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RESILIENT FARMING SYSTEMS

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Re-Livestock Abstracts

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Accelerating the Transition from Forestry to Silvopasture: Evaluating the Effects of Sown Seed Mixes and Woody Soil Amendments on Pasture Yields in Southern Portugal

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Highlights

• Diverse sown pastures increased pasture yields of silvopastoral systems established from forestry systems. Application of woody soil amendments at the rate of 10t/ha had no negative effect on pasture yields.

Introduction

Starting in the 1990s, CAP afforestation of agricultural land measures resulted in the establishment of Pinus pinea (stone pine) on extensive farmland in southern Portugal. There was an approximate 400% area gain of this species, from 50,000 ha in late 1980s to 193,600 ha in 2015. On reaching the end of the 20-year afforestation agreement, farmers have various options, including reversion to pastures, or thinning and conversion to Pinus pinea orchards. An alternative is to reduce tree densities and reintegrate grazing livestock, thereby creating silvopastoral systems where the livestock benefit from the shade and shelter the mature trees provide, with an extended grazing season due to the buffering effect of the trees. However, pasture productivity within these former forest systems is often low due to poor soil health and competition with the trees for light, water and nutrients, especially in the semi-arid climate of southern Portugal. This study is investigating two approaches to enhance pasture productivity: (1) in the short term, by sowing diverse pasture mixes to boost pasture yields and (2) in the long term, through improving soil health by applying woody soil amendments. In this paper, we report on the first year's results of an on-farm experimental trial comparing three seed mixes and two soil amendments impacts on pasture yield. We would expect that sown pasture mixes result in higher yields than natural regeneration; however, potential short-term N lock-up due to the addition of C-rich woody biomass may result in lower pasture yields where woody soil amendments have been added.

Methodology

The MVARC farm, Curralões, covers 240 ha near Mértola in Baixo Alentejo, in south-east Portugal, with average annual rainfall of 548mm falling in the winter months and hot, dry summers. The soils are lithosols/leptosols, which are shallow soils over hard rock, prone to erosion, and composed of very gravelly material, with a pH between 5.6-6.5. In 1994, over 130,000 Pinus pinea trees were planted on 160 ha of the farm, initially at tree densities of 816 trees/ha which were thinned in 2009 to 653 trees/ha. Trees are in rows 7m apart, running NW to SE. In 2024, experimental agroforestry plots were established with a split-plot design

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in a randomized complete block layout with three replications, four whole-plot treatments (seed mix and natural regeneration control), and three subplot treatments (two soil amendments and no amendment control). Each plot contains three subplots, i.e. three adjacent alleys (3 x 7m) and 100m long, with a buffer of one alley in between adjacent plots. In the summer of 2024, after disc-harrowing to clear shrubs, tree densities were reduced to around 210 trees/ha, and two soil amendments added: woodchip from the branches of the thinned Pinus pinea trees (i.e. minus the trunk), and post-distillation biomass of Cistus ladanifer, a native bush that grows vigorously between the trees and that is harvested for extraction of essential oil. Both amendments were added at a rate of 10 t/ha, in line with previous trials of ramial chipped wood (Westaway 2020). The alleys were then harrowed and 417 S3.4 Potential of Agroforestry Aystems to deliver Ecosystem Services. Evidence and Case studies rolled to create a seed bed, and three seed mixes applied at a rate of 30 kg/ha in early December 2024. The seed mixes all contained the ryegrass Lolium multiflorum and differed in the inclusion of five different clover species and five other broadleaved species. In June 2025, plant biomass was cut at 0.5cm height above ground, in a 50 cm x 50 cm quadrat, randomly located from 10m to 90m within each subplot, with five quadrats sampled per subplot. Samples were oven dried at 60°C until a stable weight was achieved, and dry weights (g/m2) calculated. Plant biomass data were analysed using a linear mixed-effects model to account for the split-plot design and nested sampling structure. Seed mix (wholeplot), soil amendment (subplot), and their interaction were included as fixed effects, with Block and its interactions with Plot and Subplot as random effects. Significance was determined via Type III ANOVA using Satterthwaite's approximation, followed by Tukey's HSD for pairwise comparisons in R (v4.5.1).

Results and Discussion

A shortened growing season caused by a rapid transition between a cool, wet winter and hot, dry summer limited plant growth in the trial plots in 2025. Yields varied between 15 and 280 g/m 2, with an average of 85 g/m2. This is at the lower end of the range presented in Rodrigues et al. (2025) and Potes (2011) for pasture yields and natural grasslands in the Montados of southern Portugal. The analysis of variance revealed a significant main effect of seed mix on pasture yields ($F_{3,6} = 5.13$, $p = 0.0076$). While pairwise comparisons showed that differences between the natural regeneration control (mean = 69.6 g/m2), and Mix 1 (mean = 94.8 g/m2, $p = 0.053$) and Mix 3 (mean = 94.2 g/m2, $p = 0.0586$) slightly exceeded the traditional 0.05 threshold, they indicated a clear trend toward increased biomass compared to natural regeneration (control), even in such an atypical spring (almost no spring). These marginal differences, combined with the global F-test, suggest that the seed mixes increased pasture productivity despite the limited degrees of freedom inherent in the whole-plot level of the split-plot design. There was no statistically significant difference in yields between the different soil amendment treatments, and no significant interactions between seed mix and soil amendments. This indicates that any potential N lockup created by the addition of woody biomass as a soil amendment was not severe enough to impact pasture productivity. Yields in Seed Mixes 1 and 3 were over 30% greater than in the natural regeneration plots, indicating a positive impact of sown mixes on pasture production. Both Mix 1 and 3 contained 10 kg/ha

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of ryegrass, compared with just 5 kg/ha in Mix 2, which may contribute to the differences. Assessments of plant cover and biodiversity (carried out in May 2025), and analysis of pasture nutritional value (carried out in collaboration with CSIC Granada, on the June 2025 samples), will provide a fuller understanding of the species underpinning these differences in yields, and implications for grazing livestock. Measurements will be repeated in 2026 to follow the development of the pasture through a second year and will include an evaluation of soil health. Finally, an economic analysis will identify whether the financial benefits, in terms of pasture production and contribution towards livestock production, outweigh the costs of establishment. To conclude, initial results indicate that diverse sown pastures increased the pasture production of silvopastoral systems established from forestry systems, while application of woody soil amendments at the rate of 10t/ha had no negative effect.
Keywords: Forage productivity, agroforestry conversion, ramial chipped wood.

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