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Understanding green jobs in the forest sector: Findings from a systematic literature review

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ABSTRACT

The forest sector has undergone significant transformations driven by environmental and societal concerns, resulting in policies to promote sustainability, technological innovation, and the bioeconomy. These policies have had an impact on employment, with green jobs emerging as a potential outcome of an environmentally sustainable economy. However, for jobs to be considered 'green', they must meet criteria for decent work – criteria that are underexplored within the forest sector. This study conducts a systematic literature review (following the Reporting standards for Systematic Evidence Synthesis) to investigate what are green jobs in the forest sector, characterize these jobs and identify incentives that have promoted they. A total of 50 English-language publications were analysed. The findings indicated that while the forest sector has generated jobs with certain positive aspects of job quality (e.g., fair earnings), unfavourable characteristics persists (e.g., informal employment). Moreover, policies promoting green job often lack systematic assessment of the quality of the jobs they create. This study underscores the need for more robust data collection on job quality to inform policies that align sustainability objectives with decent work standards. It further revels the complex interplay between environmental goals and employment dynamics in the forest sector, emphasizing the importance of clear, operational standards for defining and supporting green jobs.

1. Introduction

Since the 1990s, the forest sector has undergone a substantial transformation. Some of these changes were driven by concerns pertaining to the environment and society. In response to the call for action to halt illegal logging, deforestation, and climate change, global policy agendas have been revised (ILO, UNEP, 2008). An increasing number of policy recommendations have addressed actions to support technological development (ILO, 2012b), the growth of the bioeconomy (Ronzon et al., 2022), sustainable trade and production of timber and non-timber forest products (NTFPs), and the need for planted forests (ILO, 2019). These supporting actions, which prioritise sustainability, have served to enhance the positive environmental impact of the forest sector. Nevertheless, the advancement of sustainability within economic sectors has also resulted in a transformation of the nature of work environments (ILO, 2013b; ILO, UNEP, 2008). For example, the advent of automation and mechanisation has transformed the forestry and wood-based industry, with notable improvements in productivity, safety and health for the forest sector workforce (UNECE/FAO/Forest Europe, 2020). However, these technological developments have resulted in a significant decline in employment and thereby underscoring the shortage of skilled workers (ILO, 2019).

Abbreviations: EFI, European Forest Institute; CEE, Collaboration for Environmental Evidence; CSR, Corporate Social Responsibility; FSC, Forest Stewardship Council; IFSA, International Forestry Student Association; ILO, International Labour Organization; ISCO, International Standard Classification of Occupations; ISDEC, International Standard Classification of Education and Training; ISIC, International Standard Industrial Classification; IUFRO, International Union of Forest Research Organizations; NACE, General Industrial Classification of Economic Activities; NAICS, North American Industry Classification; NTFP, Non-timber forest products; OECD, Organization for Economic Co-operation and Development; OHSAS, Occupational Health and Safety Assessment Series; PEFC, Programme for the Endorsement of Forest Certification Schemes; PICO/PECO, Population, Intervention (or Exposure), Comparator, Outcome; ROSES, Reporting standards for Systematic Evidence Synthesis; SA8000, Social Accountability 8000; SDG, Sustainable Development Goals; UNECE, United Nations Economic Commission for Europe; UNEP, United Nations Environment Programme.

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Concurrently, the forest sector has made noteworthy advancements with respect to its workforce, particularly in the realms of labour rights and social security (UNECE/FAO/Forest Europe, 2020). However, it is regrettable that informal employment persists as a prevalent phenomenon within this sector, with the majority of affected individuals being rural workers who lack viable alternatives to job opportunities (ILO, 2019). Moreover, the forest sector workforce continues to face challenges pertaining to job insecurity, unfair remuneration, gender disparity and insecure working environments (UNECE/FAO/Forest Europe, 2020). It is therefore unclear whether the actions taken to enhance the sustainability of the forest sector have yielded favourable outcomes for workers and professionals.

The forest sector provided employment for at least 33 million people worldwide between 2017 and 2019 (Lippe et al., 2022). These positions are often framed as potential green jobs, contributing to the transition towards a sustainable and greener economy (ECE/FAO, 2018; UNECE/FAO/Forest Europe, 2020). It should be noted, however, that for a job to be considered 'green', it must meet both environmental and social criteria to ensure genuine sustainability. The concept of 'socially equitable employment' refers to the provision of good, fair and decent work for both workers and professionals. Given the current state of knowledge and the shortcomings identified in the literature, it is imperative to investigate the extent to which the forest sector not only contribute to positive environmental outcomes but also meet the criteria of green jobs, particularly with respect to ensuring socially equitable employment for all workers involved.

1.1. Objectives of the review

This review study focuses specifically on the characteristics of green jobs within the forest sector at a global scale. Broader labour market trends and the development of green jobs in other sectors are beyond its scope and therefore only addressed briefly.

The main objective of this systematic literature review is to address the following research questions:

- What are green jobs in the forest sector?
- What are the key characteristics of green jobs with respect to decent work indicators and employment quality?
- What types of incentives have promoted green jobs in the forest sector?

The findings of this review aim to provide guidance and enhance understanding of green jobs in the forest sector. They are intended to support researchers, practitioners, consultants, and decision-makers by clarifying the 'green' characteristics of jobs in the forest sector, thereby helping to prevent misclassification of green jobs.

2. Terms and definitions

To address the research questions, it is first necessary to clarify key terms. This chapter provides definitions and conceptual delimitations that guide the scope of the review. In particular, it outlines the economic activities considered part of the forest sector for the purpose of this study. The concept of a 'green job' is introduced and its relevance for the forest sector is examined. Within the review, the term 'green forest job' is utilised to refer specifically to all forest-related jobs that contributes to the sustainable forest sector.

In addition, the chapter presents definitions of 'work', 'employment' and 'job', and discusses the principles of decent work as established by international conventions. Finally, five representative methods for assessing job quality across different economic sector are outlined, providing a framework for evaluating the social and economic dimensions of green jobs.

2.1. What is the forest sector?

Table 1 presents three different delimitations of the forest sector. The economic activities highlighted in grey are those considered to fall within the forest sector, according to the three different sources. The ISIC (International Standard Industrial Classification), NACE (Statistical Classification of Economic Activities in the European Community) and the NAICS (North American Industry Classification) codes provide harmonised systems for classifying economic activities. These classifications ensure comparability of data across countries and sectors, thereby supporting research, policy development, and economic analysis.

This review adopts the forest sector delimitation provided by the ISIC (Rev. 4) Code of the United Nations, which includes the economic activities of forestry, logging, wood products and paper manufacturing. The forestry and logging activity (ISIC Code 02) covers the production of roundwood and gathering of non-timber forest products (NTFP). It also encompasses silviculture and related activities, such as the operation of forest tree nurseries, conducting inventories, providing consulting services, timber evaluation, forest fire suppression and protection, pest control, and the transportation of logs within the forest (United Nations, 2008).

Wood products manufacturing (ISIC Code 16) includes a wide range of activities, such as sawmilling, wood drying and impregnation, production of wood-based panels, builders' carpentry and joinery, manufacture of wooden containers and the production of others items such as shoes heels, frames and handles for umbrellas (United Nations, 2008). The manufacture of furniture (ISIC Code 31) covers not only wood-based furniture, but also made from other materials, such as concrete, ceramic, or metal (United Nations, 2008). The latest revision of ISIC (Rev. 5) introduces a distinction between the manufacture of other furniture (ISIC Code 3102) and other furniture (ISIC Code 3101). However, full implementation of ISIC Rev. 5 is expected to take time. Finally, paper and paper products manufacturing (ISIC Code 17) encompasses the production of wood pulp and paper products.

2.2. What are green jobs?

The term 'green jobs' has been defined internationally by the United Nations Environment Programme (UNEP) and the International Labour Organization (ILO) as "work […] that contributes substantially to preserving or restoring environmental quality" (United Nations, 2008). This definition encompasses jobs that assist in the preservation and restoration of ecosystems and biodiversity, the reduction of energy, material and water consumption, […], and the minimisation or complete avoidance of all forms of waste pollution" (ILO, UNEP, 2008). Furthermore, in accordance to the ILO, it is essential that green jobs satisfy both, environmental and social criteria, emphasizing that they must also constitute decent work (ILO, 2013a).

Decent work is defined by the ILO as employment that is productive, provides adequate income and social protection, respects the rights of workers and affords them a voice in decisions that affect their lives (ILO, 2013a). Assessing work decency requires the evaluation of multiple criteria and indicators, which at the international level are guided by the ILO's Decent Work Agenda (see Table 2).

It is important to note that terms 'work' and 'employment' are not synonymous. In accordance with the ILO, work is defined as "any activity performed by persons (of any sex or age) to produce goods or to provide services for use by others or for one's own use". Work may be undertaken in both, formal and informal sectors. In contrast, the term 'employment' refers to all individuals of working age (typically 15 years old and above) who, during a specified reference period, were engaged in any remunerated of profit-generating work. A 'job' is defined as a set of tasks and duties performed by one person, whether in an employer-employee relationship or in self-employment (United Nations, 2008).

The report *Green Jobs in the Forest Sector* (ECE/FAO, 2018) identified

Table 1
Three different delimitations of the forest sector, by economic activity.

Economic activity	ISIC code (United Nations, 2008)	NACE code (European Commission, 2013)	NAICS code (BLS, 2013)
Forestry, logging	02	02	1133
Wood Product Manufacturing	16	16	321
Paper Manufacturing	17	17	3221
Printing	18	18	323
Manufacture of furniture	31	31	337

Note: ISIC (Rev. 4) – International Standard Industrial Classification; NACE (Rev. 2) – General Industrial Classification of Economic Activities; NAICS – North American Industry Classification.

Table 2
Decent Work Agenda by International Labour Organization - ILO (tripartite meeting of experts on the measurement of decent work – September, 2008).

Elements of the Decent Work Agenda
Employment opportunities
Adequate earning and productive work
Decent Working Time
Combining work, family and personal life
Work that should be abolished
Stability and security
Equal opportunity and treatment in employment
Safe work environment
Social security
Social dialogue, worker's and employers' representation
Economic and social context for decent work

19 potential areas of activity for future green forest jobs. These were organised into seven thematic areas, within which it was suggested that decent jobs could be created in a sustainable forest sector (Table 3) (ECE/FAO, 2018). The definition of 'green forest jobs' provided by the Ministerial Conference on the Protection of Forests in Europe (Forest Europe), encompasses employment that "provides forest-related goods and services while meeting the requirements of sustainable forest management and decent work" (Forest Europe, 2022). Sustainable forest management is defined as the responsible stewardship and utilisation of forests and forest lands in a manner that preservers their biodiversity, productivity, regeneration capacity, vitality and the potential to fulfil relevant ecological, economic and social functions, at local, national, and global levels (Forest Europe, 1993). This approach ensures that forest management does not negatively impact other ecosystems while promoting social equality (ibid).

The concept of green jobs, as defined by UNEP and the ILO, is broad in scope and encompasses employment across all economic sectors that contributes substantially to environmental protection and sustainability. In contrast, the definition of green forest jobs, provided by Forest Europe, is more narrowly focused on employment that delivers forest-related goods and services in line with the principles of sustainable forest management and decent work. Although both definitions emphasize the dual dimensions of environmental sustainability and social equity, they differ in terms of sectoral coverage. While green jobs encompass a wide range of environmentally sustainable occupations across the economy, green forest jobs refer are specific to the forest sector and its potential contributions to sustainable development.

2.3. Beyond decent work

The concept of decent work is inextricably linked to the broader notion of employment quality. In addition to the ILO's Decent Work Agenda (Table 2), several other frameworks have been developed to assess the quality of employment:

- The Sustainable Development Goals (SDGs) Global Indicator Framework includes 20 indicators related to employment quality (United Nations, 2017).
- The Organization for Economic Cooperation and Development (OECD) framework on job quality provides guidelines that focus on the evaluation of various aspects of employment, including but not limited to earnings quality, labour market security and the quality of the working environment (Cazes et al., 2015).
- The United Nation Commission for Europe (UNECE) framework on the quality of employment, comprises seven dimensions and twelve sub-dimensions, accompanied by a methodological handbook (United Nations, 2015).
- Eurofound has developed seven indices of job quality, based on factors independently influencing health and well-being. These include physical environment, work intensity, working time quality, social environment, skills and discretion, prospects, and earnings (Eurofound, 2024).

Table 3
Seven thematic areas of green forest jobs by ECE and FAO.

Thematic area
Wood and Energy Production
Agroforestry and Mountain Forestry
Social and Urban Development
Forest Management, Inventory and Planning
Biodiversity and Ecosystem Functioning
Health and Recreation
Education and Research

- The United States Private Sector Job Quality Index evaluates core aspects of working conditions, notable remuneration and working hours (Hockett et al., 2019).

Although none of these frameworks were designed specifically for the forest sector, they are applicable across all economic sector. Consequently, measuring employment quality in the forest sector requires an understanding of these terms, definitions, and existing methodological approaches.

3. Research design and methods

3.1. Systematic review

The investigation of green forest jobs and the assessment of employment quality in the forest sector were conducted in accordance with an established guideline and protocol for reporting evidence, the Reporting Standards for Systematic Evidence Synthesis (ROSES) (Haddaway et al., 2018). A systematic review approach was selected to ensure a comprehensive, transparent, and replicable synthesis of existing research. This approach is particularly appropriate for addressing clearly defined research questions, as it follows a structured protocol for identifying, selecting, and analysing relevant literature.

The first step involved the development of a systematic review protocol, aligned with the standards outlined in the ROSES guidelines. The review began with the formulation of a search strategy to systematically capture literature related to the identification of characteristics of green forest jobs. The identified literature was then subjected to a two-stage screening process, based on a set of predefined inclusion criteria. Only literature meeting these criteria were retained. Subsequently, a critical appraisal of the selected literature was undertaken, followed by data extraction and analysis. A detailed description of the critical appraisal process is provided in Section 3.4.

3.2. Search strategy

The search strategy began with the formulation of search strings aligned with the research questions. The selected keywords included the terms 'green jobs', 'forest' and their synonyms. The term 'green' was combined with synonyms of 'job' and, as decent work is a prerequisite for green jobs, the term 'job' and its synonyms were also combined with 'decent'. Given that 'green' and 'sustainable' are often used interchangeably in the environmental literature, the term 'sustainable' was likewise combined with synonyms of 'work' and 'employment'.

To ensure that evidence was captured across all current forest-related activities, the search string also included terms referring to the provision of forest goods and forest services. Two benchmark sources were used to identify synonyms for these activities: the report *Green Jobs in the Forest Sector* (ECE/FAO, 2018) and the report *Trends in forest-related employment and tertiary education* (Owuor et al., 2021). The latter study, conducted by the European Forest Institute (EFI), in collaboration with the International Forestry Student Association (IFSA) and the International Union of Forest Research Organizations (IUFRO), investigated trends in education and research within the forest-related sector (Owuor et al., 2021). It provided valuable insights, facilitating a more comprehensive understanding of this thematic area and is considered a key benchmark in the relevant literature. The complete search string adopted in this review is presented in Table 4.

The literature search was conducted in January 2024, using English language search terms combined with Boolean operators to construct the search strings. Documents containing any of the keywords in the first set of parentheses, together with any of the keywords in the second set of parentheses, were systematically identified and selected for review. The databased Scopus and Web of Science were used to retrieve documents, as both provided advanced search functions that allow search strings to be applied specifically to titles, abstracts, and keywords. In Scopus this functionality is activated with the operator *TITLE-ABS-KEY* and in Web of Science with the operator *TS*. Only peer-reviewed articles, conference papers and book chapters were included in this review. It should be noted that studies published after January 2024 are not included, which should be considered as a limitation of this study.

3.3. Review process: article screening and inclusion criteria

Given that the topic of green jobs in the forest sector is relatively novel, with limited statistical evidence and predominantly qualitative studies, this review included qualitative sources to ensure comprehensive coverage. After removing duplicates with reference management software, the remaining documents underwent a two-stage screening process based on predefined inclusion and exclusion criteria. These criteria followed the PICO/PECO framework – as recommended by the Collaboration for Environmental Evidence (CEE) guidelines (Collaboration for Environmental Evidence, 2013) (Table 5). PICO, or PECO stands for population, intervention (or exposure), comparator and outcome. This framework facilitates the formulation of precise research questions and guided the systematic inclusion of relevant evidence.

The first screening phase is conducted through a review of document titles, abstracts, and keywords. This process is undertaken to exclude

Table 5
PICO/PECO framework and the inclusion criteria applied for this review.

Indicator	Inclusion criteria for literature review
Population	The formal and informal forest sector workforce
Interventions or Exposure	Emergence of green jobs in the forest sector: The Green Forest Jobs
Comparators	Evidence of indicators to measure decent work and employment quality (characteristics of green and 'non-green' jobs) Evidence of incentives and good practice examples that potentially had created green jobs
Outcome	Understanding of what are green jobs in the forest sector

Note: The forest sector is defined in chapter 2. Terms and definitions in Table 1.

Table 4
The search strings.

First set of parentheses
("green job" OR "green employment" OR "green work" OR "green workforce" OR "green labour" OR "green labor" OR "green occupation" OR "green business" OR "green enterprise" OR "green career" OR "green profession" OR "decent job" OR "decent employment" OR "decent work" OR "decent workforce" OR "decent labour" OR "decent labor" OR "decent occupation" OR "decent business" OR "decent enterprise" OR "decent career" OR "decent profession" OR "sustainable job" OR "sustainable employment" OR "sustainable work" OR "sustainable workforce" OR "sustainable labour" OR "sustainable labor" OR "sustainable occupation" OR "sustainable business" OR "sustainable enterprise" OR "sustainable career" OR "sustainable profession")
Second set of parentheses
(*forest* OR silviculture OR *wood* OR bamboo OR timber OR lumber OR sawmill OR furniture OR carpenter OR pulpmill OR "pulp mill" OR "pulp and paper" OR "paper industry" OR bioengineer* OR "non-timber forest product" OR ntfp OR "non-wood forest products" OR nwfp OR arboriculture OR tree OR "ecosystem services" OR "nature protection" OR "biodiversity conservation" OR ecotourism)
Operation: (First set of parentheses) AND (Second set of parentheses)

irrelevant documents that do not meet the established inclusion criteria, as outlined in Table 5. The remaining literature was subjected to a second screening phase, comprising a comprehensive evaluation of the full text to identify and exclude irrelevant documents. Only studies that satisfied the pre-established inclusion criteria in both screening phases were retained for critical appraisal and subsequent analysis. Following this process, 20 % of the remaining literature was peer-reviewed by a second researcher to ensure consistency and reliability in the selection process. All documents excluded in the second screening or peer-review stage were listed and categorized according to the reason for exclusion.

3.4. Critical appraisal

The selected literature was then subjected to critical appraisal using predefined quality assessment criterion, aiming to minimise bias and ensure the integrity of the review process. Documents were excluded if they made only brief reference to green jobs in the forest sector without assessing employment quality or job decency. To be deemed relevant, a document was required to meet the mandatory criterion and at least one of two additional criteria:

- **Mandatory criterion**: The document must present evidence of decent work and employment quality within the context of a sustainable forest sector, which may be considered 'green'.
  - o **Additional criterion [indicator]**: The document presents characteristics of jobs in relation to employment quality, including investigation into decent work in the forest(−related) sector based on a clear understanding of relevant terminology. Documents that mentioned green forest jobs without evidence of employment quality or decent work were excluded.
  - o **Additional criterion [promotion]**: The document reports incentives that effectively promote social equality for forest workers and professionals, highlighting practices that improve employment quality and foster the development of green forest jobs. Documents failing to define 'green jobs' or assess job decency were excluded under this criterion.

The second screening and critical appraisal were conducted using *MAXQDA*, software for qualitative and mixed methods data analysis. *MAXQDA* facilitates the organization, coding, and interpretation of qualitative data, enabling systematic identification of key themes and pattern across diverse sources. By allowing structured coding, easy retrieval, and visualisation of relationships between concepts, the software enhances transparency, efficiency and replicability in synthesising findings.

3.5. Data extraction

Data extraction was conducted concurrently with the second screening and critical appraisal. Extracted information was systematically recorded and organised for accessibility. An Excel spreadsheet was created to record a set of pre-established parameters for each selected study (Annex 3). Where the literature referenced specific occupations or professions, these were coded according to the International Standard Classification of Occupations (ISCO-08) (ILO, 2012a). Educational qualifications of individuals performing work in the forest sector were similarly classified using the International Standard Classification of Fields of Education and Training (ISDEC) (UNESCO, 2014). The extracted data were subsequently synthesised and summarised, and the findings are presented in the following Research Findings chapter.

4. Research Findings characterization of reviewed documents

A total of 517 documents were identified in the first search conducted. Of these, 79 duplicates were removed using the reference management software *Citavi*. During the first screening phase, a further 307 documents were excluded. An additional eight documents were removed because they were inaccessible in full-text (two documents) or available only in foreign languages (six documents, of which three were in Serbo-Croatian, one in Mandarin/Chinese and one in Persian/Farsi). The second screening phase began with 123 documents and resulted in the exclusion of 55. The remaining 68 documents underwent critical appraisal, during which 18 were excluded. The final review sample therefore comprised 50 documents. A flowchart of the review process is provided in Annex 2, while the composition and characteristics of the final sample are illustrated in Fig. 1.

The annual growth rate of publications in this field was calculated at 17 % per year over the period 2008–2013, calculated using the Compound Annual Growth Rate (CAGR) formula. In terms of methodology, the majority of documents (75 %) reported empirical research based on the collection of primary data through questionnaires, expert interviews or by systematic literature reviews. The remaining 25 % relied on desk-based research, without primary data collection or the use of systematic protocols. The reviewed literature included case studies from 36 countries, with particular emphasis on the United States of America, Italy, Malaysia and Finland.

Of the 43 peer-reviewed articles (papers) included in the review (see *Reviewed Articles* in References), six were published in the journal *Sustainability* and five in *Forests*, both published by MDPI. A further two articles appeared in Elsevier *Forest Policy and Economics*. The remaining articles, conference papers and book chapters were published by a variety of other editors.

The findings are organised into three groups of evidence, each addressing a specific research question. The first group presents the identified evidence of potential green forest jobs. The second group describes the key characteristics of these jobs in term of employment quality. The third group explores the incentives that have effectively promoted social equality within the forest sector.

4.1. Evidence of green forest jobs

This section presents evidence of jobs in the forest sector involving activities that aim to preserve or restore environmental quality, reduce energy, material and water consumption through the avoidance of waste, or a combination of these. Given the lack of a consistent definition in the literature, the Forest Europe definition (see Chapter 2.2) of green forest jobs was adopted as benchmark for further analysis. The identified jobs were classified according to the seven thematic areas for future green forest jobs outlined in Table 3 (ECE/FAO, 2018).

The findings do not provide sufficient evidence to categorically affirm that these jobs are fully green. Rather, they appear to exhibit varying degrees of environmental orientation—what might be described as 'greener shades' when compared to conventional jobs. Notably, the reviewed literature does not document any job in the forest sector that meet all the decent work criteria associated with fully green jobs. The majority of jobs identified were associated with forestry, logging, and the manufacture of wood and paper products. However, evidence of forest-related jobs was also found in other economic activities, as presented in Table 6 in line with ISIC standards. A considerable proportion of jobs considered to exhibit 'greener shades' according to the Forest Europe definition, were located outside the traditional boundaries of the forest sector (Table 1). While the economic activities were not always explicitly labelled in the reviewed literature, the descriptions of sectors and tasks enabled their comparison with ISIC classifications, allowing for the identification of relevant sectors increasingly connected to forest-related employment.

For instance, in Ghana, seasonal wild mushrooms harvested from forests functioned both as dietary supplement and a source of income for rural communities (Ahenkan and Boon, 2010). In Bangladesh, homestead agroforestry systems provided food, medicinal plants, and fuelwood for rural households, with surplus products contributing to income generation (Ruba and Talucder, 2023). In the United States of America,

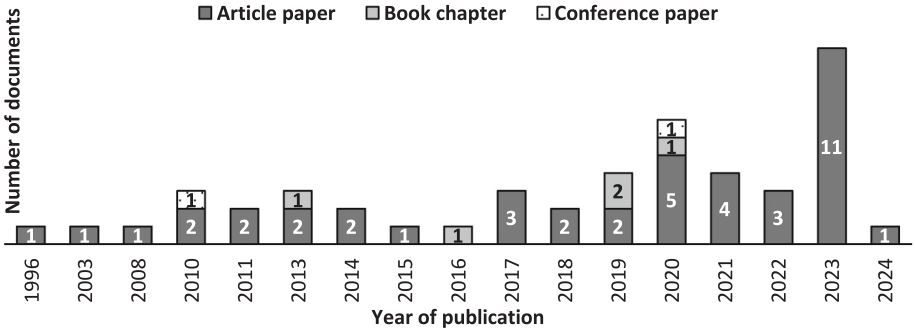

Fig. 1. Composition of documents selected for this review paper, categorized by type and year of publication.

Table 6
Economic activities (ISIC codes) for which there is evidence of forest-related jobs.

Section	Division	Description
C – Manufacturing	10	Manufacture of food products
C – Manufacturing	21	Manufacture of pharmaceutical, medicinal chemical and botanical products
C – Manufacturing	31	Manufacture of furniture
D – Electricity, gas, steam and air conditioning supply	35	Electricity, gas, steam and air conditioning supply
M – Professional, scientific and technical activities	70	Activities of head offices, management consultancy activities
M – Professional, scientific and technical activities	72	Scientific research and development
M – Professional, scientific and technical activities	74	Other professional scientific and technical activities
N – Administrative and support services activities	79	Travel agency, tour operator, reservation service and related activities
N – Administrative and support services activities	81	Services to buildings and landscape activities
P – Education	85	Education
O – Public administration and defence, compulsory social security	84	Public administration and defence, compulsory social security
Q – Human health and social work activities	86	Other human health activities
R – Arts, entertainment and recreation	91	Libraries, archives, museums and other cultural activities
S – Other service activities	94	Activities of membership organizations

sustainable and multifunctional edible landscaping enterprises generated jobs that not only supported food production through urban agroforestry but also contributed to mitigating urban challenges, such as the heat island effect by providing shade for pedestrians and the prevention of urban flooding through stormwater management (Robinson et al., 2017).

Further evidence of forest-related jobs was identified in the economic activities of travel and tour operation, where tourism depended heavily on high-quality forest ecosystems and labour of skilled workers and professionals (Charnley, 2011; Elliott and Lindley, 2017). Forest-related jobs were also observed in education, training, professional, scientific and technical services. In Australia (Mylek and Schirmer, 2015) and Mexico (Vázquez-Maguirre, 2020) forestry consultants were employed in diverse projects on environmental quality and sustainable forest management. In Brazil, specialized technical and consulting contributed to forest ecosystem restoration, including environmental licensing, reforestation, maintenance, and related services (Brancalion et al., 2022).

Another area where forest-related jobs were reported was within the manufacture of chemicals, pharmaceuticals and botanical products. These activities partly rely on forest resources such as lignocellulosic biomass. Multiproduct biorefineries were found to generate fine and specialized biochemicals in high demand, while second-generation biorefineries created both high-value biochemicals and biofuels, thereby stimulating forest-related job creation in the electricity supply sector (Santos et al., 2023).

Additional forest-related jobs were identified within policy and regulatory agencies, located in the broader economic sector of public administration, defence and compulsory social security (Mylek and Schirmer, 2015). Professionals in these agencies were tasked with improving the efficiency of business operations and regulating activities that contribute to well-being, research and development in the health, education, culture and environment sectors (United Nations, 2008). Further examples included employment within environmental, conservation and wildlife organizations (Manu et al., 2023), as well as within labour unions such as the Building and Woodworkers International, which relied on forest-related expertise in of activities of membership organizations (Bartley, 2010).

Overall, these findings highlight a wide and diverse range of emerging forest-related job opportunities across economic sectors beyond the traditional forest-based industries. Yet, for these positions to qualify as green jobs, it is essential that they are performed under conditions that comply with the ILO's decent work standards (ILO, 2013a).

4.2. Indicators of decent work and employment quality

The evidence of forest-related job opportunities was analysed and grouped according to the indicators of decent work or employment quality mentioned in Table 2. These indicators were used to distinguish job characteristics that could be considered positive (green) or negative (non-green). The reviewed literature provided examples of job characteristics across only some of the thematic areas defined by ECE and FAO (see Table 3).

Given the considerable volume of studies addressing the thematic area of *Wood and Energy Production*, the job characteristics identified within this area are presented separately in Table 7. In addition, six further examples of forest-related jobs exhibiting 'green' (positive) job characteristics in other thematic areas are compiled in Table 8. Since the literature did not systematically report job characteristics across all thematic areas, Table 8 presents only the available evidence together with the corresponding thematic areas.

However, the descriptions of the listed 'green' job characteristics do not provide sufficient detail to allow a complete assessment of the decency of working conditions. While these examples illustrate potential contributions to green jobs, they do not conclusively demonstrate compliance with the broader standards of decent work. The analysis of negative, or 'non-green' job characteristics—together with the recurrent absence of decent work and employment quality—is presented in the following section.

4.2.1. Non-green job characteristics in the forest sector

The reviewed literature shows deficits in decent work and

Table 7
Indicators of decent work and employment quality in the thematic area 'Wood and Energy Production'.

Job characteristics that indicate degrees of decent work and employment quality	Assessment method
Occupational and environmental safety in biomass power plants	Hazard Identification, Risk Analysis and Risk Assessment (Bo et al., 2014)
Continuous professional training within forestry workers	Survey with workers in Romania (Georgescu and Gliga, 2020)
Benefits to the employees after lean manufacturing implementation in furniture factories	Survey with wood and furniture companies in Malaysia (Abu et al., 2019)
Enhancement of social conditions within wood-based bioenergy exportation	Social Life Cycle Assessment (ISO 26000) (Martinez-Hernandez et al., 2022)
FSC certified furniture industry with wood dust measurement below the allowed limit	Assessment of the Sustainable Development Goals 8 on Decent Work and Economic Growth (Novelli et al., 2018)
Permanent employment in forestry with high degree of unionized workers within public companies	Interview with 268 forestry workers (Sporcic et al., 2023) and with 173 forestry experts (Šporčić et al., 2024)
Social enterprises and community-based enterprises that improved decent work and well-being	Social innovation framework (Vázquez-Maguirre, 2020)
One-year-training for workers who would operate a specific integrated system of pulp mills	Interview with managers of pulp mills in Finland (Ghosal, 2015)

Table 8
Indicators of decent work and employment quality in the forest sector by thematic area.

Thematic area	Job characteristics that indicate degrees of decent work and employment quality	Assessment method
Agroforestry and Mountain Forestry	I. Provision of training for farmers involved in agroforestry systems within the cocoa production. II. Homestead agroforestry that satisfies self-consumption and generates income opportunities, with high proportion of women engagement in Bangladesh.	I. Analysis of sustainability reports of cocoa producers at global scale and assessment of Sustainable Development Goals (Martins et al., 2023). II. Systematic literature review and assessment of Sustainable Development Goals achieved by homestead agroforestry (Ruba and Talucder, 2023).
Social and Urban Development	I. Higher wages to employees engaged in edible landscaping enterprises (urban agroforestry) than in the conventional landscaping type. II. Youth employment on training programs for urban natural resource management, with annual salary above minimum wage of New York State.	I. Semi-structured interviews, business model comparison, value potential and return-on-investment (ROI) scenarios (Robinson et al., 2017). II. Interviews with graduated students from the program, training programs are certified and entails education credits from the New York Botanical Garden (Falxa-Raymond et al., 2013).
Health and Recreation	I. Employment opportunities and job training during the Forest Service Recovery Act.	I. Semi-structured interviews, minimum wage (Charnley, 2011).

employment quality, particularly within the thematic area of *Wood and Energy Production*. A recurrent finding is the high prevalence of informal employment in the traditional forest sector (Cui et al., 2022; Larwanou et al., 2023; Lippe et al., 2023; Lippe et al., 2021; Mutta et al., 2021). For instance, a case study conducted in a forest village near Istanbul found compelling evidence that rural workers involved in wood production were offered neither decent nor green jobs (Selçuk et al., 2023).

In addition to widespread informality, the lack of adequate earnings emerged as a persistent challenge (Renner et al., 2008). A study on NTFPs trade in Ghana revealed that informality exposes collector to price and yield uncertainties (Ahenkan and Boon, 2010). Similar challenges were reported in Asia, where the collection of gaharu tree resin and wild bee honey was described as arduous yet yielded only low to moderate income (Bariyah, 2020). In the United States, NTFP collectors faced comparable low income levels, alongside severe deficiencies in social security (Lynch and McLain, 2003). Evidence from China further demonstrated that workers engaged in 'green occupations', such as tree planting, often received no remuneration (Cao et al., 2010). Comparable findings were reported in Brazil, where carbon credits and Payment for Ecosystem Services (PES) projects frequently excluded rural workers from benefit-sharing, with revenues from carbon credits sales failing to reach those safeguarding the forest (Greenleaf, 2020).

Informal sector jobs are not considered to be decent work and therefore cannot be classified as green. According to the Resolution of the Fifteenth International Conference of Labour Statisticians (15th ICLS), the informal sector is broadly characterised by low level of organization, limited separation between labour and capital, small scale production, and labour relations based primarily on casual kinship, or personal arrangements, without formal contractual guarantees.

The lack of productive employment and career prospects was also identified as a structural problem. Despite the recognised importance of training, several barriers hindered its implementation. In Turkey's furniture sector, enterprises acknowledge the value of a skilled workforce yet refrained from sending employees to training, considering it too time-consuming (Kepenek, 2013). In Uganda, the absence of trained personnel limited the potential of roadside plant nurseries to contribute effectively to biodiversity conservation (Mwavu et al., 2023).

Excessive working hours further undermine working conditions. In Portugal, workers in the pulp and paper supply chain reported long workdays (Santos et al., 2020). Comparable patterns patterns were observed in agroforestry systems in Malaysia and Indonesia, where rural workers often exceeded standard working hours and days, raising concerns about sustainability and work-life balance (Bariyah, 2020). While work-life balance and autonomy are fundamental decent work indicators (Mylek and Schirmer, 2015), they were largely absent from the literature reviewed. Notable, however, no evidence of child or forced labour was found.

Job stability and security, often measured through job tenure (the duration time a person has been continuously employed by the same employer) (United Nations, 2015), also proved problematic. In Brazil, the reliance on short-term contracts in restoration projects contributed to instability in employment (Brancalion et al., 2022). In the United States of America, seasonal and temporary work in conservation projects echoed similar instability (Charnley, 2011). In Russia, outsourcing practices in sawmilling hubs increased cyclical unemployment and reduced tenure, disproportionately affecting migrant workers (Apsalyamova et al., 2017). Similar issues were observed in Chile, where forest workers had limited social security (Meyer et al., 2019), and in China, where afforestation projects relied heavily on seasonal work (Pan et al., 2011). Interviews with 37 NTFP stakeholders in the United States of America further revealed challenged stemming from new permits requirements, including lack of social security and persistent gender imbalances (Lynch and McLain, 2003).

Inequalities in employment opportunity and treatment emerged as another critical issue. Gender wage gaps in Niger's wood charcoal trade contributed to rising rural poverty (Larwanou et al., 2023). Globally, women held the majority of part-time jobs in the forest sector (Lippe et al., 2021), yet the forest sector workforce remained male-dominated. The underrepresentation of women discouraged further participation in forest-related professions (Larasatie et al., 2020). Additional barriers to

gender equality included risks of harassment and discrimination in remote fieldworks, as well as cultural stereotypes – for instance, the portrayal of women in forestry advertisements in sexualised ways, contributing to the marginalisation of women and their 'expected' role in the forest sector (Larasatie et al., 2020).

Workplace safety was another major concern. Forestry and logging are recognised as high-risks occupations, demanding physical labour in challenging outdoor conditions (Apud et al., 2016; Maitah et al., 2020; Mylek and Schirmer, 2015). Although mechanisation has improved safety at work, injuries and occupational illness remain common. For example, forestry workers in Bosnia and Herzegovina described their work as dangerous (Sporcic et al., 2023). In Chile, forestry camps revealed severe deficiencies in basic hygiene and comfort (Meyer et al., 2019).

Beyond these deficits, the literature identified additional factors linked to employment quality. Certification schemes were frequently cited as indicators of improved labour conditions. By requiring compliance with labour rights and decent work standards, certification schemes such as FSC (Forest Stewardship Council) (Bartley, 2010; Bo et al., 2014), PEFC (Programme for the Endorsement of Forest Certification) (Blanc et al., 2019; Bo et al., 2014), and frameworks like SA8000 (Bartley, 2010) have helped mitigate informality and strengthen protections for workers. In North America, wood pellet mills certified under the Fiber Sourcing Standard demonstrated compliance with social, health, and safety requirements (Kline et al., 2021). In Chile, certification was associated with higher remuneration, longer job tenure, and improved working conditions (Meyer et al., 2019). However, acceptance of FSC certification remained limited in the Global South, indicating persistent challenges to broader implementation (Bartley, 2010).

Job satisfaction also served as an indicator of employment quality. Studies using worker surveys found strong correlations between satisfaction, workplace happiness, and perceived job security. In Lithuania, research in the furniture sector confirmed these associations (Stankevičiūtė et al., 2021), while earlier studies highlighted job satisfaction as a determinant of workforce retention (Strehlke, 1996). Training and career development opportunities were particularly relevant in fostering long-term satisfaction and retention.

Finally, Corporate Social Responsibility (CSR) practices were shown to enhance job quality where adopted. Evidence from Malaysia's wood and furniture industries suggests that enterprises assessing human rights and labour issues improved their contribution to sustainable development (Ratnasingam et al., 2023). In Finland, companies implemented additional frameworks, including OHSAS and SA8000, within their CSR initiatives (Toppinen et al., 2019). Such voluntary measures, while not universal, represent an important pathway towards improved labour standards in the forest sector.

4.2.2. *Methods to assess decent work and employment quality*

The reviewed literature revealed a general lack of comprehensive methods for assessing decent work and employment quality. Most studies concentrated on evaluating job opportunities, while the systematic assessment of decency and employment conditions remained underexplored. The most frequently applied methodological approach was the use of indicators drawn from the International Labour Organization's (ILO) Decent Work Agenda. Despite this, none of the reviewed documents conducted a full assessment encompassing all the elements of decent work (see Table 2).

The identified methodologies have structured, according to the specific indicators outlined in the Decent Work Agenda. Table 9 summarises the methods applied to evaluate the element of *Employment opportunities*. Table 10 presents the methodologies used to assess *Adequate earnings and productive work*. Tables 11 and 12 provide an overview of the the methods used to evaluate the *Safety of the working environment* and the *Economic and social context for decent work*.

The earliest attempts to develop methods for evaluating aspects of job quality in forestry introduced the concept of social criteria for sustainable forest management, focusing on job motivation and positive attitudes towards workers in logging and sawmilling operations in Tanzania, Fiji, Zimbabwe and Pakistan (Strehlke, 1996). Conducted in 1996, this study sought to capture the experiences and perspectives of forestry workers and facilitate dialogue to identify potential solutions to their challenges (ibid). Despite such early initiatives, the predominant

Table 9
Methods for evaluating employment opportunities identified in the reviewed literature.

Methods for evaluating: employment opportunities	Results
Estimation of visible and invisible global employment in the forestry and logging sub-sectors, integrating clusters analysis with labour productivity.	Visible forest-based employment by 28 million persons in FTE (64 million employed persons) (Lippe et al., 2021).
US Green Employment calculation, through monitoring of changes in worker and capital inputs.	Green percentage of employment in 29 industries in the United States of America (Elliott and Lindley, 2017).
Face-to-face semi-structured interviews with employees to identify the motivation to engage in a full-time employment in environmental restoration.	Worker's characteristics (sex, age race/ethnicity, education), and motivation to engage in environmental restoration activities (e.g., benefits to workers beyond steady income) (Falxa-Raymond et al., 2013).
Interview with workers in bioenergy plants in Italy, distinguished between local and non-local workers.	Worker's characteristics (number of employees and their origin (Nikodinoska et al., 2018).

Table 10
Methods for evaluating adequate earnings and productive work identified in the reviewed literature.

Methods for evaluating: adequate earnings and productive work	Results
Field survey via key informant interviews, questionnaires with NTFPs producers and sellers.	Worker's characteristics (sex, age, marital state, family size, education) and the share of NTFP importance on the total farmers income (Ahenkan and Boon, 2010).
Semi-structured survey among charcoal traders to characterize aspects of the stakeholders involved in the charcoal market.	Worker's characteristics (sex, age, number of children in the family, full-time/part-time and the share of charcoal in total income (Larwanou et al., 2023).
Calculation of the "unitary work income" (€/year/internal worker), based on the accounting results of four Italian companies.	Value between 31,140 and 59,488 €/year/internal worker (Blanc et al., 2019).
Survey of employees in Romania about training courses to identify training needs and perceptions of professional training.	Worker's characteristics (sex, age, seniority in work) and worker's opinions about the training courses attended (usefulness, appreciation, importance, compatible with aspirations, barriers) (Georgescu and Gliga, 2020).
Questionnaire on the skills of 171 young workers employed in the furniture industry in Turkey.	Lack of skilled workforce and most of the firms prefer not to implement training programs for their employees (Kepenek, 2013).
Expert interviews to examine the (un) intended outcomes of protected area management and related training and education in the context of community-based conservation.	Training and coaching events without an effective monitoring system (Manu et al., 2023).
Calculation of the wage gap (income differentiation between environmental and forestry sectors).	Labour market in environmental protection works more effectively than the labour market in forestry (Maitah et al., 2020).
Survey of plant nursery workers about knowledge and skill needs.	Worker's characteristics (sex, age, level of education, job tenure) and workforce with limited technical knowledge and skills (Mwavu et al., 2023).
Entrepreneur interviews and business model (canvas) comparison of edible landscapes.	Analysis of cost structure and hourly earnings of employees (Robinson et al., 2017).

Table 11
Methods for evaluating safe work environment identified in the reviewed literature.

Methods for evaluating: safe work environment	Results
Analysis of occupational risks in forest yards operations in Italy.	Risk Assessment Document to improve the found lacks of occupational and environmental safety (Bo et al., 2014).
Survey of workers in the Australian forest industry about wellbeing.	Worker's characteristics (sex, age, educational level, industry sector), information about general health and life satisfaction of workers, as well as about the physical risks associated with their work, work-related injuries and disease, formal and informal working conditions (Mylek and Schirmer, 2015)-
Test of emissions into the atmosphere in accordance with the EC Directive, 2004.	Wood dust content within workstations is below the limit value of 5 mg/m^3 (Novelli et al., 2018).

Table 12
Methods for evaluating the economic and social context for decent work identified in the reviewed literature.

Methods for evaluating: economic and social context for decent work	Results
Examination of correlation between macro-level determinants of informality in forestry.	Implication of identified determinants of informality (Education, economic conditions, institutional quality, International labour standards (ILS), forest product, forest certifications and deforestation) (Lippe et al., 2023).
Text mining analysis on corporate reports on sustainability of cocoa supply chain from agroforestry systems.	Reports that provide information about gender and education programmes and other social dimensions (Martins et al., 2023).
Performance of a Social Life-Cycle-Assessment (SLCA) and in the pulp and paper industry in Portugal.	Figures about labour rights and decent work, health and safety, human rights, governance and community infrastructure (Martinez-Hernandez et al., 2022; Santos et al., 2020).
Development of a sustainable business model for informal charcoal production, taking into account social, economic and environmental impacts, followed by interviews and workshops with key informants.	Worker's characteristics (sex, age, occupation), net income per work hour and identification of lacks of skills and competences to increase safety and efficiency in the production process (Mutta et al., 2021).
Labour productivity.	Real sales divided by total employees of 27 pulp and paper industries (Ghosal, 2015).
Interviews with workers, on compliance with Environmental, Social and Governance (ESG) criteria in the Malaysian wood products and furniture industry.	Worker's health and safety, minimum wage, minimum standards for housing and amenities, human rights (Ratnasingam et al., 2023).
Literature review on homestead agroforestry's potential to achieve Sustainable Development Goals (SDG) in Bangladesh.	Report of SDG 8 – Decent Work and Economic Growth indicators (Ruba and Talucder, 2023).
Interview with workers and forestry experts (managers, officers, executives and owners) on attitudes towards forest-related professions and worker shortage factors.	Worker's characteristics (sex, age, residence-settlement size, educational level, public/private sector, occupation), perception of decent work indicators (occupation health and safety at work, earnings and job satisfaction) (Sporcic et al., 2023).
Interview with furniture industry workers in Lithuania about job insecurity.	Worker's characteristics (sex, age, educational level, job tenure) and multiple regression results to test four hypothesis (Stankevičiūtė et al., 2021).
Social Innovation Framework.	Deep analysis of process of building indigenous social enterprises and their impact in the local community (Vázquez-Maguirre, 2020).

methodological approach employed in the literature has been the administration of interviews, questionnaires, and surveys to assess different dimensions of job decency and employment quality. Complementary methods focused on the analysis of workers' relationship with their workplace, including aspects such as job motivation and satisfaction. One possible instrument for measuring job satisfaction is the assessment of the Personal Wellbeing Index (Mylek and Schirmer, 2015).

Further methodological contributions can be found in the application of Social Impact Assessment, as demonstrated in a review paper examining multi-purpose biorefineries. This review confirmed that research remains limited in its treatment of social indicators beyond employment generation and income (Santos et al., 2023). The paper highlighted that employment quality assessments often fail to incorporate crucial aspects such as education, health and safety, and labour law compliance (ibid). In addition, the analysis of Environmental, Social and Governance (ESG) practices has been used as an approach to assess employment quality in wood and energy production, with a particular focus on labour issues and workers' health and safety (Ratnasingam et al., 2023).

4.3. *Incentives promoting green forest jobs*

This section examines the literature reporting on different types of incentives that have proven effective in promoting decent work and employment quality in the forest sector.

The findings compile evidence of good practices that have contributed to enhancing employment quality and fostering greater social equity among forest-related workers. The incentive programmes identified were initiated and implemented by a wide range of actors, including policymakers, regulators, and stakeholders with access to investment funds. Table 13 presents examples of good practice initiatives introduced at the governmental level, spanning municipal, state, and federal contexts. Table 14 summarises incentives initiated by other actors. While these tables provide illustrative examples of effective incentives, they do not claim to be exhaustive.

5. Discussion

This paper aimed to ascertain the characteristics of green jobs in the forest sector, drawing on existing literature to provide a detailed examination of the sector's prospects.

5.1. *Evidence of green forest jobs in the forest sector*

Although recent years have seen a notable increase in publications on green jobs, the actual existence of such jobs remains ambiguous. While the literature identifies a wide range of forest-related jobs aligned with green economy principles (Chabán-García and Hidalgo-Capitán, 2023), it often fails to systematically evaluate the quality characteristics of these jobs. This lack of comprehensive assessment risks producing a fragmented or misleading understanding of what constitutes a green forest job. Accurate identification requires the integration of both environmental and social dimensions, highlighting a critical knowledge gap regarding the extent to which forest jobs can be considered green, the skills they demand, and their alignment with principles of decent work.

The evidence indicates a broad spectrum of opportunities for green forest jobs, both within and beyond traditional boundaries of the forest sector. This underscores the importance of adopting a comprehensive perspective to fully capture the relevance and growth potential of emerging roles. However, the absence of a universal definition of the forest sector poses challenges, as its scope varies according to regional resource availability and utilisation. Recognising this variability is essential for accurately mapping and promoting both traditional and emerging forest-related jobs. Moreover, interest in forest-related careers

Table 13
Incentives for green forest jobs initiated by governmental actors.

Actions	Results
American Recovery and Reinvestment Act (Recovery Act) by the Forest Service	Investments in projects, including invasive plant control, the construction of a biomass power plant, wood pole and post mills, and the renovation of a research laboratory using wood-based construction, have accelerated the creation of environmentally related employment opportunities. Furthermore, these investments have facilitated job training for American Indians, offering full-time and family-wage positions (Charnley, 2011).
New forestry law in Italy (no. 34 of 2018)	Registered forestry companies should receive public funding and facilitate the training obligations for those engaged in work within the forest, as well as related investments (Blanc et al., 2019).
Revision of the National Forestry policy (2020) in Malaysia and formulation of a National Action Plan on Forced Labour	Support the protection of forests and biodiversity and combat forced and child-labour use in specific economic sectors (Ratnasingam et al., 2023).
Green Jobs Act (2007) in the United States	Financial support to establish job training programs in key renewable energy industries and other environmentally friendly practices (Elliott and Lindley, 2017).
Adoption of the legislation on relevant civil rights and litigation by the Federal Forest Agency of Russia	Incentives for the diversification process, which led to an increase in the number of women at the agency. Yet, mainly administrative jobs, rather than jobs that offer a career perspectives (Apsalyamova et al., 2017).
MillionTrees NYC Training Program (MTTP) and New York Restoration Project by the New York City Department of Parks & Recreation	Provided training in arboriculture, ecological restoration, landscape design, horticulture, use of pesticides and herbicides and chainsaws as well as training on 'Life Skills'. The MTTP initiative combined workforce development with workforce retention by providing training that facilitated employment and motivated young adults to become more active stewards of the environment (Falxa-Raymond et al., 2013).
System of Incentives for Environmental Services (SISA) by the Brazilian state of Acre	Enabled the sale of carbon credits to protect the Amazon rainforest that covers approximately 86 % of the state's land. SISA distributes the revenue of forest carbon's credits among rural workers framed as 'ecosystem service providers', including payment for those rural workers without land rights (Greenleaf, 2020).
National Strategy for Sustainable Development in Romania	Financial support to improve career perspectives of workers through vocational training (Long-Life-Learning) in forest-related sectors have established programmes for continuous professional training (Georgescu and Gliga, 2020).
New EU 2030 framework for climate and energy polices and the European Renewable Energy Directive and by the European Union	The EU energy policy framework underwent a reformulation, resulting in the creation of a system based on sustainable energy sources (Nikodinoska et al., 2018). The Directive increased the utilisation of renewable energy (e.g., wood pellets) in electric power plants, while also providing employment opportunities for residents in communities sourcing biomass. "Potential jobs involve sustainable forest management planning, processing, transportation, and maintenance in the mills, with spillover effects and investments in ports and corollary industries" (Kline et al., 2021).

Table 14
Incentives for green forest jobs initiated by one or more actors.

Actors	Actions	Results
Ministerial Conference	A work stream has been established with the objective of collaborating with the signatories and observers of the process on Green Jobs and Forest Education.	The incorporation of Green Jobs into the 2024 Ministerial Documents (e.g., The Bonn Ministerial Declaration and the Bonn Ministerial Decision), establishment of an Expert Group on the subject and relevant publications as well as policy recommendation for the pan-European region (Forest Europe, 2022).
Ministry of Labour and Employment, ILO and private sector	Workshop on Green Jobs Initiatives and Public Private Partnership in Bangladesh	Raised awareness on Green Jobs through a national assessment, complemented by a sector-based analysis and skills needs for green jobs (Bahauddin and Iftakhar, 2014).
Industrial sector	Lean manufacturing in Malaysia	Lean companies proved tangible benefit to the employees after implementing lean in wooden furniture industries (Abu et al., 2019).
Enterprises (public and private) and government	Tropical Forest Trust, World Wildlife Fund's Global Forests and Trade Network and the Timber Trade Action Plan	Actors have sponsored projects and consultancies to assist Indonesian forest concession holding firms in getting forest certification (Bartley, 2010).
Local Indigenous community and government	Creation of a community-based enterprise to provide the community with decent jobs and wellbeing	This enterprise is managed by the local political authorities that also rule the community: the Commissariat of Common Goods. This body is democratically elected every three years, and supervised by a general assembly and supervisory board. During the assemblies, the community can propose and examine different projects that benefit the community (Vázquez-Maguirre, 2020).
Local community and government	Community Fungi initiative	Training workshops and education on ecological sustainability in a forest village in Türkyie. They brought together local villagers, residents of gated communities, and scholars to emphasize vital ecosystem services by encouraging the co-creation of site-specific jobs(Selçuk et al., 2023)
Public Private Partnership	Cocoa and Forests Initiative	It has several signatories and operates as a management supporting organization by guiding the signatory members to use additional sustainability indicators that assess social equality and decent work in theirs public reports (Martins et al., 2023)
Building and Wood Workers International (BWI)	Declaration on Fundamental Principles and Rights at Work by ILO	Actors played a key role in Russia, improving the status of forest workers. Together BWI and ILO had included social criteria in the forestry certification system. Due to this, the labour conditions of some workers have improved (Apsalyamova et al., 2017)

appears linked to job type and education level, with research indicating a substantial rise in motivation among university students to pursue emerging fields such as biodiversity conservation, agroforestry, and outdoor-focused professions (Bal et al., 2020; Owuor et al., 2023; Rekola and Sharik, 2022).

5.2. Green forest jobs characteristics

While many forest-related jobs exhibit some green (positive) characteristics, significant deficits in decent work and employment quality persist, including informality, unsafe working conditions, and insufficient earnings. Even positive job characteristics, such as employment contracts and fair pay, indicate only partial adherence to employment quality standards (shades of green) and are insufficient to confirm that these positions fully promote decent work. The absence of a standardized set of criteria and indicators for green forest jobs hinders the specific assessment of their environmental, economic, and social impacts. Informality remains prevalent, and although child and forced labour were not reported in the reviewed studies, their absence in literature does not confirm their nonexistence.

None of the documented jobs fully satisfied the criteria for decent work. Many studies estimate potential green jobs in forest-related sectors without detailing methodologies or assessing employment quality. For instance, a case study from Bangladesh estimated green jobs in agriculture and forestry but did not evaluate decent work indicators (Bahauddin and Iftakhar, 2014). Similarly, jobs in the Italian bioenergy sector were automatically classified as green without assessment (Nikodinoska et al., 2018). Such misclassification underscores the need for robust methodologies and indicators for evaluating the quality of forest-related employment.

The concept of 'shades of green' illustrates the complexity of measuring green jobs, highlighting that environmental and social dimensions vary across roles (ILO, UNEP, 2008). The literature provides limited empirical evidence linking changes in occupational tasks to both environmental contributions and job quality. While task transformations may influence the greenness and decency of jobs, this relationship remains underexplored.

5.3. The promotion of green forest jobs

Evidence on effective incentives for promoting green forest jobs is limited. Many studies focus solely on job creation numbers without assessing job quality. For example, restoration projects in Brazil created thousands of positions, yet only short-term and temporary employment was reported (Brancalion et al., 2022). Similarly, governmental policies in the Czech Republic promoted environmental employment, but their impact on job quality remains unassessed (Maitah et al., 2020). Cooperative systems in Ghana increased NTFP prices, yet this does not necessarily indicate the creation of green jobs (Ahenkan and Boon, 2010).

Education and training emerge as critical measures for promoting decent work. In Indonesia, training in wild bee honey harvesting improved safety, income, and product quality, but did not automatically ensure decency of work (Bariyah, 2020). In cocoa agroforestry, producer-led sustainability initiatives enhanced income, training, and innovation, though the findings were derived from potentially biased sustainability reports (Martins et al., 2023). Overall, training supports professional development, enhances career pathways, and mitigates informality, whereas the absence of training can exacerbate precarious employment (Lippe et al., 2023).

Technological innovation and organisational strategies present a complex relationship with employment outcomes. Innovations can improve efficiency and create safer, greener jobs, yet may simultaneously reduce overall employment levels. While some displaced positions are offset by new opportunities, the literature underscores the need for integrated strategies that balance technological progress with employment quality and social equity.

6. Conclusion, limitations and directions for future research

This review provides a detailed examination of the characteristics of green forest jobs, highlighting both the opportunities and challenges associated with their development. By definition, green forest jobs are forest-related occupations that contribute to environmental sustainability. However, not all forest-related jobs qualify as green, as many fail to meet the criteria of environmental sustainability and decent work. Despite the sector's diverse employment prospects across various economic activities, a universal understanding of green forest jobs is lacking, complicating efforts to accurately identify and assess their quality dimensions.

The literature demonstrates that employment quality in the forest sector is highly variable. While evidence of new and emerging forest-related jobs exists, the extent to which these jobs meet principles of decent work and environmental sustainability is inconsistent. Green forest jobs appear to exist along a continuum, rather than as a binary state, ranging from reactive to transformative practices. The absence of standardized criteria for evaluating employment quality and social sustainability further hampers the assessment of these roles. Although some progress has been made in linking forest-related jobs to broader sustainability objectives, significant gaps remain in ensuring fair remuneration, job security, and equitable working conditions.

A limitation of this review is the exclusion of literature published after January 2024, which may contain important developments. Forest Europe has since published three documents highly relevant for future research: an analysis of emerging green job opportunities within and beyond the traditional forest sector (Forest Europe, 2024b), policy recommendations for promoting green jobs (Forest Europe, 2024a), and updated social indicators for assessing employment quality (Forest Europe, 2024c). The recent ILO report "Decent Work in Nature-based Solutions" (ILO, 2024) also provides valuable insights on current and future employment, including skill requirements, in nature-based solutions and the forest sector.

Incentives and policy measures, such as Payments for Ecosystem Services (PES), alongside investments in education, training, technology, and CSR initiatives, have been introduced to promote green forest jobs. However, the effectiveness of these interventions is often constrained by a lack of rigorous evaluation and impact assessment. The social implications of mechanisation, automation, and CSR practices also require further investigation. Addressing persistent issues of informality and substandard working conditions necessitates tailored policies at regional and national levels, alongside compliance with international labour standards.

Looking ahead, a multifaceted approach is essential to unlock the potential of green forest jobs. This includes developing clear definitions and assessment metrics, enhancing policy support for green employers, implementing region-specific strategies informed by comprehensive analyses, and investing in worker education and training. Coupled with financial incentives to support recruitment and retention, these measures can strengthen the forest sector workforce. By integrating environmental, social, and economic objectives, green forest jobs can become a cornerstone of a sustainable and equitable future for the sector.

CRediT authorship contribution statement

Emilin Joma da Silva: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Jörg Schweinle:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The author declares no conflicts of interest relevant to the content of this article.

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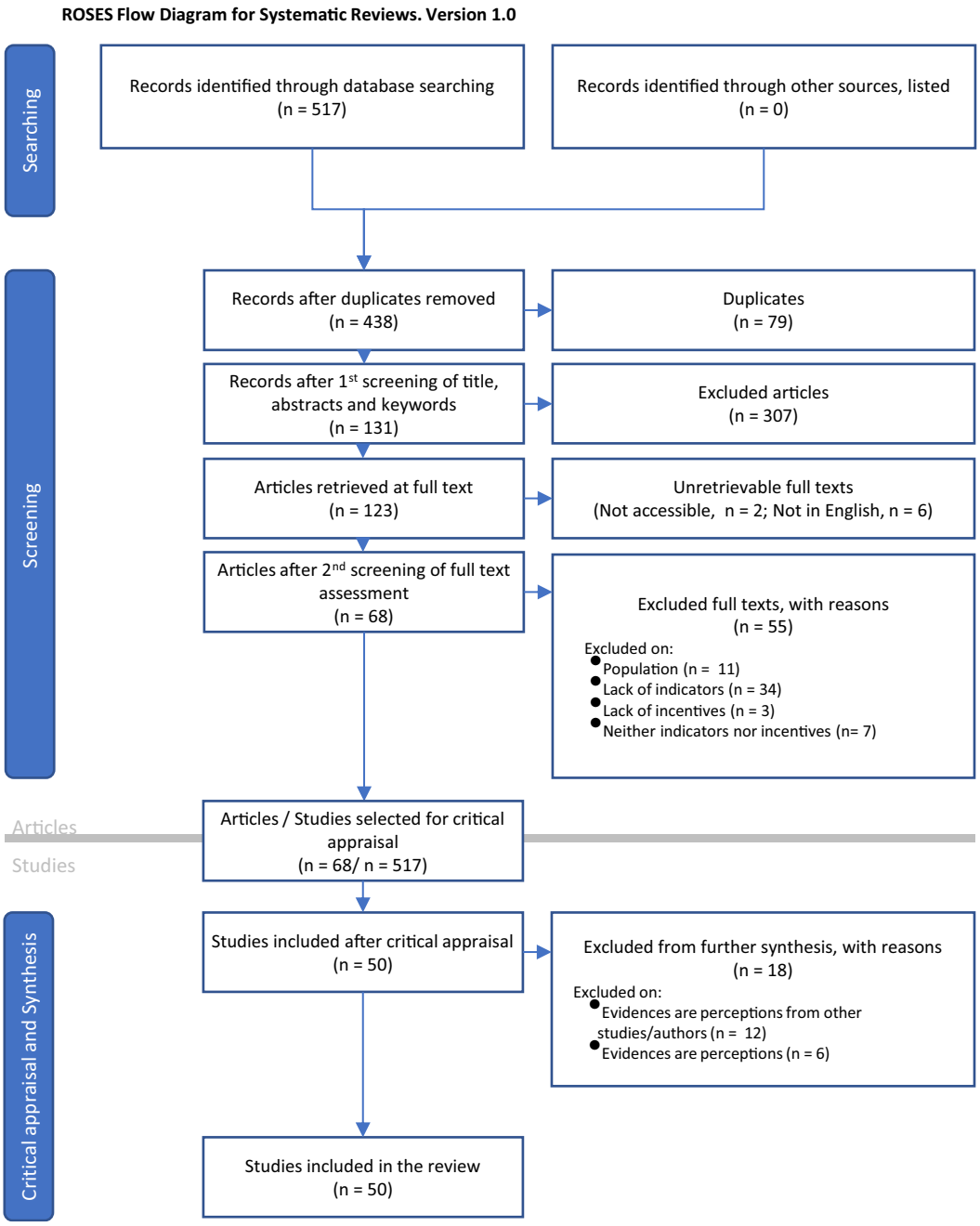
Annex

Annex 1
Decent Work Agenda.

Element of the Decent Work Agenda	Examples of indicators
Employment opportunities	Informal employment Employment by status of employment
Adequate earning and productive work	Average hourly earnings Minimum wage as % of median wage
Decent Working Time	Annual hours worked per employed person Paid annual leave
Combining work, family and personal life	Maternity protection Parental leave
Work that should be abolished	Child labour Forced labour
Stability and security	Job tenure Notice of termination of employment
Equal opportunity and treatment in employment	Gender wage gap Measure for employment of persons with disabilities
Safe work environment	Occupation injury rate (fatal, nonfatal) Labour inspection
Social security	Population covered by (basic) health care provision Pension
Social dialogue, worker's and employers' representation	Union density rate Freedom of association and the right to organize
Economic and social context for decent work	Children not in school (% by age) Labour share in GDP



Annex 2. Screening process, critical appraisal and synthesis of this systematic literature review, following the ROSES guideline for systematic reviews.

Annex 3

Parameters extracted on the 2nd screening phase of the literature sample.

Parameters	Information to be recorded
Year of publication	Year
Author(s) and title	Name of authors and title of document
Keywords	List of keywords
Aim of study	Short summary of the aim of study
Type of study	'Empirical' or 'Desktop'
Characteristic of the study	'Qualitative', 'Quantitative' or 'Quali-quanti'
Type of publication	'Article paper', 'Conference paper', 'Book chapter'
Methodology	'Available' (add short description) or 'Not available'
Forest sector	Cite according to the ISIC Rev. 4
PICO/PECO	Population, intervention or exposure, comparator outcomes
Geographic region	Global (cite countries), national (cite country) regional or municipal

(*continued on next page*)

Annex 3 (*continued*)

Parameters	Information to be recorded
Occupation or job	Cite according to the ISCO-08
Educational level	Cite according to the ISDEC

Data availability

Data will be made available on request.

References

Bechmark literature

Bal, T.L., Rouleau, M.D., Sharik, T.L., Wellstead, A.M., 2020. Enrollment decision-making by students in forestry and related natural resource degree programmes globally. Int. For. Rev. 22, 287–305. https://doi.org/10.1505/146554820830405627.

Cazes, S., Hijzen, A., Saint-Martin, A., 2015. OECD Social, Employment and Migration Working Papers: Measuring and Assessing Job Quality: The OECD Job Quality Framework, p. 174.

Collaboration for Environmental Evidence, 2013. Guidelines for Systematic Review and Evidence Synthesis in Environmental Management. Version 4.2. Environmental Evidence. https://environmentalevidence.org/wp-content/uploads/2014/06/Review-guidelines-version-4.2-finalPRINT.pdf.

ECE/FAO, 2018. Green Jobs in the Forest Sector. Geneva Timber and Forest Discussion Paper 71. FAO; UNECE, New York, Geneva, p. 75.

Eurofound, 2024. Working Conditions Survey: Job Quality Indices. European Foundation for the Improvement of Living and Working Conditions. https://www.eurofound.europa.eu/en/topic/job-quality.

Forest Europe, 1993. General Guidelines for the Sustainable Management of Forests in Europe. Resolution H1, Helsinki, Finland. https://foresteurope.org/wp-content/uploads/2022/01/MC_helsinki_resolutionH1.pdf.

Forest Europe, 2022. What are Green Forest Jobs?, Bonn. https://foresteurope.org/wp-content/uploads/2022/10/1-pager-Green-Forest-Jobs.pdf.

Forest Europe, 2024a. Forest Europe Expert Group Green Jobs Policy Recommendations, Bonn. https://foresteurope.org/wp-content/uploads/2024/04/Policy-Recommendations.pdf.

Forest Europe, 2024b. Novel Green Forest Jobs in Pan-Europe. https://foresteurope.org/wp-content/uploads/2024/05/Novel-Green-Forest-Jobs-in-Pan-Europe-Report.pdf.

Forest Europe, 2024c. Rethinking Indicator 6.5 on Forest Sector Workforce: Integrating Green Forest Jobs and Decent Work Principles, Bonn. https://foresteurope.org/wp-content/uploads/2024/11/Rethinking-Indicator-6.5-on-Forest-Sector-Workforce-Integrating-Green-Forest-Jobs-and-Decent-Work-Principles.pdf.

Haddaway, N.R., Macura, B., Whaley, P., Pullin, A.S., 2018. ROSES reporting standards for systematic evidence syntheses: pro forma, flow-diagram and descriptive summary of the plan and conduct of environmental systematic reviews and systematic maps. Environ. Evid. 7. https://doi.org/10.1186/s13750-018-0121-7.

Hockett, R.C., Alpert, D., Ferry, J., Khaleghiyan, A., 2019. The U.S. private sector job quality index. SSRN J. https://doi.org/10.2139/ssrn.3566575.

ILO, 2012a. International Standard Classification of Occupations 2008 (ISCO-08): Structure, Group Definitions and Correspondence Tables. International Labour Office, Geneva, p. 433.

ILO, 2012b. Working Towards Sustainable Development: Opportunities for Decent Work and Social Inclusion in a Green Economy, Switzerland.

ILO, 2013a. Decent Work Indicators: Guidelines for Producers and Users of Statistical and Legal Framework Indicators: ILO Manual: Second Version. International Labour Office, Geneva. https://www.ilo.org/wcmsp5/groups/public/—dgreports/—integration/documents/publication/wcms_229374.pdf.

ILO, 2013b. Sustainable Development, Decent Work and Green Jobs: Fifth Item on the Agenda. International Labour Conference Report V; 102nd Session, Geneva.

ILO, 2019. Promoting Decent Work and Safety and Health in Forestry: Report for Discussion at the Sectoral Meeting on Promoting Decent Work and Safety and Health in Forestry. International Labour Office, Geneva.

ILO, 2024. Decent Work in Nature-Based Solutions: Unlocking Jobs Through Investment in Skills and Nature-Based Infrastructure, Geneva. https://www.ilo.org/publications/decent-work-nature-based-solutions-2024-unlocking-jobs-through-investment.

ILO, UNEP, 2008. Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World. UNEP, Nairobi, Kenya, p. 352.

Lippe, R.S., Schweinle, J., Cui, S., Gurbuzer, Y., Katajamäki, W., Villarreal-Fuentes, M., Walter, S., 2022. Contribution of the Forest Sector to Total Employment in National Economies: Estimating the Number of People Employed in the Forest Sector. Food and Agricultural Organization of the United Nations, Rome, p. 40.

Owuor, J.A., Giessen, L., Prior, L.C., Cilio, D., Bal, T.L., Bernasconi, A., Burns, J., Chen, X., 2021. Trends in Forest-Related Employment and Tertiary Education: Insights from Selected Key Countries Around the Globe, Bonn. https://ifsa.net/efi-ifsa-iufro-project/.

Owuor, J.A., Winkel, G., Giessen, L., Prior, L., Burns, J., Tegegne, Y.T., Poschen, P., 2023. Passion for Nature: A Global Analysis of Student Motivations to Pursue Forest-Related Education and their Career Aspirations.

Rekola, M., Sharik, T., 2022. Global Assessment of Forest Education. FAO.

Ronzon, T., Iost, S., Philippidis, G., 2022. Has the European Union entered a bioeconomy transition? Combining an output-based approach with a shift-share analysis. Environ. Dev. Sustain. 24, 8195–8217. https://doi.org/10.1007/s10668-021-01780-8.

UNECE/FAO/Forest Europe, 2020. Guidelines on the Promotion of Green Jobs in Forestry. Geneva Timber and Forest Discussion Paper 77, Geneva.

UNESCO, 2014. ISCED Fields of Education and Training 2013 (ISCED-F 2013): Manual to Accompany the International Standard Classification of Education 2011. UNESCO Institute for Statistics.

United Nations, 2008. International Standard Industrial Classification of All Economic Activities (ISIC): 4th Ed. Statistical Papers. ISBN 9211615186.

United Nations, 2015. Handbook on Measuring Quality of Employment: A Statistical Framework ECE/CES/40, Geneva.

United Nations, 2017. Global Indicator Framework for the Sustainable Development Goals and Targets of the 2030 Agenda for Sustainable Development. https://unstats.un.org/sdgs/indicators/Global-Indicator-Framework-after-2025-review-English.pdf.

Reviewed articles

Abu, F., Gholami, H., Saman, M.Z., Zakuan, N., Streimikiene, D., 2019. The implementation of lean manufacturing in the furniture industry: a review and analysis on the motives, barriers, challenges, and the applications. J. Clean. Prod. 234, 660–680. https://doi.org/10.1016/j.jclepro.2019.06.279.

Ahenkan, A., Boon, E., 2010. Commercialization of non-timber forest products in Ghana: processing, packaging and marketing. J. Food Agric. Environ. 8, 962–969.

Apsalyamova, S.O., Khachir, B.O., Khuazhev, O.Z., 2017. Institutional aspects of forecasting socio-economic systems in the organization of forest management in the Russian federation. Acad. Strateg. Manag. J. 16, 215–223.

Apud, E., Meyer, F., Espinoza, J., Oñate, E., Freire, J., Maureira, F., 2016. Ergonomics and labor in forestry. In: Tropical Forestry Handbook, Second edition 4, pp. 3211–3310.

Bahauddin, K.M., Iftakhar, N., 2014. Prospect and potential of green jobs towards green economy in Bangladesh: a situation analysis and way forward. Int. J. Soc. Ecol. Sustain. Dev. 5, 25–38. https://doi.org/10.4018/ijsesd.2014070103.

Bariyah, N., 2020. Developing a model of employment creation in border region: Gaharu cultivation and honey bee farming in Bengkayang, West Kalimantan, Indonesia. Biodiversitas 21, 5237–5247. https://doi.org/10.13057/biodiv/d211127.

Bartley, T. (Ed.), 2010. Transnational Private Regulation in Practice: The Limits of Forest and Labor Standards Certification in Indonesia.

Blanc, S., Brun, F., Mosso, A., 2019. Performance analysis of logging enterprises operating in the western italian alps. Qual Access Success 20, 74–81.

Bo, M., Clerico, M., Pognant, F., 2014. Forest yard's safety: a methodological approach for the analysis of occupational risk. Geoingegneria Ambientale e Mineraria 143, 25–34.

Brancalion, P., de Siqueira, L.P., Amazonas, N.T., Rizek, M.B., Mendes, A.F., Santiami, E. L., Rodrigues, R.R., Calmon, M., Benini, R., Tymus, J., Holl, K.D., Chaves, R.B., 2022. Ecosystem restoration job creation potential in Brazil. People Nat. 4, 1426–1434. https://doi.org/10.1002/pan3.10370.

Cao, S., Chen, L., Zhu, Q., 2010. Remembering the ultimate goal of environmental protection: including protection of impoverished citizens in China's environmental policy. Ambio 39, 439–442. https://doi.org/10.1007/s13280-010-0043-2.

Chabán-García, O., Hidalgo-Capitán, A.L., 2023. Green economy and green jobs: a multisectoral analysis by means of Andalusia's social accounting matrix. Revista de Estudios Regionales 126, 122–148.

Charnley, S., 2011. A socioeconomic assessment of forest service recovery act projects on California's north coast. In: USDA Forest Service - General Technical Report PNW-GTR, pp. 43–69.

Cui, S., Lippe, R.S., Schweinle, J., 2022. Informal employment in the forest sector: a scoping review. Forests 13. https://doi.org/10.3390/f13030460.

Elliott, R., Lindley, J.K., 2017. Environmental jobs and growth in the United States. Ecol. Econ. 132, 232–244. https://doi.org/10.1016/j.ecolecon.2016.09.030.

Falxa-Raymond, N., Svendsen, E., Campbell, L.K., 2013. From job training to green jobs: a case study of a young adult employment program centered on environmental restoration in New York City, USA. Urban For. Urban Green. 12, 287–295. https://doi.org/10.1016/j.ufug.2013.04.003.

Georgescu, M.-A., Gliga, C., 2020. Continuous vocational training for sustainable work practices in forestry. Procedia Manuf. 299–307.

Ghosal, V., 2015. Business strategy and firm reorganization: role of changing environmental standards, sustainable business initiatives and global market conditions. Bus. Strateg. Environ. 24, 123–144. https://doi.org/10.1002/bse.1815.

Greenleaf, M., 2020. The value of the untenured forest: land rights, green labor, and forest carbon in the Brazilian Amazon. J. Peasant Stud. 47, 286–305. https://doi.org/10.1080/03066150.2019.1579197.
Kepenek, E.B., 2013. Socio-technical issues in youth employment in SMEs: the case of the furniture sector in Turkey. In: Small and Medium Enterprises: Concepts, Methodologies, Tools, and Applications, 3, pp. 1483–1493.
Kline, K.L., Dale, V.H., Rose, E., Tonn, B., 2021. Effects of production of woody pellets in the southeastern United States on the sustainable development goals. Sustainability (Switzerland) 13, 1–19. https://doi.org/10.3390/su13020821.
Larasatie, P., Barnett, T., Hansen, E., 2020. The "Catch-22" of representation of women in the forest sector: the perspective of student leaders in top global forestry universities. Forests 11. https://doi.org/10.3390/F11040419.
Larwanou, M., Mutta, D., Wekesa, C., Roos, A., 2023. Charcoal trade in Niger—product flows and business models. Forests 14. https://doi.org/10.3390/f14091910.
Lippe, R.S., Cui, S., Schweinle, J., 2021. Estimating global forest-based employment. Forests 12. https://doi.org/10.3390/f12091219.
Lippe, R.S., Ojeda Luna, T., Katajamäki, W., Schweinle, J., 2023. Labour informality in forestry: a longitudinal (2009–2020) cross-country analysis of determinants in 70 developing countries. Forest Policy Econ. 156. https://doi.org/10.1016/j.forpol.2023.103056.
Lynch, K.A., McLain, R.J., 2003. Access, labor, and wild floral greens management in western Washington's forest. In: USDA Forest Service - General Technical Report PNW, pp. 1–60.
Maitah, M., Toth, D., Smutka, L., Maitah, K., Jarolínová, V., 2020. Income differentiation as a factor of unsustainability in forestry. Sustainability (Switzerland) 12. https://doi.org/10.3390/su12114749.
Manu, G., Ndzifon Kimengsi, J., Mbatu, R.S., 2023. Responsibilization dynamics in natural resource management: insights from two protected areas in Cameroon. J. Nat. Conserv. 73. https://doi.org/10.1016/j.jnc.2023.126402.
Martinez-Hernandez, E., Sadhukhan, J., Aburto, J., Amezcua-Allieri, M.A., Morse, S., Murphy, R., 2022. Modelling to analyse the process and sustainability performance of forestry-based bioenergy systems. Clean Techn. Environ. Policy 24, 1709–1725. https://doi.org/10.1007/s10098-022-02278-1.
Martins, F.P., Batalhão, A., Ahokas, M., Liboni Amui, L.B., Cezarino, L.O., 2023. Rethinking sustainability in cocoa supply chain in light of SDG disclosure. Sustain. Account. Manag. Policy J. 14, 258–286. https://doi.org/10.1108/SAMPJ-03-2022-0132.
Meyer, F., Apud, E., Eweje, G., Tappin, D., 2019. Past, present, and future of the workforce at the Chilean forestry sector from a social and ergonomics perspective. In: Human Factors for Sustainability: Theoretical Perspectives and Global Applications, pp. 319–334.
Mutta, D., Mahamane, L., Wekesa, C., Kowero, G., Roos, A., 2021. Sustainable business models for informal charcoal producers in Kenya. Sustainability (Switzerland) 13. https://doi.org/10.3390/su13063475.
Mwavu, E.N., Nakabonge, G., Tibaingana, A., Ssegawa, P., Balikowa, K., Tabwenda, L., Syofuna, A., Kalema, V.N., 2023. Potential contribution of urban roadside plant nurseries to forest plant conservation and human well-being in the face of climate change, Uganda. Afr. Geogr. Rev. https://doi.org/10.1080/19376812.2023.2280595.
Mylek, Schirmer, J., 2015. Beyond physical health and safety: supporting the wellbeing of workers employed in the forest industry. Forestry 88, 391–406. https://doi.org/10.1093/forestry/cpv011.
Nikodinoska, N., Cesaro, L., Romano, R., Paletto, A., 2018. Sustainability metrics for renewable energy production: analysis of biomass-based energy plants in Italy. J. Renew. Sustain. Energy 10. https://doi.org/10.1063/1.5022659.
Novelli, V., Geatti, P., Ceccon, L., Bettarel, A., 2018. Eco-innovation in valcucine for a circular economy. Environ. Eng. Manag. J. 17, 2427–2436. https://doi.org/10.30638/eemj.2018.241.
Pan, J., Ma, H., Zhang, Y., 2011. Green economy and green jobs in China: current status and potentials for 2020. In: Worldwatch Paper, pp. 1–40.
Ratnasingam, J., Latib, H.A., Liat, L.C., Jegatheswaran, N., Othman, K., Amir, M.A., 2023. Environmental, social, and governance adoption in the Malaysian wood products and furniture industries: awareness, adoption, and challenges. BioResources 18, 1436–1453. https://doi.org/10.15376/biores.18.1.1436-1453.
Renner, M., Sweenex, S., Kubit, J., 2008. Green jobs: working for people and the environment. In: Worldwatch Paper, pp. 1–57.
Robinson, C., Cloutier, S., Eakin, H., 2017. Examining the business case and models for sustainable multifunctional edible landscaping enterprises in the Phoenix metro area. Sustainability (Switzerland) 9. https://doi.org/10.3390/su9122307.
Ruba, U.B., Talucder, M., 2023. Potentiality of homestead agroforestry for achieving sustainable development goals: Bangladesh perspectives. Heliyon 9. https://doi.org/10.1016/j.heliyon.2023.e14541.
Santos, A., Benoît Norris, C., Barbosa-Póvoa, A., Carvalho, A., 2020. Social life cycle assessment of pulp and paper production – a Portuguese case study. Comput. Aided Chem. Eng. 48, 15–20.
Santos, D.S., Ianda, T.F., de Carvalho, P.P., de Camargo, P.L., dos Santos, F.C., Alzate, C. A., Pessoa, F.L., Kalid, R.D., 2023. Multi-purpose biorefineries and their social impacts: a systematic literature review. Environ. Dev. Sustain. https://doi.org/10.1007/s10668-023-03445-0.
Selçuk, İ., Nircan, Z.D., Coşkun, B.S., 2023. Imagining decent work towards a green future in a former forest village of the city of Istanbul. Soc. Sci. 12. https://doi.org/10.3390/socsci12060342.
Sporcic, M., Landekic, M., Susnjar, M., Pandur, Z., Bacic, M., Mijoc, D., 2023. Deliberations of forestry workers on current challenges and future perspectives on their profession-a case study from Bosnia and Herzegovina. Forests 14. https://doi.org/10.3390/f14040817.
Šporčić, M., Landekić, M., Šušnjar, M., Pandur, Z., Bačić, M., Mijoč, D., 2024. Shortage of labour force in forestry of Bosnia and Herzegovina – forestry experts' opinions on recruiting and retaining forestry workers. Croat. J. For. Eng. 45, 183–197. https://doi.org/10.5552/crojfe.2024.2345.
Stankevičiūtė, Ž., Staniškienė, E., Ramanauskaitė, J., 2021. The impact of job insecurity on employee happiness at work: a case of robotised production line operators in furniture industry in Lithuania. Sustainability (Switzerland) 13, 1–20. https://doi.org/10.3390/su13031563.
Strehlke, B., 1996. Asking forest workers about their job. Commonw. For. Rev. 75, 217–220.
Toppinen, A., Mikkilä, M., Lähtinen, K., 2019. ISO 26000 in corporate sustainability practices: a case study of the forest and energy companies in bioeconomy. In: CSR, Sustainability, Ethics and Governance, pp. 95–113.
Vázquez-Maguirre, M., 2020. Building sustainable rural communities through indigenous social enterprises: a humanistic approach. Sustainability 12. https://doi.org/10.3390/su12229643.