# Background

Acacia belongs to family Fabaceae (Leguminosae). It is estimated that there are roughly 1380 species of Acacia worldwide. About two-third of them are native to Australia and rest of spread around tropical and subtropical region of the world. In Nepal eight species of Acacia are reported. Among these eight species Acacia Catechu is one of the most prominent species. Acacia catechu, commonly known as catechu or khair, is a deciduous tree species native to Nepal as well as the Bagmati Province. In Nepal it is widespread in the Terai and extends to about 900m (exceptionally to 1400m). It is the very characteristics of the edge of broad river channels in Terai and Dun areas and often extends someway into the beds of rivers (Jakson, 1994). The tree size of this Acacia species generally of medium sized. It has twigs with paired recurved thrones and flowers of pale yellow color. Acacia Catechu is a useful multipurpose tree for the Terai and lower hills, fairly easy to establish, and of considerable commercial importance as the source of Katha and Cutch (Jakson, 1994). It is not only valuable species from the medicinal or commercial point of view but also a valuable timber species known for its strong and durable wood, which has been widely used in construction, furniture making, and traditional medicine (Pandey et al., 2018; Joshi et al., 2019).











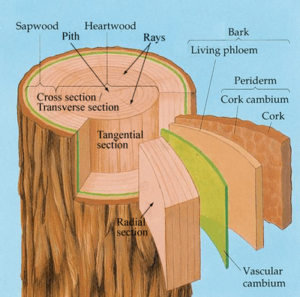


From silvicultural perspectives, Acacia Catechu is strong light demander species and grows naturally on a wide range of soils, preferring well-drained, coarse gravelly alluvial soil but it also tolerates heavy clay and calcareous soils in some places. It can be used for reaffroestation of eroded slopes which withstand flooding. The seedlings are somewhat susceptible to severe frost, but from the sapling stage frost damage occurs slightly. However, over most of its range, and the areas where it is likely to be planted, frost is not a major problem. It is very drought resistant species as well. It needs to be protected against grazing and browsing (Purkayastha, S. K., 1997). This species is deciduous, shedding its leaves above February, and putting out new leaves at the time of flowering, in June. It coppices very well unless it is in mixture with other species, when these tend to shade out the coppice shoots. Most of the seedling develops its taproot very strongly.

The regeneration of Acacia Catechu takes place through both natural as well as artificial means. In case of natural regeneration, it commence with the process when the pods ripen, turning from green through reddish-green to brown, from the end of November to early January. Then, those pods dehisce soon after ripening and began to fall in January but some remains in the tree which could be destroyed by insect by some way. The fallen pods may disseminate by wind or by water to different places. Then after, the dissemination the regeneration is most profuse on exposed alluvial soil in or near river beds. The seedling will usually be able to develop freely, but under shade most of them will die due to damping-off and other causes. The artificial regeneration can be done through the seed collection when it falls and seed treatment in nursery, then those treated seeds put inside the polybag with its requirement could produce the plant which could further planted away in the plantation area.

The most commercial products from Acacia Catechu are Katha and Cutch, obtained by boiling chips of the heartwood. Katha, an impure form of Catechin, mainly used for chewing with betel nut and pan, and also has medicinal and pharmacological uses. Cutch, Catechu tannic acid, is used in tanning and dying ships sails. Acacia Catechu heartwood contains 4-6% of Catechin and 10-12% cutch (O.P Sharma, 1984).

Sapwood and heartwood are two distinct portions of a tree trunk, each serving different functions. Sapwood, located towards the outer part of the trunk, is responsible for conducting water and nutrients from the roots to the leaves. It is generally lighter in color and has higher moisture content than heartwood (Bamber, 2012). Sapwood, also known as the xylem, living portion of the tree trunk and contains active xylem cells responsible for the tree's growth (Speer, 2019). Heartwood, on the other hand, is the older, inner portion of the trunk that provides structural support and protects the tree against decay and pests. It is usually darker in color due to the accumulation of extractives such as resins, tannins, and pigments (Bamber, 2012; Pandey et al., 2018).



The Bagmati Province in Nepal harbors significant biodiversity, including diverse forest ecosystems that support numerous plant and animal species (NPC, 2017). Acacia catechu is one of the prominent tree species found in this region with economic and ecological importance. However, limited research has been conducted on the sapwood and heartwood characteristics of Acacia catechu in Nepal, particularly in the context of the Bagmati Province. Understanding the ratio of sapwood and heartwood in Acacia catechu is crucial for sustainable management and utilization of this species.

# Rationale of the study

Studying the ratio of sapwood and heartwood in Acacia catechu is essential for several reasons. First, it provides valuable insights into the growth patterns and age determination of the species. The relative proportions of sapwood and heartwood can vary depending on factors such as tree age, environmental conditions, and management practices (Skaar, 1988). By understanding these patterns, it becomes possible to estimate the age and growth rates of Acacia catechu trees, which is crucial for sustainable forest management. Second, the sapwood and heartwood ratio influences the quality and properties of the timber derived from Acacia catechu which will ultimately influences the commercial value of the timber. The heartwood, with its higher density and durability, is often preferred for high-value applications such as furniture making and construction as well as the extraction of Katha and Cutch (Joshi et al., 2019). Knowledge of the sapwood-to-heartwood ratio can assist in optimizing timber harvesting practices as well as the proper diameter/girth size for the harvesting of the species and identifying trees with desirable wood characteristics.

The objective of this study is to assess the ratio of sapwood and heartwood in Acacia catechu trees across the Bagmati Province. By analyzing field data collected from selected sites, it aims to contribute to the understanding of the species' growth patterns, age structure, and timber quality along with the optimization of the harvesting. The findings of this research can inform forest management strategies and support the sustainable utilization of this species in future.

# Objectives of the Study

The specific objectives of this study are as follows:

1. To quantify and analyze the ratio of sapwood and heartwood in Acacia catechu trees in the Bagmati Province of Nepal.
2. To examine the variations in sapwood and heartwood proportions across different age classes of Acacia catechu.

# Significance of the Study

The findings of this study hold several implications for the management and utilization of Acacia catechu in the Bagmati Province. Firstly, the knowledge gained regarding the ratio of sapwood and heartwood can contribute to improved tree age determination for the harvesting of the species which further improves the economic benefit to all stakeholders. This information would be valuable for estimating growth rates, predicting future timber yields, and implementing appropriate silvicultural practices in future by considering the environmental factors as well.

Secondly, understanding the variations in sapwood and heartwood proportions across different age classes of Acacia catechu can assist in sustainable harvesting strategies. By targeting trees with optimal heartwood development, it is possible to maximize timber quality and minimize waste in the processing industry.

Moreover, the assessment of environmental factors influencing the sapwood and heartwood ratio can aid in site selection and management decisions. By identifying the factors that promote heartwood formation, forest managers can optimize forest growth and enhance the overall economic value of Acacia catechu stands.

Finally, the findings of this study can contribute to the scientific knowledge of Acacia catechu in the context of the Bagmati Province. It fills a research gap and provides a basis for further investigations and studies related to the species' ecology, physiology, wood properties and business.

# Literature review

This chapter provides a comprehensive review of existing literature on the sapwood and heartwood characteristics of Acacia catechu. The literature review aims to synthesize the current knowledge, identify research gaps, and establish the context for the present study conducted in the Bagmati Province of Nepal.

# Sapwood and Heartwood Formation in Acacia catechu

Sapwood and heartwood are formed through a dynamic process involving changes in cell structure and chemical composition. Sapwood consists of living cells responsible for water and nutrient transportation, while heartwood represents the inactive, non-conductive portion of the tree trunk (Bamber, 2012). The formation of heartwood involves the accumulation of secondary metabolites such as tannins, resins, and pigments, which contribute to its darker color and enhanced durability (Pandey et al., 2018).

Previous studies on Acacia catechu have shown that heartwood formation is influenced by various factors, including age, genetics, environmental conditions, and management practices. For instance, Joshi et al. (2019) reported that heartwood content in Acacia catechu increased with tree age, reaching its maximum in older trees. Similarly, Tewari et al. (2020) found that heartwood formation was enhanced in trees growing in dry and nutrient-poor soils.

# Sapwood-to-Heartwood Ratio and Timber Quality

The sapwood-to-heartwood ratio is an important factor determining the timber quality of Acacia catechu. Heartwood is generally preferred for its higher density, strength, and durability compared to sapwood (Bamber, 2012). Several studies have examined the relationship between sapwood and heartwood proportions and timber properties in Acacia species.

In a study by Sharma et al. (2017) conducted in the Terai region of Nepal, it was found that the heartwood content of Acacia catechu significantly influenced its mechanical properties, such as modulus of elasticity and compressive strength. Higher heartwood content correlated with improved timber quality, making it suitable for construction and furniture making purposes.

Furthermore, Pandey et al. (2018) investigated the extractive content in the heartwood of Acacia catechu and its implications for its commercial value. They found that the heartwood contained significant amounts of tannins, which contributed to its natural resistance against decay and pests. This property enhances the market value of Acacia catechu timber and supports its use in traditional medicine.

# Research Gap and Rationale

Although previous studies have provided valuable insights into the sapwood and heartwood characteristics of Acacia catechu, there is a noticeable research gap in the context of the Bagmati Province of Nepal. The Bagmati Province harbors diverse environmental conditions, and the species' growth patterns and heartwood formation may vary in this region. Therefore, there is a need to conduct a comprehensive study to assess the sapwood-to-heartwood ratio and its implications for timber quality in Acacia catechu specifically within the Bagmati Province.

This present study aims to fill this research gap by analyzing field data collected from selected sites within the Bagmati Province. By examining the ratio of sapwood and heartwood in Acacia catechu trees, this research will contribute to the understanding of the species' growth patterns, age structure, and timber quality, ultimately supporting sustainable forest management and harvesting practices.

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