

Classification of Tillage Systems by including Soil Covering

Since the development of tillage with no ploughing or even seeding with no tillage, attempts have been made to classify the different systems through definitions. Mainly tillage intensity is differentiated, as well as including soil coverage with a mulch layer in the definition. To eliminate possible perplexities, the attempt was made to modify the North-American definition of tillage processes to the German classification. That resulted in a change of currently valid system.

For more than 100 years cultivation systems without plough have been known. First experiences to substitute the plough by different kinds of field cultivators go back to the 18th century [1]. The discussion, whether plough or field cultivator, were in Germany activated at the turn of the century of the last century, as Holldack introduced in a paper the “cultivation system Jean” [2, 3, 4]. Because of the description of cultivation systems without plough, definitions were needed. First definitions of the different systems were made in the USA. There were different “minimum tillage” systems researched by Cook [5]. The systems were characterized by ploughing but the goal is to reduce the number of operations. This will enter the German definition as a reduced system. It also started a development of soil tillage systems without plough, from which during the years a lot of sub-forms originate. Base of this system was the so called “till-planting” [6]. There was no cultivation before seeding and the residue was left on the top of the soil. Cultivation and seeding were done in one pass. So lot of different terms were developed, but it was not possible to define the different systems. Although different definitions were introduced in the USA [7, 8], a clear classification is often not possible. Because the definitions come from the USA, a correct translation into the German language is often not possible.

Base of the German definition

Köller [9] built, based on the important terms of the American definitions, a classification of soil tillage systems. And based on this he developed a first definition of soil tillage systems for Germany. There he assumes the passes, stubble processing, soil tillage, seed bed preparation and seeding. The systems were structured in soil tillage with plough, according to the definition “conventional tillage”, soil tillage without plough, according to the definition (mulch tillage, till-planting) and no tillage. At this time, the systems soil tillage without plough and no tillage were summarized to conservation tillage. In a new definition revised by Köller [10], the system no-tillage is not more allocated to the conservation tillage, it is an own system. The system “conservation tillage” is divided into a system with soil loosening and a system without soil loosening. The differentiation refers to the soil tillage, which is done by a field cultivator and sometimes the working depth is adjusted for a deeper loosening. Or the system without loosening, that take place without soil tillage. This system is characterized by a seed bed preparation with a rotary harrow or similar tools and seeding afterwards. The definition by [10] is also accepted by the KTBL [11] and is the standard definition till today.

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Tillage, soil mulch cover, process definition

Fig. 1: Multi-beam cultivator with disc elements for shallow and for deep tillage



Classification in the USA

As these definitions classify the soil tillage systems, depending on the intensity of soil cultivation, a new way was taken in the USA. The different systems were not only different in their soil cultivation but also because in the soil coverage with residue. The "Soil Conservation Service" [12], defines three different systems because of the soil coverage with residue.

"Conservation tillage": Tillage types that leave less than 15% residue cover after planting or less than 500 pounds per acre of small grain residue equivalent throughout the critical erosion period. Generally it involves ploughing or intensive tillage trips.

"Reduced till" has between 15% and 30% residue cover on the soil's surface after planting. Conservation tillage is any tillage and planting system with 30% or more residues remaining on the soil surface after planting to reduce soil erosion by water. Conservation tillage includes no-till, ridge-till and mulch-till and any system with 30% residue remaining after planting.

Reasons for an adaptation

Because of differences in the definitions in the North American and the German language there are often misunderstandings. Also at international conferences a wrong translation of terms causes misunderstandings. An adaptation is also necessary. Therefore not only the soil tillage intensity included but also the soil coverage with residue should be included. Even in reference to the erosion it is known, that the level of soil coverage with residue as well as the kind of soil tillage have a clear influence.

Classification of soil tillage systems according to the intensity and the soil coverage

The following classification of soil tillage systems should not question the classification by [10, 11]. Simply the two different definitions should be adapted. Therefore not only the intensity of soil tillage is to include but also the residue cover on the soil surface. In Figure 2 a proposal for a new classification of soil tillage systems is presented. The main differences to the currently known classification are that the conventional systems were differed in soil turning and soil non-turning systems, depending on the soil coverage with residue. The systems of conservation soil tillage leave more than 30% residue cover on the soil surface and were differed in "mulch tillage", "ridge tillage" and "no tillage". Ridge tillage allows a strip wise loosening before or during seeding of






















Bodenbearbeitungs- u. Bestellverfahren		Arbeitsabschnitte			Bodenbedeckung nach Saat
		Grundbodenbearbeitung	Saattbettbereitung	Saat	
Konventionelle Bodenbearbeitung	wendend		 oder 		bis 15% oder 560 kg/ha
	nicht wendend		 oder 		15 - 30% oder 560 - 1120 kg/ha
Konservierende Bodenbearbeitung	Mulchsaat nicht wendend	 oder 	 oder 		> 30 % oder > 1120 kg/ha
			 oder 		
	oder 				
	Streifensaart streifenweise Lockerung bis 1/3 Reihenweite				
	Direktsaat keine Bodenbearbeitung				

Fig. 2: Classification of tillage procedures

up to 1/3 of the row width. This refers to the "strip-till" system in the USA but also to seeders with chisel openers.

In the USA the no tillage is often also known as "slot-till", which shows exactly that in this systems only seeders with disc openers are used.

Literature

Books are marked by •

- [1] • Tull, J.: Abhandlung von dem Ackerbaue nach den Grundsätzen des Herrn Tull. Verlag G.C. Walther, Dresden, 1752
- [2] Holldack, C.: Die Kulturmethode Jean – Ackerbau ohne Pflug (1. Teil). Mitteilungen der DLG (1918), H. 19, S. 280-282
- [3] Holldack, C.: Die Kulturmethode Jean (2. Teil). Mitteilungen der DLG (1918), H. 21, S. 313-314
- [4] Holldack, C.: Die Kulturmethode Jean (3. Teil). Mitteilungen der DLG (1918), H. 22, S. 325-328
- [5] Cook, R. L., et al.: Save money – water – soil with minimum tillage. Extension Bulletin 52, Michigan State University, (1958)
- [6] Poyner, R.R.: An experimental mulch planter. Agricultural Engineering (1950), no 31, pp. 509-510
- [7] Wittmus, H.D., G.B. Triplett jr. and B.W. Greeb: Concepts of conservation tillage systems using surface mulches. Conservation tillage, Proceedings National Conference, Ankeny, Iowa (1973), pp. 5-12
- [8] -: Terminology and definitions for soil tillage and soil-tool relationships. ASAE Recommendation 291.1 Agricultural Engineering Yearbook, St. Joseph, Michigan (1976)
- [9] • Köller, K.: Bodenbearbeitung ohne Pflug. Verlag Eugen Ulmer, Stuttgart, 1981
- [10] • Buchner, W., und K. Köller: Integrierte Bodenbearbeitung. Verlag Eugen Ulmer, Stuttgart, 1990
- [11] -: Definition und Einordnung von Verfahren der Bodenbearbeitung und Bestellung. KTBL Arbeitsblatt 0236, Kuratorium für Technik und Bauwesen in Landwirtschaft, Darmstadt, 1993
- [12] CTIC: National Crop Residue Management Survey. CTIC: Conservation Technology Information Center, West Lafayette, (USA), 1994
- [13] Dickey, E.C., D.P. Shelton, P.J. Jasa and T.R. Peterson: Tillage, Residue and Erosion on Moderately Sloping Soils. Transaction of the ASAE, American Society of Agricultural Engineers, 1984
- [14] Dieckmann, J., und H.-J. Koch: Pfluglose Bodenbearbeitung. Zuckerrübe 55 Jahrg., 2006, H 4, S. 226-227