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Effect of soil management practices on soil carbon dynamics under maize cultivation

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An increasing world population and change in consumer preferences necessitate the need to increase food production to meet the demand of a changing world. Intensified agriculture and an accelerated climate crisis with increasing weather extremes threaten the resource base needed to improve crop production. Maize yield obtained by farmers in the guinea savannah zone of Ghana is generally low due to low soil fertility status resulting from continuous cropping coupled with low use of external inputs. Integrated Soil Fertility Management (ISFM) practices have proven to sustainably increase maize yield. However, majority of the farmers practicing ISFM till their land conventionally, potentially resulting in substantial greenhouse gases (GHG) emissions that contribute to global climate change. However, there is dearth of information on GHG emissions regarding crop production systems in sub-Saharan Africa in general and Ghana in particular. Hence, within a field trial we seek to investigate the impact of different tillage practices and ISFM applied to sustain maize yield, on net CO_2 or ecosystem exchange (NEE) and net carbon (C) balance (NECB). The field trial was established at the Council for Scientific and Industrial Research-Savanna Agricultural Research Institute in Northern region of Ghana. A split plot design was used with the main plot treatments being conventional tillage and reduced tillage and the subplot treatments being factorial combination of organic and inorganic fertilizers at three levels each. To determine NEE and thereon based estimates of NECB, an innovative, customized, low-cost manual, dynamic closed chamber system was used. The system consists of transparent (V: 0.37 m^3, A: 0.196 m^2; for NEE measurements) and opaque chambers (for ecosystem respiration (R_{eco}) measurements) of the same size. Diurnal regimes of R_{eco} and NEE fluxes were measured twice a month by repeatedly deploying chambers for 5 to 10min on the 3 repetitive measurement plots (PVC frames inserted 5 cm deep into the soil as collars) per treatment. CO_2 concentration increase and decrease over chamber deployment time was detected by portable, inexpensive Arduino based CO_2 logging systems, consisting of a battery powered microcontroller (Arduino Uno) and data logging unit (3 sec frequency) connected to an NDIR-CO_2 sensor (SCD30; ± 30 ppm accuracy),

air temperature and humidity (DHT-22) as well as air pressure sensor (BMP280). Measured CO_2 fluxes were subsequently gap-filled to obtain seasonal NEE. C import and export were further on added to NEE to determine the NECB for each treatment. In parallel to CO_2 exchange measurement campaigns, agronomic and crop growth indices such as the normalized difference vegetation index (NDVI) were performed biweekly at all plots. Here we present NEE and NECB balances for the first crop growth period.

Keywords: Tillage, Integrated soil fertility management, CO_2 emission, Zea mays, net ecosystem carbon balance (NECB)