SMARTMUSHROOM PROJECT

"Smart Management of spent mushroom substrate to lead the MUSHROOM sector towards a circular economy"

SMARTMUSHROOM Project is an R+D Project funded by European Commission, under topic Horizon 2020, call "Fast track to Innovation pilot" (GA 820352).

Smartmushroom pilot plant is in Pradejón, La Rioja, Spain. It is installed in Sustratos de La Rioja facilities, the authorized company which manages the spent mushroom substrate (SMS) from Rioja´s area (200.000 tons per year).

Project's main objective is driving the mushroom sector into a circular economy, by SMS waste valorisation, obtaining a pelletized organic fertilizer with an elevated market value.

Due to its high-water content and low bulk density is not profitable to transport the SMS. As a result, the most feasible option is dry and pelletize the product. The SmartMushroom project proposes an economically viable process to obtain the dry product and, being able to pelletize it to obtain the organic pelletized fertilizer.

SmartMushroom innovation potential is clearly the obtainment of energy through a cost-effective technology based on a process of anaerobic digestion specifically designed to obtain energy from SMS that will feed the dryer.

The Project is been developed by four partners from different countries (SMEs and Technological Centers):

- ASOCHAMP-CTICH (Project Coordinator) (SPAIN): The Professional Association of Substrate and Mushroom Producers and Mushroom Technological Research Center of La Rioja.
- NOVIS Gmbh (GERMANY): An engineering SME specialized in biogas plants with hard-to-digest materials as well as upgrading and recycling of different kinds of residuals.
- IDECAL (SPAIN): An engineering and innovation SME who has worked since 2010 on the development and commercialisation of tailored equipment in the field of food and agriculture technologies.

- ECOSOIL doo: (SERBIA). An SME focused in R&D (sustainable agriculture) in order to find the most appropriate fertilizers, disinfectants, etc. and appropriate methodologies for organic farming.

Motivation:

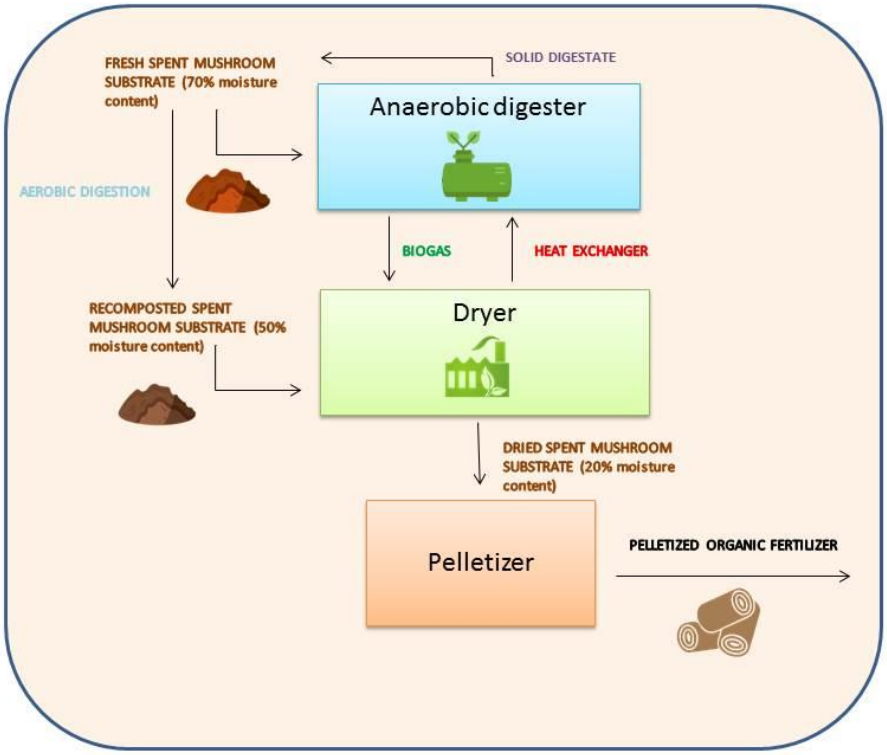
- 3,3 tons of SMS are produced per each ton of cultivated mushroom. In Europe, 3,65 MTn are produced annually
- SMS waste management cost reduce mushroom growers´ benefit
- Environmental impact due to non-controlled land disposal
- Elevated drying cost by using traditional energy sources

Main objectives:

- Biogas production from Spent Mushroom Substrate
- Using biogas for drying SMS into a dryer
- Pelletize SMS to obtain an organic fertilizer with high market value

Benefits and impacts:

- Lower waste management cost for mushroom producers
- Economic benefit improvement due to new organic fertilizer
- Drive mushroom business to a circular economy



ANAEROBIC DIGESTION

We have tested how much biogas can be produced out of SMS as well as the impact of different co-substrates and additives on the biogas yield.

For our pilot plant, we are going to use glycerine [G] and the wastewater from a nearby jam factory ("jam water") as co-substrates. The jam water [P] is very useful as it replaces half of the needed water for the digestion process, increases the biogas yield as it contains a considerable amount of sugar and as it is a waste product from a nearby factory, only costs for the supply incur. Glycerin has very good properties for biogas production, it consists of 100% of organic dry matter (ODM).

Depending on where the SMS a dryer plant may be located, any other substrates which are locally available can be used, especially substrates with a high percentage of organic dry matter are suitable.

We have chosen the mix 7:2:1 (S:P:G). In numbers it represents for our pilot plant approximately 2 tons of fresh SMS per day, 285 l/d of Glycerin and 570 l/d of jam water. We achieve a biogas production of 120 l / kg wet weight for the mentioned mixture

DRYING SYSTEM

We have focused on improving energy efficiency by extracting water from saturated air by combining a condensation system with absorption technologies such as sepiolite moisture retention filters and by recovering hot vapour/air from exhaust to reintroduce it into the process.

We have carried out trials to check the drying capacity of the material, testing it at different temperatures and mechanic treatments, concluding to run the process at a temperature of approximately 65-80°C. At this temperature the product will reduce the required percentage of humidity and will not lose the fertilizer´s nutritional properties.

FERTILIZER TRIALS

SMS contains significant amounts of essential plant nutrients to supply crops and thus replace conventional fertilizer. Trials have shown that it is an excellent source of Phosphorus (P), Potassium (K), Nitrogen (N) and trace elements. Because of its high organic matter content, it improves soil's physical structure as well. Main SMS strengths are:

- increases the activity of soil micro-organisms and earthworms
- develops a good soil crumb structure and its porosity
- exhibits soil ventilation and water-retaining capacity
- enhance soil fertility and yields
- has a low C: N ratio, equal to or less than 20:1
- cheaper and more effective than conventional fertilizers

Several SMS formulas were applied to the experimental fields, on selected cultures at both green houses and open field, monitoring impact of these on vegetable yield, structure, physicochemical and microbiological properties of soil.

Two, Three, and Four component SMS formulations are developed for: Tomato, Cucumber, Papers, Cauliflower, Cabbage, Broccoli and Lettuce.

Monitored parameters:

- yield (kg/plant, kg/m², kg/ha)
- average number of fruits (per plant/ kg)
- average length/weight/diameter of the fruit
- root thickness
- vegetative/generative potential

The first preliminary results:

- better initial rooting and vegetative growth then control sample
- earlier flowering lead to decrease in vegetative growth and equalization of vegetative growth with control plants
- the fruiting period has begun earlier

We are repeating the trials, where we will test different quantities of two selected formulas to determine the best quantities to apply for the respective vegetables.

ECONOMIC FEASIBILITY

The economic feasibility study for the Smartmushroom plant of industrial size shows very good results.

Considering a plant that can handle a throughput of 10.000 tons per year, we expect a payback time of 4.3 years and a project IRR of 21% (before tax).

Throughput / year (t)	Size (kW_{th})	Capex (M€)	Opex (€/year)	SMS utilisation savings (€/t)	Pellet Sales (€/t)	Payback (years)	Project IRR (%)
10.000	1.250	2,2	307.000	6	90	4,4	21

Table 1 Economic feasibility scenario for 1.25MW_{th}. Operational time is 15years.

Depending on the local tariffs for electricity out of biogas, it can also be an interesting option to include a CHP to the biogas plant. The generated electricity can be fed into the grid and the thermal energy can be used for the drying process.

For further information and last updates, you can visit our webpage www.smartmushroom.eu and our Facebook (SmartMushroom), Twitter (@mushroom_smart) and Instagram (smartmushroomh2020).

IF YOU ARE INTERESTED IN VISITING OUR FACILITIES AND THE PILOT PLANT, CONTACT US!