Evaluation of Soil Fertility in a minimum-till Maize Farming System using Permanent Planting Stations Practiced by Smallholders in Western Central Zimbabwe

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ABSTRACT

Maize is the dominant staple food of southern Africa; however production in this region is critically low. A minimum-till system called CF (Conservation Farming) significantly raises yields of smallholder maize farmers. CF is now being promoted by many research organizations and NGOs in southern Africa.

This minimum-till technology utilizes permanent planting stations for input application and seeding. These stations are shallow holes dug with a hand hoe and exist in a precise grid. The stations are reopened annually in advance of planting where again a basal application of lime, inorganic and/or organic fertilizers is applied before seeding. The permanent planting stations facilitate precise fertilizer application and use efficiency. The method involves no-tillage making it especially useful to households without access to mechanical or draught power for land preparation.

CF research has appropriately focused on yield; however, little emphasis on soil property changes has been investigated. The aim of this study was to explore the technology's impact on soil fertility development—the quality and rate of fertility increases over time. A less expensive, simpler carbon analysis was also used to evaluate its effectiveness in estimating soil quality for further CF research. Therefore, in western central Zimbabwe farmers' fields of 4 (CF4) and 8-9 years (CF8) CF practice were compared with conventionally ploughed fields (REF) for soil fertility parameters total C, active C, N, P, exchangeable cations K, Mg, Ca, and Na, pH, bulk density, and infiltration.

With the exception of K, Mg, and Na all tested parameters were superior inside CF4 and CF8 stations than to ploughed soils and soils outside the CF stations. P and N were significantly

higher in the stations of CF8 and CF4 than the maize ridges in REF. Total carbon and active (labile) carbon were more than 45% higher at 0-15 cm of CF4 and CF8 planting stations compared to any sampling point in ploughed fields. TC outside CF stations was modestly higher (9%) than REF. CF Station pH was 5% higher than ploughed fields, but lower outside the station than ploughed fields. Infiltration rates were higher in both 4 and 8 year CF fields both in and outside of station when compared to ploughed fields. Bulk densities averaged slightly lower in CF fields both in and outside of station when compared to ploughed fields. Combined CF treatment yield estimates (4.0 t/ha) were 6 times higher than REF (0.66 t/ha). The active carbon results correlated well with total carbon (Pearson's r, 0.859) and moderately well with nitrogen (Pearson's r, 0.796).

Fertility improvements were significantly concentrated in planting stations. The positive changes occurred within the first four years though no significant differences existed between CF4 and CF8. CF planting stations have greater overall nutrient status and physical characteristics than ploughed field sampling positions. The positive impacts of a minimum-till system combined with the accumulation of carbon and nutrients over time, especially P, within planting stations, enable smallholder farmers to achieve high yields on small pieces of land through improved optimization of water, soil, and fertility resources.

Keywords: CF, Conservation Farming, planting station, basin technology, Zimbabwe,
Active carbon