THE EFFECTS OF TILLAGE PRACTICES ON SOIL MICROBIAL BIOMASS AND CO_2 EMISSION

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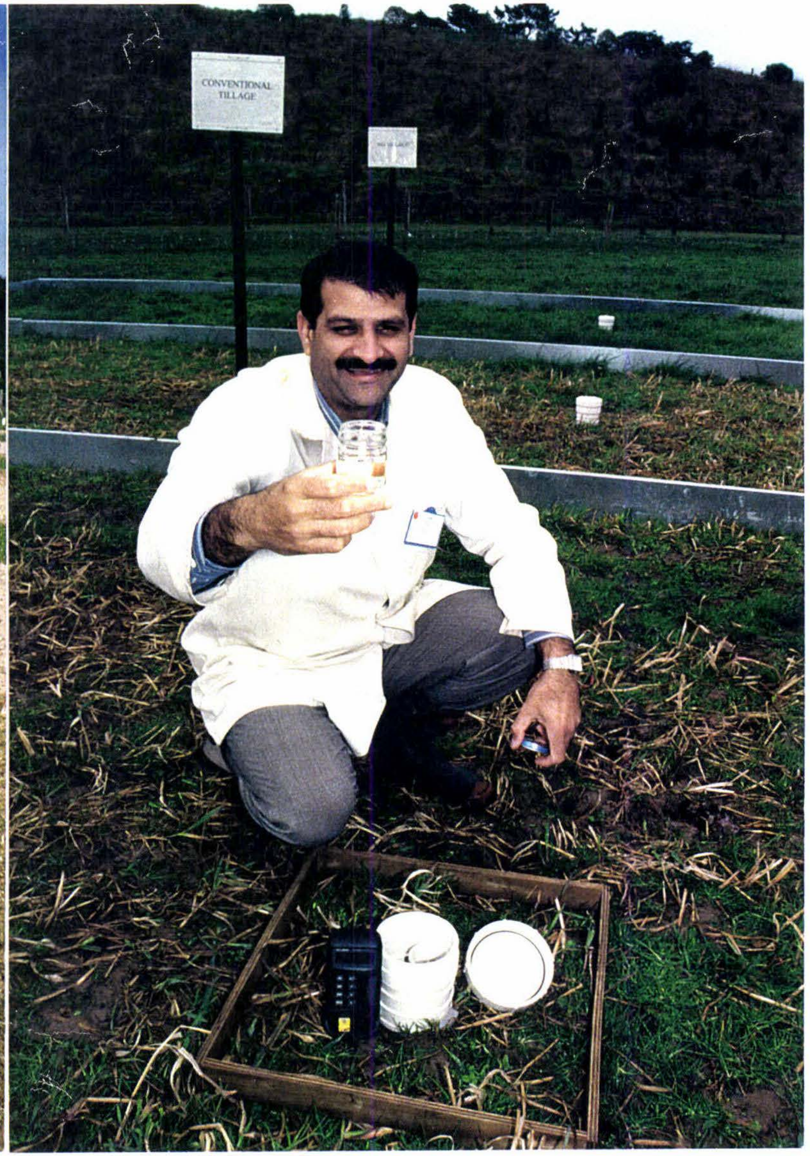
CONVENTIONAL
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ABSTRACT

Conversion of permanent pasture land to forage crop rotation by conventional tillage and reversion to pasture, for recovery of nutrients is a common practice in New Zealand. Because of their effects on soil physical, chemical and biological degradation, and the extent to which these soil management practices are sustainable is not fully known.

To evaluate short- and long-term impact of tillage induced changes in soil physical, chemical and biological properties, a quad replicated field experiment was established at Massey University, Turitea campus in 1995. Permanent pasture land was converted to a double crop rotation using conventional (CT) and no-tillage (NT) practices on the Ohakea silt loam soil. The overall aim of this research programme is to develop a sustainable land use management for pasture-based arable cropping to suit local farming conditions.

The present study investigated the effects of CT and NT practices on soil biological status and CO_2 emission. The test crops were summer fodder maize (*Zea mays L.*) and winter oats (*Avena sativa*). An adjacent permanent pasture (PP) was used as a control.

Soil samples were collected at 0-100 mm in summer, 0-50 and 50-100 mm depths in autumn and winter before or after crop harvest. The 'fresh' field moist, sieved samples were used for the measurement of microbial biomass carbon (MBC), nitrogen (MBN), phosphorus (MBP) and basal soil respiration. Earthworm population and biomass were extrusion with formaldehyde. Field CO_2 emission was measured at 3-4 weeks interval for one year.

After two years of continuous cropping, overall nutrients status (organic C, total N and total P) in NT remained similar to that in PP. In CT the nutrient

levels were significantly lower. Earthworm population and live mass were also significantly lower in CT as compared to PP and NT treatments. However, there was no differences in plant establishment, crop dry matter yield, soil temperature and soil pH (0-100 mm depth) between the two tillage (NT and CT) systems.

Higher levels of MBC, MBN and MBP were found in NT as compared with CT at 0-100 mm depth throughout the three seasons studied. When samples were analysed separately from two depths i.e. 0-50 and 50-100 mm, the microbial biomass contents were higher in surface soil (0-50 mm depth) as compared with 50-100 mm depth. Microbial biomass contents at 50-100 mm layer did not differ significantly among the three treatments. At 0-100 mm depth, MBC declined by 29%, MBN by 32% and MBP by 33% with two years (4 crops) of CT. Such a decline in microbial biomass is an early indication of future decline in soil organic matter. Soil organic matter (total C) had also declined by 22% (from 35,316 to 27,608 kg ha^{-1}) with CT. No such decline occurred either in MBC, MBN and MBP or organic matter with NT.

Basal soil respiration data indicated that microbial biomass activity in CT was 38% lower than in NT at 0-50 mm depth. However, at 50-100 mm depth, the activity was 25% higher in CT as compared with NT. Metabolic quotient (qCO_2) did not differ among the three treatments at 0-50 and 50-100 mm soil depths.

Field CO_2 emission from PP was significantly higher as compared to NT and CT treatments. The two tillage practices did not influence the CO_2 emission measured both shortly after tillage and during crop growth period. The annual estimated carbon loss through CO_2 emission was 34 t C $ha^{-1}year^{-1}$ in PP, 24 t C $ha^{-1}year^{-1}$ in NT and 21 t C $ha^{-1}year^{-1}$ in CT treatment. Field CO_2 emission was generally higher in summer and autumn as compared to winter and spring.

Overall, this study, which spanned two cropping seasons, clearly showed that 2 years cropping with CT resulted in a decline in soil biological status and organic matter. The decline in soil biological status is likely to affect crop yields in CT over the longer period. Conversely, NT cropping was efficient in sustaining soil biological status and organic matter. NT had similar influence on soil biological status as clover based PP during a short-period. Therefore, it is concluded that NT may be used as an effective tool to enhance soil productivity while promoting agricultural sustainability.

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