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Development of No-Till Systems

No-till systems are cropping systems where no tillage between the previous crop harvesting and seeding is done. In the late fifties, the development of new effective herbicides, which did not impact the following crop, made the implementation of no-till farming possible. Due to its economical and ecological advantages, no-till is a standard cropping system in North and South America and in Australia in the meantime. In Europe extreme crop rotations, strong legal regulations on crop chemicals and biotechnology and unfamiliar management requirements have impeded the further expansion of no-till farming.

The KTBL [1] divides tillage systems by the intensity of soil loosening into "Conventional Tillage with Moldboard Plow", "Conservation Tillage" and "No-Tillage". According to this definition no-till systems are characterized by seeding a crop without any tillage after harvesting the previous crop.

Cropping systems without moldboard plowing are implemented successfully on many farms, in many cases for decades [2, 3]. In no-till, i.e. cropping systems without any tillage, the situation is different. In spite of the fact that no-till is practiced successfully on large acreage in a number of countries, and a large number of studies confirm the feasibility and economic and ecological advantages of no-till for many other regions [4, 5], the dissemination of no-till in farming practice is still very limited in many countries.

Development

With the increasing development of agricultural science and increasing intensity of moldboard plowing a few people started to think about cropping systems without moldboard plowing. Initially, goals were reduction of labor and energy input respectively the increase of performance and labour productivity. For example Jethro Tull [6] tried to replace the moldboard plow by a chisel plow kind implement already in the 18th century. In 1828 Haumann [7] translated a report of Alexander Beatson from England who used on his farm a chisel plow instead of a moldboard plow successfully. In 1918 Holldack [8, 9, 10] reported about the farmer Jean from France who similar to Beatson successfully farmed without moldboard plow. Glanz reported in 1922 [11] about his experiences about farming without moldboard plow and concluded that moldboard plowing is detrimental for soil structure and soil health. During the twenties and thirties of the last century Russell et al. analyzed farming systems without moldboard plowing systematically for the first time [12, 13, 14, 15]. It was found that crop yields were largely independent of the tillage system. Nevertheless, mechanical weed control was a critical issue in systems without moldboard plow. Today cropping without moldboard plow, i.e. con-

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Keywords

Tillage, seeding, direct seeding

Literature

Literature references can be called up under LT 06SH01 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

servation tillage, is a globally established system which has been practiced successfully by many farmers for years.

In spite of the success of cropping systems without moldboard plow in farming practice moldboard plowing itself was not questioned for a long time. According to Kuipers [16] there are two different "schools" in tillage. In Germany the main goal of tillage is the improvement of the soil structure. A typical representative of this school is Roemer [17]. Weed control through tillage is only of low priority. With this approach it is not surprising that reduction of tillage intensity or complete elimination of tillage are out of question. The "English School" has a different viewpoint. Here the primary goal of tillage is weed control. Based on this, [18] concluded from his studies that mechanical crop care in potatoes tends to be detrimental if it is possible to keep the field nearly weed-free.

First no-till trials were conducted in the early fifties mainly in the US based on the theory that tillage is not necessary as long as sufficient weed control is ensured. One of the first studies about no-till was published in 1952 by [19]. At this time no-till cropping of maize succeeded for the first time by using special herbicides [20]. The introduction of no-till into farming practice became not possible before suitable herbicides became available. Such herbicides had to kill the existing vegetation especially grass without harming the succeeding crop. In the US this became possible through the introduction of Atrazine in 1959 [21]. First comprehensive field test were conducted by [22]. After the introduction of Paraquat and Deiquat in 1961 large no-till field tests were started in the UK [23]. The introduction of Glyphosate in 1973 made no-till more simple [24]. Glyphosate has made an efficient and sustainable control of persistent weeds possible. In 1981 Chlorsulfuron came as the first sulfonylurea to the market [25]. This enlarged the possibilities of weed control in no-till further. It is estimated that nearly 100 Mio ha were no-till cropped world-wide in 2004/5 [26].

Dissemination of No-Till

The first trials of no-till were conducted in the USA as described above. In 1960 no-till was not only conducted in large scale trials but also successfully in farming practice [27]. No-till is especially wide-spread in soybean and maize [28]. In the 2004/5 season about 15% of the arable land (25.3 Mio. ha) were cropped in no-till, i.e. no-till is well established in the US [29].

In South-America no-till is standard farming practice since intensive tillage causes enormous soil erosion in many areas [5]. The share of no-till on the total arable acreage was more than 40% in the 2004/5 season [26].

In Africa enormous damage is caused by water and wind erosion [30]. Comprehensive studies have shown the benefits of no-till for this continent [31, 32]. The very limited use in farming practice is caused by the lack of mulch for soil coverage since most crop residue is needed for feed, fuel or other purposes.

In Asia the share of no-till is less than 1%. Reasons for this are the small scale farming structure with nearly horticultural systems in many regions and the wide-spread rice production, which requires intensive tillage (Puddling).

In the early seventies intensive and systematic work took place to develop no-till systems in the UK. Initially, this was very successful [33] and the no-till acreage increased strongly [34]. In the mid-seventies the share dropped virtually to zero. Due to the accession of UK to the European Economic Community in 1973 farmers got the benefit of much higher product prices. Hence high cost of intensive tillage made nearly no difference anymore. Additionally, after several years of no-till yields dropped significantly since regular straw-burning, extreme winter crop rotations and the lack of efficient control of perennial weeds caused increasing soil compaction and weediness [35]. Meanwhile, the interest in no-till is growing again in the UK but the no-till acreage in farming practice is still not worth mentioning.

In Germany research on no-till was conducted in the sixties and seventies encouraged by the successes in the UK [36, 37, 38, 39, 40]. A lot of this research had considerable shortcomings in experimental design and in methodology. Based on mainly unfavorable results the feasibility of no-till in Germany was questioned as a whole [41]. Meanwhile, comprehensive long-term studies have also pointed out the economical and ecological advantages of no-till in Germany [42].

In total the dissemination of no-till in Europe is low up to now with about 960 000 ha (1.8 %) [43].

Outlook

In North and South America and Australia no-till belongs to the standard cropping systems while the dissemination of no-till in other regions of the world is low up to now in spite of significant advantages. In Europe extreme crop rotations, strong legal regulations on crop chemicals and biotechnology and the unfamiliar management requirements have impeded the further expansion of no-till in farming. Additionally, some of the positive effects of no-till such as higher labor productivity and improved erosion control are partly accomplished by conservation tillage. Hence a significant increase of no-till acreage can not be expected under the given general framework in Europe.