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Review

Developments in conservation tillage in rainfed regions of North China

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Abstract

Dryland regions in northern China account for over 50% of the nation's total area, where farming development is constrained by adverse weather, topography and water resource conditions, low fertility soils, and poor soil management. Conservation tillage research and application in dryland regions of northern China has been developed since the 1970s. Demonstration and extension of conservation tillage practices is actively stimulated by the Chinese government since 2002, following the recognition of the increased rate of degradation of the environment due to erosion and water shortage in North China. This paper reviews the research conducted on conservation tillage in dryland regions of northern China, and discusses the problems faced with the introduction and application of conservation tillage practices.

Most of the studies reported have shown positive results of soil and water conservation tillage practices. These practices generally involve a reduction in the number and intensity of operations compared to conventional tillage, with direct sowing or no-till as the strongest reduction. Crop yields and water use efficiency have increased (with up to 35%) following the implementation of reduced tillage practices. Under no-till, crop yields are equivalent to or higher than those from conventional tillage methods, especially in dry years. However, during wet years yields tend to be lower (10–15%) with no-till. Other benefits are an increased fallow water storage and reductions in water losses by evaporation. In order to fully exploit the advantages of conservation tillage, systems have to be adapted to regional characteristics. Farmers' adoption of conservation tillage is still limited.

Keywords: Conservation tillage; Residue management; Dryland farming; China; Technology adoption

Contents

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1. Introduction

Regions receiving between 250 and 600 mm of precipitation annually are considered to be dryland regions where dryland or rainfed-farming (crop production in low-rainfall areas without irrigation) is practiced (Xin and Wang, 1999). China has a large region of dryland in the north, which accounts for about 56% of the nation's total land area (Xin and Wang, 1999). Dryland farming in northern China is dominated by mono-cropping systems with mainly maize (*Zea mays* L.) and wheat (*Triticum aestivum*). Crop production in this dryland region is constrained by adverse weather, topography and water resource conditions (deep groundwater, very limited access to surface water), and low fertility soils under poor management. Conventional soil management practices include intensive soil cultivation, low fertilizer and manure inputs, and crop residue removal and burning. These practices have contributed to an exacerbation of soil, water and nutrient losses, and to degraded soils with low organic matter content and a fragile physical structure (Bi, 1995; Tang, 2004). This in turn has led to low crop yields and a low water and fertilizer use efficiency. The depletion of soil fertility and the decline in agricultural productivity in northern China have led scientists and policy makers to emphasize the need for the implementation of farming practices that contribute to the conservation of soil and water, with tillage as an important component of these practices (Wang, 1994; Lal, 2002).

The Chinese government is actively involved in the demonstration and extension of conservation tillage practices since 2002 (Zhang et al., 2004). This involvement was triggered by reports about the devastating eco-environmental degradation: topsoil loss, land degradation, air pollution, damage to trees, vegetation, buildings, transportation structures and waterways, and the deterioration of the living environment of human beings and livestock. This degradation was also shown by an increased frequency and intensity of dust storms, wind and water erosion and the loss of fertile top soil in northern China (Yang et al., 2001; Wang et al., 2004, 2006; Guo, 2004). The Chinese Ministry of Agriculture has formulated a plan for promoting a widespread application of conservation tillage throughout dryland regions of northern China within 7–10 years. Since 2002 about 60 demonstration counties within 13 provinces (municipalities and autonomous regions) of northern China, including Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Shandong, Henan, Shaanxi, Gansu, Ningxia, Qinghai, and Xinjiang were established (Rural Pastoral Area Mechanization, 2003). Demonstration areas covered 0.13 million ha in 2003 and are expected to reach 10 million ha in 2015. Notwithstanding these efforts, the present area under conservation tillage in China only accounts for 0.2% of the area worldwide where some form of no-till or conservation agriculture is applied (Bruinsma, 2003).

This paper reviews the research on conservation tillage in northern China and discusses the problems associated with the introduction and application of conservation tillage practices and their regional adaptation.

2. Site description and background information

2.1. Climate

Fig. 1 shows the dryland zones in northern China according to annual rainfall distribution pattern, based on INASR (1986). Five zones have been distinguished, i.e.: (1) arid (<250 mm); (2) arid semi-arid (250–350 mm); (3) semi-arid (350–500 mm); (4) dry semi-humid (500–600 mm); and (5) semi-humid (600–700 mm). Table 1 describes the characteristics and the dryland farming practices for each of these zones. The annual evapotranspiration ranges from 750 to 1080 mm, and the annual water deficit ranges from 40 to 740 mm (Table 2).