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How to maximise the manure value in a high livestock concentration area: the Life Optimal project

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Summary
Livestock farms in the 5 municipalities of Alta Valle Isarco (north-eastern Italy) generate approximately 250000 tons of manure per year which, due to the limits set by the Nitrates Directive (91/676/EEC), cannot be entirely spread over the farms' land. The *Life Optimal* is a project funded by the European LIFE+ program. The general aim of the project is to overcome the problem of nutrients surplus of the area. A 1MW electric centralized biogas plant and the post-processing of digestate (mechanical separation, reverse osmosis, solid fraction drying and pellet production) maximize the value chain of manure: from the production of renewable energy through anaerobic digestion, to the agronomic reutilization of digestate in permanent grasslands, orchards and vineyards.

1. Introduction
The region of Wipptal in South Tyrol is characterized by a very intensive dairy cattle activity. Approximately 400 dairy farmers operate in the area, corresponding to a total of 11000 livestock units (LSU), of which 7000 are dairy cows. The milk is processed by the Milchof Sterzing, a cooperative of 400 farmers, who is merchandising milk, yoghurt and butter all over Italy as premium products.
Due to the national Italian legislation on the protection of ground and surface waters, farmers are facing the problem of nutrients surplus and are looking for new land surfaces for the application of exceeding nutrients. Approximately half of the livestock manures can no longer be applied to farmlands according to the legal restrictions, and alternative exploitation have to be identified (Döhler, H. 2015). Moreover, the Wipptal region is a turistic spot during summer season, this leading to conflicts between livestock activity and mountains goers due to odours emission when manure is applied to grassland. Gun sprayers and splash plate indeed are still the most diffused spreading techniques in the area.
To cope with these problems and with manure surplus, the "Biogas Wipptal" has been founded in 2008, a limited liability company consisting of 67 farmers. Main purpose of the company is to comply with the legal regulations for fertilization to maintain milk production at the actual level. The Life-Optimal project (LIFE12 ENV/IT/000671) aims at demonstrating an integrated approach to manure and nutrients management, by turning the problem of nutrients surplus of a high-density livestock area into a resource for the Wipptal Region.

2. Methods
To reach the project targets a new digestate treatment system (DTS) has been developed and installed at a 1 MWel. centralised anaerobic digestion plant (ADP) having 67 farmers as members and operating in Vipiteno (BZ), Italy.

The concept of the project envisages that all the manure produced by the 67 associated farms is anaerobically digested at the ADP. 50% of digestate is afterwards processed into organic-mineral fertilizer concentrates which are reused in vineyards and orchards of the province. This saves synthetic fertilizers in wine and fruit cultivation, and the exceeding nutrients are exported to outside farm areas.
The organic-mineral fertilizers are produced in a manure processing plant consisting of: anaerobic digestion with electricity and heat generation, cascade mechanical separation, sludge resistant reverse osmosis cascade, solid fraction drying, pelletizing and packaging of the final product. The purified water from the process (liquid permeate) is discharged to the river adjacent to the plant. The digestate post processing plant was put in operation in May 2017 and is currently being monitored by the DiSAFA- Waste Management Group (Torino University).
The remaining 50% of digestate is spread as it is on the fields (sloped grassland) of the associated farms supplying manure to the ADP. A self-propelled manure spreader prototype with a high precision and a low emission application system has been designed and constructed for this specific purpose.

Fig. 2.1: the Wipptal AD plant (Vipiteno, BZ)

3. Results and discussion

The ADP is fed yearly with 70000 tons of a feeding mixture consisting of dairy farmyard manure and dairy cattle slurry. After anaerobic digestion, 33000 tons of digestate enter the post processing plant constructed with the support of the Life+ Program. The innovative technical solution for the post-processing of manure / digestates lies in a processing cascade which is up to now unique in Europe: solid-liquid separation is performed by a screw press separator and a vibrating sieve without any addition of chemicals (flocculation/coagulation aids etc.). The process is followed by a 3-stage reverse osmosis (RO), which allows 70-85% of the permeate to be discharged as purified water into the nearby receiving water course. The innovation in the process relies in one of the phases of the RO: in a vertical axial column several layers of polymer membranes are stacked; the entire system is subjected to vibration during the separation process so that fouling of the membrane is avoided. The final permeate/concentrate ratio is roughly 75/25 and the permeate properties are complying with the regional discharging water standards.
The solid fraction from screw pressing and vibrating sieve is mixed with the concentrate from the RO phase and is dried afterwards by using the thermal energy produced by the ADP cogeneration unit. After drying, the solid material is further pelletized (approximately 2000 tons per year). Pellets are packaged and put on the market or transported to orchards/vineyards areas where organic matter in the soil is lacking.

Optionally a unit for N stripping from concentrate is available so that a liquid ammonium sulphate fertilizer is produced.

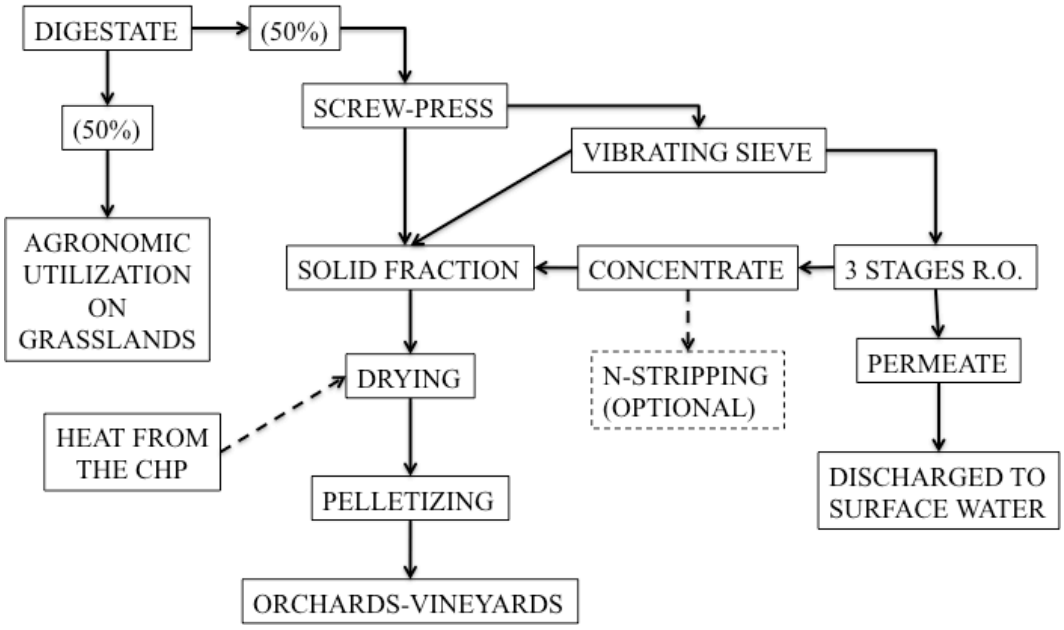

Fig. 3.1: Layout of the digestate post processing plant (R.O: reverse osmosis, CHP: combined heat and power unit)

The remaining 33000 tons of digestate are returned raw to the farms of origin and land applied to grassland by means of a high-precision/low emission slurry spreader. The self-propeller spreader consists of a 4000 litres fiberglass tank, mounted on a Muli-T9 tractor able to operate in slope surfaces. The machinery is equipped with an application rate control system fitted with a Near Infrared Spectroscopy (NIR) unit able to detect the total (TN) and ammonia (TAN) nitrogen, phosphorous (P), potassium (K) and total solids (TS) of digestate in real time during the tank loading. A GPS system enables to trace the spreading operations.

a b

Fig. 3.1: the self-propelled high-precision digestate spreader (a) and the low-emission spreading system

Key data (amount of applied NPK, manure, dominated surface..) are recorded in continuous by the central unit so that at the end of land application a complete report can be downloaded and provided to the farmer. The spreading device consists of 24 trailing hoses fitted with trailing shoes. The latter are spaced 0.25m apart on a 6m wide foldable frame. The system allows to land apply digestate at the required rate, regardless to the machine's forward speed and with reduced ammonia and odour emission.

4. Conclusion

A regional centralized manure processing plant has been constructed in Alto Adige, North Western Italy. Dairy cattle solid and liquid manure is processed by cascade mechanical separation systems and a sludge resistant reverse osmosis cascade, which is at present unique in Europe for this kind of application. Products outputs are electricity, heat, solid and liquid fertilizer concentrates. The plant is now fully operational and is being monitored by the DiSAFA – Waste Management Group. Data about gaseous (ammonia and GHG) losses, separation efficiency of the post treatment system, mass and energy balance of the management chain are expected to be ready by the end of 2018.

References

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