EU-China expert seminar

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Report from the thematic session on

"Nutrient Recovery & Recycling"

Participants

China
CUI Yanli, Zhejiang University
ZHOU Yuguang, College of Engineering, China Agricultural University
ZHENG Longyu, Huazhong Agricultural University

EU
Erik MeerS, UGENT
Emmanuel ADLER, Cabinet ACONSULT
Daniel Mulas García, Desarrollo Agrícola y Minero SA
Krystyna Malińska, Czestochowa Universtity

EU Commission
Jose Ruiz Espi (DG AGRI)

1) Overview of relevant running Horizon 2020 projects and/or topics

The issue of nutrient recovery and reuse is currently being addressed through many R&I projects and topics:

Running projects:

NEWFERT - Nutrient recovery from biobased Waste for Fertilizer production

AGRIMAX - Agri and food waste valorisation co-ops based on flexible multi-feedstocks biorefinery processing technologies for new high added value applications

TREAT&USE - Safe and efficient treatment and reuse of wastewater in agricultural production schemes

R&I topics:

Topic BBI-2016-R01 - Valorisation of the organic content of wastewater as feedstock, contributing to the renewable circular economy

Topic SFS-30-2017 - Closing loops at farm and regional levels to mitigate GHG emissions and environmental contamination - focus on carbon, nitrogen and phosphorus cycling in agro-ecosystems

Some past projects have also developed relevant R&I in this domain, e.g. FP7 projects REFERTIL, FERTIPLUS, INEMAD.

A EU-China network of research institutions was active recently, devoted to nutrient & energy cycling from organic wastes, under the name 'The Great Cycle'.

2) Overview of challenges from the EU and China

Both regions share a similar background: on one hand, vast volumes of organic residues and wastes (e.g. manure, food waste, municipal waste, etc.), and on the other hand a high demand for nutrients (Nitrogen, Phosphorus, Potassium, etc.) to sustain food security.

Finding more effective ways of recovering nutrients from such residues would increase local self-sufficiency in relation to food production, and make the overall process more sustainable regarding the carbon footprint or the consumption of primary resources.

For the context of nutrient recycling in Europe, we refer to the European Innovation Partnership (EIP) on Nutrient Recycling (EIP-AGRI Focus Group 19), in which 20 European experts have discussed research requirements for Europe specifically. This focus group is currently in progress and will deliver (I) a starting paper, (II) eleven descriptive papers, (iii) an end-report which all will be uploaded within the coming 4 to 6 months (see https://ec.europa.eu/eip/agriculture/en/content/nutrient-recycling).

For the context of nutrient recycling in China, the Chinese experts went through a process of pre-screening of research challenges and proposed directions.

Pre-stage processing for wastes is encouraged since different wastes have different compositions. Proper approaches should be adopted: fruit and vegetables waste can be converted into garbage enzyme; poultry and animal feces used for culture of fly and maggot. Some other wastes are suitable for multi-stage processing (such as rice bran, crops peel, etc.): high-value nutrients -oil and lipids- can be recovered primarily (pre-stage), and the secondary residues be treated in an integrated biorefinery including e.g. the preparation of biochar.

Conventional waste treatment strategies must turn into advanced and standardized means in the future, due to the organic pollution from large-scale agriculture or husbandry sectors around mega city clusters and new urbanized areas in China. The following avenues are prioritised:

(i) Efficient anaerobic digestion systems with different modules and intelligent functions as a core part of farming organic waste treatment. Such systems should aim at compact size, integration, under-ground construction, water conservation, and multiple energy production. It is suggested that the recovery of major elements such as carbon, nitrogen, or phosphorus, and the neutralization and capturing of volatile and suspension compounds should be addressed. In this way, the pressure of carbon and nitrogen recycle would be reduced and farming organic pollution around newly urbanized areas would be effectively controlled.

(ii) Insect-Based Biorefinery for Converting Waste Biomass into Energy and Protein: Saprophagous insect species including Hermetia illucens, Musca domestica in Diptera and Tenebrio molitor in Coleoptera, are very promising to recycle nutrient in organic waste, including animal manure, food waste, municipal waste, lignocelluloses, and other bio-solids. An economically viable insect biomass rich in fat and protein could be produced and further processed into biodiesel and animal feed. A union of insects and microbes could further improve the current artificial mass breeding system of insects, enhance the processing capacity of the waste management system, and increase the final insect biomass yields, making waste-to-energy more feasible.

3) Common challenges and role of the R&I

Experts discussed and prioritised on common challenges and on issues which could benefit from European-Chinese collaboration:

A common interest was identified by all experts regarding the **feedstock sources** (manure, slurries, municipal & food waste, agro-residues) from which to start for nutrient recovery. The session did not further elaborate on this topic, but it was identified as a given that both regions share a common omnipresence of such re-usable residues.

Generally, both regions share a great interest in **integrated biorefinery approaches** in which wastes/residues are processed/converted into multiple complementary added-value products and commodities: energy, soil enhancers, other products (e.g. insects' proteins), fertilizing products and nutrients.

In further detail, both regions put emphasis on the development of biogas technology and attention on the **use of digestate for fertilization**. Biogas technology and peripheral techniques offer great prospects for an integrated recovery of both nutrients and energy from the vast quantities of organic biomass streams present in both regions. Nevertheless, both upstream and downstream of the biomass conversion value chain; numerous challenges remain to be addressed in order for the transition to a more circular economy.

Points of attention requiring to be addressed further when adopting nutrient recovery from residues and wastes, concern **quality (assurance) of products** from (microbial) processing of wastes/residues, which includes the fertilising value, as well as the presence/absence of undesired components when starting from heterogeneous wastes.

An interesting outcome of the introduction presentations and discussions was the common interest in **insect technology** to produce more sustainable animal proteins and lipids from breeding insects on organic residues ('mini animal husbandry'). China is largely dependent on imports to secure its animal protein supply for its population, whereas both Europe and China share a genuine interest in making the production of animal proteins more environmentally sustainable (e.g. lower carbon footprint). Shifting towards insect proteins and lipids might help in this endeavour.

In addition, the following topics **also received attention** : (i) thermal processes for organic residue conversion and potential role in nutrient cycling (e.g. biochars); (ii) interest in the role of composts as soil enhancer; (iii) dealing with feedstock heterogeneity / seasonality (and implications for storage/logistics).

Participants also agreed on the need to support **networking activities** between R&I organisations active in this domain.