Trends in Brazil’s Forestry Education—Part 2: Mismatch between Training and Forest Sector Demands

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Abstract: This study used four surveys to capture perceptions of the current scenario of the forest sector and on the trends of the sector regarding human resources. The aim was to investigate the skills entailed by the profession from the viewpoint of professionals, taking into account job offers and the opinion of new college graduates. All surveys were analyzed using proportions and mean estimates. The first survey on forest organizations indicated a shortage of qualified professionals for the job market as well as a lack of training in behavioral skills (soft skills), pointed out by 100% of the organizations surveyed. We identified a gap between the importance given to certain skills and the performance of new college graduates in their academic training. Behavioral skills, such as communication, problem solving, leadership, and proactivity were considered of high importance; nevertheless, new graduates usually lacked these soft skills. In addition, a gap was identified in areas of knowledge not traditionally addressed in forest-engineering programs, such as REDD+ mechanisms, carbon market, and landscape management. The third and fourth surveys point to a convergence between job requirements from candidates and the responses of new graduates about the skills they consider important for their professional career. A three-line discussion is suggested, encompassing extension activities and professional experience in the academic world, bringing academia closer to job-market requirements, and including curriculum changes to follow current trends.

Keywords: skills; employers; higher education; professionals

1. Introduction

Civilizations have built their history through the use of forest resources [1]. Currently, more than 2.4 billion people use wood as a source of energy worldwide and one in five inhabitants makes constant use of non-timber forest products [2]. In response to the growing importance for the sustainable use of forest products, the first forest-engineering program was created in Germany in 1811 [3]. In the United States, the first program was initiated in Biltmore in 1898 [4], while in Brazil, the first program was established at the Federal University of Viçosa, Minas Gerais State, in 1960, through a partnership supported by the Food and Agriculture Administration (FAO), also due to the growing demand for forest products [5].

Professionals in the forestry sector have a large array of areas to work in, namely silviculture and forest management, nature conservation and ecology, and forest-product technology, to name the major areas [6]. Most sustainable development goals (SDGs) are aligned to the academic forest-engineering programs, such as affordable and clean energy [2]. Forests cover 4 billion ha worldwide [7] and the global forest sector has a total contribution of US$1.3 trillion to the global gross domestic product (GDP) [8]. In Brazil, the forest sector represents important numbers in the economy, accounting for 1.1% of the GDP and 6.9% of the industrial GDP, in addition to generating more than 3.8 million direct and indirect jobs [9].
New forestry programs are implemented each year in universities in Brazil with an increase from 43 to 75 programs between 2008 and 2022, while the number of trained forest engineers rose from 850 to 1850 a year [10], reinforcing the importance of this profession from a strategic viewpoint for the country. Nevertheless, the increase in the number of programs and graduates may not necessarily result in qualified professionals to meet the job market demands, since the quality of training programs at institutions may not be adequate. The modern university worldwide is evolving into a more professional environment, seeking to prepare graduates to solve real problems in society [11] and not only the aspirations of the academy itself; however, the level of commitment of science sectors, such as forestry, to following this trend is not known.

Therefore, understanding market demands has significant importance for making changes in the forest-engineering curriculum at universities and improving forestry programs [12]. Many studies have assessed the proficiency of new graduates in important skills for professional preparation [13–15] to identify areas to be improved and focused on in forestry programs. These investigations have been conducted in consultation with professionals beyond the academic sphere, including forest managers and market experts. In Brazil, only one study has reported on perceptions of undergraduate students about forestry courses [16]; therefore, more comprehensive data through empirical evidence are needed to support the improvement of forestry courses at Brazilian universities.

Another avenue to better understand job-market requirements involves the evaluation of competencies highlighted in advertisements for job positions in the industry. A study of job advertisements for 234 positions for forestry graduates showed that 72% of these advertisements required some knowledge of mapping technology [14], highlighting that understanding the market requirements could help program coordinators and the academic society to adapt the course curriculum to meet the demands.

Thus, our study aimed to capture the perception of the forestry sector regarding the current scenario and trends regarding human resources and to investigate the importance and performance of some skills of new graduates from the perspective of professionals in the forestry sector by investigating the skills required by job offers and by capturing the opinion of new graduates in forest engineering. We grouped four surveys to reach the objectives. In the first survey, where the first objective was covered, interviews were conducted with organizations related to the Forest Research and Technology Institute (IPEF) to capture the main perceptions of the current scenario regarding human resources. The next three surveys were carried out to cover the second objective. The second survey aimed to obtain an insight into the performance and importance of 46 skills from professionals belonging to various segments of the forestry sector, based on Brown et al. (1998) [13] and Sample et al. (2015) [12]. The third survey captured the job requirements for forest engineers, while the fourth survey aimed to capture the perception of new graduates (up to 5 years after graduation) on the skills they consider the most relevant for professional performance as well as the main gaps in their training during their undergraduate course. Information obtained in this work may be useful to improve forest-engineering programs around the world, mainly in Brazil. Finally, three lines of work are proposed to improve the training of forestry students as a way to encourage curricular changes.

2. Materials and Methods

2.1. Interviews with Human Resources Personnel and Forest Managers

Firstly, we interviewed human resources managers of organizations and IPEF managers and directors. IPEF is a cooperative forest research institute that operates in partnership with the main stakeholders of the forestry sector in Brazil. We interviewed personnel for 15 companies associated with IPEF and from IPEF itself. The interviews are carried out with actors linked to the sector, namely two non-governmental organizations (NGOs), four consulting companies, and three enterprises that supply inputs and equipment to other companies in the sector, totaling 24 organizations. Organizations were selected based on their relevance to the country, recognized as references in their fields. The interviewees
answered a semi-structured questionnaire on the current scenario and trends of human resources in the Brazilian forestry sector. The answers were grouped as descriptive statistics with the percentage of companies that indicated a certain answer. The interviews lasted between 40–90 min and were recorded for further details.

2.2. GAP Analysis of a Questionnaire Applied to Professionals on Relevant Skills and on the Training of New Graduates

The questionnaire was carried out using the Google Forms® tool and responses were collected from 35 professionals from academia, namely program coordinators or professors that comprise the Structuring Teaching Core, a committee to periodically evaluate the course curriculum, and from 35 professionals in the labor market that work for companies, consulting firms, governmental offices, and NGOs. The questions concerned two aspects related to the skills and competences of new graduates. The first question regarded the importance of that skill for new graduates when acting professionally, while the second question concerned the training level of new graduates for that skill. The questionnaire comprised 50 questions and respondents scored from 1 to 5, with 1 being the lowest and 5 being the highest rating. The descriptive statistics were prepared with the average for each skill in terms of the importance and training level of new graduates. A gap analysis was elaborated based on Arevalo (2010) and Mgaga and Scholes (2019) to analyze which skills were considered most relevant and the main gaps in course curricula [17,18].

2.3. Survey of Job Advertisements Using Social Media, E-Mail, and Company Websites

In this survey, a sample of 200 job offers announced on social networks (LinkedIn, Facebook, WhatsApp, Instagram, and Telegram) were searched as well as offers announced on company websites from July 2018 to April 2023. All skills, knowledge, and job requirements were grouped into the categories of technical skills, that is, those acquired during the undergraduate course program with a direct relationship to the curriculum in a forest-engineering course, such as forest inventory, silviculture, or mathematics; soft skills (teamwork or leadership skills); and personal skills (required for a particular job opening, such as a driver’s license or English skills).

2.4. Questionnaire Distributed to New Graduates about Their Perception of the Main Skills Needed

Finally, we sought to capture the critical viewpoint of new graduates of their training. We distributed a questionnaire to 55 professionals up to five years after graduation who work in the forestry-sector job market. The questions (i) investigated which skills the graduates consider most relevant for their professional performance and (ii) what gaps of knowledge/skills they perceive that could have been addressed during the forestry program. We grouped the top 10 skills and gaps cited and calculated their relative frequency against the total number of respondents.

2.5. Study Limitations

Our study has a great representativeness for forest-based companies. This sector hires a significant proportion of forest engineers in Brazil—circa 35% of graduates [19]; nevertheless, the group of forestry-based companies could be overrepresented. Another possible limitation is that in the fourth survey, we decided to collect the opinion of professionals currently employed in a job related to the forestry program, which represented most new graduates in Brazil (about 85%) [10]. Therefore, the opinions of unemployed professionals (about 6%) or those that are working in other fields (6%) could point to other aspects to improve in the course curricula at universities.

2.6. Statistical Analysis

A descriptive analysis was used in the four approaches of this research. In the interview with business managers and the human resources team, we carried out a proportion analysis, as we grouped the number of organizations that answered with the same response
and divided it by the total number of organizations. In the second survey, we presented the mean rates of each skill for all 70 respondents, with one value for importance and another for performance. In the third survey, a proportion analysis was performed for each skill required in the job advertisements. Finally, in the questionnaire with new graduates, we also applied a proportion analysis, with the percentage of graduates that responded with the same skill divided by the total number of graduates interviewed.

3. Results

3.1. Trends and Current Scenario of Forest-Engineering Jobs in IPEF-Connected Organizations

Brazil is experiencing a moment of increased job offers and a heated market, as highlighted by 74% of the organizations as a current scenario in our first survey. Besides this, 100% of the organizations studied recognized a shortage of professionals prepared for the current job requirements. In addition, all organizations pointed out that new graduates lack training in soft skills [10]. The survey also showed that new professionals displayed an adequate technological background (58%) and were autonomous in learning (58%), possibly related to a result pointed out by 65% of the interviewees who recognize a lack of adequate training in the management of operations and field activities for new professionals. The survey showed that newly employed professionals have a profile more connected to the values of the organization (52%) and search for jobs that generate a better balance between their professional and personal life (35%). Finally, 52% of interviewees recognize the need to improve their internal technical training of professionals, while 39% feel that they do not provide enough support for the technical training of newly hired employees.

Figure 1 shows the percentage of organizations that cited the scenario and trends related to human resources in the forestry sector in Brazil, in which two comments appeared for all 25 organizations: a shortage of prepared professionals connected to the real world and the low level of development of soft skills.

![Figure 1](image)

**Figure 1.** Percentage of trends and scenario of jobs in forest engineering in forest organizations.

3.2. Importance of Skills and Performance of New graduates

The most important skills indicated by professionals (20%) from academia and the job market were oral and written communication, problem-solving, proactivity, leadership and teamwork, practical experience outside of academia, use of analytical software data, use of the Excel program (Microsoft Excel 2016), use of basic forest statistics, project development and management, and silviculture of planted forests (Figure 2).
The dark bars in Figure 2 correspond to the first 20% of the largest gaps between importance and performance, encompassing problem-solving abilities, oral and written communication, project development and management, leadership and teamwork, practical experience outside academia, and proactivity. The other third is composed of REDD+ and clean-development mechanisms, integrated landscape management, and the carbon market.

Figure 2. Performance and importance of skills of new graduates according to professionals from academia and the labor market.

Two groups of gaps classified in the first quartile drew attention in Figure 2. In the first group, there is a set of behavioral skills classified as of high importance and low performance, such as oral and written communication, problem-solving ability, leadership, and proactivity. In the second group, a gap of skills in areas of knowledge not included as traditional in forest-engineering programs, such as REDD+ mechanisms, the carbon market, and landscape management.

3.3. Survey of Job Offers for New Graduates in Forest Engineering

Figure 3 shows the skills required with more than 10% frequency in 200 job offers to new graduates in forest engineering between 2018 and 2023 in Brazil. The vacancies were offered on the social media, by e-mail, and on the websites of organizations, where many skills are very connected to the level of importance observed in Figure 2. Job offers to forest engineers highlight the need for professionals with technical and/or practical knowledge in the work field. The second most required skill is the capacity to use the Excel program, although the desirable level is not specified in many job advertisements. An advanced English level is the third most frequently desired skill, with 43% of vacancies requiring an advanced level of the language. Soft skills are less frequent, being asked for in an average of 20% of the vacancies.
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### 3.4. Perceptions of New Graduates’ Skills’ Relevance and Importance

The skills considered most relevant by at least 50% of new graduates (<5 years) interviewed were oral and written communication, leadership and teamwork, programming and data analysis, soft skills in general, geoprocessing, and GIS techniques (Figure 4).

![Figure 3](image3.png)  
**Figure 3.** Skills required for job offers to new graduates in forest engineering between 2018 and 2023 in Brazil.

The same group of interviewees was asked about the main gaps during their academic formation in the forest-engineering program in Brazil. Most respondents mentioned that the main gaps were data management, practical classes, connection with the real world, people management/leadership, structure of program/forest chains, and current topics, such as climate change, environment, social and governance (ESG), and the carbon market (Figure 5).

![Figure 4](image4.png)  
**Figure 4.** Skills considered most important for new graduates (<5 years) who work in organizations linked to forest engineering. The questionnaire used essay questions; thus, their emergence demonstrates their relevance even with a relatively low percentage.
The perception of what new graduates consider relevant, as well as the large existing gaps, stand out, as observed in the responses that new graduates presented about the main skills needed for the profession. The interviewees in this group highlighted several characteristics as gaps in Survey 2 as well as the desirable characteristics of job offers in Survey 3, which should be addressed in order to align the adequate training and skills learning of forestry students to meet the job requirements. Of the 12 skills with more than 10% citations by new graduates, only two have syllabus content in academic courses, namely knowledge of data analysis and of Excel and GIS platforms, showing that this group of interviewees also recognizes the importance of soft skills, although this is not formally addressed in academic curricula in Brazilian universities. An example of the inclusion of formative subjects in soft skills occurs in Hong Kong, where a year of high school was reduced nationwide to increase the academic course by one year to provide training to
students on soft skills, such as leadership, problem-solving skills, critical thinking, and resilience, among other skills mentioned in the present study [24].

Three major actions are suggested to improve the forest-engineering program and better prepare forest engineers for the job market.

4.1. Extension Activities and Professional Experience

Universities are science-driven [25] and thus high value is given to research activities in the academic admission process and during evaluations during the undergraduate courses at universities in Brazil [26,27]. Ways to approach the academic world and the job market include the request that professors have professional experience before joining academia and extension activities. Activities that involve contact with companies, NGOs, and citizens in general improve the connection of professors and students with the requirements of professional activity. The characteristic most valued by students in professors was the ability to connect with the professional world [24]. A study carried out in the United Kingdom evaluated 200 vacancies for university professors [28] and showed that the PhD title was considered mandatory, while professional experience was desirable, showing that this profile occurs not only in forestry, but also in other programs. Pilcher et al. (2017) cited that students desire to be taught by professor with professional experience in the job market rather than purely academic experience [29]. Students argue that there should be a balance between professors who are theoretical and practical, since only a portion of graduates may pursue an academic career [30].

4.2. Bringing the Labor Market to Academia

All interviewees (100% of respondents) in the first survey highlighted the need to approach the labor market and the academic world at all levels. Generally, forest-based companies in Brazil are connected to universities and research centers through their research and development sector; however, operational areas, such as planning, forestry, and harvesting are distant from the university. Internship programs outside the R&D area within organizations should be encouraged. An example to be followed is the professional residency program in the medical field, where the professional needs to go through a residency period to become a specialist in a certain field. In 2020, a government-supported agricultural residency program was carried out, which provided scholarships to young graduates to work in organizations in agricultural areas, including forestry [31]. Three projects were approved involving the field of planted forests, and all seven residents, who have already completed their work, were hired by enterprises in the forestry sector, showing a possible model to be followed.

The Society of Forest Investigation [32] and IPEF [33] are clear examples of bringing the forest sector into contact with universities, where a scientific leader, normally a university professor, manages a project regarding a specific research line, for example, in watershed management (see example in https://www.ipef.br/promab/, accessed on 3 August 2023). This kind of interaction could be used as an example for the development of a conjunct action between universities and enterprises of the forest sector. Many outstanding forest-education practices worldwide can also be cited [34,35], for example, the Forests of the Future Project, an initiative lead by a group of an extension called the “Monte Olimpo Forestry Group” based in Piracicaba, Brazil. The idea of the project is to teach forest education to children of public schools in Brazil, while building the teaching skill of undergraduate students of the forestry program at the University of Sào Paulo (USP). Junior enterprises are other possibilities, which have been regulated in Brazil by law since 2016 [36]. These enterprises allow students to conduct career-related projects that do not require a higher level of experience. Many university departments offer services, such as soil and plant analyses, plant identification, and general training to society; therefore, these kinds of activities could strengthen the connection between the university and society.
4.3. Curriculum Modifications

The world has undergone many changes since the creation of the first forest-engineering program in Brazil (1960); nonetheless, the university course curriculum, in general, has not followed this transformation. The Brazilian population has tripled since 1960, from 72 to 210 million people [37]; conversely, the percentage of the population living in rural areas has decreased from 55 to 15% [37]. Population growth has increased the demand for forestry products; for instance, the world production of tissue paper (toilet paper, paper towels) rose from 3 to 35 million tons per year [38]. Another example is the açai fruit collected in the Amazon region in Brazil, which has become of the main non-timber forest products in the country. Açai production went from family-farming production concentrated in the northern region of the country to a large-scale production of more than 1.3 million tons per year [39]. The carbon market was not considered in the 1960s; however, currently companies, NGOs, and professionals specialize in quantifying and managing this market. The integrated crop, livestock, and forestry systems (or agroforestry systems) already occupy roughly 3 million ha, according to the ILPF Network, and are predicted to occupy 35 million hectares in 2030 [40]. Finally, forest restoration has always been a significant theme since the creation of the forestry program at universities in Brazil; nevertheless, only in June 2021 was the Decade of Restoration was launched by the United Nations, aimed at promoting the theme within societies [41].

There are numerous possibilities to change academic course curricula, but changes that bring students closer to reality are suggested. In Brazil, workload of college programs comprise 4100 h spread over 10 semesters and about only 5% of this workload is dedicated to internships, while 75% of the hours are allocated to required courses, making the course curriculum very rigid, not allowing time for training other skills of future forest engineers. Internships should be encouraged both at university laboratories and at external institutions, as suggested for university students in South Africa [18]. An initiative of the University of São Paulo (USP), São Paulo State, Brazil, was to implement a semester to be partially carried out inside forest experimental research stations that belong to the university. This required all undergraduates in the forest-engineering programs to spend an entire semester in practical field experiences in areas of watershed management, forestry, forest operations, management of natural parks, dendrometry, forest inventory, and environmental education. However, it is important to highlight some positive actions implemented in forest programs in Brazil; for instance, 10% of the course workload must be dedicated to extension activities [42] and 3% of the workload should comprise complementary teaching and research activities [10].

Another suggested change in the course curricula is to replace traditional computer classes for courses on data analysis, database management, and programming languages such as SQL, R and Python, as 48% of job opportunities in our survey required advanced knowledge of Excel (or a programming language) and 39% required knowledge of data analysis. Innes (2005) and Temu (2008) also report a mismatch with the traditional course curriculum, containing only technical courses. The authors point out that this curriculum model is outdated both for the labor market and for the scientific field, due to the intense focus only on specific areas, with a low multidisciplinary vision [43,44]. Some of the main gaps between the skills required by the market are the ability to work in groups and a ‘results’ orientation [17,45]; knowledge of current affairs, such as climate change [6,46]; ability to communicate [47]; basic computer skills; and soft skills, as well as adequate practical training programs [48], human-resource management, and business skills [49]. Ethics was also regarded as a gap to be filled [12], mainly in underdeveloped countries due to the high corruption level in bodies related to forest management, as observed in Ghana [50] and Latin American countries [51]. GIS techniques were being used 13 years ago by 43% of professionals trained in graduate programs in the United States [52] and currently 71% of these professional use GIS techniques almost daily [15]. A survey conducted in the United States showed that 72% of job offers for foresters required knowledge of some type of map
The use of the English language could be promoted, for example, through programs held virtually for different countries in which students from different parts of the world interact to discuss major current issues. English should be incorporated into mandatory bibliographies to motivate students to improve their language skills and consult other quality materials, mainly in high-impact scientific journals. The fundamental courses of mathematics, physics, chemistry, and biology play a crucial role in enhancing students’ abilities to solve problems and ultimately deepen their understanding of the world. In the context of forest-engineering programs in Brazil, these courses are typically offered in the first two years of study; however, it is during this initial period that a significant number of dropouts occur, as evidenced by studies in various federal universities in Brazil [53] and one common reason for these dropouts is the struggle with low grades, particularly in basic courses [54,55]. To address this issue, there is a need to consider a redesign of the course curriculum, focusing on building educational paths that connect basic knowledge to practical aspects of forestry by integrating the core concepts of mathematics, physics, chemistry, and biology into forestry courses. This allows students to see the direct application of these fundamental principles in their field of study, making the learning process more engaging and relevant. Another viable solution is to establish strong connections between the basic courses and the forestry program, and by demonstrating how these foundational subjects are intertwined with specific challenges and tasks faced by future forest engineers students can develop a deeper appreciation for their importance and relevance.

Subjects such as agroforestry systems, entrepreneurship, non-timber forest products, bioeconomy, forest energy, the carbon market, and landscape management should be part of the mandatory course content due to the topicality of the themes and as a way to attract future university students. The incorporation of extracurricular activities to improve interpersonal skills and management techniques require special attention, which could also be included in the course curriculum, as observed in Hong Kong in the case cited above [24]. It is essential to emphasize that all proposed changes must be aligned with federal laws, which impose a strict program for forest-engineering programs. Some institutions have opted to include elective courses as an alternative, for instance, the University of Sao Paulo (USP) has introduced elective courses such as wildlife management, urban silviculture, and climate change. A comprehensive discussion involving councils and society stakeholders is necessary to enhance the current course curriculum of forest-engineering programs in alignment with the current needs of the forest sector.

5. Conclusions

The present study does not seek to exhaust the theme, but to strengthen the discussion of the academic training of forest-engineering students in Brazil, which can be used in other regions of the world. Currently, graduates of forest-engineering courses in Brazil are prepared to meet the demands of the job market, according to the organizations that hire these professionals. There are important gaps mainly in aspects related to holistic competencies and the new areas of professional activity, such as the carbon market, REDD+ mechanisms, landscape management, and the mechanization and automation of forestry processes. Integration of the academic world and the job market should be sought to allow graduates to insert themselves into real-world problems. In this sense, actions should range from changes in structural aspects, such as the requirements to hire professors, to changes in the course curricula to implement modernization in the preparation of students to be lifelong learners and global citizens in an increasingly unpredictable future.

Among the curricular changes, actions that bring about more up-to-date content and that encourage students to practice problem-solving skills outside the academic world should be encouraged, such as an increase in the workload of internships and the creation of summer programs focused on practical activities.
Author Contributions: Conceptualization, R.H.; methodology, R.H. and S.F.d.B.F.; formal analysis, R.H.; writing—original draft preparation, R.H., S.F.d.B.F. and B.S.-R.; writing—review and editing, R.H., S.F.d.B.F. and B.S.-R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data is contained within the article.

Acknowledgments: The authors wish to thank all the forestry students and professionals involved in the large discussion conducted throughout Brazil to improve the quality of forestry education.

Conflicts of Interest: The authors declare no conflict of interest.

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