Summary
CHAPTER 6 SUMMARY

Carbon sequestration potential and litter dynamics of four commercially important bamboo species viz. *Bambusa balcooa*, *B. bambos*, *Ochlandra travancorica* and *Thrysostachys oliveri* in Kerala above commercial exploitation age were explored in the present investigation. Observations on clump structure of bamboo species indicated that the frequency distribution of culms in different girth classes at the age of seven years in bamboo clumps varied with species. *B. balcooa*, *B. bambos*, *O. travancorica* and *T. oliveri* produced 7799, 7000, 29945 and 3725 culms ha⁻¹, respectively. In *B. balcooa* and *T. oliveri* most of the culms belonged to 15-20 cm and 20-25 cm (large) girth class. In *B. bambos* and *O. travancorica* most of the culms belonged to lower girth classes. The clump and culm attributes of bamboo species increased with increase in age and the culms produced in successive years recorded greater height, girth, internodes and internodal length.

With regard to biomass accumulation, the total green weight of *B. balcooa*, *B. bambos*, *O. travancorica* and *T. oliveri* clumps at the age of six years (2011) was to the tune of 216.087, 56.804, 23.625, 179.160 kg per clump respectively and that of seven year old clumps was 293.629, 86.702, 27.826, and 201.200 kg. Total biomass (dry weight) of *B. balcooa*, *B. bambos*, *O. travancorica* and *T. oliveri* clumps at the age of six years was to the tune of 116.079, 31.660, 12.145 and 99.067 kg per clump, respectively and that of seven year old clump was 159.935, 51.334, 17.731 and 111.286 kg respectively. In general, the culms constituted the major share of green and dry weight in all bamboo species. Multiple linear regression equations connecting above ground biomass components and culm characteristics like height, girth at breast height, number of internodes and internodal length were developed for all bamboo species and that connecting total above ground green and dry weight recorded high $R^2$ values. The annual productivity of *B. balcooa*, *B. bambos*, *O. travancorica* and *T. oliveri* during sixth and seventh year deduced from current estimates was 18.57, 7.07, 0.89, and 5.92 Mg ha⁻¹ year⁻¹. Six allometric models (both linear and exponential based on girth at breast height alone and GBH and height connecting culm, branch,
leaf and total biomass were tested for the best fit. The log: log allometric equations were the best fit in most of the cases.

Carbon concentration of biomass clump components like culm, branch, leaf, rhizome and root, species wise variation was not obvious but significantly varied among clump components. Generally, the above ground components recorded a higher carbon concentration than below ground components in all bamboo species. Magnitude of carbon storage in the bamboo clumps was in the order \( B. \text{balcooa} > T. \text{oliveri} > B. \text{bambos} > O. \text{travancorica} \). Carbon storage in the clumps of \( B. \text{balcooa} \) was 55.86±17.18 and 76.66±25.02 kg, respectively at sixth and seventh years while that of \( B. \text{bambos} \) was 17.96±1.33 and 25.82±6.44 kg. Carbon storage at sixth and seventh years in \( O. \text{travancorica} \) was 6.72±0.34 and 7.56±0.57 kg per clump and that in \( T. \text{oliveri} \) was 46.65±5.47 52.84±15.38 kg, respectively. Carbon sequestration potential of \( B. \text{balcooa} \) at sixth and seventh year was to the tune of 22.34±6.87 and 30.66±10.01 Mg ha\(^{-1}\); that of \( B. \text{bambos} \) was 7.19±0.53 and 10.33±2.58 Mg ha\(^{-1}\) respectively. Meanwhile, carbon storage of \( O. \text{travancorica} \) at of sixth and seventh year was 2.690±0.14 and 3.02±0.23 Mg ha\(^{-1}\) and that of \( T. \text{oliveri} \) was 18.66±2.19 and 21.14±6.15 Mg ha\(^{-1}\), respectively.

Soil also played an important role in carbon sequestration. Soil carbon content under bamboo species varied due to depth and a decrease in carbon concentration was observed with increasing soil depth. Total carbon density of soils up to 60 cm depth deduced from the densities at different depths of \( B. \text{balcooa}, B. \text{bambos}, O. \text{travancorica} \) and \( T. \text{oliveri} \) was 56.95±4.34, 62.86±6.26, 46.28±4.31 and 54.02±3.17 Mg ha\(^{-1}\), respectively.

Litter production of six and seven year old plantations of \( B. \text{balcooa}, B. \text{bambos}, O. \text{travancorica} \) and \( T. \text{oliveri} \) varied between months. Annual litter production at the end of May 2011 was to the tune of 4.064, 3.340, 1.846 and 4.488 Mg ha\(^{-1}\) year\(^{-1}\) in \( B. \text{balcooa}, B. \text{bambos}, O. \text{travancorica} \) and \( T. \text{oliveri} \), respectively. Litter production of
bamboos increased with age and in May, 2012 the litter production in *B. balcooa*, *B. bambos*, *O. travancorica* and *T. oliveri* was to the tune of 5.087, 3.909, 2.227 and 5.522 Mg ha\(^{-1}\) year\(^{-1}\), respectively. Litterfall followed a bimodal distribution pattern with a major peak during February and a minor peak during July or December. Profound seasonal variation was observed in litter production with rainy season recording the lowest litterfall. Litter production was correlated with climatic factors like monthly rainfall and maximum and minimum temperature. It was negatively correlated with rainfall.

As regards to the proximate composition of litter, leaf litter accounted for more than ninety per cent of the total litter mass. In *O. travancorica*, leaf contributed up to 95.34 per cent of the total litter. The contribution of culm sheath to total litter mass was the lowest. Initial litter chemistry of bamboo species varied and carbon was the major constituent of litter mass followed by nitrogen and the ratio of carbon to other nutrients also varied significantly.

During litter decomposition, mass disappearance of litter varied due to species and month. A two phase pattern of litter decomposition comprising an initial rapid phase followed by a slower phase was observed in all the species. The rates of decomposition in different bamboo species was a good fit to exponential decay model suggested by Olson (1963). The decomposition rate of litter mass in different bamboo species was in the order *O. travancorica* > *B. balcooa* > *B. bambos* > *T. oliveri*. The highest decomposition rate constant was recorded in *O. travancorica* (0.014 day\(^{-1}\)) and the lowest was obtained for *T. oliveri* (0.009 day\(^{-1}\)). Halflife of the litter of bamboo species were different and the time taken for 50 and 99 per cent decomposition was the highest in *T. oliveri* (77 and 555.56 days, respectively) and it was followed by *B. bambos* (63.00 and 454.55 days), *B. balcooa* (60.26 and 434.78 days) and *O. travancorica* (49.50 and 357.14 days, respectively).
Concentration (per cent) of nutrients, N, P, K, Ca and Mg in the litter mass retrieved at monthly interval varied in the four species and the nutrient content in general was lower towards the end of decomposition. In all the species multi-phasic pattern of increase or decrease in nutrient concentration during decomposition was observed. Percentage nutrient remaining in the litter calculated from nutrient concentration and litter mass remaining declined with time in general with some accumulation phases in due course. The nutrient release from the decomposing litter mass was in the order Mg > N > Ca > P > K.