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Trends in Brazil's Forestry Education—Part 3: Employment Patterns of Forest Engineering Graduates from Two Public Universities in the Last 15 Years

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Abstract: The employment rate of graduates and the interest of organizations in a high-skilled professional workforce are essential drivers of actions within the universities to improve the qualifications of college students. Our objective was to identify the sectors of employment pursued by graduates from forestry engineering programs of the Luiz de Queiroz College of Agriculture (ESALQ/USP) and of the Federal Rural University of Pernambuco (UFRPE). We also conducted a survey among companies affiliated with the Forest Science and Research Institute (IPEF) to understand the percentage of forest engineers employed by these organizations to gain insights into the scale of this occupation in Brazil. We established two graduate cohorts to investigate the impact of changes in the last five years. In the first cohort (2008–2017), 82% and 40% of graduates from ESALQ/USP and UFRPE were involved in the forestry sector, respectively. However, in the second cohort (2018–2022), the percentage increased from 82% to 97% for graduates from ESALQ/USP, and after changes in the program, the percentage of graduates from UFRPE engaged in the forestry industry significantly rose from 40% to 73%. We discussed the reasons for these increases, mainly in terms of the growing market demand for forestry professionals. In the case of UFRPE, the boost in employment was attributed to the creation of a group for forestry practices along with actions to approach the private sector. We also found a strong ratio of one forest engineer to 4000 ha of planted forest among the enterprises associated with IPEF, indicating a substantial potential of employment in the forestry sector.

Keywords: employability; area of expertise; forestry sciences

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1. Introduction

Higher education provides in-depth instruction in specific areas of knowledge, enabling students to gain a solid foundation of theoretical and practical knowledge for their professional careers. Several professions deal with issues related to sustainability, food production, and other products for society. Forestry schools emerged in 1811 in Germany, seeking to manage the use of forest resources that had been exploited in a disorderly way [1]. In Brazil, the first program was started in 1960 at the Federal University of Viçosa (Minas Gerais State), and currently there are 75 programs in the country, training around 1500 professionals per year [2].

The Brazilian forestry market is on the rise, employing currently approximately 3 million professionals and accounting for 3.5% of the Brazilian gross domestic product (GDP) [3]. The production chain of the forestry sector ranges from various pre-production inputs to the consumption of goods and services, encompassing the production chain associated with planted forests and to the extraction of products from native forests, namely, production of rubbers, waxes, oils, food items, and timber forest products [4].

Nevertheless, notable disparities exist across regions within the forestry sector. The Brazilian southeastern region holds 42% of the population and contributes to 52% of the national GDP [5]. Conversely, the northeastern region has 27% of the country's population, but it accounts for only 14% of the GDP. These differences are also evident in forest-related metrics. For instance, the area occupied by planted forests encompasses 3 million ha in the southeast, while in the northeast, planted forests cover only 1 million ha, despite the significant potential of the latter. Furthermore, the number of forest engineering programs varies [2] from 24 programs in the southeastern region to 12 programs in the northeastern region.

Hakamada et al. [6] reported that 100% of organizations affiliated with the Brazilian forestry sector recognized a shortage of qualified forest engineers in the job market. This gap persists, despite the growing number of graduates in recent years, with numbers ranging from 1000 graduates per year in 2009 to approximately 1500 in 2019 [7]. Therefore, it is imperative for universities to provide graduates more than the traditional technical training to foster engagement within the forestry sector.

New graduates in forest engineering primarily aim to find a source of income through employment or entrepreneurship. Where graduates are employed has been tracked by Wageningen University since 1973 [8]. In that university in The Netherlands, for example, the study showed the majority of graduates are working in the research area (around 40%) and about 45% were working for the government or semi-government organizations. In another study performed in Germany, it was found that 90% of forest graduates obtained their first job after 12–15 months [9]. This kind of information can be used in many ways: to adapt the curriculum to the new demands of society, to inform new graduates the areas that are offering more jobs, and to adjust government policies and educational managers for strategic reasons based on the demands, strengths and weakness of a determined region or program.

In the present study, our objective was to identify the fields of employment pursued by new graduates in forest engineering from the Luiz de Queiroz College of Agriculture (ESALQ/USP) and from the Federal Rural University of Pernambuco (UFRPE) using two cohorts, 2008–2017 and 2018–2022, taking into account changes implemented in the forest sector and forest engineering programs. We also conducted a survey among companies affiliated with the Forest Research and Development Institute (IPEF) to collect information on the number of forest engineers employed in the forest private sector and gain insights into the scale and prevalence of this occupation in Brazil. We discussed the main changes in the time periods studied and presented specific actions to universities aiming to increase the employment rate of graduates in forestry-related jobs.

2. Materials and Methods

2.1. Survey on the Occupation of Graduates

We conducted a survey on the employment rate of graduates from the Luiz de Queiroz College of Agriculture (ESALQ/USP) in the state of São Paulo, Brazil. The forest engineering program at ESALQ/USP was created in 1901 and had its first group of graduates in 1974. We also surveyed graduates from the Federal Rural University of Pernambuco (UFRPE), founded in 1912, located in Recife, capital city of Pernambuco State, northeastern Brazil. The first cohort of forest engineering graduates dates back to 1979. ESALQ/USP and UFRPE were the 6th and 9th schools, respectively, to offer the forest engineering program in Brazil. Both universities were selected for the following reasons. ESALQ/USP is located in the southeastern region in São Paulo State, the richest and the most populated state in the country, while UFRPE is situated in the northeastern region, a state without a representative forest plantation area. ESALQ/USP is frequently cited as one of the best agricultural universities in the world and the first in Latin America and Brazil and served as a reference, while UFRPE is ranked number 10 in Brazil and number 12 in Latin America.

Initially, we used the management system of the institutions to search for the percentage of forest engineering students who entered and graduated from the program.

Subsequently, a survey was carried out with the information of graduates in two distinct periods—between 2008 and 2017 and between 2018 and 2022—at both universities. The research was carried out in two cohorts because there were changes in the sector and actions in the universities that could modify the responses in the second period. We collected data on graduates individually in person through the curriculum vitae platform from the National Council for Scientific and Technological Development (CNPQ) or through social media (LinkedIn, Facebook, WhatsApp or Instagram).

For each one of the graduates, three divisions were established. The first division comprised those 1. working in the forestry industry; 2. working in forestry-related industries; 3. working in other industries; or 4. seeking employment. The forestry-related industry is defined in this study as fundamental disciplines in the forest engineering curriculum that may not be directly associated with forest sciences, for instance, data analysis, general business management and operations, and teaching in primary education, among others. We consider as forestry or forest sciences those authorized by the Regional Council of Engineering and Agronomy, namely silviculture, dendrology, forestry and reforestation, genetics and forest improvement, forest seeds, forest nutrition, forest physiology, forest soils, forest protection, forest management, forest economy, forest policy and legislation, forest administration, dendrometry and forest inventory, forest photointerpretation, forest planning, forest techniques and operations, forest exploitation, forest mechanization, technology and use of forest products, anatomy and identification of forest products, physical–mechanical properties of wood, wood–water relations and drying, wood treatment, mechanical wood processing, wood chemistry, wood resins, pulp and paper technology, nature conservation, forest hydrology, wildlife conservation, conservation of hydrographic basins, recovery of degraded areas, and energy from forest biomass.

The second division pertains to the predominant types of jobs, which were categorized into six distinct groups: (1) public sector, including positions in municipal offices, inspection bodies, forest service, political positions, and management of public parks; (2) academic sector, involving graduate, postdoctoral, and research positions within higher education and research institutions, such as universities and the Brazilian Agricultural Research Company (EMBRAPA); (3) forestry sector, comprising forest engineers working in verticalized companies that have staff in the forestry field, managing areas between 20,000 and 1.3 million ha; (4) business owners, including those who decided to open their own business or to work on the family property; (5) third sector; and (6) consulting jobs and small companies providing services in general.

The last group was organized based on the overarching categories of forest sciences, which comprises four specific fields: silviculture and forest management, conservation of natural resources, forest products, and mixed activities. The mixed activities category includes scenarios where the work of professionals cannot be clearly classified into one of the groups, for instance, professionals involved in work related to the carbon market, where they consistently deal with both forest plantation and native forests.

2.2. Number of Forest Engineers Working in the Forestry Companies

A survey was conducted among forestry companies affiliated with IPEF to estimate the number of forest engineers employed by these companies in June/2018. We invited 17 companies to participate in the survey (Aperam, AVB, Arcelor Mittal, Bracell, Cenibra, CMPC, Dexco, Eldorado, Eucatex, Gerdau, Klabin, Ramires, Suzano, Sylvamo, Vallourec, Veracel, WestRock), and 100% of the companies responded. The survey was distributed electronically via email or social media (e.g., WhatsApp) in May 2018. This survey aimed to assess the market demand for forest engineers in the sector of planted forests in Brazil.

2.3. Statistical Analysis

To compare the evaluations of ESALQ/USP and UFRPE graduates, we formulated descriptive statistics and applied the chi-squared test to determine significant differences in the distributions. We formulated a linear equation linking the number of forest engineers to

the planted area and assessed the assumptions of residue distribution and normal data distribution. The analysis and figures were developed in the Microsoft Excel® software 2016.

3. Results

3.1. Occupations of 2008–2017 Graduates

Between 2008 and 2017, an annual average of 32 and 23 students graduated from ESALQ/USP and UFRPE, respectively, accounting for 80% and 34% of the total number of graduates. The remaining students who did not graduate might have dropped out during the program or experienced delays; nevertheless, this information was not available.

Among the students who successfully completed the program between 2008 and 2017, the percentage of ESALQ/USP graduates working in the forestry industry was twice as much as that of UFRPE graduates (82% versus 40%). However, the combined percentage of graduates working in other industries and forestry-related industries was 12% and 39% for ESALQ/USP and UFRPE, respectively. Notably, the number of UFRPE graduates seeking employment was more than three times higher than ESALQ/USP graduates (21% versus 6%) (Figure 1).

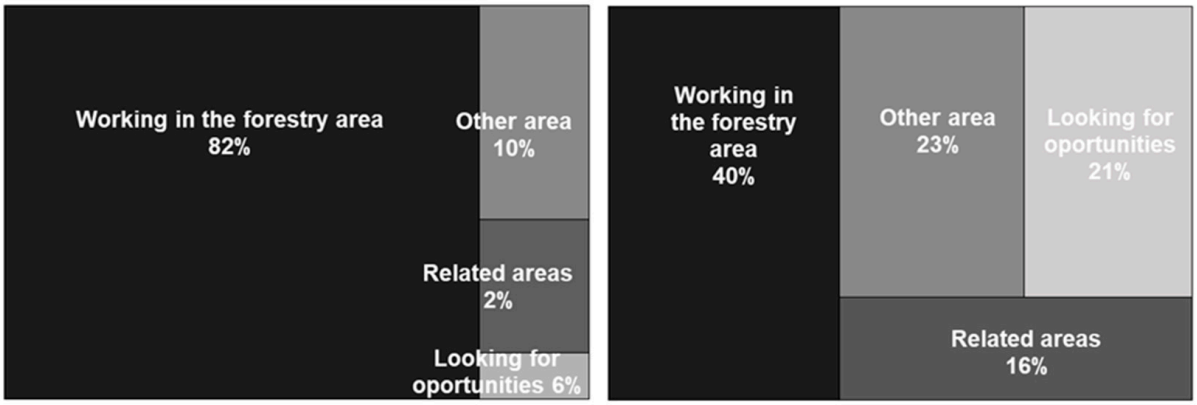

Figure 1. Percentage of graduates from ESALQ/USP (**left**) and UFRPE (**right**) between 2008 and 2017 who either work in the forestry industry, forestry-related industries, other industries, or are seeking employment. The chi-squared test presented a significance of $p < 0.0001$.

We observed a substantial disparity in the type of sector among the graduates employed in the forestry industry ($p < 0.0001$). Figure 2 depicts the dispersion of the different sectors in which graduates from ESALQ/USP and UFRPE are employed. Private companies linked to the forestry sector employ the largest portion of ESALQ/USP graduates (28%), while only 2% of UFRPE graduates work in the forestry sector. On the other hand, the academic sector prevails and UFRPE employs 45% of graduates, whereas ESALQ/USP employs 28% of graduates. This category includes researchers, professors in universities and research institutes, as well as graduate students at master's and doctoral levels. Furthermore, professionals who established their own business or work in a family-owned business represented a similar percentage at both institutions, accounting for 14% and 23% of graduates at ESALQ/USP and UFRPE, respectively. The performance in the public sector was nearly three times higher at UFRPE (24%) compared to ESALQ/USP (9%), while the performance in small companies or consulting companies showed similar percentages between the two institutions. Finally, the third sector had a presence at ESALQ/USP (7%); however, it did not appear to be a source of employment in UFRPE.

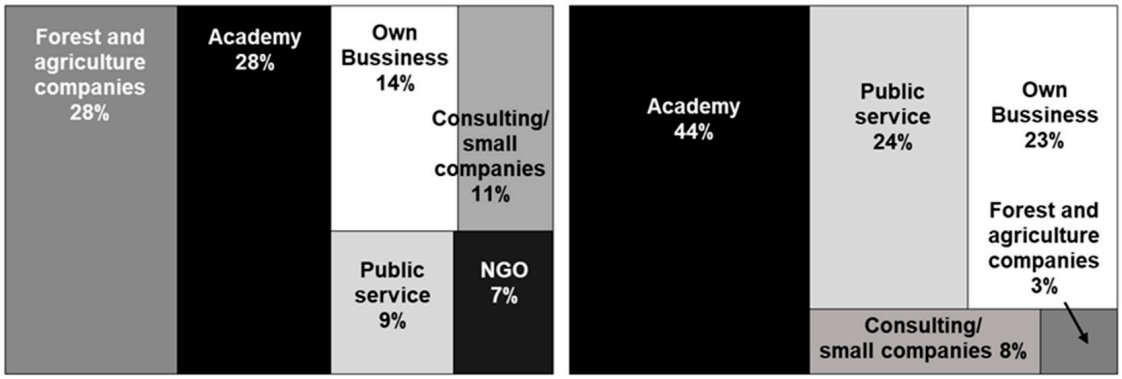

Figure 2. Percentage of ESALQ/USP graduates between 2008 and 2017 employed in the forestry industry and their distribution across various sectors, including the forestry sector, public sector, academic sector, own business, consulting and small companies, and the third sector. The chi-squared test presented a significance of $p < 0.0001$.

3.2. Occupation of 2018–2022 Graduates

One prominent characteristic is that only 39% and 20% of the freshmen who should have graduated during this time period (2018–2022) (400 at UFRPE and 200 at ESALQ/USP) actually did, indicating a dramatic effect caused by the COVID-19 pandemic. Although we did not have access to data on dropouts during this period, the number of college dropouts possibly increased significantly.

In relation to graduates, 5% from UFRPE and 6% from ESALQ/USP were not located. The percentage of ESALQ/USP graduates working in the forestry industry significantly increased from 80% to 97%, while UFRPE graduates rose from 41% to 73% (Figure 3). It was observed that a significant number of ESALQ/USP graduates moved to other professional sectors and the number of unemployed individuals was minimal, near zero. On the other hand, the number of unemployed UFRPE graduates decreased by 9%. The most substantial decreases were evident in graduates working in other sectors, which declined from 14% to 6%, and in related sectors, which decreased from 23% to 9%.

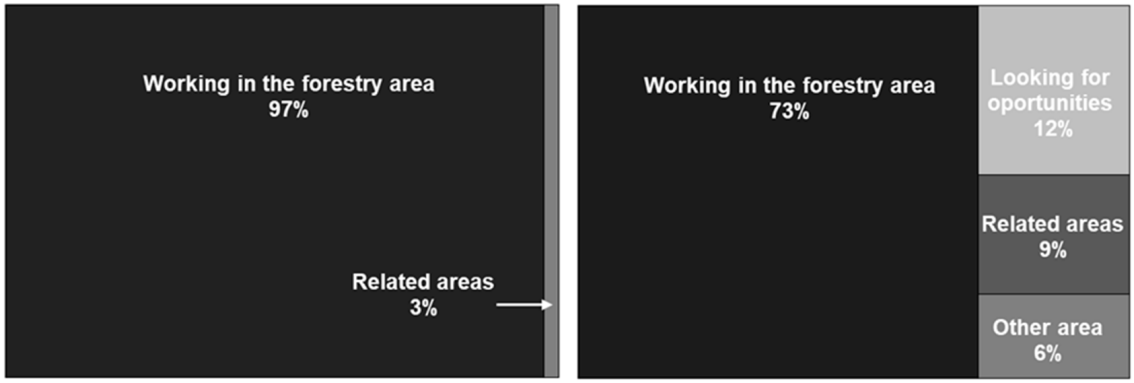

Figure 3. Percentage of graduates from ESALQ/USP (**left**) and UFRPE (**right**) between 2018 and 2022 who either work in the forestry industry, forestry-related industries, other industries, or are seeking employment. The chi-squared test presented a significance $p < 0.0001$.

In the second cohort, there was a significant transformation in both institutions regarding the type of career pursued by their graduates (2018–2022). At ESALQ/USP, the number of graduates working in small and consulting companies increased from 11% to 49% (Figure 4). This shift was accompanied by a decline in the academic sector (from 28% to 10%), own-business ventures (from 14% to 10%), and third sector (from 7% to 2%). However, the proportion of graduates engaged in companies related to agriculture and forestry remained steady at 30%, with a minimal change to 28%.

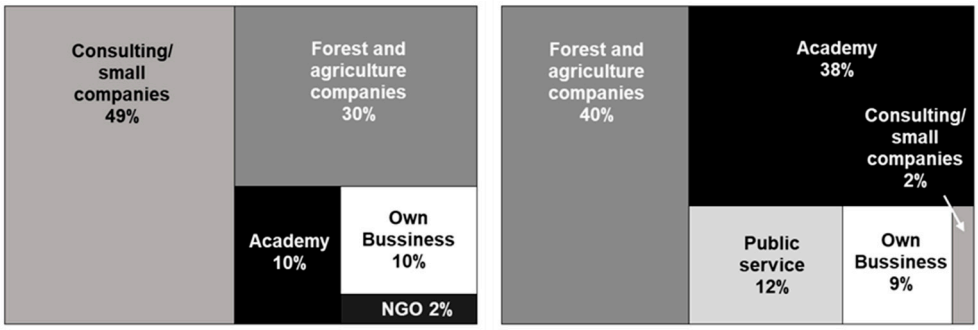

Figure 4. Percentage of ESALQ/USP graduates between 2018 and 2022 employed in the forestry industry and their distribution across various sectors, including forestry sector, public sector, academic sector, own business, consulting and small companies, and third sector. The chi-squared test presented a significance of $p < 0.0001$.

On the other hand, UFRPE experienced its most notable change in employment in the private sector, surging from 2% to 40%. This growth came at the expense of academic sector positions (decreasing from 45% to 38%), public sector positions (from 23% to 12%) and graduates starting their own businesses (from 23% to 9%). However, the proportion of graduates involved in small companies and consultancies remained stable throughout this period.

Considering the 15-year study period, our findings reveal that 82% and 44% of graduates from ESALQ/USP and UFRPE, respectively, pursued careers in the forestry industry. A weighted average, considering both institutions, highlights the distribution of employment of graduates as follows: academic sector (32%), forestry sector (25%), own business (15%), consulting and small companies (13%), public sector (12%), and third sector (3%).

3.3. Areas of Knowledge

In the first cohort (2008–2017), ESALQ/USP graduates were primarily engaged in silviculture and management (47%), followed by conservation of natural resources (36%), mixed activities (13%), where professionals were not predominantly associated with a specific area of knowledge, and a small percentage in forest products (4%). Conversely, UFRPE presented an almost inverted profile, with graduates more involved in conservation activities (65%), followed by silviculture and management (21%), while mixed activities and forest products showed a pattern similar to that observed for ESALQ/USP graduates. Figure 5 depicts the dispersion of the different knowledge areas in which graduates from ESALQ/USP and UFRPE were employed from 2008 to 2017.

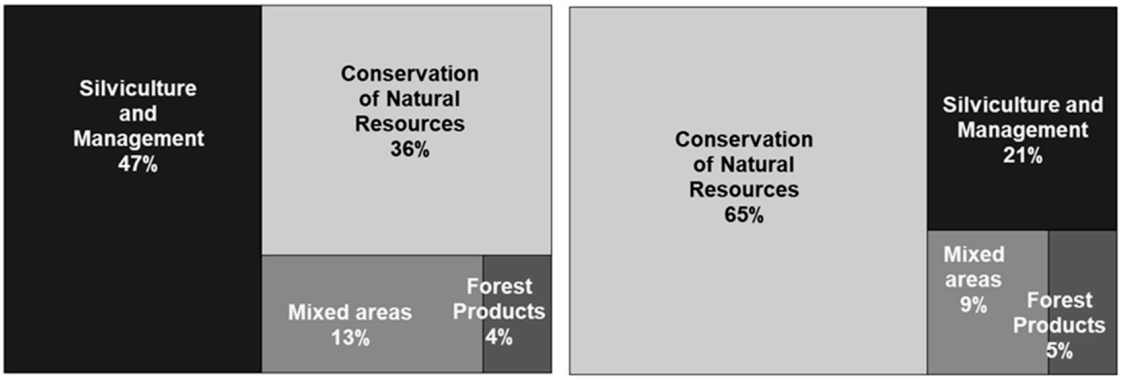

Figure 5. Division of employment of areas of knowledge of graduates from 2008 to 2017, highlighting the predominant occupations of graduates from ESALQ/USP (**left**) in silviculture and management and from UFRPE (**right**) in conservation of natural resources. The chi-squared test presented a significance of $p < 0.0001$.

There was a significant change in the second cohort (2018–2022) in both universities. Most ESALQ/USP graduates worked in mixed areas (60%), followed by silviculture and management (21%), while UFRPE graduates shifted from the predominance of conservation (36%) to silviculture and management, which represented 54%. In both cases, there is a clear scarcity of professionals working with forest products (3%). Figure 6 shows the dispersion of the different areas of knowledge where ESALQ/USP and UFRPE graduates were employed from 2018 to 2022.

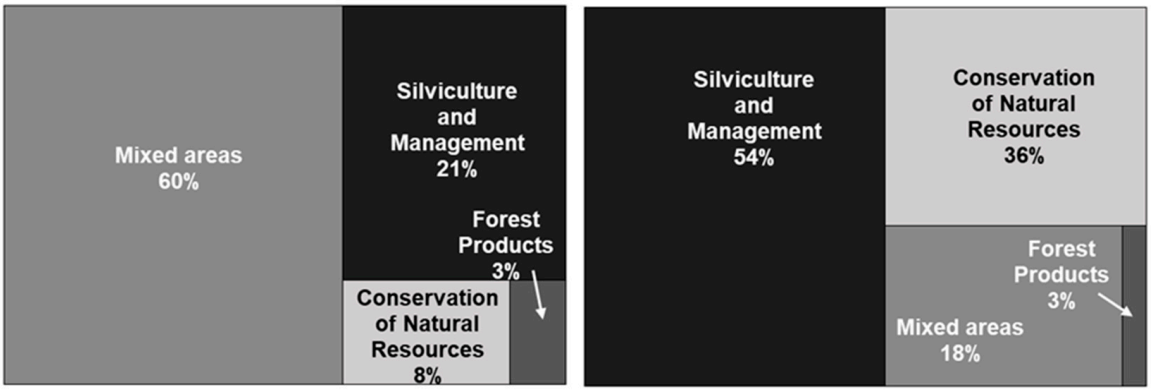

Figure 6. Division of employment of areas of knowledge of graduates from 2018 to 2022, highlighting the predominant occupations of ESALQ/USP graduates (**left**) in mixed areas and UFRPE graduates (**right**) in silviculture and management. The chi-squared test presented a significance of $p < 0.0001$.

3.4. Number of Engineers Working in Forestry Companies

We found an average ratio of one forest engineer for approximately 4000 ha of planted forests among the 18 companies interviewed, with the total number of forest engineers per company ranging from 2 to 650 (Figure 7).

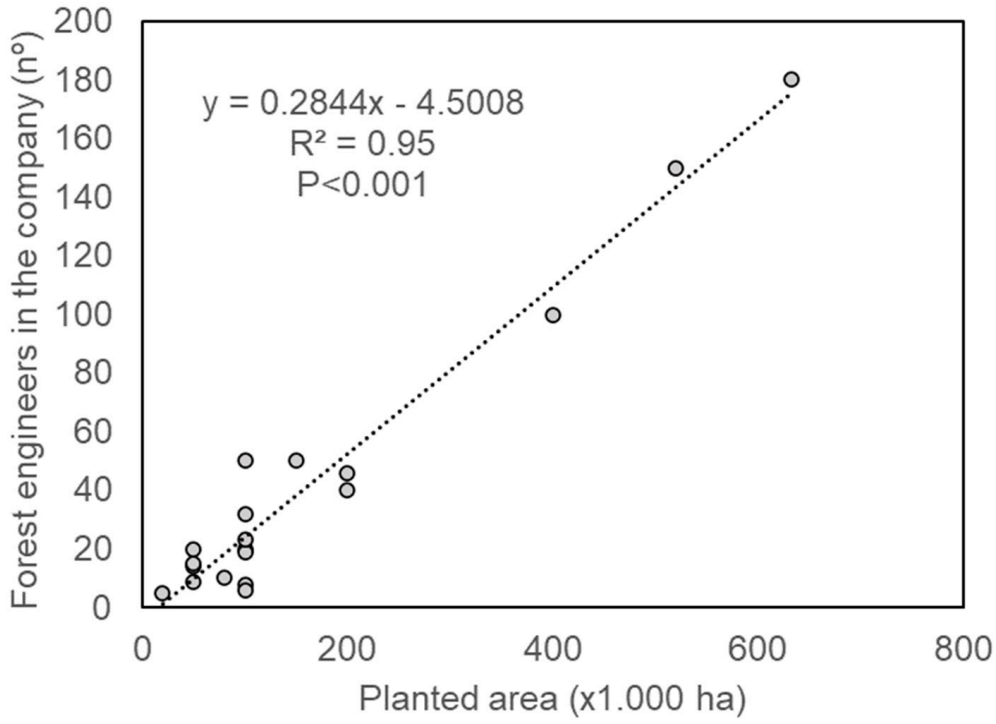

Figure 7. Linear relationship between forest engineers employed by forest companies in Brazil and planted area.

4. Discussion

4.1. General Comparison over a 15-Year Evaluation Period

The employment percentage in the forestry industry of ESALQ/USP graduates over the 15-year period was twice as high as that of UFRPE graduates (82% versus 44%). This difference can be partially attributed to the greater concentration of the economy in the state of São Paulo (accounting for 32% of Brazil GDP) compared to Pernambuco State (3% of Brazil GDP). Additionally, the global excellence of ESALQ/USP, ranked as the 16th-best institution of higher education in agrarian areas and the first in Latin America and Brazil [10], possibly played a significant role in the graduates' achievements.

The significant increase of 15% and 33% in the proportion of graduates from ESALQ/USP and UFRPE, respectively, working in the forestry industry between 2008–2017 and 2018–2022 (reaching 97 and 73%) highlights a highly competitive and dynamic job market in this industry. This observation is consistent with the findings of a survey conducted by Hakamada et al. 2023 [6], which involved organizations in the Brazilian forestry sector.

Understanding the requirements of forest jobs is very important to understand how the programs are connected with society's demand [11]. According to a global survey in forest education in higher education level [12], participants around the world pointed out that forest undergraduates had inadequate experience in forestry, with an imbalance between theoretical and practical classes. The results of the first period at the UFRPE revealed a very low proportion of graduates working directly with forest sciences, which could be attributed part of this disconnection with the job market. A study in Germany revealed 90% of graduates were employed after 12–15 months [9], a result similar to ESALQ during the full period, showing this could represent a standard of employment for the forestry courses.

As for UFRPE specifically, two major changes have been implemented based on the successful model of ESALQ/USP. ESALQ/USP places emphasis on actively involving students in work groups focused on practical experiences and extension and outreach activities and has served as model for UFRPE from 2018 to 2022. This approach appears to have played a crucial role in doubling the number of UFRPE graduates pursuing careers in the forestry industry.

Despite achieving high performance in recent program quality assessments [7] and the only institution in the northeastern region of the country offering a doctoral-level program in forestry sciences, UFRPE faced challenges in terms of a low proportion of graduates working in the forestry industry. The 2008–2017 cohort revealed that only 3% of graduates pursued careers in the forestry sector, despite the immense potential for job creation in the sector (Figure 5).

Two main actions were undertaken at UFRPE to increase the engagement of professionals in the forestry sector: the establishment of the Forest Practices Group (GPFLOR), a teaching and extension initiative to foster closer ties between students and the job market through internships and interaction with industry professionals. Field work is an integral part of the strategy to generate interest, fostering engagement, and presenting potential career opportunities in the forestry industry [13,14].

The GPFLOR brought together over 100 students from 2018 to 2022, implementing problem-based learning (PBL) methodology. PBL is an active teaching approach that involves students in real-world problems and situations closely related to the sector. This methodology provides students with the opportunity to acquire both theoretical knowledge and practical experience, leading to a more comprehensive and in-depth training [15]. Additionally, PBL nurtures essential entrepreneurial skills, such as leadership, problem-solving, teamwork, and autonomy [16].

The voluntary involvement of students in GPFLOR includes five projects overseeing the major areas of forest engineering, such as forestry and forest management, nature conservation, ecology, and technology of forest products [17]. The focus of the group is to provide intellectual capital for entrepreneurship and innovation in forestry sciences.

Finally, another initiative to enhance opportunities for students was to increase internships outside the university and foster greater interaction with professionals working in the forestry sector. Between 2018 and 2022, approximately 40 students participated in various work experiences outside the university particularly through collaborations with IPEF. These initiatives involved projects in partnership with forestry companies and ESALQ/USP. This collaborative relationship enabled students to engage with different areas of forestry through practical experiences in experimental plots at ESALQ/USP and to gain insights into the diverse aspects of forestry in real-life scenarios.

4.2. Potential of Updating the Program Curriculum Based on Diagnosis of Graduates' Performance

The curriculum of forestry engineering programs in Brazil follows the standard of engineering courses, focusing on fundamental subjects such as physics, mathematics, biology, and chemistry in the initial years. The course structure has remained similar since the 1960s, but like other engineering programs in Brazil, there is limited flexibility for changes, as the course content is regulated by the Ministry of Education and the Regional Council of Engineering (CREA). However, there is space for modernizing the teaching methods, enhancing the integration of theory and practice, and updating professional subjects to encompass the principles of forest science, aiming to support emerging technologies [18].

To address this discrepancy, it is important to strengthen entrepreneurship by introducing elective courses and incorporating the theme in complementary program activities. Currently, only about 15% of forestry engineering graduates work in entrepreneurial roles, and forestry programs in Brazil lack courses focused on this subject. Innovative practices with modern techniques, including assessment, can develop soft skills in addition to the technical content. Windmuller-Campione and Carter (2017) exposed its effects in graduate training by creating videos that can help students to develop ideas for future professional work [19].

Moreover, universities should enhance their focus on preparing students for the private sector. A survey found that 100% of human resources sectors and managers in forestry organizations recognize a shortage of well-prepared forestry professionals [6]. Additionally, attention should be given to the approximately 50% of graduates working in forest sciences who are directly or indirectly involved in management and administration roles (unpublished data). Soft skills and people and process management can be developed by extension groups, such as the GPFLOR.

Policies to strengthen the forestry profession should be supported by trade associations to enhance the employability of graduates. A classic example in Brazil is the authorization for agronomists [20] and biologists [21] to execute forest management plans, which has reduced demand for forestry professionals in the labor market. This scenario resembles the United States, where a growing lack of relevance for the forestry profession was observed [22,23].

Another action that can serve as a reference is the establishment of technical schools rather than of higher-education programs. For instance, Japan has a significant number of forestry technical schools compared to only two in Brazil. Emulating such models can enhance technical training and address specific industry demands more effectively.

Furthermore, addressing the issue of low funding for public universities, as reported in South Africa [24], requires the formulation of public policies to facilitate the process of public–private partnerships. Collaborative curriculum development involving not only university members but also stakeholders is crucial to align the educational programs with demands of society. Examples of successful collaborative efforts in curriculum development can be found in Vietnam [25] and Denmark [26].

4.3. Need for Balance: Analyzing Results of Areas of Knowledge

Another trend observed in the study is the prevalence of consulting and service companies engaged in mixed activities, rather than a prevalence of the specific sector. This is evident in professionals working in the carbon market, constituting 44% of ESALQ/USP

graduates between 2018 and 2022. Consulting companies in the carbon market are involved in various aspects related to forestry, management of planted and native forests, and conservation of natural resources. This exemplifies the evolving nature of forest engineering, aligning with its original purpose described in the first course descriptions [27] and reflecting its role in creating "healthy forest systems permanently capable of purifying the air, circulating water and supplying products essentials for our existence".

This scenario reveals a realm of entrepreneurs, small enterprises, and innovative companies that have coalesced around ESALQ/USP. They actively engage students during their undergraduate years and offer an appeal based on purpose, autonomy, and potential income, qualities often more attractive than those offered by larger corporations. This might mean an emerging market trend, where the number of direct employees within corporations diminishes while smaller enterprises are contracted to provide services. Perhaps this movement is something new that will extend to other regions. Large corporations may need to modernize their employment approaches by offering greater flexibility, enhanced purpose, and improved compensation. A recent survey on human resources in the forestry sector indicated that a significant proportion of organizations recognize that newly graduated professionals seek alignment with the company's values (52% of organizations) and prioritize achieving a better work–life balance (35%). This underscores the evolving expectations and aspirations of the workforce within this sector [1].

Although this study is a recent addition to the Brazilian forest environment research, we acknowledge its limitations. The analysis of only two institutions restricts the generalization of results to the entire country, and certain aspects, such as the reasons for graduates not pursuing careers in the forestry industry, could not be further explored. However, 15 years of sampling in two renowned institutions offer valuable insights into the employment trends of graduates. The observed surge in forestry-related activities in recent years can be attributed to increased exposure to practical experiences among young professionals and the encouragement of internships beyond the university, potentially serving as a model for other courses.

This diagnosis is not exhaustive, but it aims to lay the foundation for more comprehensive research involving other institutions and providing valuable input for the enhancement of forest engineering courses at both national and global scales. By collaborating on a broader scale, we can further understand the dynamics of forestry employment, promote career opportunities to graduates, and contribute to continuous improvement in forest engineering education.

5. Conclusions

This 15-year evaluation of forest engineering graduates from ESALQ/USP and UFRPE revealed valuable insights into their employment patterns and the dynamics of the forestry sector in Brazil. ESALQ/USP graduates demonstrated a higher engagement in the forestry sector compared to UFRPE graduates, partially attributed to the economic concentration in the state of São Paulo and the global excellence of ESALQ/USP as an institution.

The significant increase in the proportion of graduates working in the forestry sector in both institutions in 2008–2017 and 2018–2022 highlights the competitiveness and dynamism of the job market in this sector. The study highlighted the prevalence of consulting and small companies with mixed activities in the carbon market, reflecting the evolving nature of forest engineering and its significant role in creating sustainable forest systems.

The success of the second UFRPE cohort can be attributed, among other actions, to the implementation of GPFLOR and fostering closer ties between students and the job market through internships and partnerships. GPFLOR, applying the PBL methodology, effectively engaged students in practical experiences, leading to a remarkable increase in UFRPE graduates pursuing forestry careers.

Forestry companies affiliated with IPEF employed a large number of forest engineers with a general average of one professional for each 4000 ha of planted forests, showing themselves to be important actors in the job market for these professionals.

Despite its limitations, this study lays the groundwork for future research involving more institutions, offering valuable insights to improve forest engineering programs nationally and globally. Collaborative efforts and public–private partnerships are essential to balance the curriculum, align educational programs with society demands, and ensure graduates are well prepared to meet the challenges and opportunities in the dynamic forestry job market.

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