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Review

Comparing the profitability of tillage methods in Northeast Germany—A field trial from 2002 to 2005

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ABSTRACT

Modern no-tillage techniques are being practiced worldwide on more than 100 million hectares of land. Despite proven advantages, reduced tillage (RT) is used only on 25% of agricultural land in Germany and direct seeding (DS) is not at all practised. Therefore, a trial was performed at the Leibniz Centre for Landscape Research (ZALF e. V.) from 2002 to 2005 to compare conventional tillage (CT), RT and DS practices in the following crop rotation: winter rape (*Brassica napus* L.) – winter wheat (*Triticum aestivum* L.) – maize (*Zea mays* L.) – winter wheat – winter barley (*Hordeum vulgare* L.) (in DS: winter wheat). The study was aimed at determining the profitability (net return) of these methods under on farm conditions.

The application of RT proved to be the most competitive system with the highest net return of 111 euro ha^{-1} recorded at the midpoint of the 4-year trial period. The system of CT in contrast produced −7 euro ha^{-1} at the midpoint of this trial period, yielding the poorest results. Problems with the establishment of rape and wheat in soil with wheat straw residues in the DS system resulted in high losses in individual cases, so that the profit for DS at the midpoint period was at 55 euros ha^{-1}. The expanded use of reduced-tillage practices would therefore improve the profitability of crop production in Northeast Germany. The introduction of DS systems would, however, require the modification of common crop rotations and the employment of an appropriate seeding technology.

Contents

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1. Introduction

No-till techniques have been successfully applied on more than 100 million hectares worldwide (Lal et al., 2007). This holds true particularly for North and South America, as well as Australia. The advantages of no-till techniques have likewise been demonstrated for China and Southern Europe (Wang et al., 2006; Garcia-Prechac et al., 2004; Lal, 2007). The advantages are of both ecological and economic nature. Soil protection from water and wind erosion, a higher efficiency of water usage in dry areas and carbon (C) sequestration in the soil ensure a sustainable way of farming (Derpsch et al., 1986; Schillinger and Young, 2004). With the increase of energy prices, the profitability of energy-saving no-till techniques tended towards improvement in all locations (Nail et al., 2007). However, the economic success hinges on a great number of site and climatic factors (Uri, 2000). This makes the adaptation to the respective conditions crucial and general statements regarding the competitiveness of no-till techniques impossible.

Despite the proven advantages, soil-conserving methods such as reduced tillage (RT) or direct seeding (DS) was only used to a small extent in Europe (Holland, 2004). In Southern Europe (Spain) under Mediterranean climate, Fernandez et al. (2007) reported of a long-term positive yield situation following DS practices. Canell and Hawes (1994) made reference to problems under conditions of cool and moist climate. Problems such as the spread of grass weed or the reseeding of crops in large quantities of cereal straw hamper the spread of soil-conserving methods. For South Germany, Tebrügge and Düring (1999) reported of the advantages of DS practices in regard to the soil functions. They also demonstrated the potentials of these techniques for Germany for when the required improvements in seeding technology and crop protection are met. It is unclear whether soil conservation methods can also be economically and successfully practiced under the drier and cooler climate conditions of Northeast Germany.

Therefore, a trial was performed at the Leibniz Centre for Agricultural Landscape Research (ZALF e. V.), with the intention to compare conventional tillage (CT), RT and direct drilling. The study was aimed at determining the profitability of these techniques under on farm conditions.

2. Materials and methods

2.1. Experimental site and growing conditions

Dedelow (53°22′N, 13°48′E) is located in the northeast German lowlands, 100 km north of Berlin, at an altitude of about 60 m above sea level. The soils of our study area were formed from calcareous till and glaciofluvial sediments. The most dominating soil type within the study field is the Haplic Luvisol (WRB, 2006), with a particle size distribution of 600 g kg^{-1} sand (63 to <200 μm), 300 g kg^{-1} silt (2 to 63 μm) and 100 g kg^{-1} clay (<2 μm), a pH-value of 6.8, and an average content of 8.0 g kg^{-1} soil organic carbon, 85 mg kg^{-1} soil P, and 85 mg kg^{-1} soil K.

The trial years (2002–2005) were warmer and dryer than the long-term average (Table 1). The yearly weather influence in terms of crop yields is shown in Table 2. The trial years 2003 and 2004 with dry/hot and cool/moist weather, were the ones with particularly low and high yields, respectively.

It was due to the strong annual climatic effects of the years 2002–2005 (Table 2) that the yields and returns of the cropping systems were found to vary greatly. Therefore, a statistical comparison of the three studied tillage systems was made for the individual years.

2.2. Experimental design

In the following, the effect of three tillage systems tested in a rotation with five crops (winter rape – winter wheat – maize – winter wheat – winter barley (in direct seeding: wheat)) on five fields each year will be discussed. The short period between the harvest of wheat (end of July) and the sowing of winter barley (20 August) can cause the mixing of barley and the preceding wheat crop. Therefore, barley was replaced by wheat in the DS system. Each crop was sown on a whole plot, with the tillage treatments within each crop being studied on sub-plots. The resulting split-plot design has three replicates (plots 9 m × 6 m). At maturity 9 m^2 per plot were harvested and weighed with a combine (Wintersteiger, Ried, Austria). The fresh grain was dried at 65 °C for 48 h to determine the dry matter content.

2.3. Tillage systems and soil management

In this experiment, three tillage systems were compared:

2.3.1. Conventional tillage (CT)

In conventional tillage, a 3 m disc cultivator (Lemken, Alpen, Germany) was used at the depth of 15 cm for mixing the residues (stubble and straw) and for the germination of the volunteer cereals or rapeseed after harvesting. The ground was ploughed deep (0.25 m) with a mouldboard plough (Albatross, Rabe Bad Essen, Germany) before the wheat, barley and canola were sown. The sowing was done with a rotary harrow drill combination (3 m) (Amazone AD3, Hasbergen, Germany). Before the maize seeds were sown, the soil was deep ploughed (0.25 m) in November. In April, the soil was ploughed 0.05 m deep with a rotary harrow and the sowing was done with a precision seed drill (row of 0.75 m) (Aeromat M4Z, Danagri, Oberweser, Germany).

2.3.2. Reduced tillage (RT)

The disc cultivator (0.15 m deep) was used for ploughing after the harvest and before sowing. The sowing for cereals and oilseed