Due to the rapid development of mass spectrometry and its applications, the use of stable isotope techniques in environmental studies, plant nutrition and soil science has increased considerably during the last decades. Both, applying stable isotopes as tracers or using the natural abundance, especially of $^{13}$C and $^{15}$N, opens the chance of quantifying even single processes within the complicated soil system.

Plants differ distinctly in their C-isotopic composition. The largest difference occur between plant species with different photosynthetic pathways. C$_3$- and C$_4$-plants are differentiated by approximately 14% on the δ-scale (app. -27% $^{13}$C versus -13% $^{13}$C). Modern elemental analyser - mass spectrometer combinations reach accuracies of at least 0.1% 6$^{13}$C. Therefore, the difference between C$_3$ and C$_4$ plants is sufficient to be used for tracer studies.

Several investigations of SOM turnover under field conditions were undertaken using the fact that the vegetation cover changed between C$_3$ and C$_4$ plants (Baldesdent and Mariotti, 1996). Cerri et al. (1991) described the discrimination between SOM originating from indigenous vegetation (forest, C$_3$) and sugar cane (C$_4$) after 50 years of cropping introducing two SOM compartments of different stability. Another example is the change from prairie vegetation (C$_4$) to different C$_3$-crops and the evaluation of the carbon origin at or near equilibrium (Wagner, 1991). More recent studies use $^{15}$N-labelled C$_4$-plant residues or $^{13}$C-labelled C$_3$-plants (Hopkins et al., 1997) to elucidate the fate of carbon and nitrogen in soils developed under C$_3$-vegetation. Both in situ experiments (Alta et al., 1997) and laboratory incubations (Stemmer et al., 1998) were used to evaluate carbon and nitrogen fluxes from crop residues. Physical fractionation of bulk soil into particle sizes proved to be of advantage to follow short and long-term dynamics of crop residues within SOM.

Changes in the natural abundance of $^{13}$C and $^{15}$N within soil profiles can elucidate leaching or mineralization of humic substances (Gerzabek et al., 1989). Changes in the natural abundance of stable isotopes are also possible due to the application of organic manures, quantification, however is not easy because of the small isotopic differences between soil and manure carbon and nitrogen (Gerzabek et al., 1997).

$^{15}$N labelling of soil nitrogen has been widely used in the last two decades to quantify biological nitrogen fixation. Considerable progress has been made due to the isotope dilution method in estimating absolute rates of mineralisation, immobilisation, nitrification and nitrate reduction in soil, which cannot be directly deduced from non-tracer experiments. A very interesting topic seems to be the measurement of nitrogen released from organic residues, like N-fixing plants (Elwaraky and Haunold, 1991), sewage sludge (Gerzabek et al., 1997) or other manures.

Further potential of stable isotope techniques in SOM dynamics studies can be envisaged in the field of quantifying the pools contributing to N-mineralization, the role of soil microbial biomass in this context, the sulphur cycle ($^{32}$S), climate change and the impact of nitrogen oxide pollution on SOM dynamics, especially in semi-natural environments.