Sustainable system for recycling of plant nutrients

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Application for project support (draft)

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Give a clear description of the planned project.

The aim of the project is that it will result in a sustainable system for recycling of plant nutrients, for utilization of bioenergy and for increasing biodiversity.

NOTE!
The application can fit in more focus areas: biodiversity; energy efficiency; prevent soil erosion and improve soil management; renewable energy; reduce greenhouse gas and ammonia emissions.

The most important innovation is a biogas plant that is placed on a farm in removable containers and to which is delivered / applied

- renewable organic material from the waste generated on the farm; and
- food and toilet waste collected from households using devices designed for the purpose (see below).

Innovations included in the project:

- Prototypes for hygienic collection of food and toilet waste. The prototypes minimize emissions and thus the losses that occur in the current system.
- Equipment for pre-treatment of incoming substrates
  - to provide microorganisms with the best possible conditions for efficient conversion to biogas and biofertilizers/organic fertilizers
  - to prevent emissions that cause losses and create unhygienic working environment.
- Innovative bioreactor for substrates with about 30% dry matter to reduce the use and contamination of water and be able to build smaller bioreactors at lower cost.
- Biofertilizer finishing equipment to increase biodiversity of microorganisms and adapt biofertilizers to crop needs.

The biogas energy shall be converted into electricity and heat / cooling according to already known systems.

The entire innovative system of the project is called the "**Sustainable Biological Recycling System**" (**SBRS**). This includes the following subsystems:

- The biogas plant's innovative process, called "Optimum Solids Anaerobic Digestion" (OSAD).
- Innovative hygienic collection for food waste, called “Collecting Food Waste BAS” (CFW BAS).
- Innovative hygiene collection for toilet waste, called "Collecting Closet BAS" (CC BAS).

“Group training support” is sought for group members who contribute to the formulation of the application for the implementation of the project.

Other
During the project planning, the group participants will also discuss the potential for

- to use solar cells that ensure continuous operation
- to locally clean biological gray water (BDT water) from the property's households when food and toilet waste is collected - without using water as a means of transport that significantly reduces the presence of drug residues in water and reduces the use of chemicals.

General questions about the project
Describe what problem the proposed innovation will solve and what is new with the intended solution.

In cities, only a very small proportion (<2%) of the valuable plant nutrients go back to crops, writes the Ellen MacArthur Foundation in the report CITIES AND CIRCULAR ECONOMY FOR FOOD, published in May 2019.
The report emphasizes the importance of utilizing plant nutrients from all types of renewable organic material, including the excrement of animals, humans and insects. The report describes the benefits of 'Regenerative Agriculture'. The benefits are reflected below the competitiveness of the intended project.

The project will result in a scalable system to radically increase

- the recycling of the plant nutrients
- the biodiversity of fields and garden substrates and
- carbon storage in arable land and horticulture substrates
- knowledge of the possibilities of deactivating drug residues and other synthetic chemicals.

This will lead to a faster conversion of 'Conventional agriculture and horticulture' to 'Regenerative agriculture and horticulture'.

SBRS offers hygienic resource management and energy efficiency in biological conversion to biogas and bio fertilizers. This enables - economically, ecologically and socially sustainable - production of

- biofertilizers to replace most of the imported mineral fertilizers and increase amounts of microorganisms
- biogas to contribute to the phasing out of imported fossil fuels.

The project's SBRS shall

1) solve the emission problems associated with today's management of renewable organic material in waste and sewer systems
2) replace energy-intensive processes that are costly and adversely affect health, the environment and climate
3) more efficiently than today use most of the plant nutrients and bioenergy contained in renewable organic material by sustainable processes
4) increase soil fertility / production capacity - needed for production of food, feed and fibre
5) create new green jobs
6) with local systems reduce the vulnerability caused for example by today's need for polluting and energy-intensive transport.

SBRS counteracts the following problems
Thermal conversion processes (combustion, thermal gasification and pyrolysis) cause environmentally hazardous emissions into air, water, soil and food. All microorganisms are killed. This greatly limits the biodiversity of microorganisms that should be returned and utilized in cultivated lands. Organic carbon and plant nutrients do not return to arable land.

Even current biological conversion systems create emissions that are both polluting and loss-making:

- In composting plants, about 100 kg of raw material is formed about 30 kg of compost of uncertain quality. This is expensive for whole society. We cannot afford to run a process where 70% of the raw material is lost. It emits carbon dioxide (becomes less carbon binding in the soil) and water vapor. Both are greenhouse gases. Gaseous compounds also exit where nitrogen, sulphur and other elements cause contaminated losses that are unhealthy.

- In water-borne biogas plants where the content of dry matter varies between 3-12%, the process is unnecessarily expensive as both large bioreactors and water management are expensive. Water does not produce biogas or bio fertilizer.
- In biogas plants that apply 'dry digestion', both pre-treatment and post-treatment have been neglected, resulting in pollutant emissions which at the same time entails losses of plant nutrients and bioenergy.

Does the intended innovation contribute to improving the competitiveness of agriculture, horticulture or reindeer husbandry? Answer yes
If yes, explain how competitiveness improves in comparison with the solutions available on the market in Sweden and internationally. Response:

The project results will lead to:

- Sustainable return of all vital 16 chemical elements for plants - and for all other living organisms. Essentials are H, C, O, N, P, K, Ca, Mg, S, Cl, Fe, B, Mn, Zn, Cu, Mo; Stimulating elements are Co, Cr, Ni, V, Sn, Li, F, Se, Si etc.
- Biofertilizers containing bioenergy and all the vital chemical elements in partially transformed organic structures and in microorganisms. Biofertilizers contributes to carbon sequestration i.e. decarbonisation and increases biodiversity.
- A significant place in the area of REGENERATIVE AGRICULTURE.

Here we would like to refer to the Ellen MacArthur Foundation which in May 2019 presented the following:
FIGURE 5: REGENERATIVE FOOD PRODUCTION SUPPORT NATURAL SYSTEM.
Conventional farming practices tend to degrade ecosystems and pollute the air and waterways, while regenerative methods rebuild and improve ecosystems while maintaining air and water quality. - Below is the figure converted to text:
CONVENTIONAL AGRICULTURE
Weak, easily erodible soils; High cost of intervention funds; Constantly increasing amount of synthetic fertilizers and pesticides; High irrigation requirements; Small biodiversity; Contaminated watercourses; Health risks for agricultural workers in chemical exposure; Low resistance due to soil degradation; Threats to long-term returns.
REGENERATIVE AGRICULTURE
Biologically active soil; Low cost of intervention funds; High infiltration and storage of water; Great biodiversity; Healthy local ecosystem; Tasty crops with high content of micronutrients; Increased resistance; Supports long-term returns.
SBRS leads to the conversion of conventional cultivation into regenerative.

Describe for whom, in what industry and in what way the intended innovation will be important. Response:

End users are

- Agricultural companies that use the SBRS for their own use or are commissioned by municipalities to handle Renewable Organic Material that would otherwise be treated with unsustainable methods.
  Examples of such unsustainable methods for Renewable Organic Material are:
  waste incineration, thermal gasification and pyrolysis for production of biochar as well as transport in water to wastewater treatment plants. As is well known, these methods are costly and polluting while creating an unhealthy working environment.
- Municipalities responsible for the management of waste and wastewater.

- Decision makers, planners, manufacturers of all components that contribute to the introduction of new products, services and working methods in SBRS.

New Products - **TECHNOLOGY IN BIOLOGY SERVICE**

- Hygienic devices for the collection of food waste from households, catering kitchens, shops, restaurants and the food industry without dilution with water.
- Hygienic devices for the collection of toilet waste (urine, stools and toilet paper) without dilution with water.
  In both cases, the emissions that make up polluting losses are reduced as well as both the consumption and the pollution of water.
- A new pre-treatment system that will fulfil two purposes:
  - prevents emissions using biofilters and thereby create a hygienic working environment;
  - enables the production of well-balanced substrates for the microorganisms that carry out the conversion to biogas and bio-fertilizers.
- New type of bioreactor that enables more efficient conversion.
- New biofertilizer post-treatment system that minimizes pollutant losses, increases the quality and sustainability of bio-fertilizers and adapts bio-fertilizers to the needs of cultivation.

New services

- Agricultural companies can perform new services as responsible to produce biogas and bio-fertilizers in local, high-tech plants in both rural and urban neighbourhoods.
- Companies for biological treatment of grey water without black water (toilet water). These technological innovations thus ensure a healthy working environment for the people who run the plants.
- Other specialized companies will contribute services in the production of equipment (both hardware and software), maintenance, digitization, automation etc. and stand for upgrades as new knowledge is added.

New working methods

- In local systems for handling residues and waste from plants, animals and microorganisms, the methods must be adapted to the area's waste types Whether it is in the area of food industry, supermarket, restaurants or a large grocery store where organic waste arises great attention must be paid to the choice of the most suitable method. With today's ability to electronically follow material streams, solutions can be created that help biogas plants to be prepared for incoming quantities and type of materials.
- Closed containers should be adapted to type of material to minimize losses and pollutions thus create a hygienic environment throughout the chain. As already pointed out, emissions involve economic losses.
- Modern logistics tools and methods will be applied to reduce transport and their emissions from vehicles, particles from road wear and other negative environmental impacts such as noise and vibration.
- Material and energy flows are monitored, which makes management of Renewable Organic Material in waste sustainable - ecologically economically and socially.

Will the proposed innovation help to improve the environment and climate? Answer yes
If yes, state in what way. Response:

The project's innovations will reduce emissions of carbon dioxide and other substances during the collection, transport and pre-treatment of waste types from plants, animals and microorganisms and during the treatment of biofertilizers. This leads to increased carbon storage, amount of plant

nutrients and biodiversity in the soil. By applying biofertilizers that are better adapted to the needs of cultivated crops, the possibility increases

- to positively affect the physical, chemical and biological properties of the arable land, which are collected under the term soil fertility / production capacity
- to increase precision fertilization and thus support precision cultivation.

SBRS contributes to meeting the following national (Swedish) environmental objectives:
Limited climate impact, Fresh air, Only natural acidification, Non-toxic environment, No eutrophication, Living lakes and watercourses, Good quality groundwater, Sea in balance and Living coast and archipelago, Living forests, A rich cultivation landscape, Good built environment and A rich plant- and wildlife.
Regarding the **Generation Goal's** area "Waste treated", the project's innovations will increase the knowledge to meet one of the waste management stage goals.

The innovations within SBRS positively impact 10 of 17 SDG's i.e. global sustainability goals in Agenda 2030; the other goals are affected indirectly.

What knowledge and skills need to be included in the innovation group?
Response:

Experts we are looking for:

- Construction, Technical Information, Drawings, Calculations
- Manufacturing
- Microbiology - additives that accelerate processes during anaerobic transformation
- Bioenergy - efficiency
- Digitization of the entire SBRS
- Analysis of
  - drug residues
  - bioenergy in renewable organic materials
  - the 16 essential chemical elements that plants need.