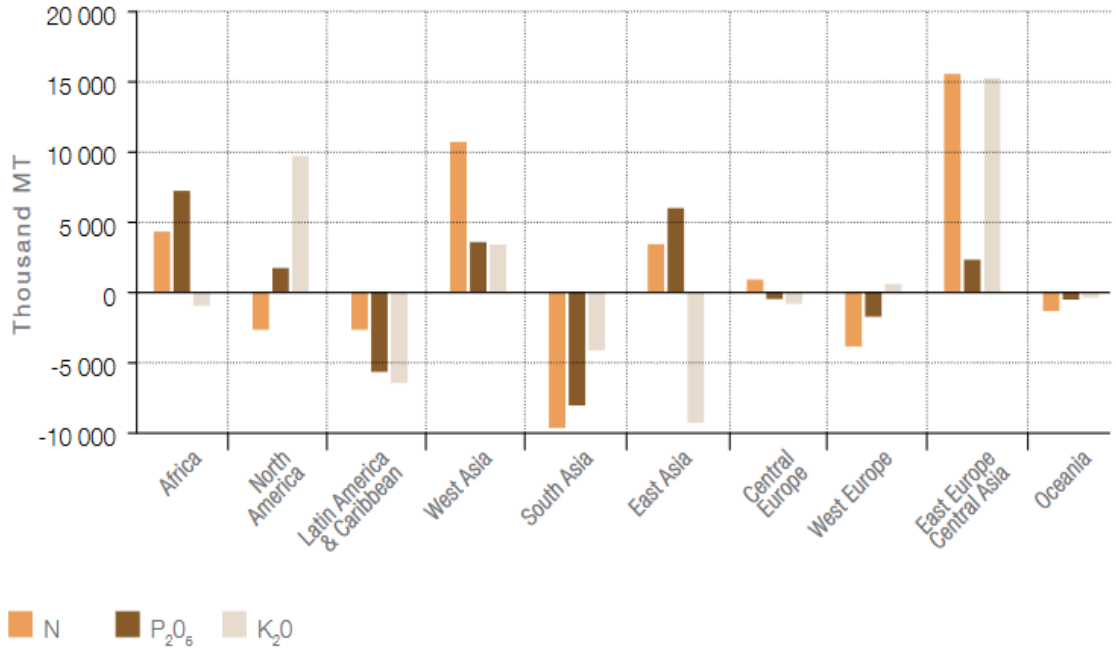
Nutrients recycling: from waste to crop

D. Hidalgo, F. Corona, J.M. Martín-Marroquín
(*dolhid@cartif.es)

Introduction

Fertilizers: some data…

- World demand for total fertilizer nutrients (nitrogen, phosphorus and potassium) is estimated to grow at 1.9 percent per annum, reaching 202 million tons (expected) by the end of 2020.



Nutrients balance situation foreseen for 2019 in different regions, calculated as the difference between fertilizers supply and demand.

Fertilizers: some data…

- The use of nutrients is not uniform.
- In **developing countries**, only a minority of farmers use synthetic fertilizers, while the majority produces at a subsistence level based on crop rotation, recycling of crop residues, organic wastes and animal excreta.
- On the other hand, in the **developed world** and in several rapidly developing regions of Asia, there is the problem of excessive nutrient use (natural and synthetic) with uncontrolled consequences.

Fertilizers: burning issues…

When dealing with nutrients there are four important aspects to consider:

- In order to feed 7 billion people, the sustainability of this world depends on nutrients.
- The world's N and P cycles are now out of balance, causing major environmental, health and economic problems.
- Insufficient access to nutrients still limits food production and contributes to land degradation in some parts of the world.
- Finite P reserves represent a potential risk for future global food security, pointing to the need for their prudent use.
- Unless action is taken, increases in population and per capita consumption of energy and animal products will exacerbate nutrient losses, pollution levels and land degradation, further threatening the quality of water, air and soils, affecting climate and biodiversity.

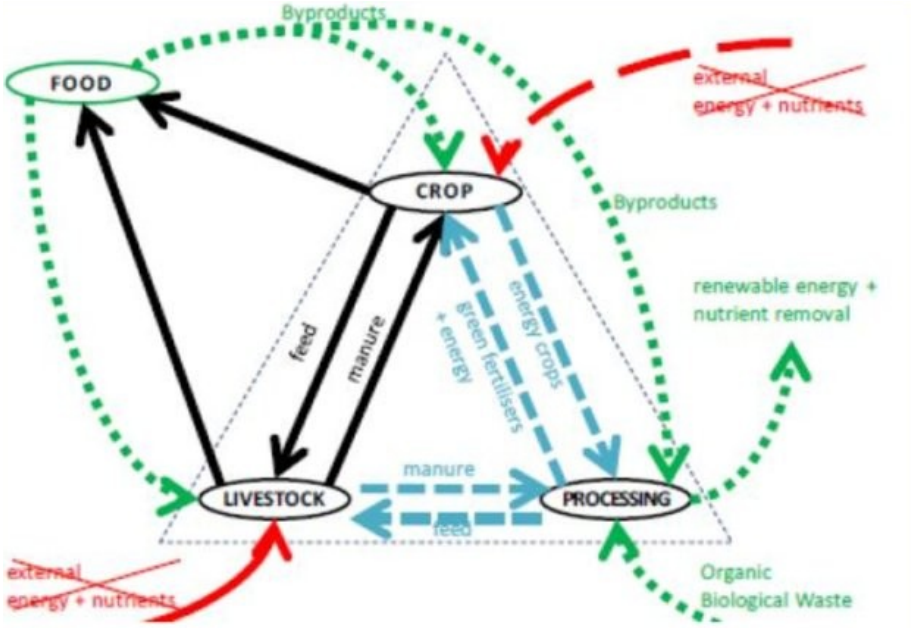
Fertilizers: the keys

- Need for improved infrastructure and innovative models to **improve access to nutrients** for agricultural areas often distant from fertilizer production and distribution points.
- Efforts are needed to understand and manage the risks for long-term sustainability, considering the **synergies** between imported mineral fertilizer sources, manure recycling and biological nutrients fixation.
- Recycling energy and materials through **re-connecting crop and livestock production** becomes indispensable for attaining agricultural sustainability.

Proposed actions

Transition towards a more carbon and nutrient efficient agriculture in Europe

- Focusing on three pillars: agro-processing, animal husbandry and plant processing, promoting the creation of better synergies between animal breeding and crop production.
- These improvements intends to facilitate the return of carbon to soil and reduce greenhouse gas emissions, which could be combined with the production of energy for self-consumption on-farm.



NUTRIent MANagement and Nutrient Recovery Thematic Network

- Current situation:
  - Low farmers' knowledge, confidence and acceptance toward novel bio-based fertilizers could undermining ambitious targets of the EU Circular Economy.
  - For expansion of the use of new products, “trust” and "knowledge" is needed all along the value chain.
  - Farmers should understand and know the real benefits of the bio-based fertilizers and how to practically adopt and use it in their farming practices.
- It is essential to spread knowledge and information about the insufficiently exploited nutrients recovery innovations (technologies, products, practices) that are already commercially and market “ready for practice” to agricultural practitioners.

Key actions to improve nutrient use efficiency

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Working on improving nutrient use efficiency in crop production and in animal production!!

Key actions to improve nutrient use efficiency

Key actions for crop production:

- Further develop and implement the '**4R** Nutrient Management Stewardship´, the Right fertilizer, the Right amount, the Right time of application and the Right placement.
- Select the **right crop**, planted at right spacing and right time, within the right crop rotation.
- **Irrigate the crop whenever needed**, using precision methods, such as drip irrigation, combined with soil water harvesting methods and soil conservation practices.
- Implement integrated weed, pest and **disease management measures** to minimize yield losses while protecting the environment.
- **Reduce nutrient losses** through site-specific mitigation measures, including erosion control measures, cover crops, tillage management, best practices for fertilizer and manure applications, and buffer strips.

Key actions to improve nutrient use efficiency

Key actions for animal production:

- Genetic advances through breeding has improved productivity of food animals.

  Which has led to more efficient use of ingested feeds, better partitioning nutrients into animal products as opposed to excreted waste.

- Avoid over-feeding of nutrients, unnecessarily enriching manures with valuable feed N and P.

  Planning animal diets, using easily digestible feeds, feeding to well-established nutritional requirements, and using additives that increase feed nutrient digestibility are key actions that can improve livestock nutrient use efficiency.

- Improve the fertilizer value of animal manure.

  This can be achieved by modifying animal diet (controlling the levels of nitrogen and phosphorus added), manure storage and handling practices (avoiding losses to the environment) or improving fertilizer value by manure processing (pelletizing, mixing with inorganic fertilizer nutrients, extracting nutrients, etc.).

Key actions to improve nutrient use efficiency

Key actions for waste and recycling:

- Improving food supply efficiency and reducing food waste.

  Since a large share of food is wasted at all stages of food chain, a reduction of each of these losses would improve efficiency of the overall food supply chain, with the result that fewer nutrients would be needed to produce the same amount of food consumed.

- Recycling nitrogen and phosphorus from waste streams.

  One of the greatest challenges is to implement existing technologies, or redesigning and upgrading existing treatment systems. This is often a matter for governments due to the large costs associated with these actions.

- Reducing waste from phosphorus mining and processing.

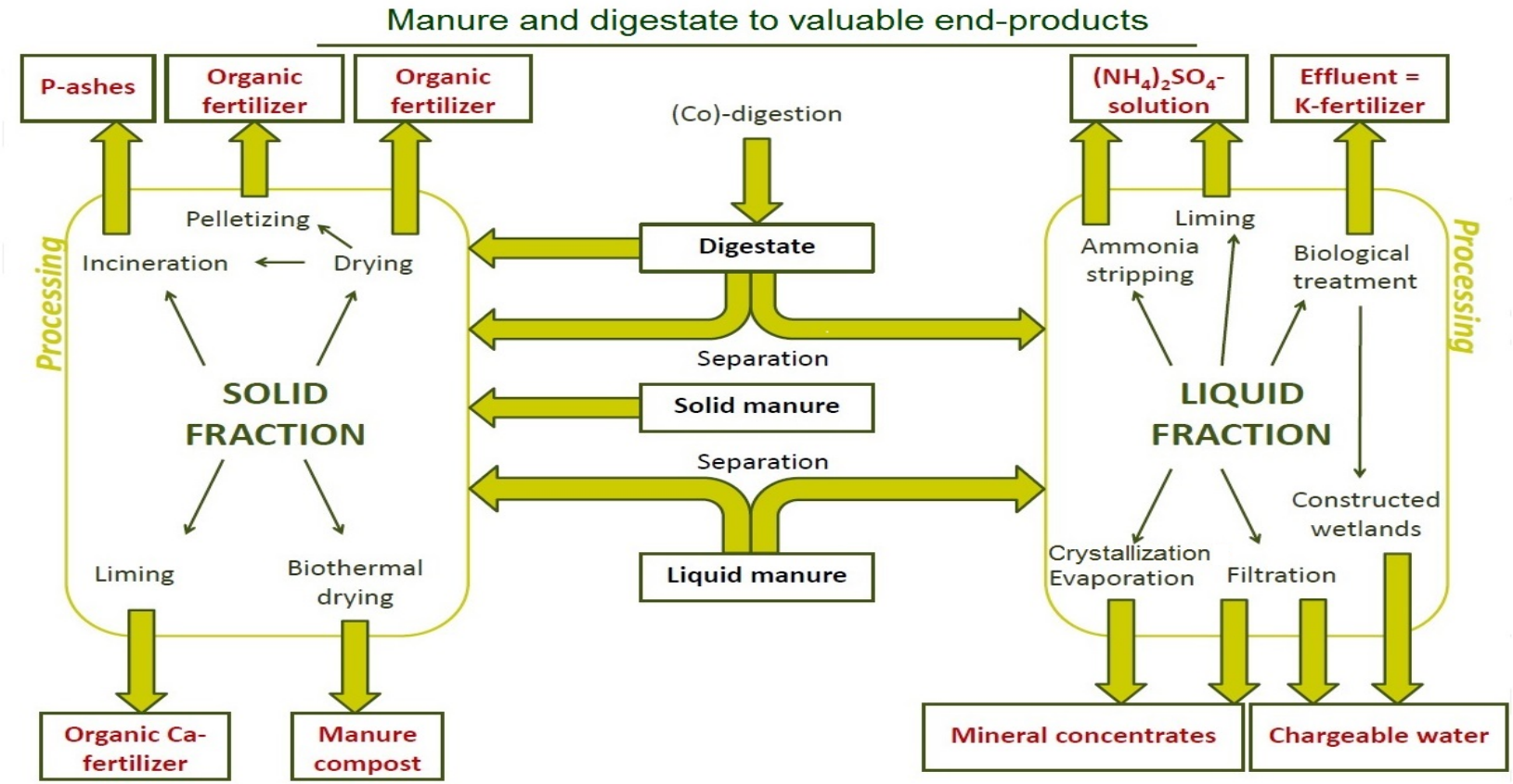
  The main issues are the recycling of process water, reclaiming mines and treating waste streams.

Process options to recover residual nutrients

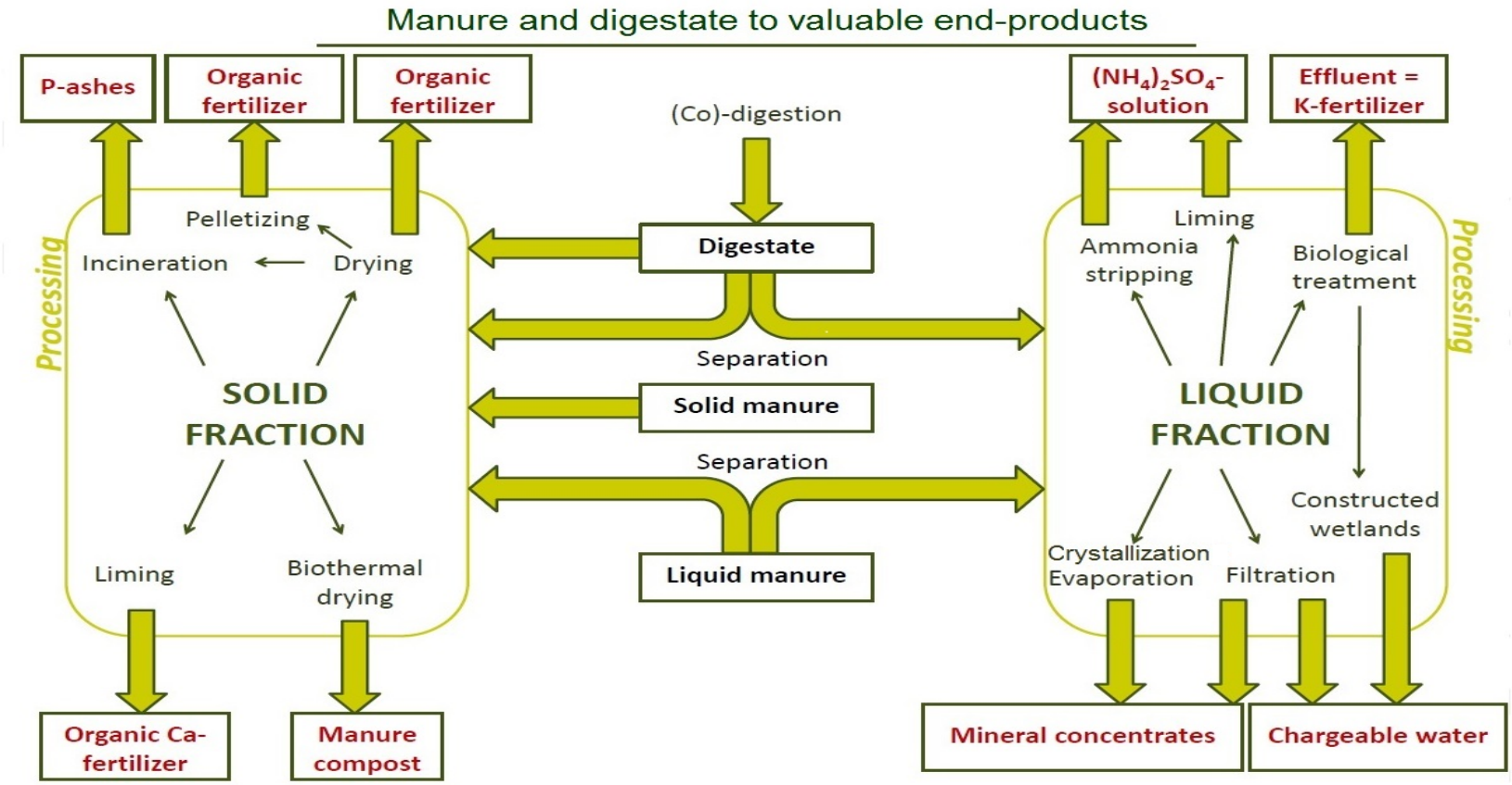
Process options to recover residual nutrients

- Focus on process options, which can upcycle (that is **reuse in such a way as to create a product of a higher quality or value than the original**), and recover nutrients to higher grade end-products, characterized by higher nutrient use efficiency in comparison.

Process options to recover residual nutrients

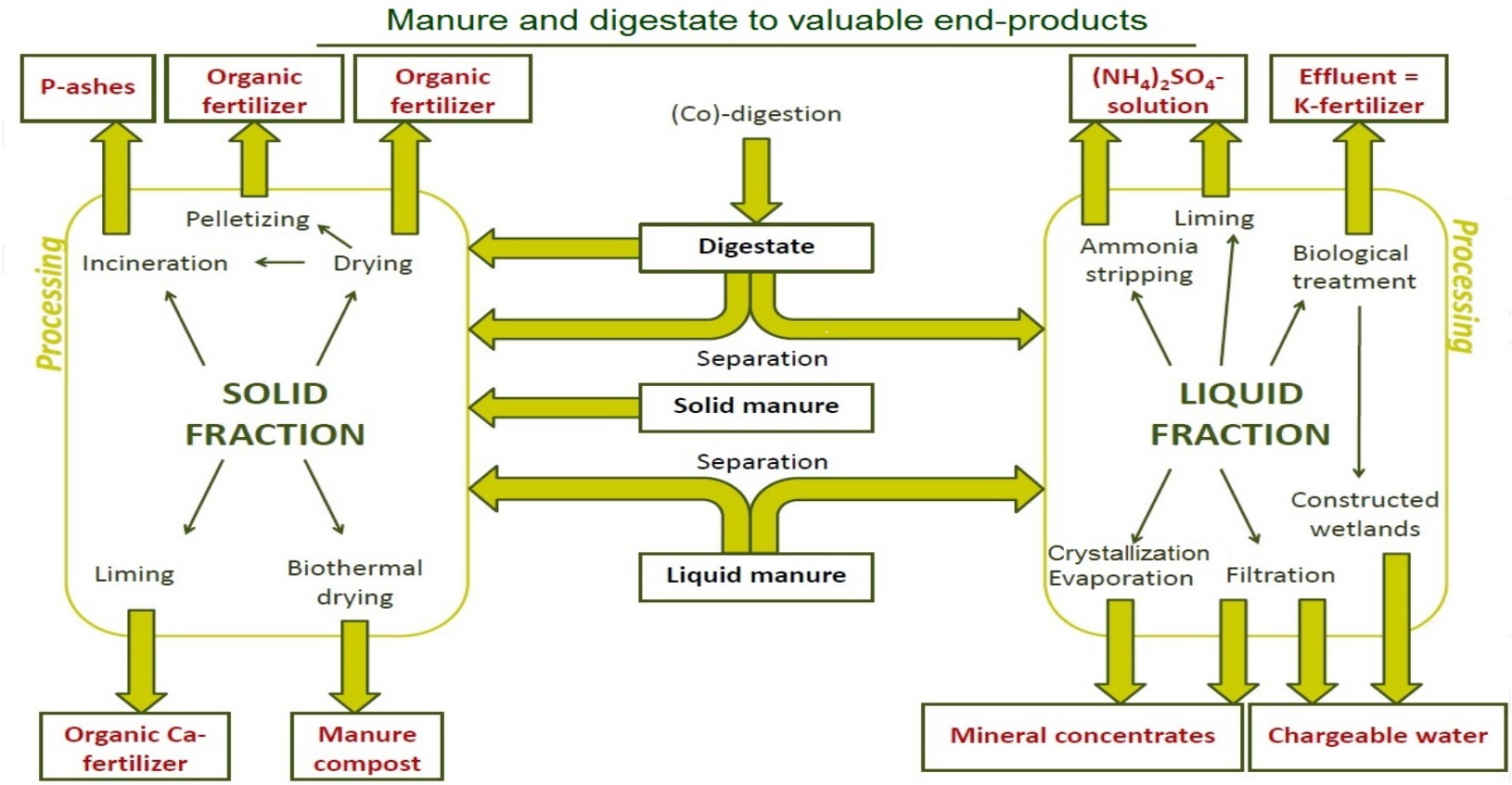


Process options to recover residual nutrients



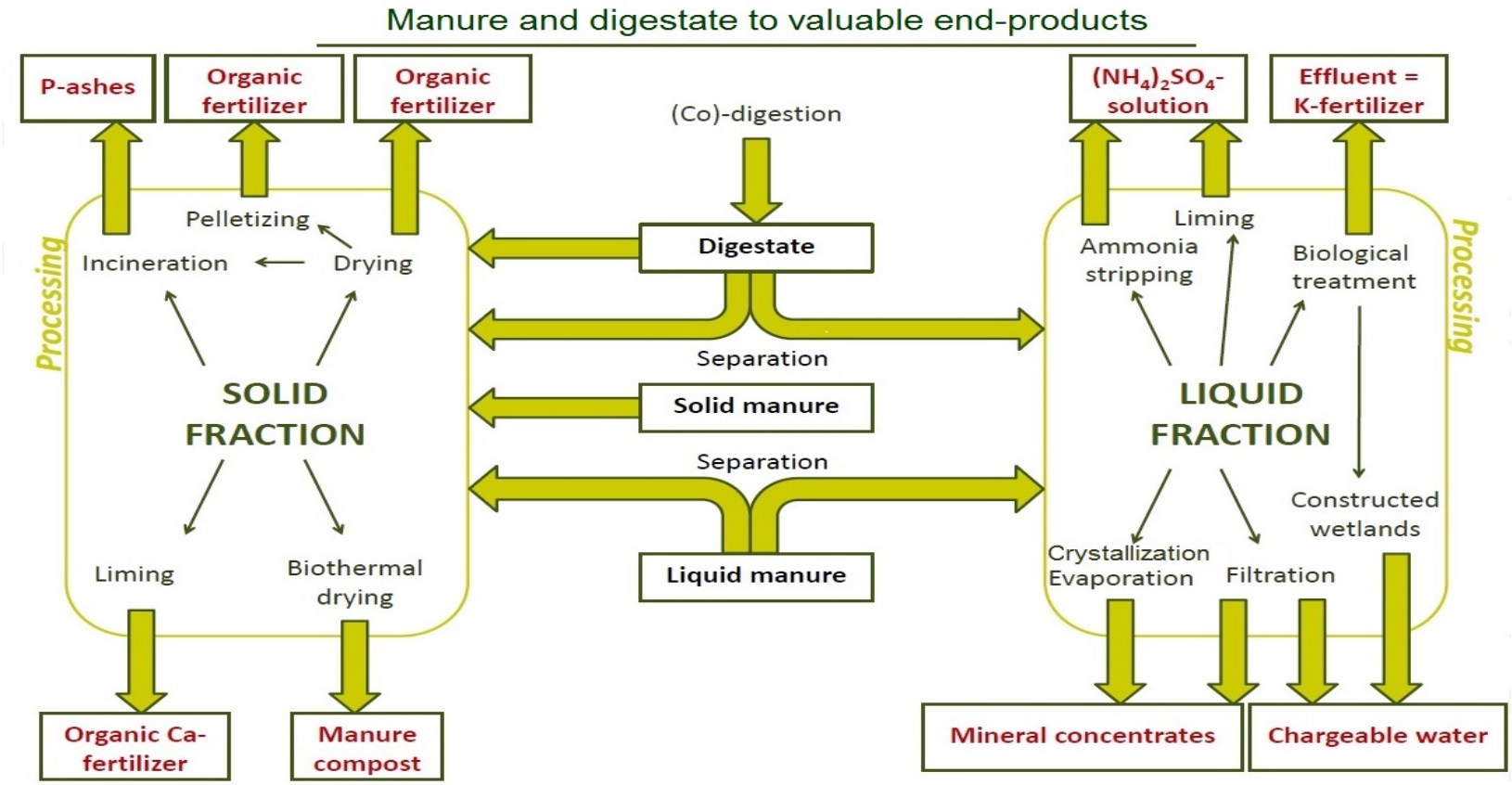
- It is usual that manure and digestate upgrading start with a physical separation resulting in a liquid phase (80-90%) and a solid phase (10-20%).

Process options to recover residual nutrients



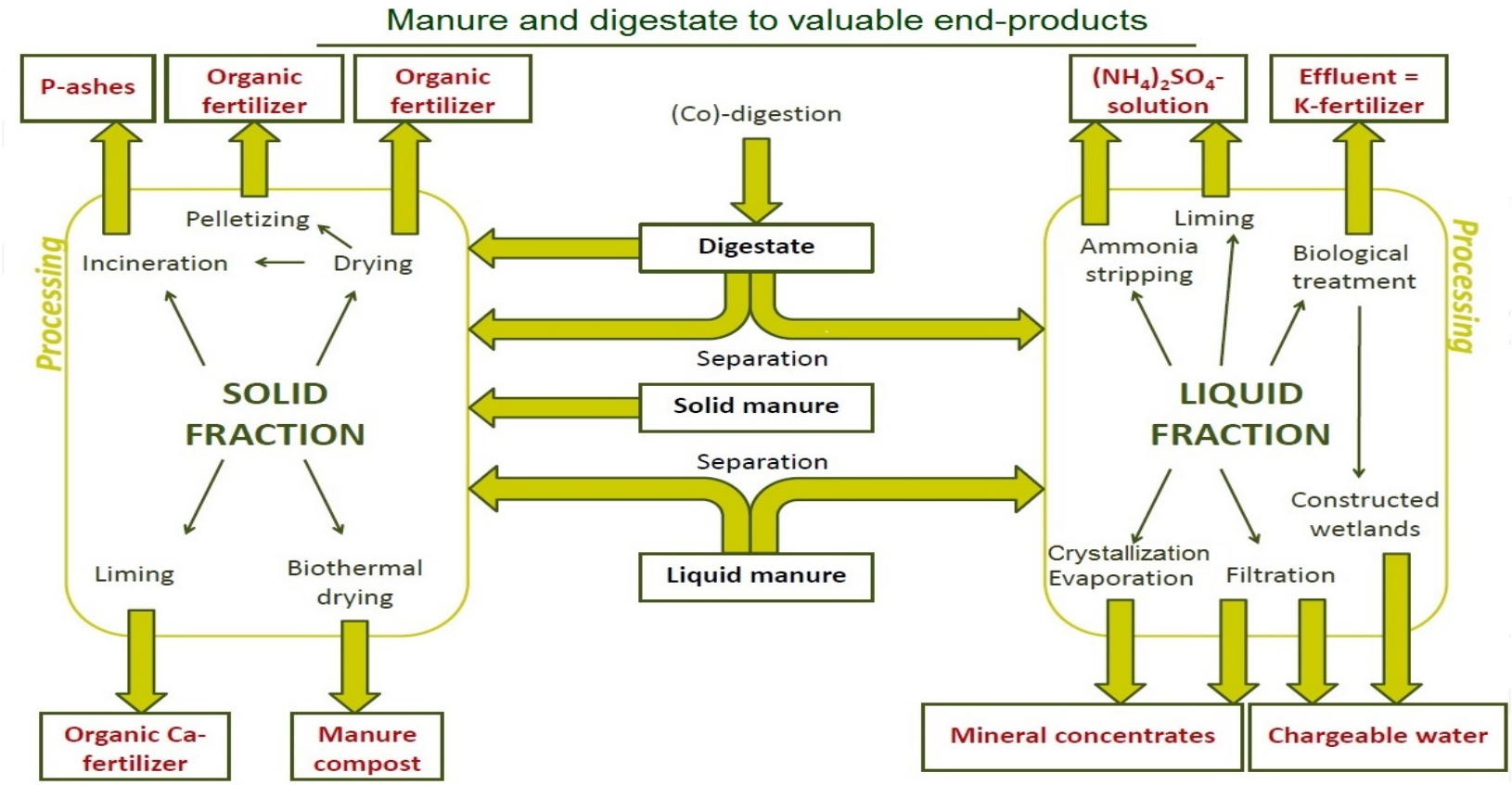
- Nitrogen and potassium tend to end up in the liquid fraction while the solid fraction retains most of the phosphorus and the organic carbon.

Process options to recover residual nutrients



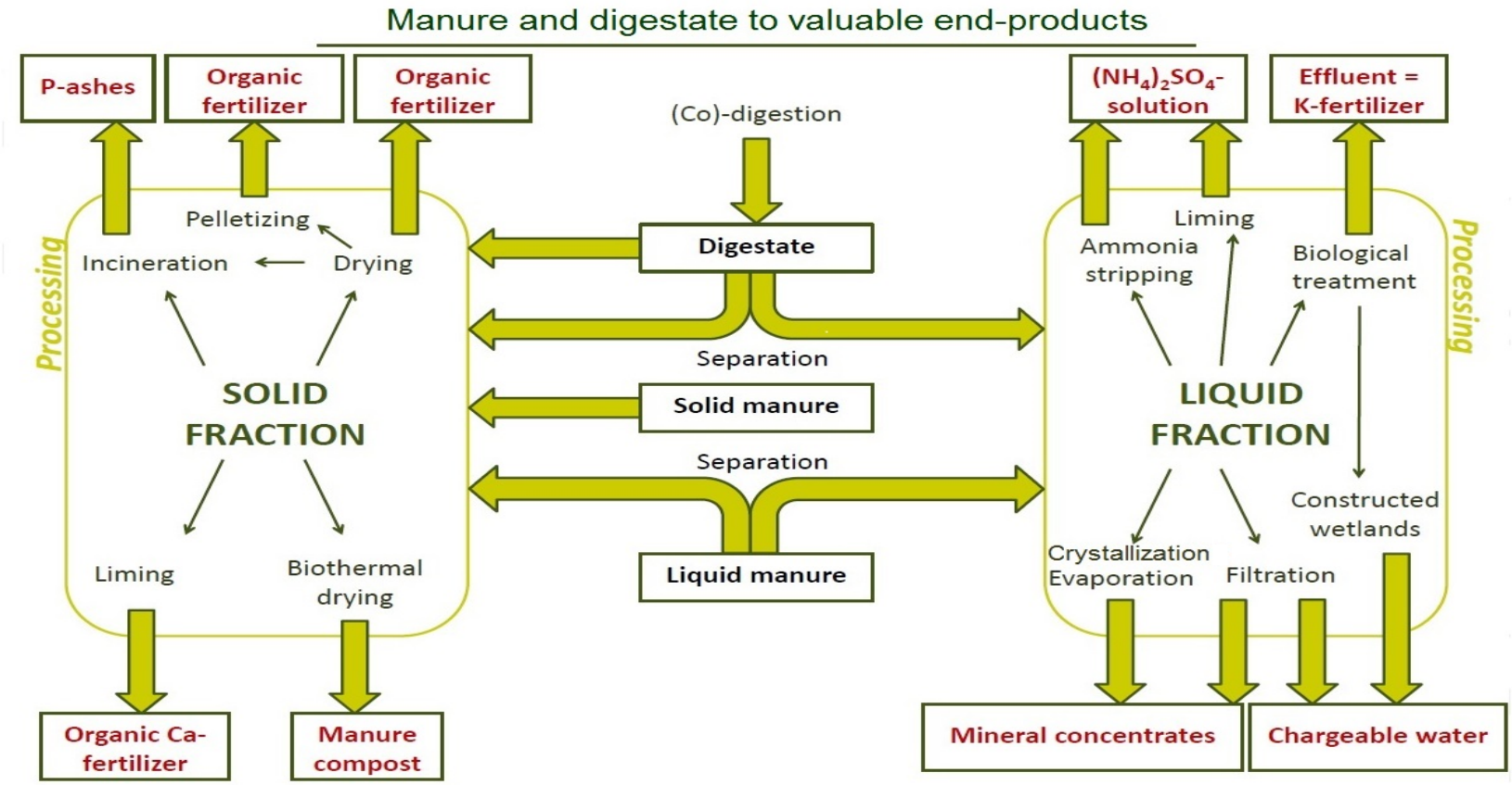
- Mechanical separation, thermal drying or evaporation to concentrate nutrients are the pre-treatment techniques more frequently used.

Process options to recover residual nutrients



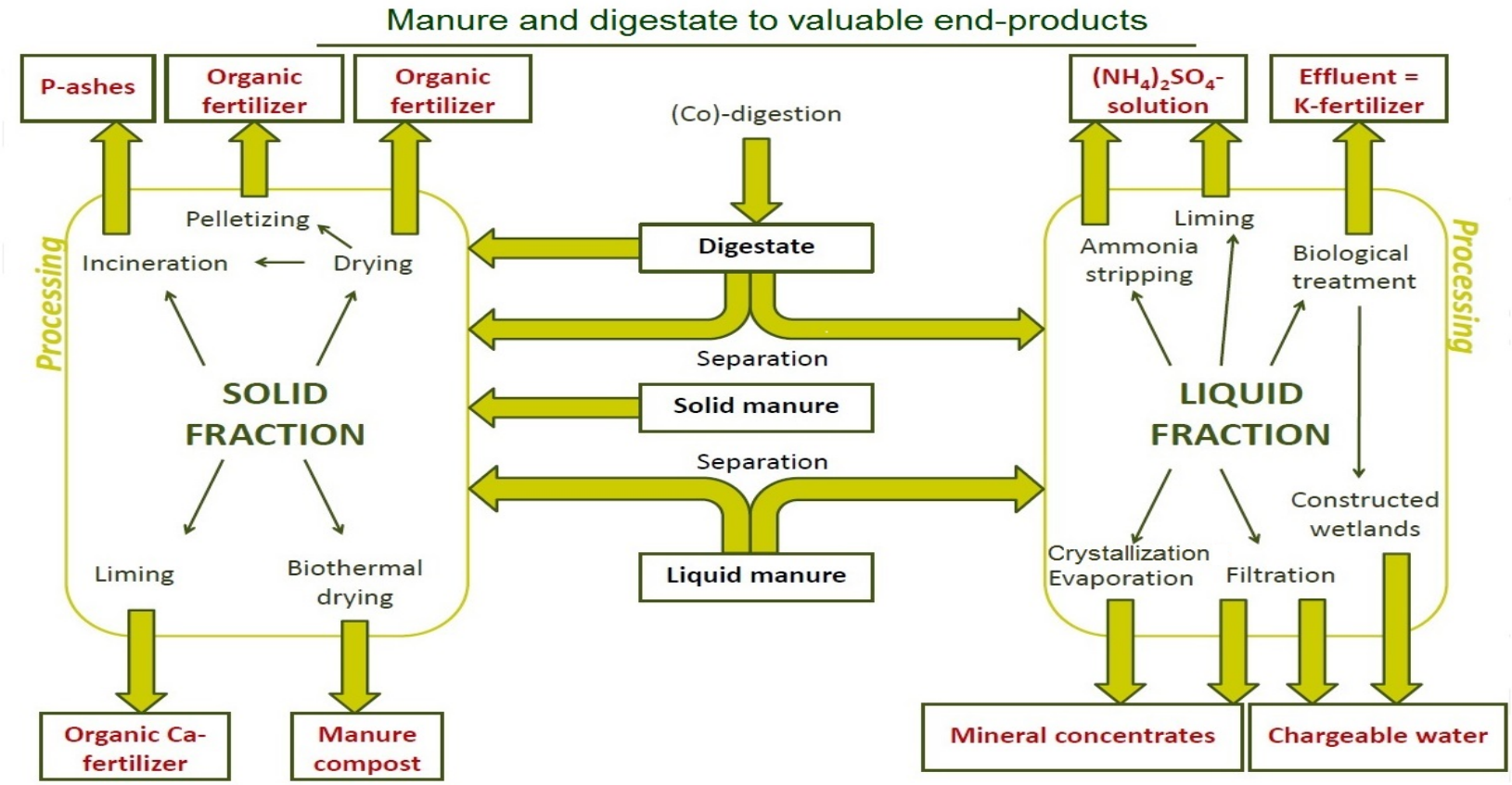
- Ammonia removal from nitrogen rich liquid streams can be achieved by pressurized membrane filtration or ammonia stripping-scrubbing.

Process options to recover residual nutrients



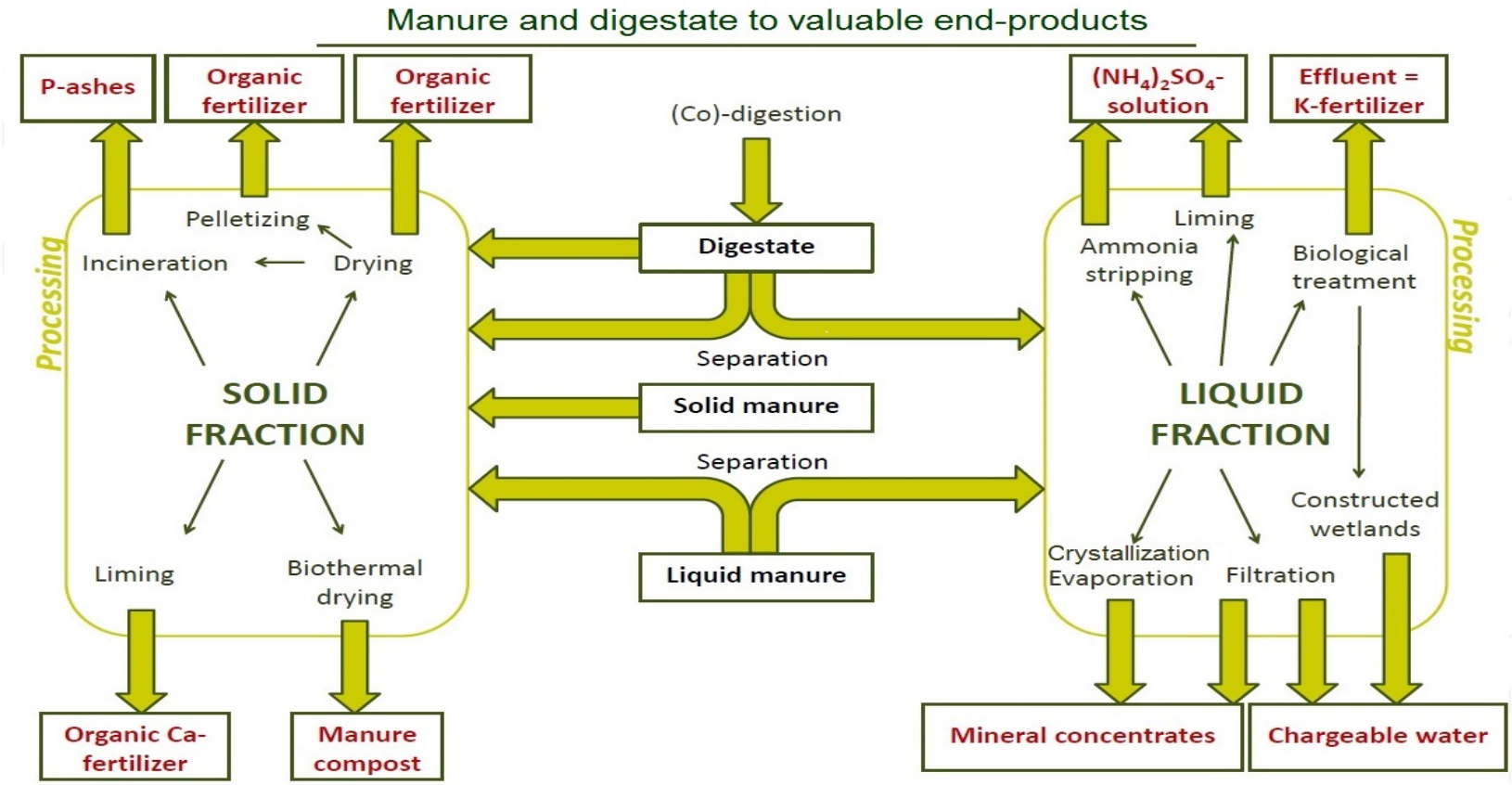
- Phosphorus can be recovered from waste streams alone or together with other components, such as nitrogen. Phosphorus precipitation is the most common recovery strategy for this element .

Process options to recover residual nutrients



- Another technique for nutrient recovery is biomass production. Growing algae on nutrient-rich waste streams is a promising process since harvested algae have many potential commercial uses including as: fertilizers, animal feed, bioplastics, biofuels, etc.

Process options to recover residual nutrients



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Process options to recover residual nutrients

From the **economic side**:

- The methodologies traditionally used to determine the feasibility of nutrients recovery projects are usually focused only on **internal costs** without considering environmental externalities.
- This methodology usually yields a negative economic balance.
- The economic feasibility analysis taking into account the **environmental benefits** shows that the nutrients recovery is viable, in most of the situations, not only from sustainable development but also from an economic point of view.

Nutrient related policies

Nutrient related policies

- **Fertilizers Regulation Revision initiative,** in the EU:
  - aims to incentive large scale fertilizer production in the region from domestic organic or secondary raw materials,
  - in line with the Circular Economy policy,
  - by conversing by-products of the agro-food or the forestry sectors into novel fertilizers.
  - Novel fertilizers have the potential to mitigate environmental impacts of crop production through effective nutrient recovery.

Nutrient related policies

- **Fertilizers policies,** in the world:
  - Each region in the word has specific characteristics when dealing with the "nutrients use" issue.
  - Recent efforts of regions with too much nutrients, have focused on regulation to avoid pollution losses.
  - Other countries have emphasized the need for nutrient subsidies to ensure food production.

Common need:

To improve the full chain nutrient use efficiency and its components to be able to produce more food and energy with less pollution and less nutrients demand.

Conclusions

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- There is an urgent need to optimize nutrient cycles in all the regions to satisfy world food and energy needs, while reducing threats to human health, climate and ecosystems.
- Important to quantify the multiple benefits of meeting the nutrient targets for marine, freshwater and terrestrial ecosystems, mitigation of greenhouse gases and other climate threats, and improvement of human health.
- There are some big opportunities in all the world regions in relation with fertilizers use that can realistically be achieved.
- Solid waste management strategies of the developed nations are creating economic, social and environmental opportunities for the recovery of nutrients.
- Markets are showing positive demand on organic fertilizers, even in less developed countries.

Further information:

dolhid@cartif.es
Fundación CARTIF, Boecillo, Valladolid (SP)
Tel. +34 983 546504

Thank you for your attention