Appeal - innovate the most important survival systems!

Contribution to VINNOVA's "Design of the next generation innovation program" 2022-04-29

Time to invest in radical innovations of entire systems for future safe production of food and other goods from cultivation systems instead of making small adjustments according to yesterday's expectations.

Can it be appropriate to start with knowledge-based innovations for sustainable resource management within "**Production, consumption and value chains within the planet's boundaries**" in order to build "Well-functioning attractive societies" that will result in "Good & equal health"? "**The value chain** begins with the raw materials used to make their products and consists of everything that is added before the product is sold to consumers."

Fertilizers should be considered as an important raw material (input agent) for producing food and many other products from forestry, agriculture, and horticulture.

The most important thing is to start with innovations for sustainable resource management.

Food consists of chemical elements. At least the following 16 are essential for plant growth and development: H, C, O, N, P, K, Ca, Mg, S, Cl, Fe, B, Mn, Zn, Cu and Mo. These hold together with the help of bioenergy[i] Most of the essential chemical elements are called plant nutrients. To produce plant biomass and **produce food in a sustainable way**, all the essential chemical elements must be reused with minimal losses.

About 30 years ago, an elderly person in the journal BioCycle wrote his thoughts on the seemingly well-developed civilizations that we find remnants of in different parts of the world. He wondered: "Have these civilizations possibly perished because of the inability to handle waste?"

It is quite frightening that waste and wastewater management in most developed countries takes place in an unsustainable way - i.e. wastes resource, pollutes, damages living organisms and thus negatively affects biodiversity and is very costly. Soil degradation and pollution of air and water / oceans continue. Conversion to sustainable methods we can afford – so far.

ELLEN MACARTHUR FOUDATION writes that "less than 2% of plant nutrients that come to the cities are returned to cultivated land" (Cities-and-Circular-Economy-for-Food_280119.pdf). This means that 98% of the plant nutrients pollutes air, water, vegetation, buildings and land with current expensive and unhygienic waste and sewage systems.

With the help of knowledge-based innovations for the entire food value chain, which is equal to the circular bioeconomy, costly pollution and losses can be prevented.
"From photosynthesis to photosynthesis" is the slogan of the circular bioeconomy. Circular bioeconomy begins with photosynthesis products and plants are used for food, feed, and fibre in woody plants.

In order for the circle to close, all the chemical elements that are essential for the plants must be available in cultivation systems before the coming photosynthesis period. Building **local systems** is a great advantage because it reduces transports and all emissions, increase precision in the entire chain from the generation of residual products and waste to the production of useful products and increase the commitment of all citizens both in cities and rural areas.

Appeal - innovate the most important survival systems!

Contribution to VINNOVA's "Design of the next generation innovation program" 2022-04-29

Suggestions

Resource management must be radically improved with innovations in waste and sewage management. BAS-konsult AB proposes a decentralized SBRS concept that stands for "Sustainable Biological Recycling System" adapted for the cities' different sub-areas, villages, agricultural and other companies. Presentation of the SBRS concept is available at http://biotransform.eu/wp-content/uploads/2022/05/From-Photosynthesis-to-Photosynthesis-SBRS-concept-RS-BS.pdf. Sustainable systems and methods must be used – for the environment, health, economy and climate.

All material originating from plants, animals and microorganisms should be called Renewable Organic Material[ii]. Unsustainable methods of handling these materials include thermal and chemical treatment such as combustion, thermal gasification, pyrolysis, esterification, etc. as all living organisms that live on and in Renewable Organic Material are killed and thus these processes adversely affect biodiversity.

The most sustainable method is the biological conversion of Renewable Organic Material in bioreactors in high-tech biogas plants. Microorganisms that remain in biofertilizer after the process enrich biodiversity in cultivated land and even can act as biological control.

Organic carbon in Renewable Organic Material, the raw material, is converted in the process of anaerobic digestion a) to methane (CH_4) and carbon dioxide (CO_2) in the biogas and b) to organic carbon structures in biofertilizers where organic carbon act as an energy source for the soil's organisms and are partly stored in the soil humus as a carbon sink. Carbon atoms in both biogas and biofertilizer are used cascadingly, unlike combustion, when all carbon atoms immediately become carbon dioxide.

Example - unsustainable thermal conversion

A combined heat and power plant uses 310,000 tonnes of fuel / year and uses bark, caves, RT chips, sawdust, and peat". Some of Renewable Organic Material is imported with questionable content, which results in environmentally hazardous ashes. To be able to calculate losses of various elements, it is assumed that the plant uses only pellets of wood - pine - where analysis results are available. This means that in fuels used, there is some difference between the content of plant nutrients while the content of the element carbon is relevant. The analysis shows that pellets contain 9% water.

Emissions per year are estimated to be:
564.2 tonnes of nitrogen (N) to the air, nitrogen oxides (NO and NO_2) are formed.
9.9 tonnes of phosphorus (P) remain in the fly ash and bottom ash.
141.6 tonnes of potassium (K) remain in the fly and bottom ash.
16.1 tonnes of sulphur (S) form sulphur dioxide (S_2O).
536 289 tonnes of carbon dioxide (CO_2) are released.
During combustion, water vapor (H_2O) is emitted, which is also a greenhouse gas.
The farmers' cost for the purchase of the corresponding mineral fertilizer that is lost in the CHP plant per year is a total of just over SEK 5 million.

There is no valuation of
1) other plant nutrients that are lost
2) the lack of biodiversity when all living things are killed during incineration

3) no carbon storage when all organic carbon becomes carbon dioxide
4) the total negative impact on soil fertility due to
4a) acid rain is mainly due to emissions of sulphur dioxide and nitrogen oxides
4b) lack of return to cultivated soils of organic carbon which is an energy source for soil organisms, and which contributes to carbon storage
4c) lack of recycling of plant nutrients
5) life cycle costs for sustainable compared with unsustainable methods of managing Renewable Organic Materials in terms of the overall environment, health, economy and climate.

More about the CHP plant can be found on page 14 in the brochure "Lönsamhet på rätt sätt" which can be read at http://biotransform.eu/wp-content/uploads/2017/10/L%C3%B6nsamhet-p%C3%A5-r%C3%A4tt-s%C3%A4tt-H%C3%A5llbar-hantering-av-F%C3%B6rnybart-Organiskt-Material-i-avfall-och-avlopp-RS-2020.pdf. Examples of a city's possible investment in the transition to sustainable management of Renewable Organic Material in waste and sewage can be found in the brochure on page 13. Each page in the brochure can be used as a basis for discussion on a topic that is important for sustainability.

Example Malmö - unsustainable sewage system
Some information is taken from "Bilaga 1 Samrådsunderlag Nya Sjölunda".

Malmö's more than 300,000 inhabitants are connected to Sjölunda sewage treatment plant. In urine and faeces from 300,000 people, there are 1,500 tonnes of nitrogen, 200 tonnes of phosphorus and 300 tonnes of potassium annually to a value of approximately SEK 22.8 million. Most are emissions that cause costly pollution and costly losses. It is unclear how much is returned with the sludge.

The purification process is energy-intensive, and the following chemicals are used per year: precipitating chemical 3,400 tonnes, polymeric water purification 3 tonnes, carbon source - methanol 1,500 tonnes, pH regulation 900 tonnes and dry polymer 80 tonnes. Costs for chemicals are missing.

Nitrogen reduction, that means sending nitrogen to the air is costly, data are lacking. However, there is the following information from the United States: "Municipal wastewater treatment plants expend more than $ 140, on average, to remove one pound of nitrogen." After a purification process, sea in Lommabukten is polluted annually with 481 tonnes of total nitrogen and 12 tonnes of total phosphorus to a value of just over SEK 5 million. Emissions of nitrogen and phosphorus have already crossed the planet's boundary.

Are municipal decision-makers responsible for today's unsustainable systems or is the responsibility on decision-makers at all levels, including donors?
When will there be funding for innovations to transform waste and sewage systems?

A sustainable alternative
Malmö can build (instead of the planned sewage tunnel for 2.1 billion) about 100 high-tech local biogas plants and 100 local treatment plants for household greywater and use short, digitized transports for hygienically collected food and toilet waste (without water) mixed with plant material, pellets etc. - according to SBRS.

Results: No pollution of water with food and toilet waste, drug residues, chemicals etc., no rats, no chemicals to treat wastewater, unhygienic work environments are absent - but new jobs are created, long-term savings regarding transport, energy and plant nutrients arise, and there are no costs for ill health, environmental degradation and negative climate impact.

Benefits for 3,000 inhabitants per biogas plant:
1) In the biogas produces about 2.2 GWh of energy / year, which with co-generation becomes 30% electricity and 65% heat.
2) Biofertilizer creates carbon sink, returns all plant nutrients to crops and adds microorganisms with which increase the biodiversity in cultivated soils and thus maintain or increase soil fertility.
3) Plant nutrients are used - only nitrogen (N), phosphorus (P) and potassium (K) for about SEK 250,000 / year. Other essential elements are included in biofertilizer, but the value is lacking.
4) Local jobs.
5) Lesser transports of waste and employees in local systems.
6) Biologically purified greywater in local facilities can be used for irrigation, fountains, water play, etc. Reduced costs.
7) Long-term lower costs for waste and sewage as well as reduced societal costs for pollution and ill health.
8) With decentralized systems, vulnerability decreases, according to People & Defence, and thus reduces concern for the future.

To create a good and easy-care mixture / substrate from 100,000 inhabitants, 43,000 food and toilet waste can be mixed annually with about 16,500 tonnes of straw and wood pellets. Malmö would need about 137 tonnes daily and about 50,000 tonnes of pellets annually. 310,000 tonnes Renewable Organic Material instead of incinerated at the CHP plant can be used for mixing with food and toilet waste from 620,000 inhabitants per year.
Economists should calculate how much pellets and the like will be needed in total to mix with residual nitrogen rich products from the food industry, manure, etc.

The situation in Ukraine shows how many countries are dependent on Russia's fossil fuels but also on several chemicals. Russia exports, among other things, mineral fertilizers, and chemicals to purify drinking water and treat – not clean! – wastewater.
With the proposed sustainable management of Renewable Organic Materials with biological transformation methods in local systems, several societal problems can be solved such as reduced emissions that pollute air, water and soil, more renewable energy will be available as well as domestic full-fledged organic fertilizers, reduced need for chemicals, reduced transport, local decent jobs, etc.

---

[i] Bioenergy is the sun's radiant energy that during photosynthesis is captured and stored in the plants' biomass. Bioenergy can be called "the energy of life" because bio means life. Most living organisms are dependent on bioenergy. Food contains the most important bioenergy for humans.

[ii] Renewable Organic Material is all material originating in now living plants, animals, and microorganisms, unlike:
Fossil Organic Material - coal, oil, natural gas.
Synthetic Organic Material - from renewable or fossil material such as plasters, chemicals, etc.