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BOOK OF ABSTRACTS

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INTENSIFICATION OF A MIXED ORGANIC FARMING SYSTEM IN THE NORTHEAST OF PORTUGAL WITH GRAZING OF CHURRA GALEGA BRAGANÇANA SHEEP

Fernandes M. [1], Aguiar C. [2]*

[1]Aguiarfloresta - Associação Florestal e Ambiental de Vila Pouca de Aguiar, Central de Camionagem nº 4, 5450-011 Vila Pouca de Aguiar; [2]Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus Santa Apolónia, 5300-253 Bragança, Portugal.

Summary: Efficient management of nutrient cycling is key to ecologically intensifying, reducing environmental impacts and optimizing the economic performance of agricultural holdings. Traditional practices such as crop diversification, rotations, grazing and the use of organic sources of nutrients (organic amendments) are the starting point for designing efficient nutrient management systems.

Keywords: Nutrient cycling; mixed organic farming systems; sheep grazing; ecological intensification; sustainable farming

Introduction

Animals play a pivotal role in the sustainable ecological intensification of organic farming systems, a process essential for improving work efficiency and ensuring fair incomes for farmers. Mixed organic farming systems address the critical challenge of increasing agricultural productivity without escalating environmental costs (Garnett et al., 2013). These systems are believed to enhance soil quality while simultaneously producing high-quality crops and animal products (LaCanne and Lundgren, 2018).

Ecological intensification relies on the efficient management of nutrient cycling, which not only reduces environmental impacts but also optimizes the economic performance of farms. Organic mixed farming systems exemplify sustainable agriculture by enhancing the efficiency of nutrient cycling, thereby promoting both ecological and economic resilience.

A case study conducted on a mixed organic farm in Fonte Quintela, Quintela, Vinhais, Portugal, involved identifying system compartments and partially quantifying the stocks and flows of nitrogen (N) and phosphorus (P). Based on these findings, proposals were developed to optimize nutrient cycling, as well as the environmental and economic performance of the system. The nutrient circulation model for this farm was adapted from the conceptual framework of the Terra Fria farming system by Moreira (1998).

Materials and methods

The Fonte Quintela farm has 20 plots, totalling 14.75 ha, most of which are subject to an extensive grazing regime with a flock of 41 'Churra Galega Bragançana' sheep breed. Nutrient cycling was studied during the 2022/2023 farming year using the following quantitative data:

(i) dry matter (DM) production (grazed grass and hay) from irrigated and non-irrigated hay meadows (grazing exclusion cages; three cages/plot);

(ii) DM production and grazed DM of sorghum, corn and turnip fields (three subplots of 1m^2/plot);

(iii) DM production of rye and oat straw (three subplots of 1m^2/plot);

(iv) nitrogen (N) and phosphorus (P) content in the forage biomass (mean of three samples/plot);

(v) grazing maps (sheep grazing hours/plot.year evaluated through GPS collars and sheep summer overnight hours/plot.year);

(vi) estimated DM extraction of forage biomass from oak (*Quercus pyrenaica*) woodlands, chestnut groves and vegetable gardens (calculated using grazing maps and standard sheep DM ingestion/kg live weight.day);

(vii) trampled biomass (data from bibliography);

(viii) rejected forage in the manger (1 day evaluation with hay; three replications);

(ix) chemical analysis of manure composition, including DM, N, P and boron (B) (mean of three biomass samples);

(x) average excretion rates of N and P per sheep/hour, measured over 12-hour and 24-hour periods;

(ix) manure mass (DM) transport between pens and plots (evaluated through the number of carts, the mean weight of carts and the mean water content of the manure);

(xii) soil analysis (P).

Results

The nitrogen (N) and phosphorus (P) fluxes across the compartments of the Fonte Quintela farm are illustrated in the figures below.

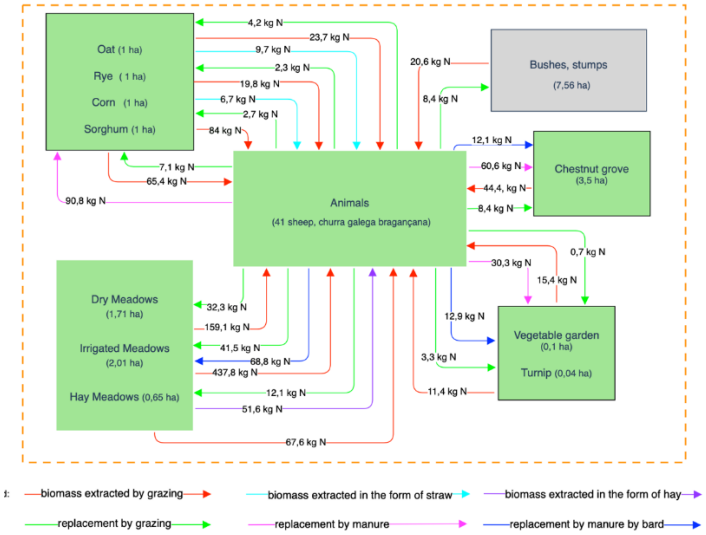

Fig. 1: Total nitrogen (N) fluxes within the mixed organic farming system of the Fonte Quintela farm (Vinhais, Portugal) in the farming year of 2022/2023.

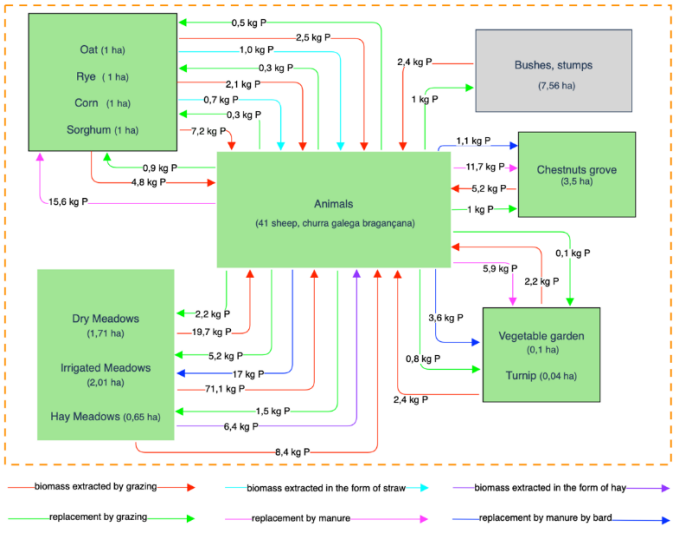

Fig. 2: Total phosphorus (P) fluxes within the mixed organic farming system of the Fonte Quintela farm (Vinhais, Portugal) in the farming year of 2022/2023.

Conclusions and improvement recommendations

From Figures 1 and 2, it can be inferred that grazing acts as an extractive activity for nitrogen (N) and phosphorus (P), primarily because the animals spend most nights in the pen (and approximately 50% of excretions occur at night). Nutrient cycling is significantly improved through sheep overnight plot stays in the summer and the application of barnyard manure. While hay meadows and oak woodlands export N and P, cereal plots export N. In contrast, nutrient restitution in the chestnut grove and vegetable garden exceeds requirements.

High P levels in the soils of vegetable gardens and chestnut groves, coupled with low P levels in cereals, hay meadows, and oak woodlands, highlight the inefficient nutrient cycling within the system (P soil analyses not presented). The accumulation of P in garden soils is challenging to mitigate due to high N demands of garden crops, which are met through heavy manure applications. Additionally, the oak woodland is currently overgrazed.

Ecological intensification of the farm system could be achieved through the following measures:

(i) Sheep, being gregarious animals, naturally form herds, leading to nutrient concentration in shaded areas or near water sources. To enhance nutrient cycling, measures such as relocating water points, using mobile shade structures, implementing rotational grazing systems, and monitoring animal movements can be effective.

(ii) Encouraging sheep overnight stays in forage crops land would further improve nutrient cycling.

(iii) Earlier grazing exclusion in hay meadows is recommended, extending the exclusion period to 90 days to increase hay production.

(iv) Importing P from external sources is unavoidable to address deficiencies within the system.

(v) Increasing residue mass in the oak woodland through rotational grazing and reducing shrub mass (via mechanical shredding) will ensure sufficient pasture residues at the end of summer. This protects the soil, promotes the emergence of annual plants, and enhances seed production.

(vi) Shrubs should not be entirely removed, as they help maintain tall grass species under grazing pressure;

(vii) Replacing part of the annual forage area (oats, rye, sorghum, and corn) with permanent legume-rich pastures will boost N fixation and reduce energy inputs (e.g., fewer tractor hours).

(viii) A similar strategy should be applied in the chestnut orchard by establishing subterranean clover pastures.

The Fonte Quintela farm demonstrates how effective nutrient management practices can transform an agricultural system, making it more productive, environmentally sustainable, and economically viable. Adopting ecological intensification techniques, supported by a thorough analysis of nutrient cycles, is essential for achieving a balance between productivity, economic performance, and environmental sustainability.

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