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## HEALTH AND WORKING CONDITIONS IN MANUAL FOREST EXTRACTION IN MOUNTAIN LAND

**Marina Pinto Coelho**

**Email:** [marinapc@hotmail.com](mailto:marinapc@hotmail.com)

UFMG

**David Soares de Souza Lima**

**Email:** [davidsslima@yahoo.com.br](mailto:davidsslima@yahoo.com.br)

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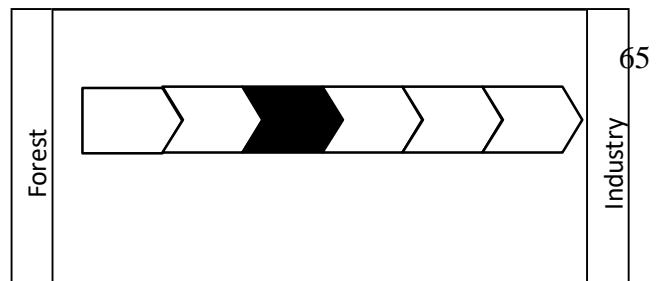
**Giovanni Campos Fonseca**

**Email:** [giovannifonseca@gmail.com](mailto:giovannifonseca@gmail.com)

UGMG

**Abstract:** The forestry sector stands out as a relevant segment of the national economy. However, its economic potential contrasts with precarious work situations, high number of accidents and occupational diseases, attracting the attention of the scientific community. The objective of the present study was to perform the ergonomic analysis of the activity, aiming to understand the environmental, material and organizational aspects of Tombo and Manual Stacking, in an outsourcing company in the forest harvesting and transportation sector, located in the metropolitan Vale do Steel-MG. Ergonomic Work Analysis (AET) was used as a method, including global and systematic observations, filming and photographs of the work process, simultaneous verbalisations, semi-structured interviews and individual and collective self-confrontation. It was observed that workers who harvest wood are exposed to various environmental and material risk factors, such as: excessive weight loading, stereotyped posture requirements, exposure to environmental hazards (openworking), inadequate tools, work on steep and irregular terrain with a high risk of accidents. It was also possible to identify aspects related to the organization of work and theremuneration system adopted, which precarize the work even more. In view of the identified conditions, recommendations of material, environmental and organizational orders were made, aiming at better health and work conditions in Tombo and Manual Stacking.

**Keywords:** Forest Sector, Timber Extraction, Environmental Risk Factors, Risk of Accidents, AET.



## 1. INTRODUCTION

The forestry sector in Brazil expanded greatly from the 1990s onwards, deserving prominence as an important segment of the national economy (BANTEL, 2006; CARVALHO et al, 2005). At the

However, its importance and economic potential contrast with precarious work situations, a high number of accidents and occupational diseases. The sector is considered one of the most dangerous worldwide, attracting the attention of researchers and authorities to create safety and protection measures for workers (ASSUNÇÃO, CAMARA, 2011). The segment has undergone a process of increasing mechanization in recent decades with the aim of containing labor replacement costs, reducing accident rates and easing forestry work. However, in Brazil there is still coexistence between different stages of development and uses of technologies. Not all companies in the sector are in the complete or advanced mechanization phase and several continue with manual and semi-mechanized production methods, with precarious working conditions.

In the forestry sector, harvesting is considered the most important phase from an economic point of view, representing more than half of the cost of wood production, with a high share of the final cost of the product, in addition to the risks of loss involved in this stage of the production process. (CONEGLIAN et al, 2010, BANTEL, 2006). Forest harvesting can be defined as a set of operations carried out in the forest massif, which comprises all partial stages from felling the tree to unloading the wood in the consuming industry's yard (MACHADO, 2002). The present work aimed to analyze the extraction of wood, which in the case of the company studied is carried out through Manual Tumbling and Stacking (Figure 1).

felling and stacking is used mainly in mountainous regions, where it is impossible for tractors to enter rough terrain (SEIXAS, 2002).

Manual extraction tends to be less and less frequent and is only recommended when operating costs are low, the distance to remove the wood is reduced and the logs or other pieces of harvested wood are light enough so that they can be easily handled by man. . However, it is observed that these conditions are often not respected, exposing workers to inappropriate and dangerous work situations. Given the precariousness of working conditions and the risk to workers' health, manual tipping and stacking generally involves poorly paid workers, attracting workers with lower professional qualifications and low education, who find there a

Manual Tumbling and Stacking is an extraction method that involves the worker taking the wooden logs, already cut and peeled, lifting them and throwing them down the hill towards the sides of the road, with the help of hatchets or hooks. The worker begins the operation at the cutting site and finishes it by stacking the wood on the sides of the road, which is prepared for loading and transportation. Wood extraction through manual way to provide for their families. families (SILVA et al, 2010). Given this scenario, the present study aimed to carry out the Ergonomic Work Analysis (AET) in the Manual Tumbling and Stacking stage, seeking to highlight environmental, material and organizational aspects, relating them to the health and working conditions of this Forest Harvest activity.

## THEORETICAL REFERENCE

Montmollin (1990) defines working conditions as everything that characterizes a work situation and that allows or prevents workers' activity. For Guérin et al (2001), working conditions include the technical means for carrying out tasks, the organization of work, rules and norms, human resources, the space or environment in which the work is carried out, as well as the employment contract. work, salary and benefits. From the

Figure 1: Forest Harvest Process. Source: author

literature review, it was possible to find notes on the material, environmental and organizational aspects that characterize the activity of Manual Tipping and Stacking. Regarding environmental and material aspects, several authors point out negative factors of Manual Wood Extraction activity on workers' health, due to great physical effort, unsafe conditions, inadequate tools, stereotypical or asymmetrical postures, repetitive movements, heat, dust and lifting. of excessive loads, which contributes to the emergence of illnesses and accidents with serious repercussions on their lives (PIGNATI, MACHADO, 2005; MINETTE, 1996; SILVA et al,

2008). Furthermore, adverse weather conditions and the topography of the land where the tasks are carried out constitute another aggravating factor for working conditions in Manual Tipping and Stacking. In the open air, climatic conditions cannot be controlled and the worker may have his heat tolerance limit exceeded, characterizing a situation of thermal overload with indisposition and fatigue, reducing efficiency and increasing the risk of accidents (MINETTE, 1996). The topographical characteristics of the workplace also impose difficulties, which makes the movement of wood dangerous, as well as access to the field, resulting in isolation of workers and precarious health and safety assistance. (ASSUNÇÃO, CAMARA, 2011). Often, due to inadequate environmental conditions and working materials, there is a loss or decrease in workers' working capacity, which can contribute to the high rates of absenteeism commonly observed in the sector (SIMÕES, 2010).

Organizational aspects, in turn, are related to the way in which work is distributed over time (who does what, how, when, how much and under what conditions), as well as the way in which tasks and responsibilities are distributed among employees. groupings of people and other resources, and how responsibility and coordination relationships between groupings are defined (RIO, PIRES, 2000). In Manual Tipping and Stacking, the literature points out that organizational aspects are also a relevant aspect in the health and work process. An important aspect is the results-based remuneration method, commonly adopted by companies in the sector,

whereby workers' earnings vary according to their income/productivity. Some authors point out that this model can cause competitiveness and dissatisfaction in addition to increasing worker exhaustion, who feel pressured to produce more to earn more, which can lead to non-compliance with safety standards (POZ E VARELLA, 2000; LINCK E MORETTO, 2007). Assunção and Camara (2011) state that employers, when setting goals, often neglect the precarious situations and vicissitudes of work in the field. They also state that the conception that guides the definition of production targets is not always determined by the potential of the work and workers, but is guided by financial criteria that are unreasonable in terms of safety.

The literature also points to the increasing outsourcing of forest harvesting as a factor that hampers the organization of work in the field. There is a record of the presence of outsourced services in 70% of forestry services (MORAIS FILHO, SEIXAS, 2009), this being a strategy used by large companies to reduce costs. The stage in which outsourcing is most present is harvesting, considered the most costly and dangerous part of the production process. Outsourcing in the forestry sector is often linked to the selected transfer of risks and responsibilities, from contractors to contractors, in relation to the implementation of health and safety measures, making labor relations precarious and hampering health and safety conditions for workers (ASSUNÇÃO, CAMARA, 2011)

## 2. METHODOLOGY

The study was carried out in a forestry harvesting and transportation company in Vale do Aço – MG, founded in 1993, with approximately 500 employees. The company studied is a service provider for a large industry that produces bleached eucalyptus pulp, which makes its planting areas available for harvesting and forest transport. To understand the activity of manual tipping and stacking workers, the research was based on the AET methodology, which is based on the theoretical framework of the ergonomics of the activity, aiming to compare the work prescribed to workers and the real conditions of its execution. This type of analysis makes it possible to understand the intrinsic and extrinsic elements that directly or indirectly affect workers, highlighting the multiple components of the work situation and demonstrating, in a concrete way, how these components manifest themselves in their daily lives and in the

execution of their activities. In the present study, to understand the activity of Tumbling and Stacking, the following techniques were applied:

Global and systematic observations of the work in its different aspects; Filming and photographs; Simultaneous verbalizations; Individual and collective self-confrontation – technique used through films/photos of workers in a work situation, so that they can observe their actions, compare them with those of other colleagues, helping to clarify for themselves and the ergonomist their behaviors, operating methods and actions in a given context; Semi-structured interviews with different company actors; Measurement of the weight of wooden logs during the natural drying process. To collect data, biweekly visits to the field were carried out over a period of 14 months.

### **3 – RESULTS**

The results presented here refer to the analysis of real work, that is, how the prescribed task is carried out, understanding the personal characteristics of workers, individual management, real conditions and the effective results achieved (GUÉRIN et al, 2001) . In their routine, Manual Tombo and Empilamento workers are transported on company buses, traveling long distances, since the harvesting sites are far from the urban center. They arrive at the field around 6:00 am and start activities very early to take advantage of the times when exposure to the sun and temperatures are milder. A mobile support point is available close to the harvesting site, with minimal structure for them to eat their meals and have access to the bathroom. The work is carried out in the open air, in a hot region, with relief that varies from strongly undulating (slopes between 20 and 45%) to mountainous (slopes between 45 and 75%). The most common work accidents in the field are falls, often caused by the characteristics of the terrain itself, which is generally steep and slippery, in addition to having uneven levels, holes and dense vegetation. Cases of bites from venomous animals, such as snakes and scorpions, bees and wasps, are also common. Another not uncommon and highly serious cause of accidents is the sliding of logs that hit workers.

Workers are divided into teams, each with a responsible supervisor. Remuneration is made through a fixed salary plus variable remuneration, which is associated with individual production. It was observed that the established production target was not met by the majority of Tombo and Empilhamento workers, which was proven through the analysis of production data over the course of a year, indicating that this target was overestimated. The activity of manually tipping and stacking wood required great physical effort on the part of the worker, especially on the trunk and upper limbs, when manipulating and moving the wooden logs (size 2.60m and weight varying between 25 and 100kg each). The activity consisted of throwing wooden logs “down the hill” to the side of the roads, where they will later be stacked on a platform made with local wood, called a “pillow”. To move the logs, the worker uses his own hands or an axe, commonly called a “hatchet” (Figure 1).



Figure 1: a) Manual tipping

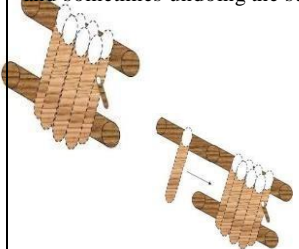


Figure 1: b) Manual Stacking

Source: Field Research

The table below (Table 1) presents the material, environmental and organizational problems encountered, as well as the ergonomic recommendations suggested to mitigate the effects on workers' health and safety.

MATERIAL AND ENVIRONMENTAL ASPECTS	
PROBLEM	RECOMMENDATION
<b>Work tool inadequate – "Hatchet"</b> Difficulties found: Cable size (incompatible with characteristics anthropometric measurements of workers); Material cable (not very resistant); Cable slippery (makes it difficult to secure grip); Bad state conservation (blades lose cutting edge quickly). “Firewood escapes easily... Turn and move the hatchet loose from the wood... sometimes it gives a I lock up and make it too difficult... We ended up catching it with hand” (worker).	- Availability of axes with handles different sizes to better adapt to the anthropometric characteristics of workers. It is suggested to replace the single 1 meter standard, for the following size options: 80 centimeters; 90 centimeters, 1 meter. - Replacement of the handle material with high-resistance wood; - Coating of cables with non-slip rubberized material for safer handling; - Biweekly periodic maintenance, providing the most effective and safe use of the tool.
<b>Non-standardization of height of the stacks wood</b>  There is no standard regarding at the height of the piles of wood, which vary between 70 to 100cm high. How much more the pile is higher, the greater the effort of the worker to lift the log from the ground. Per On the other hand, the lower the stack, the easier it is handling of logs, which can be dragged by workers, with less use of postures stereotypical and overload, especially the spine spine and limbs superiors.	It is suggested that the maximum stacking height of logs is 50 cm. With this maximum size, the worker is able to stack without completely removing the wood from contact with the ground, with consequently less use of physical strength and stereotypical movements.

<p><b>Imbalance between water needs and energy and the rigors of working day.</b></p> <p>“The 5 liter gallon is small near the headquarters that</p> <p>Yes... there are days when it's not enough,</p> <p>there is no water...” (worker).</p> <p>During the activity the worker has excessive water loss, with replacement inadequate supply of water and salts</p> <p>minerals.</p> <p>“You have to bring it from home... If you only eat what the company tells you, you won't be able to handle the hard work in the field...” (worker). The food offered does not meet the energy needs of workers. According to Occupational Hygiene Standard 06 of the Fundacentro, the metabolic rate in an activity such as Tumbling and Empilhamento is 450kcal/hour (MTE, 2002).</p>	<p>It is necessary to carry out a technical study to prepare a food menu that meets the energy needs of workers during the working day.</p> <p>Medical assessment/guidance for water and mineral salt replacement strategies appropriate to workers' demands.</p>
<p><b>Exhibition of the region cervical in the sun</b></p> <p>The body of workers practically all covered with the use of protective equipment (PPE), except for cervical region, which is exposed to the sun. You workers do not receive sunscreen and some improvise protection for the exposed region.</p>	<p>It is recommended to use the “Arab Cap” equipment, made of resistant, anti-allergenic and perforated polyester, which guarantees protection and heat exchange. It has a flexible elastic band that allows the accessory to attach to helmets.</p>
<p><b>Obstacles to log sliding in the field</b></p> <p>The irregularities of the terrain, the presence of branches and pieces of trees that were cut, etc., are obstacles that prevent the favorable use of the slope for the tipping and sliding of wood. Therefore, workers need to lift and move the same log a greater number of times until it reaches the desired location.</p>	<p>To facilitate the sliding of the logs, it is suggested to increase the “Pillow” by adding another wooden log on one of its sides, facilitating the sliding of the logs to be stacked. It was decided to extend on one side only, as through tests with both sides extended, it was found that the logs slid very quickly, colliding with each other and sometimes undoing the stack.</p>  <p>Figure 2: Conventional Pillow x Extended Pillow</p>

ORGANIZATIONAL ASPECTS	
PROBLEM IDENTIFIED	ERGONOMIC RECOMMENDATION
<p><b>Influence of processes previous – “wood breastfeeding”</b></p> <p>It is observed that the steps cutting and delimbing he has great influence on Tombo process Stacking. Workers complain that often found if you are badly delimbed and/or poorly drawn (“suckling”). Such a situation that generate rework and dissatisfaction with the team tipping and stacking due to rework, commitment of productivity and greater physical effort during journey.</p>	<p>Although it was not the target of this study, it was observed Cutting and delimbing workers also encounter difficulties in carrying out their work. Therefore, it is suggested that an Ergonomic Work Analysis (AET) be carried out for cutting and delimbing activities, aiming at a systemic understanding of the problem and a more assertive approach to minimize it among workers.</p>
<p><b>Concentration of I work at Morning Period</b></p> <p>It is observed that due to the heat/exposure to the sun, workers organize their routine by concentrating all work in the morning. “What do we have to</p> <p>produce we produce it's morning really... It's impossible work in this ‘solo’ after lunch...” (worker)</p> <p>“There is no other option... we have to speed up morning to realize... if staying in the afternoon is not possible Even if you have not complied with the goal in the morning, no fulfills more...”</p>	<p>It was recommended to the company that this aspect be considered when calculating workers' production targets, since work in</p> <p>afternoon period shows if unfeasible due to heat exposure. A work concentration in one period leads to non-compliance with pauses and consequent overload to</p>

<p><b>Interval between steps Cut and Fall and Stacking</b> The break average adopted between the Cut and Fall and Stacking is 5 days. This period is insufficient for natural drying of wood. “It makes a lot of difference... this wood here must have some five or six days it was cut...looks much better heavy... When the wood stays longer days, when are we going to catch It's much lighter” (worker).</p>	<p>Cut wooden logs were observed and weighed for 30 days, resulting in a weight reduction of up to 20%, with the greatest loss being concentrated in the first 3 weeks after cutting. A minimum interval of 15 days was recommended between Cutting and Tumbling and Stacking, favoring the natural drying process of the wood, with a consequent reduction in the weight of the logs to be handled.</p>
<p><b>Poor sizing of production goals</b> Through data analysis of production, it was observed that Stacking target if is overestimated, not being achieved by workers throughout the months.</p>	<p>It is recommended to reduce the Tombo target and Stacking or replacing the pay-for-production system. To this end, new studies applied to the topic are necessary, for decision-making appropriate to the company and workers.</p>

## 5. CONCLUSION

The ergonomic analysis carried out revealed that, in addition to adverse material and environmental conditions, organizational factors also exert a significant influence, contributing to greater precariousness of work. The remuneration system based on production targets becomes a factor of conflict for Tombo and Empilhamento workers. Manual, resulting in the sacrifice of one's own health, with an increase in the pace and intensification of work, failure to take rest breaks, in addition to greater competitiveness in the team. Goals are commonly overestimated, neglecting precarious situations and the heavy work carried out in the field. Other aspects of work organization such as outsourcing, interdependence between stages of the Forest Harvest, the forestry sector: an approach comparativa com outros setores da economia.

period necessary for the natural drying of the logs and working in pairs also need to be considered when seeking better working conditions in Tumbling, Stacking and Manual. It is hoped that this research will contribute to broadening our perspective on the vicissitudes of work in manual forest harvesting. We emphasize that the findings presented here do not exhaust the possibilities for intervention and improvements, and it is important to continue research, since interdisciplinary and intersectoral efforts are necessary so that the material, environmental and organizational conditions of Manual Tipping and Stacking are transformed.

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