Phosphorus Flows in Portuguese Livestock and Agriculture Sectors

A Roadmap Towards Sustainability

Joana Rocha¹, Célia Dias-Ferreira¹, ²

¹ Research Centre for Natural Resources, Environment, and Society (CERNAS), Polytechnic of Coimbra, Portugal
² Materials and Ceramic Engineering Department, CICECO, University of Aveiro, Portugal
Overview

• The Phosphorus Addiction

• Phosphorus Challenge

• Portuguese Agriculture and Livestock Sectors

• The Need for Phosphorus

• P Flow Analysis for the year 2015

• Space to Improve
The Phosphorus Addiction

- P is essential to support life on Earth
  - It makes part of DNA, ATP

- It is a limiting nutrient for plant growth
  - Essential to ensure food security

- It is an important nutrient in eutrophication processes
  - It is responsible for algal blooms and consequence depletion of the water body’s oxygen

- There is no P substitute nor is it possible to process in the lab
Phosphorus Challenge

• Non renewable at human time scale

• Relatively low price but very volatile

• Lower P-rock quality
  • Decreasing P content
  • Impurities (cadmium and uranium)

• Spatially concentrated
  • Geopolitical dependency and tension
Portuguese Agriculture & Livestock Sectors

- The Utilized Agricultural Area (UAA) represents 40% of the territory $3.6 \times 10^6$ ha

- Dominated by small and medium farms

- Agriculture is an important economic activity although, Portugal is not auto-sufficient in majority of productions

- The most important livestock are pigs, cattle and poultry production (auto-sufficiency in poultry and eggs production)
The Need for Phosphorus

• High agricultural yields depend on phosphorus inputs: phosphate-fertilizer, manure, compost and biosolids

• Livestock production in large scale relies on the use of manufactured animal feed which is enriched with P-additives

Due to P scarcity and P pollution impacts it is fundamental to improve P use efficiency in both livestock and agriculture sectors
P Flow Analysis

• Based on the mass conservation principle

• Quantification in mass of P of all the inputs, outputs and within the systems flows
  • P content x mass of flow
  • Data gathered from OECD, INE, Eurostat, FAOstat and literature

▪ Identification of P stocks and sinks
  ▪ Formulation of sustainable P use practices
P Flows in Portuguese Agriculture & Livestock Sectors
P- Use in Agriculture

Inputs

- Manure
- Biosolids

Outputs

- Compost
- Forage
- Agro. Production

Inputs:
- Mineral Fert.

Outputs:
- 0
- 15000
- 30000
- 45000

Bar graph showing the usage of phosphorus (P) in agriculture, with inputs and outputs categorized.
P Flows in 2015

Livestock

- Meat, Eggs, Milk: 2,144.50 t
- Animal Feed: 21,224.20 t
- Manure: 27,554.00 t
- Livestock losses: 1,690.30 t
- Forage: 14,882.00 t
- Agricultural losses: 1,092.50 t

Agriculture

- Agro. Prod: 13,455.00 t
- Atmospheric: 110.04 t
- Bio-solids: 1,602.97 t
- Fertilizers: 19,214.00 t
- Compost: 818.00 t

Flows (t)
Stocks (tP/y)
P -Stocks and P-Use Efficiency

\[ P \text{ soil stock} = \frac{\text{Mass of Phosphorus in the Soil}}{\text{Agricultural Area}} \]

\[ = 5.4 \text{ kg P/ha} \]

\[ P \text{ Use Efficiency} = \frac{P \text{ outputs}}{P \text{ inputs}} \times 100 \]

\[ = 60 \% \text{ (in 2015)} \]

But, if No Mineral Fertilizer was Used

\[ = 98.5 \% \]
Space to Improve

- There are several problems arising from this Phosphorus Addiction:
  - The inputs are **much larger** than the outputs
  - Manure and the other **organic inputs cover the needs** for the agricultural production
  - In the livestock system, **losses can be decreased** by: utilization of low P feed, improvement of the manure storage facilities (concrete floors, covered manure piles to avoid rain infiltration)
  - Losses in the agriculture sector are a consequence of **over fertilization**: avoided by smart fertilization techniques and with the use of retention zones
THANK YOU FOR YOUR ATTENTION

For more information Joana Rocha, joanarocha@esac.pt

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