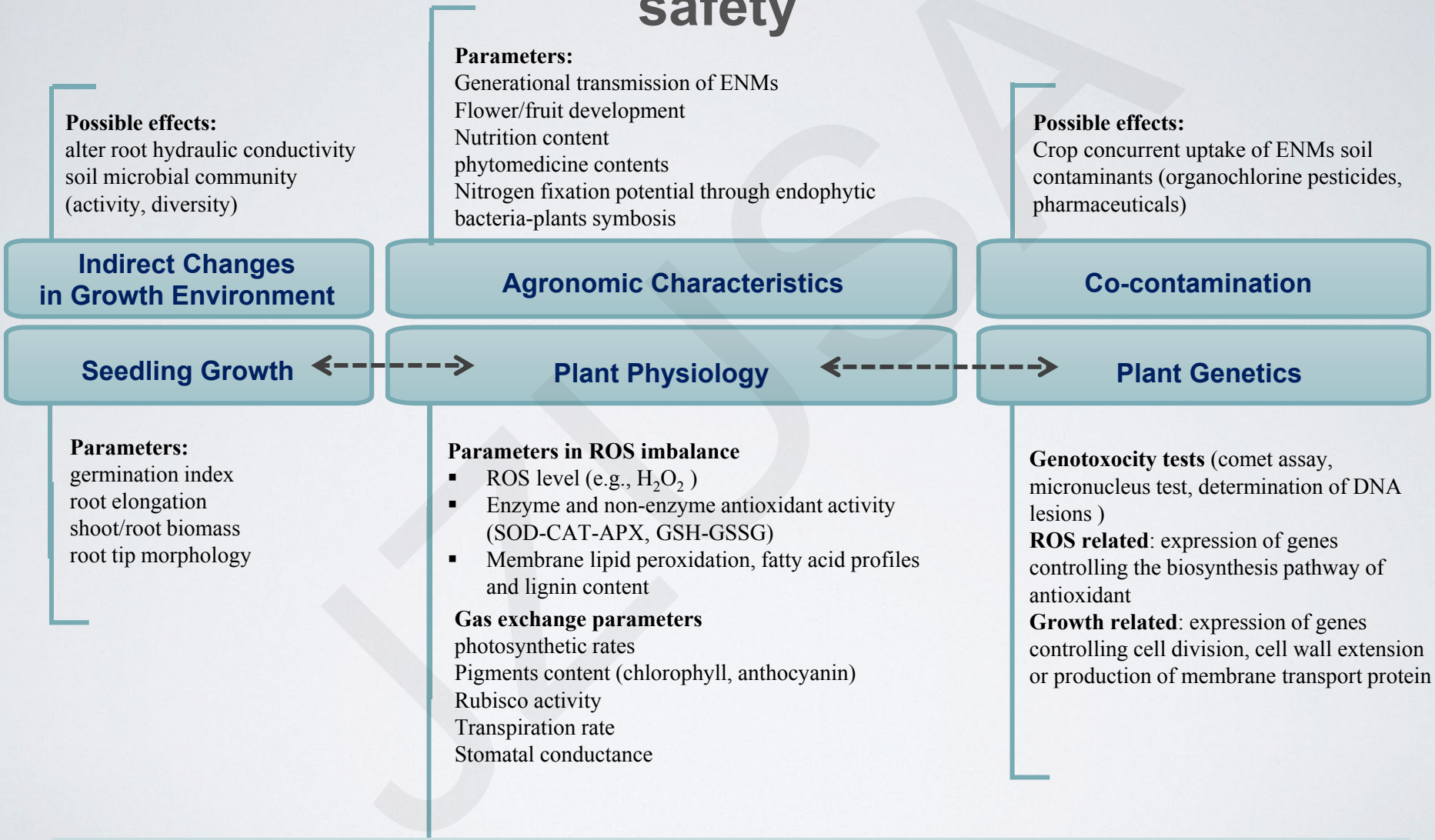

Figure 2. An overview of ENMs impact on agricultural crops, including toxicity, growth performance and physiological changes observed from seeds/seedlings stage to mature crop plants.

Perspectives and Research Priorities

Research Priorities:

- Further study on transmission of ENMs through the food chain
- Elucidation of underlying molecular mechanisms of interaction
- Illustration of various environmental factors that affecting ENMs-crop interactions under realistic conditions.

Many details of ENMs-crop interactions remain poorly understood, including the possibility of ENMs transmission from crops to human beings, co-contamination effects of ENMs with other soil pollutants, the mechanisms in plant uptake and stress response, and environmental factors mediating these interaction processes. With such a limited knowledge in ENMs-crop interactions, the quality, quantity and safety of food products from ENMs-containing environments are impossible to assess. An awareness of potential risks from growing crops in ENMs-contaminated soils and with the development of novel measurement techniques will help to overcome these knowledge gaps.