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Determination of local soil loading

The distribution of soil loading within a field area is a parameter for local soil condition changes. These are compared here with one standard working pass (cultivating) and one coincidental working pass (grain transport).

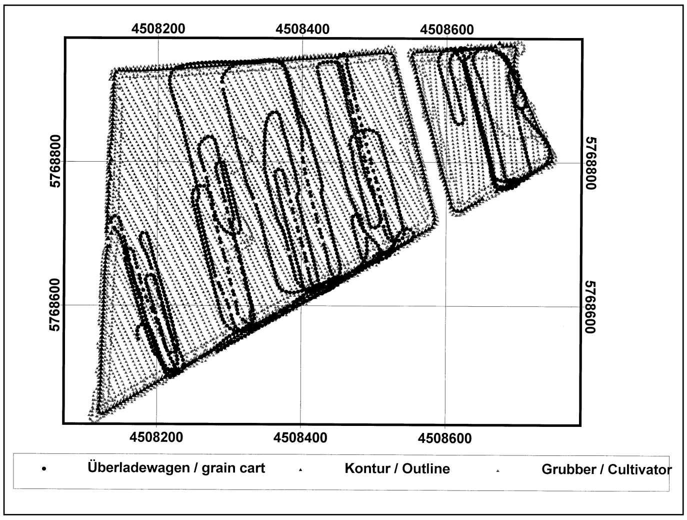

Bild 1: Befahrmuster zweier Feldfahrzeuge

Fig.1: Traffic pattern of two field vehicles

The field traffic, the sum of all vehicle movements on a field, creates a load pattern and, as a result, an inconsistent soil condition. The consideration of changing soil condition is part of spatial site-specific cultivations.

The minimum size of a field area which can have procedural intensity adjusted for the achievement of the following intensity stages is represented by the working width of the cultivation implement or the width of the vehicle track. In reality larger field areas would be more practical. A representative value of the soil condition is to be determined for field areas.

The soil compaction of an arbitrary point in a field depends on the composition of the soil profile there and the previous working measures, the resultant loads and the soil moisture condition at the time of the loading in question [1]. For a typical Brandenburg soil profile there follows the determination of its potential compaction susceptibility [2].Thus, soil profile maps can be changed into maps depicting areas of potential compaction risk. Soil maps which indicate the classes of soil profiles with sufficient accuracy are up until now not available. Their importance for nearly all working operations in a spatial site-specific management system means that we can expect that they will be produced in the future. Here, we have good preconditions for the integration of electrical conductivity maps, which can be produced at relatively little expense, as a preliminary information source for a precise soil language [3].

Although the association is not critical, it is suggested with regard to spatial site-specific cultivations that the changes may bring with them a certain increase in compaction danger with increasing total loading. The actual distribution of wheel tracks, and with this the precise distribution of compaction zones, can not be taken account of by the current economically practical positioning systems.

Every soil loading incident has to be classified along with the soil moisture situation which can also vary within a field area. The aim of this report should be to analyse and evaluate, as a part of the total problematic, the distribution of the loading by field vehicles on areas of the field.

Movement of field vehicles

Tractor movement in rowcrop work is able to be relatively precisely modelled within a field area, although the headland movements cannot be documented so precisely. With a navigation system such as DGPS, real movements of every vehicle can be simultaneously recorded at reasonable cost with a precision of under 2 m. This also allows the movements of transport vehicles, up until now neglected in this context, to be studied.

On the farm AgriCo Lindau a reference station was set-up and a JD tractor equipped with a DGPS system. The tractor was used with a'catcher' grain wagon for combine-truck in-field transportation of grain during harvest and for stubble cultivations, seedbed preparations and sowing.

Not only the drilling and the following crop care operations, but also the stubble cultivations carried out at an angle to the

Table 1: Comparing various vehicle aggregates with regard to factor c

Vehicle-aggregate	Tyre inner-pressure kPa	Load condition	Factor c forr total aggregate	Max. factor c for a single-wheel
JD 8400 + shallow grubber 8,1 m	Tractorfront 70 Traktor rear 70	without	2,62	0,7
JD 8400 + Hawe grain wagon ULW2500T	Tractor front 70 Tractorrear 70 ÜLW 150	empty	5,7	0,78
		full	13,6	2,68
MD JD 2066	Front 210 Rear 230	empty	11,1	4,2
		full	14,5	5,5

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Keywords

Soil load, field traffic, site specific tillage, grain cart

Literature details are available from the publishers under LT 00427 or via Internet at http://www.landwirtschaftsverlag.com/landtech/local/fliteratur.htm

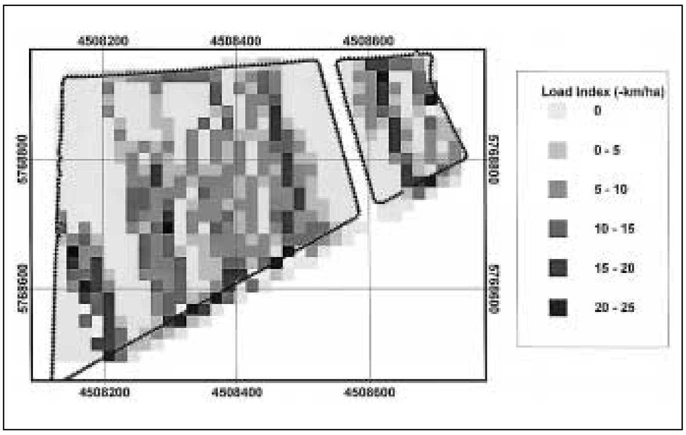

Fig.2: Local distribution pattern of soil load caused by grain transport

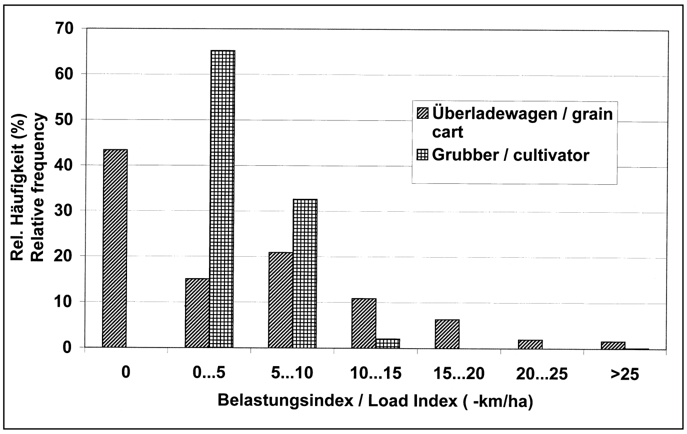

Fig.3: Histogram of the load index for two field vehicles

usual working direction, created a consistently distributed vehicle track pattern over the field surface (fig. 1). Contrary to this, the field was only driven over in some areas during grain transportation, the position of the areas being dependent on the working pattern adopted by the combines. The southern headland was driven on especially often because on that area the grain was transferred onto road-going vehicles.

Assessment of soil loading of areas

Stress on a field increases with the distance travelled on it by a vehicle and with the time during which the vehicle moves on the area. Because of this, assessment parameters of area loading are based often on these ground parameters which are additionally based on an area unit [4]. In considering the type of vehicle, the weight was used as a factor for the first approach. From this were produced loading parameters with the units t(h/ha or t(km/ha. The form of running gear was not taken account of in this simple assessment. For consideration of [5] for the investigations, a vehicle factor in the form

$$c=\sum_{i=1}^{n}\left(\frac{Fi}{Fo}\times\frac{pi}{po}\right)$$

was produced with the parameters i =lfd. Number of wheels, F = wheel load/kN, Fo = relative wheel load = 20 kN, p = tyre inner pressure = 150 kPa in order to identify the vehicle (table 1). This factor was also combined with the driving distance or the length of time within the field area to form a loading parameter.

The farm AgriCo Lindau AG, which pays attention to protecting its soil structure, reduced the vehicle's tyre inner pressure to the minimum permitted. With this, the factor c of the grain wagon did not increase over that of the combine despite a load of 16 t. The maximum value of a single wheel with the combine is substantially greater. The vehicle factor during the stubble cultivations is small compared to that with the combine.

Every evaluation of a site-specific loading compressed into a numerical form cannot be more than a rough estimate of the actual position-associated loading within a field area. But such a measurement is practical enough for a decision between high and less high loadings.

The Feldverv program for spatial site-associated representation of soil loadings

The calculation on the local distribution of soil loadings requires an evaluation of the investigated movement routes and also of the chosen loading indices. For this, a program was developed that enabled:

- a grid, with the measurements preferred, laid over the field,
- the calculation of the route and the time required for a vehicle per grid element,
- using these parameters, and a vehicle-dependant factor, the calculation of a loading index whereby the factor of the load carried by the transport vehicle can also be taken account of,
- addition of the loading of different working passes for every grid element to enable answers regarding length of time or method.

The data presentation took place with a GIS program.

Result

Compared were the loading index (c(track/area) for grid elements of 18 m(18 m for a ULW 2500T grain wagon transporting grain between combine and road vehicles and a 8.1 m cultivator during stubble cultivations (fig. 2).The changing load condition of the grain wagon was roughly estimated from the DGPS data.

More than a third of the field area was not driven on by the wagon. Only relatively small areas were affected by high loadings (fig. 3). Compared with this, the loading with the cultivator was on the whole consistent. This was mainly concentrated on two neighbouring classes in the lower region of the loading scale. Because of the limited travelling distance during the grain transport over 80% of the field area on average was not more highly loaded.

The combine loading with its 6 m cutterhead was, because of its large running gear and the high vehicle factor, substantially over that caused by the grain wagon. Thus, the grain transport with a grain wagon running on reduced tyre inner pressures would not additionally damage the ground during combining operations.

Conclusion

With the program presented here one can calculate the spatial site-specific loading on a field surface by vehicles. This also allows the evaluation of transport operations.

The program allows the identification of alterations in soil conditions and draws attention to the operations causing high loadings on the soil and to the areas of the field driven over more often than others.

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