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Profile stratification of carbon and nitrogen in a native perennial pasture in northern New South Wales, Australia

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Organic carbon in the soil profile is highly stratified typically with largest concentrations in the top 30 cm. Despite low carbon concentrations in the subsoil, these deeper soil horizons nevertheless have the capacity to sequester large amounts of soil organic carbon. The importance of carbon sequestration in sub soils is steadily growing with regard to greenhouse gas mitigation, with increasing evidence of its low turnover rates and relatively stable forms. However, most work to date in Australia has been focused on the surface layers and our knowledge of subsurface carbon distribution is limited.

Of the many factors influencing stratification of soil organic carbon in a profile, land use has been shown to have a significant influence on its distribution and quantity. Perennial grass systems in particular, are deeply rooted with various studies reporting a belowground translocation of photosynthetic C of about 30-80% and a global mean soil organic carbon sequestration potential of 0.54 Mg C/ha/yr. Defining the depth at which these carbon densities occur is important as this can give an indication of the stability of the carbon stored in these systems.

The objective of the present study was therefore to characterize the distribution of soil carbon and nitrogen stored down the whole soil profile and particularly in the subsoil of a mixed perennial pasture in northern NSW. The study was carried out at Kirby Research Station in northern New South Wales, Australia where a mixed native pasture has grown for over 10 years. Sampling followed a randomized design with 10 replicates. Soils were sampled up to 1m depth and divided into 11 depth increments of 0-5, 5-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80, 80-90 and 90-100 cm in October 2009. Samples were analysed for total organic carbon and total nitrogen (using LECO C/N auto analyser) down the soil profile. Further, an incubation experiment has been set up to determine the sizes and fluxes (turnover rates) of soil organic carbon pools at these depths. This data will subsequently be used to interpret the dynamics of soil carbon at depth and presented in the final paper.

The results show that density distribution of carbon in the profile declined steadily from the surface soils to the sub horizons. This distribution was stratified into three significantly ($P<0.05$) different cluster horizons of 0-20, 20-50 and 50-100 cm. The surface layer (0-20 cm) had the highest mean C density of 70 t/ha, with the subsequent two cluster horizons having 44 t/ha and 20 t/ha respectively. The decline in C density in sub horizons below 50 cm was at a rate of 3 t/ha for every 10 cm. The C concentration was significantly ($P<0.05$) influenced by depth, with the highest concentration (6%) attained at the top 0-5 cm and < 5% in the subsequent sub-horizons. The nitrogen concentration followed a similar trend as carbon with the top 10 cm having > 0.2 % N. Carbon: nitrogen ratios of above 10 were recorded in the top 50 cm indicating that these horizons are of higher fertility. High fertility levels could further lead to high plant growth which will maintain high inputs of C and therefore high C level in these mixed native pasture system.

Key words: carbon sequestration, nitrogen, subsoil, native pastures, Australia.