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The effects of various tillage and sowing systems on energy input and crop production parameters

On a trial farm near Leipzig the effects of various husbandry systems on yield relevant and economic parameters were investigated. With no-plough systems average crop emergence decreased at first, although without visible differences between individual conservation cultivation intensity levels. But yield increased markedly by up to 5% with no ploughing and where cultivation intensity was continually reduced.

The picture was similar with fuel and labour inputs with fuel consumption reduced (- 70%) and labour requirement (- 65%) in line with lessening cultivation intensity.

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Keywords

Soil tillage, sowing, tillage intensity, field emergence, yield, fuel consumption, labour requirements

The effect of field operations on fuel consumption has direct influence on variable production costs. Although producer prices in the last two years have improved markedly, drastically increased input costs have meant that the overall situation has not noticeably changed.

Basically there are numerous possibilities for minimising costs. Potentials can be exploited by changing cropping methods. Appearing much more interesting than this is the questioning of required tillage intensity and number of passes needed in the field according to the motto: "Only as deep as necessary and as shallow as possible."

For some years now this question has been looked into on the trial fields of the agricultural cooperative Kitzen in the Leipzig area with experiments managed in cooperation with Amazone-BBG and the Johann Heinrich von Thünen Institute (vTI), Brunswick.

Trial configuration

The trial area (~ 40 ha) is divided into four blocks for cultivation variations (blocks A to D). Whereas block A is conventionally ploughed, blocks B to D receive conservation cultivations of reduced intensity with grubber–disc harrows (blocks B, C) and compact disc harrows (block D). Three different drilling techniques are used within the individual blocks, again with reduced cultivation intensities (*Fig. 1*). Stubble cultivations post harvest are generally shallow and carried out by compact disc harrows.

Implement application and working passes

Soil cultivation

Stubble cultivation is with compact disc harrows working at mean depth of 6 to 7 cm. Method and intensity were differentiated in following cultivations.

Block A is conventionally worked with plough at an average 22 to 25 cm depth followed by reconsolidation by furrow press. In blocks B and C a four row grubber-disc harrow combination is used with working depths from 20 to 22 cm and 13 to 15 cm. Block D has least cultivation intensity and subject only to a second pass with the compact disc harrows at 8 to 10 cm depth. Summarised the different cultivation depths in the conservation cultivation blocks give an incorporation ratio of from 2 to 2.5 cm soil/t straw, 1.5 to 2 cm soil/t straw and 1 to 1.5 cm soil/t straw.

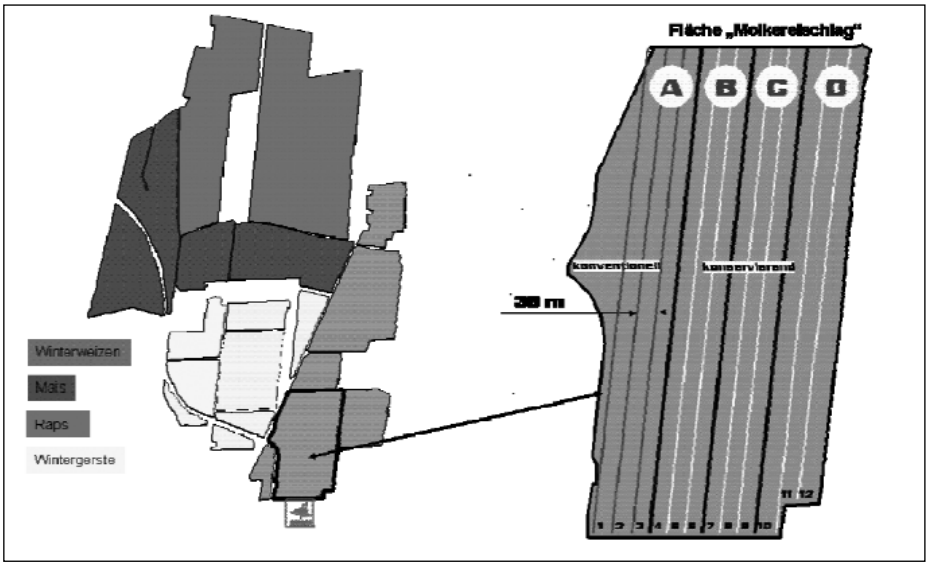

Fig. 1: Configuration and layout of the trial field "Molkereischlag"

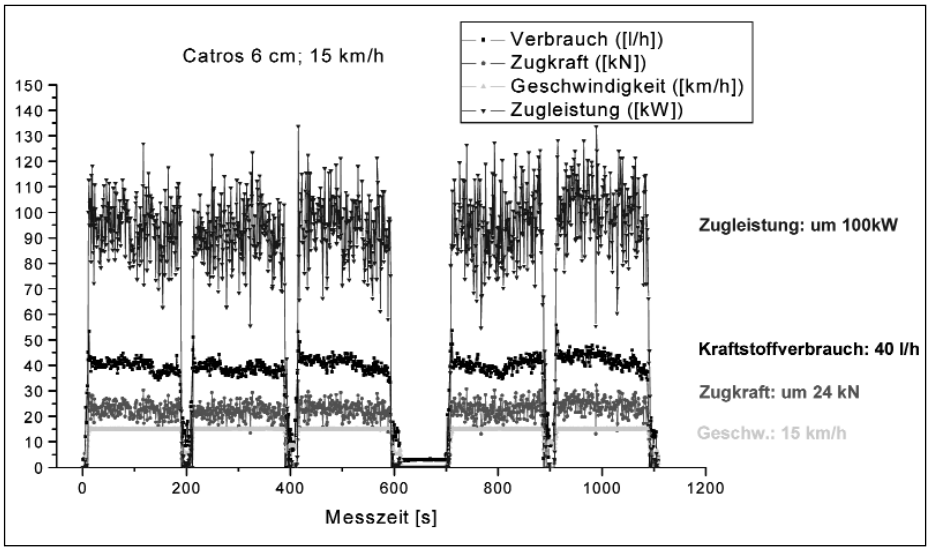

Fig. 2: Graphic representation of a test run

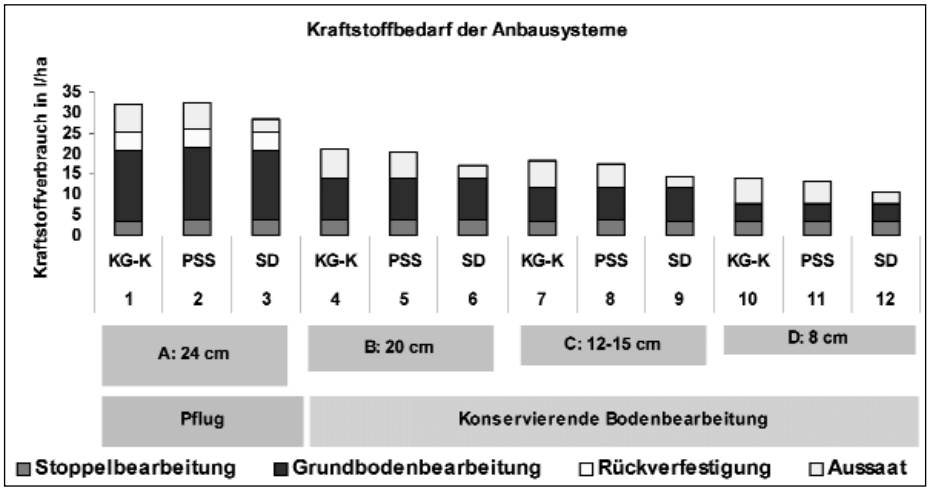

Fig. 3: Fuel consumption for different cultivation systems

Sowing
Three drills are used for sowing. The first variant is a pto-powered drill combination, the second a pulled drill combination with integrated disc harrows unit and the third a solo drill.

Tractors
Used are standard tractors of 125 kW and 220 kW with special measuring equipment to record:
- Fuel consumption
- Ground speed
- PTO power
- Draught traction

Test run example
Figures gathered by data recording are processed via special computer program with graphic data analyses of the individual work passes (*Fig. 2*).

Results

Fuel consumption of cultivation system
Results indicate clear differences in fuel consumption. Conventional cultivations with following sowing in block A returns consumptions of 28.2 and 32.2 l/ha (*Fig. 3*) representing highest consumption for the highest intensity cultivation level. Lowest consumption is in block D with blocks B and C between the two extremes. Depending on intensity level, drilling requires 10.7 to 14.0 l/ha at working depth of only 8 cm.

Labour time requirement
Usually, more intensive cultivations require more work input (*Fig. 4*). Basically, however, the total work requirement of a crop establishment system is influenced more by the soil cultivation operations. Between most intensive methods and the lowest there's a difference of 30 minutes bringing a percentage reduction in labour requirement of 50 %.

Crop emergence
Results per square metre are recorded with appropriate replicates. Annual averages for emergence results show a clear tendency to the advantage of conventional cultivations. The low degree of straw coverage at drilling means no negative influence on crop emergence from this aspect. Conservation cultivations result in slightly lower emergence performance because of higher surface trash. Surprisingly, no further deterioration in emergence is observed with further reductions in cultivation intensity (blocks C and D). Apparently, a cultivation depth from 8 to 10 cm suffices for achieving uniform crops.

Area yield
A completely new situation is presented through observation of area yields (*Fig. 5*). The conservation systems which during early recording appear backward end-up in part by producing markedly higher yields with block C performing best with 5.5 % more yield although cultivation depth is only 13 to

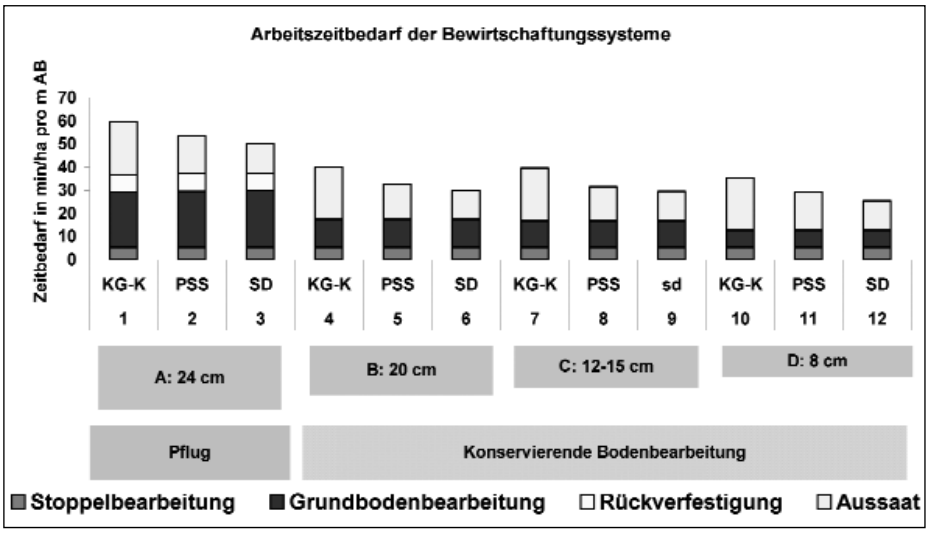

Fig. 4: Labour requirements for different cultivation systems

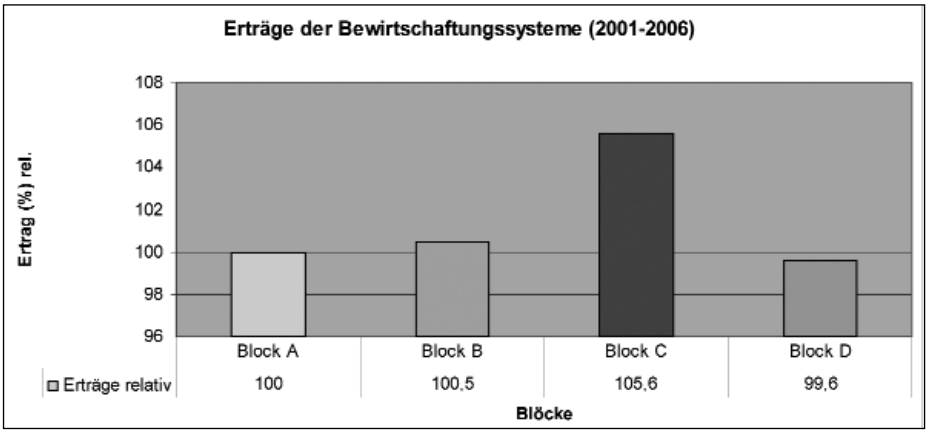

Fig. 5: Yield development in recorded period 2001 to 2006

15 cm. To a certain extent, reduction in cultivation intensity brings extra yield because of improved soil moisture availability. However, too little cultivation intensity (block D) leads to a drop in yield despite markedly increased soil moisture availability. In this case higher straw concentration in surface soil proves the greater influence.

Summary

The excellence of a crop production system is determined equally by location yield and level of variable production costs.

Main target of the long-term trial is to determine the effects of yield-relevant and economic parameters through different management systems with graduated soil cultivation and sowing intensities.

Changing from conventional to conservation cropping always led to a reduced crop emergence during the observed period. Higher degrees of straw cover on soil surface and decomposition products released during straw rotting were recognised as main grounds. Between the graduated intensities of conservation cultivations, on the other hand, there were only minimum variations in crop emergence. Area yield over the observed period where cultivation depths were comparable indicated no appreciable differences between conventional and conservation management. With a further reduction of cultivation intensity within the conservation approach yield levels at first increased markedly (block C) then fell strongly (block D). Thus the method with the least intensity always resulted in the lowest yield.

Looking at the economic parameters, fuel and labour requirements were main points of interest. While differences were minimal for stubble cultivations because of similar targets and implements, primary soil cultivation passes showed more marked differences through application of different techniques. Using the plough for primary cultivation required the highest input in fuel consumption as well as labour while the grubber-disc harrows combination and the compact disc harrows used in the conservation management systems could markedly reduce fuel consumption, in ideal cases by as much as 70 %. Labour requirement was similarly affected and here savings of up to 65 % are realistic. With sowing the savings potential was reduced mainly to required working time whereby marked differences in fuel consumption were not identified. Using different drills gave differences in required working time of up to 45 %.