

## **Bioenergy is the energy of life**

**Bioenergy from Forestry, Agriculture and Horticulture is base for sustainable future when Renewable Organic Material in residues and waste are reused sustainably, and air and water is protected.**

During photosynthesis, the sun's radiant energy is captured and converted into bioenergy that is stored in the plants' biomass. All organisms that eat plants or eat other organisms use bioenergy from food or feed for their life processes.

Biomass in forestry, agriculture, horticulture is the mass of all living organisms. Products that come from plants, animals and microorganisms are Renewable Organic Material. The sun's radiant energy has been also stored in Fossil Organic Materials such as coal, oil, and fossil natural gas, but for millions of years ago.

For photosynthesis to work, plants must have access to at least 16 chemical elements. These are hydrogen (H), carbon (C), oxygen (O), nitrogen (N), phosphorus (P), potash (K), calcium (Ca), magnesium (Mg), sulphur (S), chloride (Cl), iron (Fe), boron (B), manganese (Mn), zinc (Zn), cuprum (Cu), and molybdenum (Mo). Stimulating elements are cobalt (Co), chromium (Cr), nickel (Ni), vanadium (V), strontium (Sr), lithium (Li), fluorine (F), selenium (Se), silicon (Si), etc. Carbon, oxygen, and hydrogen the plants get from carbon dioxide (CO<sub>2</sub>) and water (H<sub>2</sub>O). Other elements are called plant nutrients that must be present in the soil.

Shifting from current unsustainable systems for managing waste and wastewater is necessary to ensure that all plant nutrients are returned to cultivation systems in an ecologically, economically, and socially sustainable way. All Renewable Organic Material in residues and waste contains both bioenergy and plant nutrients that must be utilized with minimal losses.

Before the essential elements are returned to the cultivation system, it must first be planned for the cascade use of all residues and waste to increase resource utilization. The final step in the cascade should be anaerobic methane fermentation to take advantage of both the bioenergy and the elements. Methane fermentation is to date the most sustainable method.

Local production and wise use of biogas increases energy efficiency. A gas car drive 2680 km on biogas from 1 ton of substrate of well mixed and disintegrated types of Renewable Organic Material. The more efficient system is to convert the energy of the biogas into electricity (approx. 30%) and the electric car can travel 2570 km. The heat (approx. 65%) can be used for heating or converted to cold.

Bioenergy stored in biofertilizers is important for soil organisms, which in various ways help the plants with the uptake of plant nutrients. The biofertilizer's content of organic carbon structures and microorganisms contributes both to increased biological diversity and to carbon sequestration.

Biofertilizer positively affects the soil's ability to hold water and plant nutrients, increases the soil's cation exchange capacity and microbial activity, the roots are easier to penetrate the soil, machines are easier to cultivate the soil, the compaction capacity decreases, etc.

All these factors - and several more - contribute to increasing the soil's production capacity and thus plants can transform more of sun's radiation energy to bioenergy. Biofertilizer is domestic complete fertilizer with all the chemical elements that the plant needs, unlike

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imported mineral fertilizers which replace only individual elements. Production of mineral fertilizers require lot of energy and causes pollutions.

Transition to novel biologically based system should begin in households because about 70% of household waste consists of Renewable Organic Material. Therefore, it should be processed locally together with hygienically collected food waste, toilet waste as well as with plant waste from residential areas and from cultivation systems. Similar conditions as for households apply to office buildings, hotels, old people's homes, hospitals, schools, etc.

The SBRS concept "Sustainable Biological Recycling System" consists of hygienic collection of food and toilet waste without water, including modern logistics, local high-tech biogas plants using "Optimal Solids Anaerobic Digestion" (OSAD) and local biological treatment of greywater with the name "BIO-H<sub>2</sub>O". The SBRS concept is suitable for decentralized systems, for example in districts, villages, agricultural and horticultural companies, the food industry, etc.

Substrates for OSAD consist of a well-balanced mixture of different types of Renewable Organic Material. They are processed daily into biogas and biofertilizer. Both substrates and equipment for pretreatment, bioreactors for processing and methods of post-processing of biofertilisers must be adapted to microorganisms that take care of the biochemical transformation.

Transport of toilet waste and food waste with water should be prohibited. Hygienic collection of food and toilet waste is possible with innovation that guarantees that the portion-encapsulated waste is transported to local high-tech biogas plants without polluting emissions of air and water. Packaging material consists of plastic-like foil of biomaterial that also covers the toilet seat. At each toilet visit, the toilet seat is covered with clean foil. Prototype of "collecting closet" CC-BAS is tested, and description is available to all interested.

The food waste can be left in the CC-BAS, or a similar collection device for encapsulating the food waste can be installed in the kitchen. At present, toilet waste and a large part of the food waste with wastewater goes to sewage treatment plants. The energy-intensive nitrogen treatment and costly chemicals to bind phosphorus and to create sludge become unnecessary. No bioaerosols will make the work environment unhygienic.

Less water will be consumed, no pollution of air and water during food and toilet waste management. No need for detergent in the toilet. No problems with rats in the sewage system and only stormwater and wastewater from industries will be treated in the wastewater treatment plants. No remnants of medicine need to get to rivers and seas. In bioreactors, many drugs can be inactivated under the influence of microorganisms and the process then continues in the soil. At the present time drug residues in water affect fish and other organisms that we use as food.

Grey water, without fecal contamination, will be purified biologically in local resource-efficient facilities BIO-H<sub>2</sub>O. Purified water can be used for irrigation, water play, etc. The water remains in cities and other settlements for the benefit of residents. The SBRS concept have a positive direct effect on 10 of the 17 SDGs in Agenda 2030, the others indirectly.

Politicians' responsibility is to know the basics of human well-being and survival. They must enact laws that only promote sustainable products, methods, and systems.