Joachim Brunotte, Matthias Wagner and Claus Sommer, Brunswick

Soil protection and cost savings

Demands on modern soil cultivations

Rotation and cultivation with implements serves to create suitable growing conditions and secure sustainable soil fertility. At the same time „Good farming practice" as required by the Federal Soil Protection Act (BBodSchG), helps avoid conflicts between soil protection and cost savings and the securing of yield and food. Soil cultivation is of special interest because influenced by the intensity of application are:

- *crop yield development,*
- *load bearing capacity of soil (avoidance of compaction), and also*
- *ground cover capacity (avoidance of ground erosion risk).*

Dr. Joachim Brunotte and Dipl.-Ing. agr. Matthias Wagner are members of the scientific staff, Dir. and Prof. Dr.-Ing. habil. Claus Sommer is director of the Institute for Farm Technology and Building Research, FAL, Bundesallee 50, 38116 Brunswick; e-mail: *J.Brunotte@fal.de*

Keywords

Soil protection law, trafficability, fuel consumption, unit costs

Management targets such as soil protection and care and input savings can be achieved nowadays when applying conservation soil cultivation methods [3,4]. The effect of reduced loosening intensity on field surface ground covering capacity, load-bearing capacity of the soil, cost savings, crop health and yield development have been investigated together by the FAL and BBA in a BMVL-supported research and development programme [6].

Under the themes technique and soil protection, mulch systems (minimum cultivations) remained for a long time almost exclusively a central strategy against erosion losses. In a rotation segment with sugar beet/winter wheat/ winter wheat, this method achieved opening crop establishment with straw and stubble only. For beet, however, this required an altered straw management which was given special attention during the investigations.

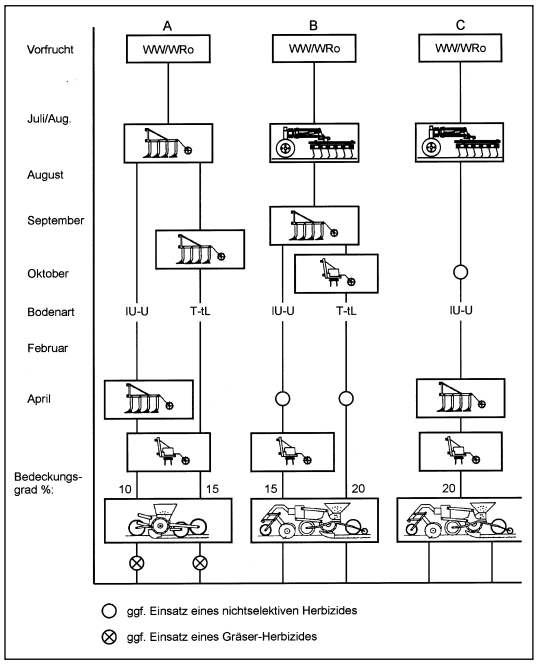


Fig. 1: Site specific tillage – straw mulch for sugar beet

Minimum cultivation method

Precise straw spread is a basic requirement for successful minimum cultivations. Measurements of lateral straw distribution with modern combines produce variation coefficients from 20 to 85%. Increasing working widths (> 6 m) lead to a worsening of results. If straw chopper and chaff broadcaster are optimally adjusted only the application of a straw harrow can improve the distribution under certain conditions [6]. This implement encourages the germination of lost harvest grain and weed seeds (e.g. brome grass) in the stubble just after harvest. The straw harrow is therefore a permanent component in straw/minimum cultivations methods for sugar beet and cereals *(fig. 1)*. The choice of implement influences the ground covering capacity [1] of crop residues on the surface and thus effective protection against soil erosion.

Path A: Here, only the plough is replaced by grubber harrow. The reduced ground cover capacity of 10 to 15% in most cases allows the use of a conventional drill. Silting protection, load bearing capacity and cost savings are only slightly improved compared with plough cultivations.

Path B: Spared operations lead to a 15 to 20% ground covering capacity. However, a low-till drill is required. The effective protection from erosion and compaction damage is further improved.

Path C: This represents the lowest level of cultivation intensity. The fact that the soil is not worked until just before seeding leads to higher water storage and the method is therefore not suitable for clay locations. Silty loam and sands are cultivated down to 10 to 15 cm with the grubber harrow to warm-up the ground shortly before sowing. The ground covering capacity of over 20% achieves effective erosion protection on locations with low to medium erosion susceptibility. Here, the highest cost savings are achieved. On locations with high erosion susceptibility the stubble wheat should be replaced with winter barley and an intercrop should be integrated into the rotation to achieve effective ground protection.

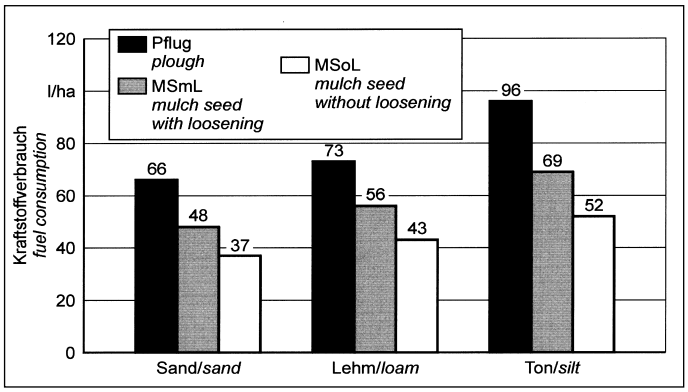


Fig. 2: Fuel consumption in l/ha for stubble, primary and secondary tillage at different sites

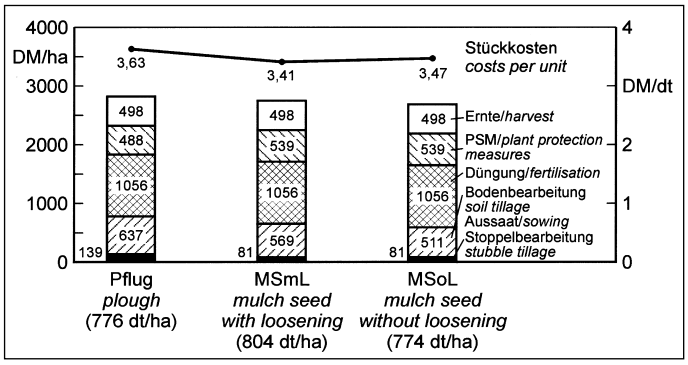


Fig. 3: Costs of soil tillage systems and production costs for sugar beet production on a loam site (1996-2000)

Fuel consumption

Through the reorganisation of the diesel support and higher mineral oil taxation (in Germany), fuel consumption during cultivations has an increasing cost-saving influence.

Diesel consumption was measured on three locations (sand, loam and clay) for the different cultivation procedures (stubble, basic, and secondary soil cultivations) with a flow recorder (PLU) (2 recordings/sec.) and from the data recording system UNILOG *(fig. 2)*. Consumption on the clay location was highest with, during loosening (with plough or non-inversion with layered grubber) an enormous ground resistance to overcome and a high crumbing effort required to achieve a satisfactory standard for sowing. With minimum cultivations without loosening only around half the fuel is required when compared with conventional plough cultivations. It is plain, therefore, that loosening should only take place on locations where it can show yield advantages.

Unit costs

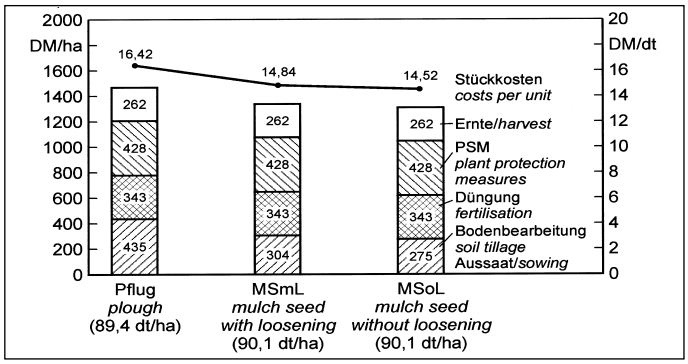
Diesel consumption represents only one cost factor. To evaluate the competitiveness of the methods, yields must be considered along with costs. For this, the full costs of a farm were determined under the assumption that the machines had been financially written off. Farm-specific costs such as rent, calculated enterprise profit and non-specific enterprise costs were not taken account of because these vary very strongly between farms and are not influenced by the cultivation approach.

Unit costs for sugar beet and beet-wheat were presented as an example for the loam location. For simplification, basic fertiliser is taken account of alongside the nitrogen with the sugar beet *(fig. 3)*. Spring ploughing produced the highest unit costs with 36.30 DM/t (when the farm-specific costs were taken into account the unit cost level rose to around 60 DM/t).

Minimum cultivations without loosening (MsoL, 10 cm deep) returned the same yields, but required less expenditure in that the effortful basic soil cultivations were spared. The minimum cultivations with loosening (MSmL, surface soil depth) method was the most profitable on loam. The loosening had an effect on yield and reduced the unit costs compared with ploughing by 2 DM/t. This system of cultivation combines surface silting control, optimum root growth and improved load bearing capacity of soil.

The following wheat profited from the improved soil structure and load bearing capacity after minimum cultivation beet. High-effort inversion cultivation (ploughing) meant wheat was produced most expensively in this way at 164.20 DM/t *(fig. 4)*. The soil-protecting, top layer loosening (MSmL) had no effect on yield on annual average, and therefore caused avoidable costs. With 145.20 DM/t the most profitable was MsoL. An important requirement for the no-plough wheat establishment after beet harvest is relatively dry ground conditions. The faster, therefore, drilling follows the beet harvester (which can now lift from one side with modern header systems) the better does minimum cultivation wheat achieve the described advantages.

Fig. 4: Soil tillage systems and production costs for wheat following sugar beets on a loam site (1996-1998)



Summary

The targets of achieving competitive and also environmentally protective farm management methods demand the use of clear management procedures from the start. Analysing implement application on the basis of specific location and rotation stage with regard to soil protection and cost savings is critical.

For example, effective protection from soil erosion through ground covering capacity can be realised by minimum cultivations in a beet/wheat rotation. Improving loosening with a layered grubber improved the load bearing capacity for heavy harvesting machinery and reduced loosening intensity, thus saving costs.

Literature

[1] *Brunotte, J., B. Winnige, M. Frielinghaus und C. Sommer*: Der Bodenbedeckungsgrad - Schlüssel für gute fachliche Praxis im Hinblick auf das Problem Bodenabtrag in der pflanzlichen Produktion. Bodenschutz (1999), H. 2, S. 57-61

[2] KTBL: Bodenbearbeitung und Bodenschutz. Arbeitspapier 266, 1998, 130 S.

[3] *Sommer, C.*: Konservierende Bodenbearbeitung – ein Konzept zur Lösung agrarrelevanter Bodenschutzprobleme. Bodenschutz (1999), H. 1, S.15-19

[4] *Tebrügge, F. und H. Eichhorn*: Die ökonomischen und ökologischen Aspekte von Bodenbearbeitungssystemen. Friebe, Wechselwirkungen von Bodenbearbeitungssystemen auf das Ökosystem Boden. Tagungsband Gießen, 1992, S. 7-20

[5] *Vosshenrich, H.-H.*: Gleichmäßige Strohverteilung sichert den Feldaufgang. Rhein. Bauernzeitung 54 (2000), Nr. 29, S. 14-16

[6] *Wagner, M., J. Brunotte und C. Sommer*: Bodenschonung und Kosteneinsparung – Einführung technischer Lösungskonzepte zur Minderung und Vorbeugung von Bodenschutzproblemen in der Pflanzenproduktion. KTBL-Schrift 398, Darmstadt, 2001