MACHINES IN CONSERVATION SOIL TILLAGE TECHNOLOGIES

Jiří Mašek, Pavel Procházka, Zdeněk Kvíz, Rudolf Šindelář
Czech University of Life Sciences Prague, Faculty of Engineering,
Department of Agricultural Machines
masekj@tf.czu.cz

Abstract. Conservation agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. Conservation agriculture is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes. CA is characterized by two principles, which are linked to each other. It is continuous minimum mechanical soil disturbance and permanent organic soil cover. Conservation tillage (agriculture) technologies where ploughing by a moldboard plough is replaced by tillers and shallow soil loosening in increasingly used as a soil treatment. It is typical for shallow soil tillage that all plant residues are left on the soil surface, or in the tilled upper soil layer. The plant residues can play very important role by next plant cultivation. The shovel and discs tillers are possible to use to advantage in conventional soil tillage systems and also by using conservation soil tillage technologies where is ploughing replaced by shallow tillage. In the experimental section the aim of research was described which is possible to summarize briefly as follows – the evaluation of soil physical properties on tillers work quality (especially on size of clods after soil treatment on the top and in the soil profile), evaluation of sweep tillers and disc tillers work quality by stubble ploughing.

Key words: conservation soil tillage, consevation agriculture, sweep tiller.

Introduction

Conventional "arable" agriculture is normally based on soil tillage as the main operation. The most widely known tool for this operation is the plough, which has become a symbol of agriculture. Soil tillage has in the past been associated with increased fertility, which originated from the mineralization of soil nutrients as a consequence of soil tillage. This process leads in the long term to a reduction of soil organic matter. Soil organic matter not only provides nutrients for the crop, but it is also, above all else, a crucial element for the stabilization of soil structure. Therefore, most soils degrade under prolonged intensive arable agriculture. This structural degradation of the soils results in the formation of crusts and compaction and leads in the end to soil erosion. The process is dramatic under tropical climatic situations but can be noticed all over the world. Mechanization of soil tillage, allowing higher working depths and speeds and the use of certain implements like ploughs, disk harrows and rotary cultivators have particularly detrimental effects on soil structure [1].

Soil erosion resulting from soil tillage has forced us to look for alternatives and to reverse the process of soil degradation. The logical approach to this has been to reduce tillage. This led finally to movements promoting conservation tillage, and especially zero-tillage, particularly in southern Brazil, North America, New Zealand and Australia. Over the last two decades the technologies have been improved and adapted for nearly all farm sizes; soils; crop types; and climatic zones [2].

Conservation agriculture systems utilize soils for the production of crops with the aim of reducing excessive mixing of the soil and maintaining crop residues on the soil surface in order to minimize damage to the environment.

The constant addition of crop residues leads to an increase in the organic matter content of the soil. In the beginning this is limited to the top layer of the soil, but with time this will extend to deeper soil layers. Organic matter plays an important role in the soil: fertilizer use efficiency, water holding capacity, soil aggregation, rooting environment and nutrient retention, all depend on organic matter.

Residues on the soil surface reduce the splash-effect of the raindrops, and once the energy of the raindrops has dissipated the drops proceed to the soil without any harmful effect. This results in higher infiltration and reduced runoff, leading to less erosion. The residues also form a physical barrier that reduces the speed of water and wind over the surface. Reduction of wind speed reduces evaporation of soil moisture.

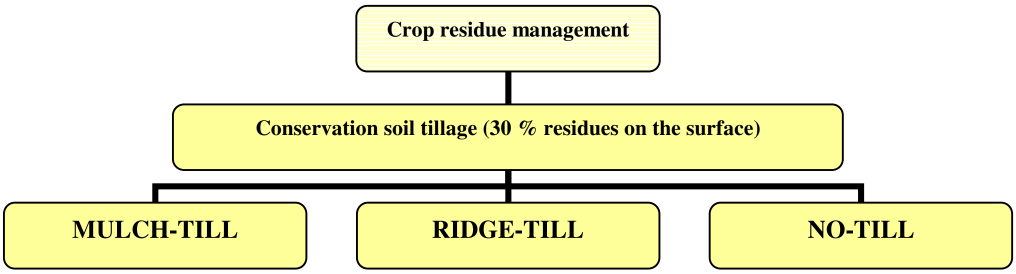

Fig. 1. **Soil tillage conservation technologies by different crop residue management [3]**

Keeping the soil covered is a fundamental principle of conservation agriculture. Crop residues are left on the soil surface, but cover crops may be needed if the gap is too long between harvesting one crop and establishing the next. Cover crops improve the stability of the conservation agriculture system, not only on the improvement of soil properties but also for their capacity to promote an increased biodiversity in the agro-ecosystem [5]. The soil tillage working mechanism plays a crucial role in soil protection system. Different working tools take different quantity of plant residues on the soil surface. The main aim of our observation is working quality evaluation by different soil tillage.

Material and Methods

There were preparing observation in field conditions for different soil tillage technologies provided with different working tools. On first experimental field ware evaluated difference between sweep and disc tillers work quality with accent on plant residues distribution and size of clods after shallow ploughing. On the second experimental field was marked divers' variants according to different working speed and different working depth. Very important for observation is distribution plant residues after stubble ploughing in work-in-process level and rate of plant residues on the top of soil. For evaluation of surface covering by crop residues we used software Photoshop 7. There is very easy way to recognized grade of covering according to count white and black pixels in the picture of surface [6].

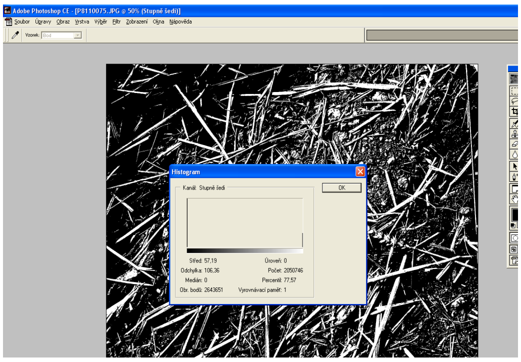

Fig. 2. **Photoshop tools for picture analysis**

For influence of speed and working depth evaluation on a working quality, especially on a crop residue distribution in a working profile and surface we used sweep tiller Horsch Tiger. There ware evaluated four working depth and four working speeds in a cross combination. It means 16 variants of soil tillage.

Fig. 3. **Sweep tiller by Horsch Company**

Results and Discussion

In the field experiment we had prepare 6 variants of tillage. I – 1x sweep tiller, II – 2x sweep tiller, III – 1x sweep tiller and 1x discs tiller, IV – 1x discs tiller, V – 2x discs tiller and VI 1x discs and 1x sweep tiller. Option 0 is without tillage.

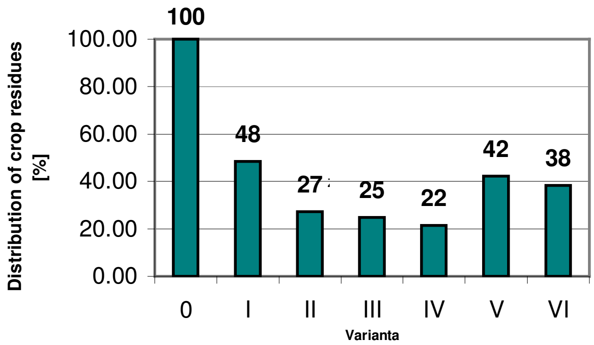

Fig. 4. **Distribution of crop residues by different variant of tillage**

The sweep tiller left more plant residues on the soil surface than disc tiller (Fig. 4). By using disc tiller two times was observed that crop residues going up back on surface. Size of clods is smaller by sweep tiller cultivation (Fig. 5). There was recognized significant statistical difference of plant residues distribution in different work depth. There is minimum clods fraction with size more than 50 mm. This value is very important because size of clods greater than 50 mm can make problem by secondary tillage and by seeding also.

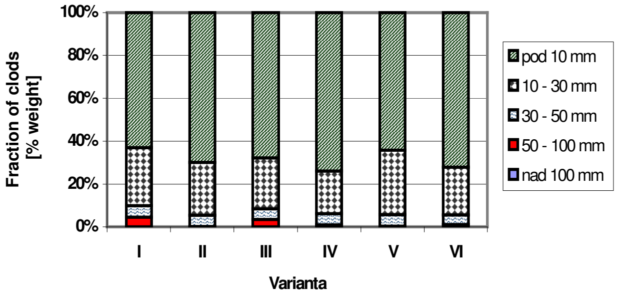

Fig. 5. **Clods fraction by different soil tillage**

In the measurement on the second field was evaluated sweep tiller work quality according to work speed and work depth (evaluation of sweep tiller by stubble ploughing after winter wheat harvest without straw collection). On the experiment field was marked divers' variants according to different working speed and different working depth. Very important for observation is distribution plant residues after stubble ploughing in work-in-process level and rate of plant residues on the top of soil. There was recognized significant important difference of plant residues distribution in different work depth (Fig. 6). The working speed (Fig. 7) had not statistically significant difference in the variants with different working speed by the same depth level.

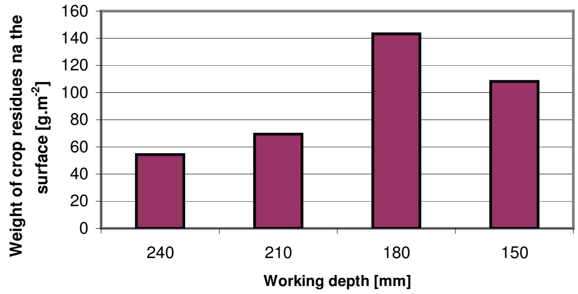

Fig. 6. **Weight of crop residues according to working depth**

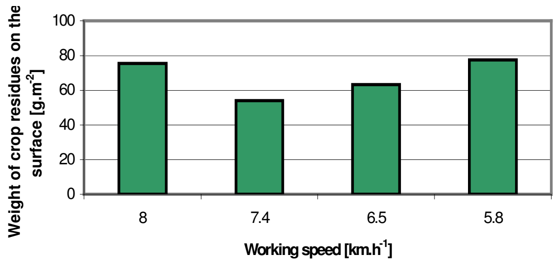

Fig. 7. **Weight of crop residues according to working speed**

Evaluation of crop residue distribution in a tilled soil profile give this results. The most of residues is covered by soil in depth from 0 to 60 mm and on the soil surface (Table 1). In depth 60 to 120 mm is it smaller part of total quantum crop residues and in a lower layer is not any crop residues. By tillage by this kind of tiller by different working speed and different working depth the plants rest are covering up to maximum 120 mm depth. Between variants isn't significant statistically difference.

Table 1

Weight of crop residues in different working layers

Working layer	**Weight of crop residues [g.m^{-2}]**				
	1	2	3	4	5
surface	94.00	156.00	104.00	240.80	122.00
depth 0 - 60 mm	894.80	402.80	320.40	520.40	212.80
depth 60 - 120 mm	58.80	61.60	62.40	32.00	160.00
depth 120 - 180 mm	0.00	0.00	0.00	0.00	0.00

In the picture 8 is described different ratio of covering the soil surface. According to Johnson (1988) must be surface covered more than 30 % [4]. This is the main signature of conservation soil tillage technologies. By measurement on experimental field was soil surface covered from 28 to 42 %. So this tiller is suitable for conservation soil tillage technologies.

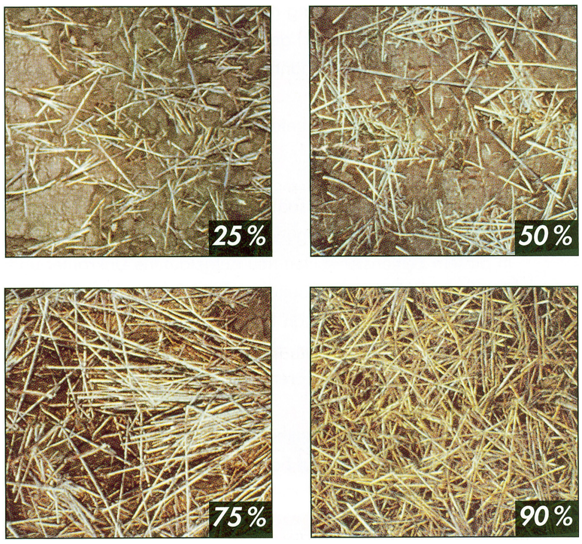

Fig. 8. **Soil surface covered by plant residues**

Conclusion

Results of this work are important because conservation (minimal) soil tillage technologies play an important role in plant production. Especially conservation tillage systems with their modification are increasingly being introduced under an economic pressure on the field around the world. By evaluation working quality of sweep tiller and discs tiller we can say that sweep tiller put more residues on the surface than disc tiller. But by second tillage by discs tiller covered plant residues are going up on the surface and the number of plant rests is similar like by tillage by sweep tiller. It is interesting that by shallow tillage by sweep tiller are the crop residues put in to up layer and soil surface as well. In all scale of working depth crop residues contains the soil to the deep of 120 mm. Lower layer are only tilled but without crop residues which are normally in deep layer by classical ploughing. It means that soil tillage based on shallow tillage have a very good influence on a soil protection from water and wind erosion.

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