



- 1 *Conventional manure spreading in agricultural fields.*
- 2 *Recovered soil improver and phosphate and nitrogen fertilizers from manure.*

MANURE VALORIZATION AS FERTILIZERS AND ORGANIC SOIL IMPROVERS

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Land application of animal manure, digestate from biogas plants and other agricultural residues supply agricultural soil with valuable organic matter and essential nutrients that help to meet crop nutrient requirements and maintain soil fertility. However, in regions with intensive livestock production, land application is not always possible because of the already high nutrient content of the soil. Thus, in regions with intensive livestock production, this digestate and surplus manure must be either transported to other areas with nutrient demand or stored for long periods.

Moreover, due to the dramatically increasing interest in the production of biobased products and bioenergy, soil degradation is becoming a serious problem in Europe. In recent years, several areas of forests and grasslands have been converted into agricultural land. This results in loss of soil fertility, carbon and biodiversity, lower water-retention capacity, and disruption of nutrient cycles. At the moment, the decline of soil fertility is only masked by the overuse of synthetic fertilizers – without the replacement of organic matter.



Objective – Manure as resource

The EU-funded project BioEcoSIM, a project consortium with 14 partners from 5 countries, aimed therefore to valorize pig manure as a resource. Coordinated by Fraunhofer IGB, the constituents of livestock manure were processed to mineral fertilizers and organic soil improvers and the processes were demonstrated in pilot-plant scale.

Pilot plant for processing of livestock manure

Pig manure has a high water content of 90 percent; further components are valuable plant nutrients, mainly nitrogen and phosphorus, and indigestible feed solids such as plant fibers. In the BioEcoSIM project, different processes to convert the constituents of livestock manure into high-value fertilizers were developed and integrated as separate modules within a single pilot plant. This makes it possible to treat the manure directly at its place of origin.

Every hour the BioEcoSim pilot plant processes for demonstration purposes 50 kilograms of pig manure to about 500 grams of mineral phosphate fertilizer (a mixture of calcium phosphate, magnesium ammonium phosphate and magnesium phosphate), 500 grams of mineral nitrogen fertilizer (pure ammonium sulfate), as well as 900 grams of organic biochar.

Combined processes

In a first step, manure is pretreated, so that the phosphorus dissolves completely, and separated by a coarse filtration into a solid and a liquid phase. The solid phase is then dried using a process developed at Fraunhofer IGB; this works with superheated steam in a closed system and therefore achieves a high energy efficiency. Microorganisms are completely destroyed in the process. Optionally, the dried organic components are converted to organic biochar at over 300°C by a pyrolysis process – in an atmosphere of superheated steam, as in the drying step.

The liquid manure fraction contains plenty of dissolved inorganic nutrients. In a precipitation reactor first of all phosphorus is recovered, and filtered off as calcium phosphate, magnesium phosphate and magnesium ammonium phosphate. Nitrogen is recovered in a second step. For this purpose the liquid fraction is transferred to a membrane cell. Ammonia dissolved in the water diffuses across the membrane and is recovered as crystalline ammonium sulfate. What remains is water that now contains only traces of phosphorus and nitrogen, but which is rich in potassium and ideal for irrigation purposes.

Advantages and outlook

Extensive investigations and field studies have shown that the mineral fertilizers and organic soil conditioners made from livestock manure can be used directly in agriculture as readily available fertilizers and humus-forming substrates. Finally, the mass of the dewatered and processed products makes up only about four percent of the original volume of livestock manure. It is planned, to further develop and transfer the technologies into a marketable plant for serial production.

- 3 *Production of granulated phosphate fertilizers.*
- 4 *BioEcoSIM pilot plant for the valorization of manure.*

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