



Conservation tillage impacts on soil, crop and the environment

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Abstract

There is an urgent need to match food production with increasing world population through identification of sustainable land management strategies. However, the struggle to achieve food security should be carried out keeping in mind the soil where the crops are grown and the environment in which the living things survive. Conservation agriculture (CA), practising agriculture in such a way so as to cause minimum damage to the environment, is being advocated at a large scale world-wide. Conservation tillage, the most important aspect of CA, is thought to take care of the soil health, plant growth and the environment. This paper aims to review the work done on conservation tillage in different agro-ecological regions so as to understand its impact from the perspectives of the soil, the crop and the environment. Research reports have identified several benefits of conservation tillage over conventional tillage (CT) with respect to soil physical, chemical and biological properties as well as crop yields. Not less than 25% of the greenhouse gas effluxes to the atmosphere are attributed to agriculture. Processes of climate change mitigation and adaptation found zero tillage (ZT) to be the most environmental friendly among different tillage techniques. Therefore, conservation tillage involving ZT and minimum tillage which has potential to break the surface compact zone in soil with reduced soil disturbance offers to lead to a better soil environment and crop yield with minimal impact on the environment.

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1. Introduction

The growing concern for food security through improved soil management techniques demands identification of an environmental friendly and crop yield sustainable system of tillage.

Tillage is defined as the mechanical manipulation of the soil for the purpose of crop production affecting significantly the soil characteristics such as soil water conservation, soil temperature, infiltration and evapotranspiration processes. This suggests that tillage exerts impact on the soil purposely to produce crop and consequently affects the environment. As world population is increasing so the demand for food is increasing and as such the need to open more lands for crop production arises. The yearning for yield increases to meet growing demand must be done in a way that soil degradation is minimal and the soil is prepared to serve as a sink rather than a source of atmospheric pollutants. Thus, conservation tillage, along with some complimentary practices such as soil cover and crop diversity (Corsi, Friedrich, Kassam, Pisante, & de Moraes Sà, 2012) has emerged as a viable option to ensure sustainable food production and maintain environmental integrity. This implies that conservation tillage is a component of conservation agriculture (CA).

Corsi et al. (2012) define CA as a method of managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. They added that minimum mechanical soil disturbance, permanent organic soil cover and crop diversification are the three basic principles of CA. According to CTIC (2004), conservation tillage is any tillage system that leaves at least 30% of the soil surface covered with crop residue after planting to reduce soil erosion by water. Lal (1990) described conservation tillage as the method of seedbed preparation that includes the presence of residue mulch and an increase in surface roughness as the key criteria. Conservation tillage is an ecological approach to soil surface management and seedbed preparation. Conversion from conventional to conservation tillage, when this is done in line with the principle of CA, may improve soil structure, increase soil organic carbon, minimize soil erosion risks, conserve soil water, decrease fluctuations in soil temperature and enhance soil quality and its environmental regulatory capacity. Crop residue is an important and a renewable resource. Developing techniques for effective utilization of this vast resource is a major challenge. Improper uses of crop residues (e.g. removal, burning or ploughing under) can aid accelerated erosion, soil fertility depletion and environmental pollution through burning.

The principle of conservation tillage involves maintenance of surface soil cover through retention of crop residues achievable by practicing zero tillage and minimal mechanical soil disturbance. Retention of crop residue protects the soil from direct impact of raindrops and sunlight while the minimal soil disturbance enhances soil biological activities as well as soil air and water movement. The aim of this review, therefore, was to examine the effects of conservation tillage on soil, crop and the net effect on the environment. This may provide farmers and other land users the information on the desirability of a conservation tillage system for sustainable crop yield increases with minimal negative impact on the soil and the environment.

2. Types of conservation tillage

Conservation tillage practices range from zero tillage (No-till), reduced (minimum) tillage, mulch tillage, ridge tillage to contour tillage. No tillage (NT) involves land cultivation with little or no soil surface disturbance, the only disturbance being during planting while minimum tillage means reduced level of soil manipulation involving ploughing using primary tillage implements. In mulch tillage, the soil is prepared or tilled in such a way that the plant residues or other materials are left to cover the surface to a maximum extent. Ridge tillage involves planting crops in

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