It is impossible to imagine a world without plants. The existence and the survival of human being on the earth are absolutely dependent on plants. Forest having direct effect on man’s life and economic position; tend to have a moderating influence on the natural climate. They form a buffer for the earth against natural climate – monsoon, wind, El Nino, cyclones, precipitation, solar radiation etc. Forest litter adds a great deal to the enrichment of the soil, and makes it fertile. In addition to supply of oxygen to living being, trees are also responsible for precious products such as paper, pulp, fertilizers, food & fuel, medicines and timber are precious products of the trees. However, of all the good things we get from trees, ‘wood is perhaps, nature’s most wonderful gift to humanity (Kumar, 1994). Weight for weight, wood is a strong as steel and has been used by human in hundreds of different ways for centuries ago. Wood represented a major advance in plant evolution during the cretaceous and allows trees to reach considerable height and lifespan. Wood (cell wall) is the most abundant biomass produced by trees on terrestrial ecosystem and has been considered as the fifth most important product because of its great economic and environmental values.

Plants are the dominant species in most of our ecosystems, and the adaptation of plants to the land dependent on the evolution and diversity of their cell walls. All plants evolved from a leafless, rootless, freshwater alga about 400 million years ago. To survive on the land over this time, plants were able to transport water, often to great heights, resist strong mechanical forces, withstand transient changes in drought, heat, attacks by pests and pathogens, and adapt to long-term climate change. In the development and survival of land plants cell wall perform vital role because they support the aerial organs in much the same way as bones and muscles support the animal body (Taylor et al., 1992; Hoson, 1998).
Higher plants are mainly made up of three organs: leaf, root and stem and all are more or less different in their size and shapes from species to species; likewise, their internal anatomical structures are also different from each others. Examine a thin section of any higher plant organ with the light microscope, and one will immediately notice two features. First, the plant has more than one type of cells which can be identified by its size, location, the thickness, organization and structure of cell wall that surrounds it. Second, the different cell types are neatly cemented to their neighbors by their walls in beautiful and reproducible patterns (Albersheim et al., 2010). In multicellular plants, growth is based on two processes, cell division and cell enlargement (Evert, 2006). Plant growth begins with the germination of seed into seedlings which grows under suitable conditions and convert into young mature plant. The seedling grows, extends its roots into the soils and its shoots (stems and leaves) into the atmosphere. The growth of the shoots and roots is due to the formation of new cells by meristematic (embryonic) tissues of the growing points, followed by growth and differentiation of these cells (Fahn, 1990). The common classification of meristems is based on their position in the plant body. There are apical meristems that are, meristems located at the apices of main and lateral shoots and roots, and lateral meristems that are, meristem arranged parallel with the sides of the axis, usually that of the stem and root. Both root and shoot apical meristem perpetuate themselves and also give rise to new meristem in an interactive process that produces the characteristics

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**Fig. 1:** Cambium and production of secondary conducting tissues. Arrows: centrifugal and centripetal differentiation of phloem and wood, respectively (Lachud et al., 1999).
structures of the mature plants, including leaves and flowers. The lateral meristems include pro-cambium and vascular cambium. Pro-cambium is responsible for primary growth while vascular cambium generates secondary xylem (wood) inner side and phloem outer side (Fig. 1).

In most dicotyledons and gymnosperms, stem thickening is continued into secondary phase of growth. That is to say, though the stems have ceased to elongate, they still increase radially. As this is a continuing process, the older the stem is, the thicker it becomes. The tissue which is responsible for radial thickening of stem is known as vascular cambium, briefly called cambium and which is sandwiched between secondary xylem and secondary phloem in form of cylinder. Bannan (1955) has outlined the history of the use of the word cambium but it was originally applied by Grew in 1682, to a refined sap which became elaborated as it moved from the bark to the wood (Philipson et al., 1971).

The vascular cambium consists of cambial initials and their undifferentiated derivatives; the entire zone is called cambial zone (CZ) or cambium. Cambium normally consists of an unbroken cylinder of cells, arranged in radial files. Undifferentiated cells to the inside of the cambial initials are known as xylem mother cells, those to the outside as phloem mother cells. Cambium is made of two types of initials, different in size and shape, fusiform initials (FIs) and ray initials (RIs). FIs are radially and tangentially short but vertically elongated with tapering ends in most of the plants and give rise to the vertical elements of secondary xylem and phloem-tracheids, vessel elements, sieve tube members, companion cells, fibers and axial parenchyma. RIs are small, almost isodiametric cells which produce the horizontal elements of the secondary vascular system. In tangential longitudinal section of CZ, two basic patterns may be distinguished in the
arrangement of Fls. First, the ends of vertically adjacent initials overlap in a random manner and the cambium is said to be non-storied cambium. On the other hand, storied cambium in which the Fls are arranged in horizontal tiers. In storied type of arrangement, fusiform cells divide anticlinally whereas in non-storied pattern pseudo-transverse divisions occurs which further give secondary xylem and phloem.

Wood, used by human society for millennia, remains one of the world’s largest abundant raw materials for industrial use and as renewable energy. Wood, the secondary xylem of tree species is a tissue formed from the terminal differentiation of the inner side of the cambial meristem for vertical and horizontal transport of water, minerals, and extractives. The secondary wall structure and composition of wood are the primary determinants of its physical and chemical property as well as its energy content. Wood typically composed of about 25% lignin, and 70% cellulosic carbohydrates and roughly 45% cellulose and 25% of hemicelluloses (Sjostrom, 1993; Novaes et al., 2010). The process of formation of secondary xylem is known as xylogenesis. Xylogenesis includes five major steps: (1) cell division, (2) cell differentiation, (3) secondary wall deposition, (4) lignification, and (5) programmed cell death. In the first step, anticlinal and periclinal divisions occur in the CZ; anticlinal divisions are found mostly in cambial initials and occur occasionally in the xylem mother cells and rarely in phloem mother cells, while periclinal divisions extend throughout the CZ, but most frequent in the zone of xylem mother cells (Philipson et al., 1971). Periclinal divisions lead to an increase in the amount of secondary xylem. As the volume of secondary xylem increase, tangential stress is produced on the vascular cambium immediately outside it, and this stress is countered by extension of the cambium circumference. This might be possible by increase in the tangential dimensions of the cambial initials, by elongation of initials or by anticlinal divisions. Expansion of the
daughter cells occurs after the anticlinal divisions in the initials and daughter cells gain same height as mother cells. The initial developmental stages differ in storied and non-storied cambium. In storied cambium radial longitudinal division followed by tangential expansions whereas in non-storied cambium the divisions are obliquely transverse (pseudo transverse) and the daughter cells expand longitudinally. During these divisions, suitable ratio (in terms of amount and distribution) between fusiform and RIs are also maintained because rays are essential for the functioning of the horizontal conduction elements of the wood (Philipson et al., 1971). This constancy results from the addition of new rays as the column of xylem increases in girth; that is new RIs appear in the cambium (Evert, 2006). These new rays arise from the FIs in various ways: a single cell may be cut off the side or the end of a FIs (Braun, 1955); the origin of rays, however, may be a highly complicated processes involving transverse subdivision of FIs into several cells, loss of some of the products of these divisions, and the transformation of others into RIs (Evert, 1961; Rao, 1988; Wilczek et al., 2011) and ray cambial cell can elongate into fusiform cambial cells (FCCs) (Philipson et al., 1971).

Once the cell division process is completed, xylem mother cells entered into next phase and this phase corresponds to cell differentiation and radial expansion zone. The process of cell differentiation involves a series of steps in which the pattern of gene expression and the cell’s complement of organelles, protein, polysaccharides, and other components becomes progressively graded to the particular function of the mature cell type (Albersheim et al., 2010). The cell wall property varies among cambial cells and their immediate derivatives (vessel elements or fibers) and this indicate that cell fate has already been determined at this early stage (Catesson and Ronald, 1981; Catesson et al., 1994). All the cells in the expanding zone undergo radial and tangential enlargement, with cell types differing in the extent, polarity, and
type of enlargement. Fibers and axial parenchyma cells expand primarily in the radial direction while vessel element in addition to radial expansion, may undergo substantial tangential growth that is accomplished by the uniaxial extension of radial wall and lateral displacement of adjacent cells. Fiber elongation is achieved by intrusive tip growth and requires local wall biogenesis and dissolution of the middle lamellae between neighboring cells (Mellerowicz et al., 2001). When a cell has finished expanding, it may begin to add successive new layers to its wall, always on the side of the wall next to the plasma membrane, to create what is designated as the secondary wall. This wall varies greatly in thickness depending partly on the role the cell wall play and partly on the age of the individual cell. Generally, young cells have thinner cell walls as compared to fully developed cells. The secondary wall commonly is reported to be deposited after the increase in surface area of primary wall has ceased (Evert, 2006). However, evidences also suggest that the initial layer of secondary wall becomes slightly extended because its deposition begins somewhat before increase in surface of the wall ceases (Roelofsen, 1959; Abe et al., 1997, Macadam and Nelson, 2002; Gritsch and Murphy, 2005). In thick walled wood cells, three distinct layers designated S₁, S₂ and S₃, for outer, middle and inner layer respectively- can frequently be distinguished in the secondary wall (Fig. 2). The S₂ layer is the thickest layer while S₃ layer is thin or some time entirely absent. These three S-layers can be identified on the bases.
of their differently arranged microfibrils (Frey-Wyssling, 1976). These cellulose microfibrils are oriented helically in various layers. In $S_1$ and $S_3$, the fibrils run along crossed helices which make a large angle, while in $S_2$, the micro fibrils angle is small. The macromolecular organization of secondary wall of the cells from tree xylem is a larger part responsible for the mechanical and physiological properties of wood (Ruel et al., 2006). Secondary wall mainly made up of cellulose, hemicellulose and lignin polymers and covers more than 90% of total cell wall biomass. Cellulose is present in both primary and secondary wall but lignification start during secondary wall formation and this process continues side by side while secondary wall has been building up (Evert, 2006). Lignification forms one of the most important biochemical events that accompany the formation of the secondary plant cell wall. This polyphenolic polymer is laid down in the secondary wall within the template of cellulose and hemicelluloses and also occurs in junction areas of middle lamella and cell corners.

From prospective of plant’s survival, lignin plays very important functions. The development of lignin was a keystone event in the evolution of vascular land plants because lignin provided the necessary strength and hydrophobicity to fiber and vessel cell walls to allow plants to grow tall in a gravitropic environment and to transport water and nutrients in their vascular system (Rogers and Campbell, 2004; Weng and Chapple, 2010). Lignin also functions as binding agent imparting compressive strength and bending stiffness to the woody stem (Grisebach, 1981). According to Sederoff and Chang (1991) lignin may have first function as an antimicrobial agent and only later assumed a role in water transport and mechanical support in the evolution of land plants. Lignin is a complex aromatic polymer in which the cell wall polysaccharides (mainly cellulose and hemicelluloses) and cell wall glycoprotein are embedded. The process of lignification is an irreversible
process and typically proceeded by the deposition of cellulose and non-cellulosic matrix compounds (hemicelluloses, pectin and structural proteins) (Terashima et al., 1993). Monolignols are delivered to cell wall by vesicles that are derived from the golgi aperture or endoplasmic reticulum and they polymerize into lignin by wall bound peroxidase isoenzymes via free-radical formation in the presence of \( \text{H}_2\text{O}_2 \). Lignification starts first from middle lamella particularly at cell corners, when cell have completed the deposition of \( S_1 \) layers. Lignification progress inwards during the \( S_2 \) layer formation, concomitantly with cellulose, mannan and xylan deposition. Lignin deposition is most intense when \( S_3 \) layer is formed and it progress inwards the cell lumen until all the wall layers are lignified (Evert, 2006). Lignin monomer composition varies according to species, cell types and size of tissues development. Lignin content is typically higher in coniferous wood (25-40%) than in angiosperm wood (20-25%) (Adler, 1977). In conifers, lignin is mainly composed of guaiacyl (G) unit, whereas in angiosperms it is composed of both syringyl (S) and guaiacyl (G) units (Nimz et al., 1981). H units derived from p-Coniferyl alcohol are present in both angiosperms and gymnosperms in small amounts, but are most abundant in grasses (Nimz et al., 1981). Lignin composition change during the cell differentiation in relation to the distance from the cambium, the closer to the cambium, the more \( P \)-hydroxyphenyl (H) and guaiacyl (G) units are present in lignin, where as further away from cambium, the more syringyl (s) units are incorporated (Terashima et al., 1979, 1993; Yoshinaga et al., 1997b). In the context of lignin heterogeneity in cell wall, certainly the consequences of chemical treatments or the susceptibility of lignocellulosic to the attack by microorganisms must be greatly depends upon the distribution pattern of lignin subunits and interlinkage within lignified cell walls. Therefore, the knowledge of relative distribution of various types of lignin in wood cell types will be of great interest.
The secondary growth of woody plants is a dynamic process that integrates multiple developmental mechanisms and responds to physiological and environmental cues. As mentioned above, the process of xylogenesis is directly related with cambial activity (CA) and dormancy. According to Savidge (2001), cambial growth is the formation of secondary xylem and phloem as well as formation, continuing areal expansion and maintenance of the vascular cambium itself. The cambial growth is achieved by CA. In woody temperate trees CA and reproductive phase alternate with periods of relative inactivity during winter, while in tropical trees, CA along with vegetative and reproductive growth cease for few months or continue throughout the year. During dormancy period productions of new cells by the vascular cambium stops completely and mature xylem and phloem cells appears more or less closely to the CZ. Cambial cells during these periods show thicker radial walls as compared to active period. Before initiation of cell division, cambial cells expand radially (swelling of cells) resulting thinner and weaker radial wall. Although the resumption of CA may be preceded by decrease in density of their protoplast, the cambial cells do not expand radially prior to cell division in most of the temperate zone species (Evert, 2006) but in the case of Robinia pseudoacacia cell division start prior to radial expansion (Farrar and Evert, 1997b). Tropical trees also show same trends of cell division followed by radial expansion through they are showing different kinds of timing of CA and dormancy (evergreen, semi deciduous and deciduous) (Dave and Rao, 1982; Fahn, 1982; Sass et al., 1995; Rajput and Rao, 2001, Venugopal and Liangkuwan, 2007; Marcati et al., 2008; Rajput et al., 2008). Most of the data related to CA and tree growth are reported in temperate tree species, while information regarding CA in tropical trees is less. According to literature CA is concise and limited to summer/spring season in temperate species, while in tropical trees show relatively longer time periods of CA.
The cambial reactivation, duration and cessation of CA as well as rate of production of wood are depend on various internal and external factors. Savidge (1996) classified these generic constitutions, physiological phenomena and environmental factors act as extrinsic and intrinsic signal which regulate the cambial growth and development. Extrinsic factors include temperature, water (rainfall), relative humidity, photoperiod and growing season etc. regulate the CA indirectly by controlling the timing and extent of metabolites and primary and secondary growth in plants. The genomic content, phytohormones, reserve food material and physiological state of the plant are considered as intrinsic factors which influence the CA and xylem formation directly (Kozlowski, 1962).

Impact of various external and internal factors has been studied by various workers. Temperature and water are to be considered as important extrinsic factors (Rao and Dave, 1983; Rao et al., 1996a, b; Fonti and Jansen, 2012; Rajput et al., 2008; Giantomasi et al., 2012; Marcati et al., 2006, Borchert, 1999; Krepkowski et al., 2011; Oliveira et al., 2009; Venugopal and Liangkuwan, 2007, Begum et al., 2008; Die et al., 2012; Rao and Rajput, 2001) for CA and xylogenesis. Most of the data reported on climatic control of tree growth and CA is based on observation made on temperate trees where seasonal variation in temperature constituent the principal climatic driving variable, while in tropical climate, rainfall playing major role to activate cambium and xylem differentiation (Rajput and Rao, 2005). Studies on CA and wood formation in temperate species indicate that temperature is closely associated with the radial growth of tree stems (Denne and Dodd, 1981; Schweingruber, 1988; Fonti et al., 2006; Schmitt et al., 2004; Rossi et al., 2007, 2008a). Makinen et al. (2003) also suggested that the annual maximum growth rate of cambium in Picea abies is regulated by temperature. Likewise, in tropical trees, reactivation of cambium is dependent on temperature (Rao and Rajput, 2001; Rajput and
Rao, 2000, 2005; Begum et al., 2007; Marcati et al., 2006; Pumijumnog and Buajan, 2012). In Dellenia indica, the monthly mean minimum temperature plays an important role for the CA and xylem production rather than influenced by rainfall and relative humidity (Venugopal and Liangkuwan, 2007), while in Pinus kesiya growing in sub-tropical condition showed average temperature influenced the CA and xylem formation and secondly rainfall (Singh and Venugopal, 2011). In summer along with the temperature day length is also increasing. Rossi et al. (2008b) reported that, in conifers such as Abies, Larix, Picea and Pinus, the maximum growth rate occurs at about the same time as maximum day length. It is known that most of the tree species (temperate or tropical) showing reactivation of cambium in early summer when duration of photoperiod start increasing. Short day stops shoot expansion and cause development of dormant state, where as long days delay or prevent dormancy (Krammer and Kozlowski, 1979; Paliwal, 1981). Studies on effect of artificial heating on dormant cambial cell in tropical (Pathak, 2008) and temperate species (Oribe et al., 2003; Begum et al., 2010) indicate the role of temperature in reactivation of cambium necessary in some tree species.

Second major factor which controls the CA in tropics is water availability (rainfall). Trees will not continue growing without adequate amount of water. Most of the tropical trees show peak CA and xylem differentiation during rainy seasons. Species growing under different climatic conditions (in relation to water availability) also showed noticeable changes in timing and duration of CA and amount of xylem formation (Rajput, 1997; Rajput and Rao, 2000). Krepkowski et al. (2011) also observed that stem diameter was comparatively broader during long rainy period than short rainy period in three evergreens and one deciduous species in Ethiopia. In absence of water (less than required) the turgor pressure of the cell goes down and indirectly it reduces the growth of leaves and supply hormones. On contrary in
Pentaclebra macroloba, CA was observed during drier period of the year (Hazlett, 1987). Humidity and rainfall both are interdependent factors and CA and xylem formation in softwood and hardwood trees of tropical climate is strongly correlated with humidity next to rainfall (Venugopal and Liangkuwan, 2007; Singh and Venugopal, 2011). Dave and Rao (1982) also noticed positive correlation between CA and humidity.

Other than temperature, rainfall and humidity, phenology also plays crucial role in cambial reactivation. Temperature influence shoot growth through which effect on bud formation and sprouting of new leaves and also bud dormancy (Kramer and Kozlowski, 1979). Shoot growth in tropical plants is diverse. It is intermittent with shoots expanding in one to several growth flushes during the year. The interval between growth flushes very among species cultivars, climatic regimes, individual trees within species and even branches of a given tree. Shoots of Acrocarpus fraxinifolius tend to flush only once or twice (Kramer and Kozlowski, 1979), while K. africana shows three to four flushes in a year (Rohit, 2010). In evergreen trees like Moringa oleifera, Peltophorum pterocarpum, Mangifera indica, leaf development is continuous throughout the year. In some tree species continuous cambial growth is linked to continued shoot expansion and ceases soon after shoot elongation stops. Actively growing shoots produced hormones which stimulate the cambial cell divisions. Dave and Rao (1982) observed that development of new leaves reanimate the cambium in Gmelina arborea. The emergence of new leaves is an essential requisite for the reactivation of cambium was also reported in certain tropical tree species (Paliwal and Prasad, 1970; Ghouse and Hasmi, 1979; Rao and Dave, 1981).

Internal factors mainly involve various hormones, genetic content, reserve food materials and physiological state of the plant which directly
influence the cambial behavior (Kozlowski, 1962) and also control seasonality of cambium for very short duration (Savidge and Wareing, 1981; Savidge, 1991). Auxin (Indol-3-acetic acid), cytokinin, abscisic acid and gibberellins are believed to regulate cambial cell activity and xylem formation at different time intervals (Sorce et al., 2013). In tree trunks, there is an auxin maximum in the cambium and its vicinity (Uggla et al., 1998, 2001). At the beginning of growing season, the basipetal flux of auxin is correlated with the basipetal reactivation of the dormant cambium (Beck, 2010). Along with auxin, gibberellin is also known to stimulate cell division in cambial initials and young cambial derivatives and also regulating frequency and distribution of fusiform and RIs (Bjorklund et al., 2007). Although cytokinins are generally considered to be important regulators of cell division, their role in CA has not yet been elucidated.

Other than hormones, cambial cells requires energy source for divisions and differentiation which is provided either by reserve food materials or directly from the photosynthetic organs when present. Carbohydrates in the form of starch are the major storage materials in various plant cells and used by trees in different ways during its growth and development (Barajas et al., 1997). Generally, ray parenchyma and axial parenchyma cells serve as the major storage sites in plants, however in some plants fibers also may play the major role as storage sites and are known as living wood fibers. To support enough carbon demand during winter and to fuel bud flush and shoot growth in the following spring, trees need to store reserve materials when new leaves are not capable to generate sufficient photosynthates (Regier et al., 2010). Whenever species experience seasonal asynchronies in resource supply and demand, stored reserves to play an important role in the plant’s resource budgets (Chapin et al., 1990; Barajas et al., 1997). Studies on seasonal starch distribution in tropical and temperate tree species suggest that much of the
reserve food materials are utilized during CA and xylem differentiation (Rao and Dave, 1983; Essiamah and Eschrich, 1985; Rao and Menon, 1989; Barajas et al., 1997; Rajput and Rao, 1999; Rao and Rajput, 2001b; Begam et al., 2010).

In flowering plants, starch not only functioning as reserve materials but also plays vital role to perceive gravity mainly in roots (Boonsirichai et al., 2002; Vitha et al., 2007), stem (Nakamura et al., 2001), leaf petiole (Mano et al., 2006), gynophores (Mectezuma and Feldman, 1999) and inflorescence stem (Weise and Kiss, 1999). Gravity perception by plants is believed to be the movement and sedimentation of dense, starch filled plastids known as amyloplast. Statoliths are specialized cells which detect the gravity strains caused by self loading, internal growth, mechanical loading, sound, within cell hydration etc and convert this physical information into physiological data within the statocytes (Morita, 2010). Thus, the nature of the cellular mechanism of gravitropism is one of the most important and fundamental questions in the plant biology (Vitha et al., 2007). Both the starch-statoliths hypothesis (Boonsirichai et al., 2002) and the hydrostatic model of gravisensing (MacCleery and Kiss, 1999) ultimately relay on the sensing of a mechanical signal at the cytoskeleton-plasma membrane cell-wall interference. Earlier studies have demonstrated the gravity mediated growth responses through sedimented amyloplasts along the axis of herbaceous stems (Sack, 1997; Kiss et al., 1997; Fukaki et al., 1998) and are proposed to play a role in regulation of growth direction and secondary xylem formation in woody stems (Nakamura et al., 2001). On the other hand, series of studies on starch less mutants has indicated that starch is not absolutely essential but does play a role in sensing gravity and is necessary for a full gravitropic response (Morita, 2010).
From the perusal of above cited literature it is clear that rain fall (soil water availability) and temperature are the most important factors that influence CA. In addition to this photoperiod (day length), phenology, hormonal level and reserve metabolites also plays significance role in the process of wood formation by controlling CA. The study of relationship between seasonal CA and its duration are significant parameters to know the effect of climatic factors on wood formation (Oladi et al., 2011). CA and xylem development also gives clues about the possible factors that control tree growth, in predicting timber and biomass yield, and in determining forest dynamics (Jacoby, 1989). Comparison of phenological events like bud burst, flowering, fruiting, defoliation with environmental factors have been helped to build growth model which is used for ecological monitoring (Vries et al., 2002) as well as to detect the relationship between environmental influences and the fitness of plants and to find causal analytic interpretation and explanations (Rotzer et al., 2004). Long term monitoring of CA and phenological events helps to prepare the computerized model that can predict the future as well as past environmental conditions. Although the structure of wood, as well as its chemical, physical and mechanical properties have been studied extensively, details of the processes of wood formation are not fully understood (Funada, 2008). To produce high quality wood with desirable qualities by biotechnological manipulations, we need to improve our understanding of the cellular and molecular details of wood formation (Begum et al., 2012).

Despite of new techniques for studying the cell biology of plant development in recent years, the secondary vascular system has been neglected. Our current understanding on biology of cambial seasonality and wood formation greatly contributed by extensive studied on relatively less diversified tree fauna in the temperate conditions while large diversity of
tropical trees have received little attention on seasonality of cambium and wood formation. Xylogenesis has a great importance not only because of the function of xylem is essential to the existence of vascular plants but also because xylem formation appears to be a good model system for the analysis of differentiation processes in higher plants (Fukuda et al., 1996). CA and xylem development also gives clues about the possible factors that control tree growth and development which help in predicting timber and biomass yield, and in determining forest dynamics (Jacoby, 1989; Kozlowski et al., 1991; Eckstein et al., 1995; Priya and Bhat, 1999). One of the characteristics features of the secondary vascular system which make it ideal for studying questions concerning cell differentiation and determinations is the ordered cell files that are produced by the cambium facilitate the tracking of different stages of differentiation of an individual cell (Chaffey, 2001). Moreover, a great deal of fundamental on basic biology of secondary vascular system is required to describe the system at the level of cell before it is possible to fully exploit the possibilities that might exploit for its multiplication at the molecular genetic level. In the light of global issues such as concern over rising CO₂ levels and dwindle fossil fuel resources, there has never been a better time to promote the relevance and importance work on the tree secondary vascular system (Chaffey, 2001). There is a clear need to identify the impact of xylem structure and ecophysiology on CA, especially considering the necessary time-lag and carry-over effects (Fonti and Jansen, 2012).

Looking into these important gap areas in the biology of wood formation in tropical trees, the present work is focused on short term monitoring of seasonal anatomical changes in the cambium and wood development in four tropical tree species which include evergreen tree species Moringa oleifera and Peltophorum pterocarpum, deciduous species Erythrina indica and semi deciduous species Kigelia africana in relation to
environmental factors and tree phenology. This study also includes lignin deposition during xylogenesis, seasonal distribution of starch in various wood elements using histochemical methods and wood anatomy of the selected tree species.