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Soil Protection through Limitation of Wheel Load of Agricultural Machinery?

From an agricultural point of view, the current differences between pedology and agricultural engineering are unacceptable and unjustifiable. All sides, including the farm machinery industry, are obligated to set soil protection as a mutual goal; which can only be achieved through a comprehensive effort to find effective and relevant solutions by questioning fixed opinions. Limiting wheel loads by legislators is not seen as expedient, when considering all aspects of sustainability.

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The issue of prevention and minimisation of soil damages induced by use of agricultural machinery in crop cultivation is a fairly long and highly controversial discussed subject between representatives of pedology and agricultural engineering. Crucial point of the debate is the requirement of a limitation of axle respectively wheel loads by legislation raised by the representatives of pedology. This requirement meets wide refusal as the scientific derivation of yet varying limit values is a controversial issue, the problem referring to generally determined limit values does not seem to be solvable in practice due to both, variation of soil vulnerability as for seasonal and regional differences and finally, as the previous possibilities of good agricultural practice for minimisation of soil damage are continuously subject to further development. In addition, there are no uniform and solid data available in regard to the extent and the assessment of damages. Moreover, it might be pointed at the further growth of the yields also on soils exposed to mechanical loads so far. The progress in development of technology often is criticised, but can also be used for soil protection and cultivation in the provided time.

Sustainability as a common aim

It is accepted generally that agriculture has to meet the criteria of sustainability. This means that our today's activities shall not impair the chances of succeeding generations. This namely under social, ecological and economic aspects which means in consideration of all three mentioned aspects in the appropriate way. The German Soil Protection Act as of 1998 already determines objectives of protection, even though in general. In the Act, agriculture is asked to achieve these objectives by compliance with the good agricultural practice including avoiding soil damages, which are particularly mentioned. Soil damage is the deformation of the soil structure with negative effects on soil, yield, regulatory and habitat functions.

From cultivation ...

Damages

In the context under consideration here, damages are generated under certain unfavourable conditions by exposure of soil to mechanical loads, caused by soils driven-over with high-capacity and, consequently often heavy machinery and vehicles. Topsoil compactions are comparatively unproblematic to be handled as they can be eliminated more or less by appropriate soil loosening. On the contrary, existing compactions in deeper soil layers can only be eliminated with considerable extent and costs, if at all. Therefore, the generation of compactions should be avoided preferably. However, local conditions such as soil texture and moisture as well as carrying parameters of the used technology have an effect on this. In crop production under particular consideration here, these parameters are crop-related cultivation methods, depth and time of soil tillage, available time for machine operation, number of operations and, thus drives over the field, consistency of topsoil and subsoil, transport capacity and tractive power requirements, weight, surface contact pressure and tyre inflation pressure. The resulting complexity of the problem is even aggravated as practically suitable, reliable and, first of all, accepted analyses of soil

deformations are not available. However, on the basis of empirical, semi-theoretical and soil mechanical patterns, analytical methods are subject to testing. Verified positions on limit values, maximum loads under practical conditions and tolerable further compactions are not yet available.

Dubious demand

Taking into account all this and with regard to the serious economic effects of wheel load limit values for both, agriculture and agricultural engineering, the responsibility of Science is in demand, particularly when claiming appropriate legislative measures in Germany. The existing unilateral claim of limit values regulated by law is all the more questionable as the resulting economic and social consequences are consciously not being taken into account. The German as well as the entire European agriculture is under considerable pressure with respect to costs in order to maintain their international competitiveness - which, incidentally is also the purpose of the reform of the common agricultural policy initiated by the legislator. The resulting necessity to improve the efficiency of the crop production - also for the future - is only achievable by optimised production processes by use of modern machinery, particularly large machines, too. The requirement of global wheel load limitation to values which i.e. would prevent the use of tractors of categories > 50 kW is counterproductive. Anybody requesting the legislator to do so is acting in a one-sided way and dismisses economic and social consequences for both, agriculture and entire economics.

Prevention of damages

Besides of taking into account such consequences and in view of a responsible and qualified elaboration of appropriate solutions with practical relevance, there are 3 fields of activities deemed to be suitable for further prevention of soil damage:

1. Measures to increase the soil bearing capacity, including the demand-oriented and protective soil loosening (conservation soil tillage) as well as the use of permanent tracks with DGPS. With respect to the latter, a compaction in this section is accepted then, but a conservation of the majority of the area is achieved.
2. Soil protecting operations. Empirical studies show that damages occur in the headland as well as in tracks, in particular. Furthermore, it is unquestioned that the risks of a damage at dry soils are low, but higher at moist soils. However, the existing studies do not prove that in the recent years characterised by increasing machine axle loads the soil damage has increased. In this respect, it is assumed that already many measures of good agricultural practice are effective as being applied today and which increasingly shall be taken into consideration for the future. This comprises the use of implement combinations, which reduce the number of drives over the field, ploughing under preferably dry weather conditions, reduction of tractor axle load by use of towed instead of semi-mounted implements, on-land ploughing, optimised chains of transportation means for harvesting, rubber tracks and chassis with tyres of different track widths as well as the use of appropriate tyres.
3. Moist soil conditions that particularly occur in spring and autumn, may primarily generate high soil stress during machine operation. These are significantly influenced by the interaction of soil and vehicle features. If the provision by legislation of maximum wheel loads does not help achieving the aims due to the stated reasons and the preceding measures are not satisfactory in any case, the bearing parameter „surface contact pressure“ merits increased attention, without doubts. The minimisation (at equal or lower wheel load) of this parameter by adaptation of the tyre inflation pressure to the soil condition is due known, however is far too less used by now. Examinations have shown that the tyre inflation pressure is more appropriate as indicator for recommendations of soil conserving drives over the field than that of the wheel load.

Today, tyre inflation pressure control systems permit an adaptation to varying requirements as they may already generate from the change between road and field travel and from the different soil bearing capacity depending on the soil moisture. Further development optimising the adaptation by means of sensors promise additional progress.

Conclusion

Subsoil damages are a well-known problem, particularly with regard to headlands and tracks. These problems are largely solvable by technical and procedure-oriented measures already existing today as well as those under development, yet. Limit values for maximum permissible wheel loads are unsuitable as they do not meet the complex causation of the generation of damages and the effect of already existing solutions is unrecognised. After all, maintaining the competitiveness of the German agriculture also for the future has to be taken into account.

... till the harvest, modern agricultural technology serves soil protection, too.

Literature

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