Microregional Agricultural Labor Productivity

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Understanding the factors that influence agricultural productivity is critical for promoting sustainable food production, economic growth, and rural livelihoods.

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1. Introduction

Agricultural labor productivity varies greatly across Europe, with significant differences between the continental northern central countries and the continental peripheries, namely the Mediterranean, Eastern Europe, and Scandinavia [1]. This disparity poses a challenge to achieving balanced territorial development in rural economies and communities, which is a key priority of the European Union's rural development policies [2].

In addition to the attainment of the European Union's territorial cohesion goals, the examination and enhancement of agricultural productivity assume paramount importance in view of the prevailing global challenges confronting the agricultural sector. These challenges encompass food security, poverty reduction, adaptation and mitigation of climate change, degradation and depletion of natural resources, and global market competitiveness.

Over the past few decades, a number of empirical studies have been conducted to investigate the disparities in agricultural productivity among countries, with the aim of gaining insights into the underlying factors contributing to these variations [3][4][5][6][7][8][9][10]. Several authors have studied differences within nations, specifically in Italy, France, Czechia, and Poland [8][10][11][12].

There is currently no published research on agricultural labor productivity in Portugal. However, a concise analysis of available data reveals significant disparities among the NUT2 regions of Portugal (**Figure 1**). The mean standard output produced per annual work unit (AWU), which can be used as an approximation for agricultural labor productivity, varies from approximately EUR 10,000/AWU in the Madeira region to nearly EUR 45,000/AWU in the Alentejo region (**Table 1**).

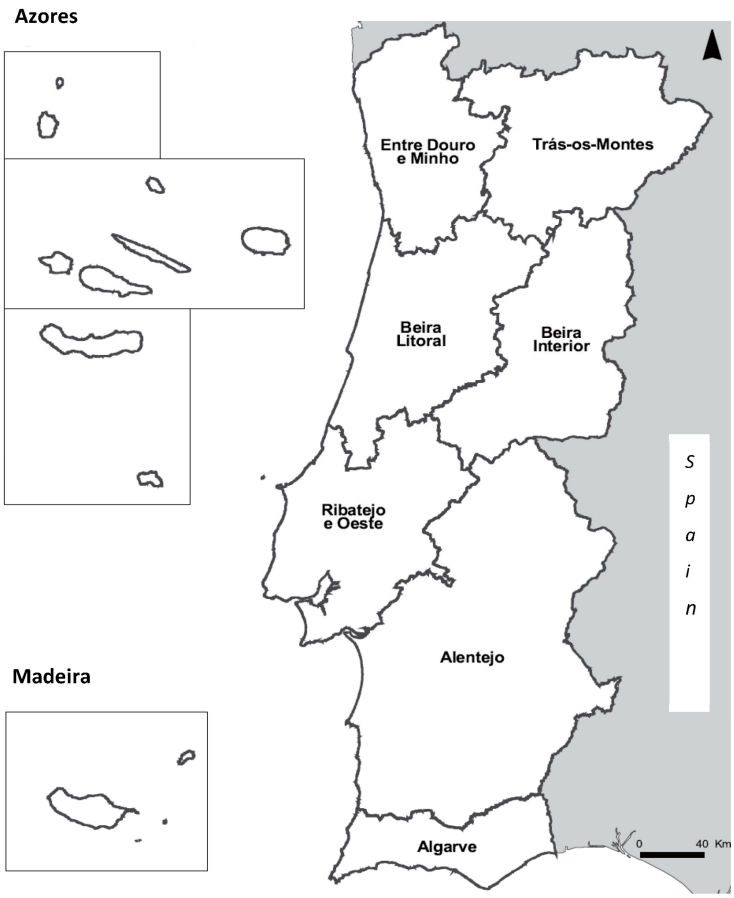

Figure 1. Portuguese agrarian regions.

The observed discrepancy is to be expected, considering the extensive range of farm structures, natural resource allocations, and geographical limitations such as soil composition and climate that exist within the country. According to Pelucha et al. [13], when discussing European territorial cohesion, NUT2 and NUT3 include rural areas with varying characteristics, making local or microregional analysis more appropriate. The locality's unique mix of natural resources, know-how, traditions, and culture allows for a more detailed assessment of the determinants of agricultural productivity [14]. However, there is a limited understanding of the factors that effectively influence agricultural labor productivity at a micro-level, specifically within different farming systems and production contexts. The primary focus of research on agricultural productivity has predominantly been at the national [3][15] and regional [4][9][16] scales, with a limited number of studies examining local variations, specifically at the municipal level [14]. This study specifically concentrates on the commune (*Freguesia* in Portuguese), which is the smallest administrative spatial unit in Portugal and serves as a division within a municipality.

Table 1. Portuguese average value of total standard output by annual work unit (EUR/AWU) per NUT2.

NUT2	SO (EUR/AWU)
Norte	**10,989.9**
Centro	**18,572.8**
Área Metropolitana de Lisboa	**32,895.4**
Alentejo	**44,904.6**
Algarve	**27,201.3**
Região Autónoma dos Açores	**40,020.2**
Região Autónoma da Madeira	**10,033.4**
Portugal	**21,488.6**

2. Microregional Agricultural Labor Productivity

Differences in agricultural productivity across countries, regions, and farms can be attributed to a variety of proximate and fundamental causes. The productive factors included in any agricultural production function, namely capital, labor, and land, are the proximate causes. The fundamental causes of variations in farm efficiency can be attributed to various factors within a broader context. These factors include, but are not limited to, natural resources and environmental conditions, product and factor markets, agricultural policies, investment incentives and credit availability, human capital skills, and innovation [15][17].

The accumulation of physical capital, including machinery and infrastructure, is essential for long-term agricultural productivity growth. This is due to its ability to enhance output, ensure precision, accuracy, and consistency in production, and reduce time and labor costs [5][15][18]. The link between physical capital and technological progress has been extensively discussed in the literature. Various authors [15][18][19][20] have identified technological progress as the main catalyst for enhancing agricultural efficiency and productivity. Investments in research and development (R&D) play a crucial role in the advancement of improved crop varieties, innovative farming techniques, pest and disease control measures, and sustainable agricultural practices.

Nevertheless, the accumulation of human capital is essential for the successful integration of new technologies, as the proficient utilization of the most advanced innovations requires higher levels of expertise [5]. The development of human capital through education, training programs, research initiatives, and extension services plays a pivotal role in facilitating the adoption of improved practices, efficient resource management, and informed decision-making processes [21][22][23][24]. It is important to acknowledge that education is not the sole means of enhancing human capital. It is also imperative to take into account the inclusion of labor experience, learning by doing, and inherent worker skills [18].

Regarding land, there is a growing recognition that farm size influences technical efficiency and overall farm performance. However, it is worth noting that there is no consensus on the specific direction of this relationship. Some authors have reported that larger farm sizes are associated with higher levels of efficiency [4][18]. However, other researchers have demonstrated that the association between these variables does not always exhibit a linear pattern [8]. Indeed, it has been observed that once a specific size threshold is surpassed, there is a potential decline in efficiency [22][25]. The positive relationship can be explained by the fact that larger farms may experience advantages in terms of enhanced labor division, improved accessibility to raw materials, increased capital resources, and the adoption of innovative technologies and practices that can augment productivity [1][12]. In addition, small farms frequently engage in income diversification as a means of addressing the difficulties associated with achieving economies of scale. This strategy involves allocating relatively less effort towards agricultural activities [26][27][28]. An inverse relationship between farm size and productivity was discovered mainly in developing economies, and it was observed primarily for land productivity rather than labor productivity [14].

The availability and quality of natural resources such as land, water, and climate conditions are fundamental determinants of agricultural productivity. Suitable soil fertility, favorable topography, sufficient water resources, and appropriate climatic conditions are essential factors for achieving successful agricultural production [15]. One crucial factor in explaining productivity is the extent of irrigated land, which plays a significant role in mitigating adverse climatic conditions in specific semi-arid European areas [15], including the majority of the Portuguese territory.

Policies and institutional support play a significant role in directly influencing and contributing to the efficiency and productivity of agricultural systems. Agricultural subsidies have the potential to impede or delay the departure of labor from the agricultural sector by maintaining or augmenting farmers' income, thereby exerting a detrimental influence on productivity. In contrast, agricultural policies play a significant role in enhancing productivity by offering farmers more consistent prospects and encouraging capital investment in agricultural operations. The Common Agricultural Policy (CAP) has consistently prioritized the increase in agricultural output, as demonstrated by its continuous commitment to providing assistance for farm restructuring and modernization [9]. Many studies [3][8][9][29] have consistently revealed a favorable influence of structural funds on these economic indicators. On the contrary, direct payments seem to have the opposite effect. Garrone et al. [30] found that, on average, CAP subsidies have a positive impact on the growth of agricultural labor productivity. However, this aggregate effect conceals significant heterogeneity in the effects of different types of subsidies. Pillar I decoupled payments, and some Pillar II payments, have a positive effect on productivity, while coupled Pillar I subsidies have the opposite effect, slowing productivity growth.

Agricultural productivity is influenced by various social and institutional factors, such as land tenure systems, property rights, governance structures, and social support systems. According to Liu et al. [6], the productivity growth rate in both

the short and long term is significantly influenced by the availability of healthcare services in rural areas, as well as the spillover effects of research from other regions and non-agricultural sectors. External factors, particularly the capacity of non-agricultural sectors to attract workers from the agricultural sector, play a crucial role in explaining labor productivity [15]. The enhancement of productivity may occur if there is migration from the agricultural sector and rural areas, in cases where the agricultural labor force is deemed inefficient [18][31].

Economic factors, including market access, pricing mechanisms, trade policies, and infrastructure, exert a significant influence on agricultural productivity. Farmers are encouraged to invest in modern and productivity-enhancing practices, provided they possess good access to markets, fair pricing mechanisms, and a favorable economic environment. To account for overall economic development, several authors have used gross domestic product (GDP) as a metric for evaluating disparities in agricultural productivity [4][15][32][33]. The rationale is that agricultural labor in advanced economies is expected to exhibit higher productivity levels as a result of enhanced infrastructure and improved market accessibility [15].

Finally, location is another major driver of productivity growth. As stated by Ženka et al. [14], farms located in metropolitan areas face the challenge of high rental costs, which requires the enhancement of their technical efficiency or a shift towards the production of commodities with higher value-added and increased yields. Farmers can derive advantages from different forms of urbanization economies, including the advantageous proximity to a sizable market for their agricultural products and the ability to sell directly to final customers, public canteens, and restaurants, thereby avoiding burdensome transaction costs associated with intermediaries.

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