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Remote servicing for farm machinery

Practical experience with a self-propelled potato harvester

Reactions from potential users of remote servicing for farm machinery have shown that there's interest in the new technologies and that the need exists. First trials with a self-propelled potato harvester showed promising results that would allow a more precise modelling and simulation of the machine. It has become apparent, however, that the rather slow realisation of the new remote data service could well obstruct development, use and spread of remote service application in the farm machinery sector.

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Keywords

Remote service, remote diagnosis, remote data transmissions

A Grimme potato harvester with additional recording equipment (pressure, temperature, volume flow and position sensors) was used for the ILF field trials to collect information on individual components and the complete hydraulic system. Target was a comprehensive modelling of the machine as well as indications on other sensors required for a remote servicing system. First measurements on the harvester were conducted during the early potato harvest and these will be gone into in more detail in the following report.

Figure 1 shows a model of the harvester used and the potato route through the individual separation and cleaning steps: after lifting of the furrow, soil, hauls and potatoes are separated on the sieve webbing and by first and second separation equipment. Subsequently, potatoes are cleaned on the hedgehog belt situated under the tuber-delivering later finger belt and then manually sorted. The potatoes can then be directly deposited from the sorting table into the bunker.

Data preparation and transmission

In preliminary trials on other test machines the manufacturer had already statistically prepared the data available on the CAN bus and transmitted it via SMS over a GSM modem. In the first phase of these field trials the data was not transmitted but instead temporarily saved on a measurement PC on the machine. The subsequent processing then took place offline on the working place PC. In this way, suitable filter procedures and practical combinations of measurement values could be established which could then be summarised into reference values.

Even in the first investigations early fears were confirmed that current data transmission rates for online diagnoses were insufficient and that real time data transmission was impossible. To get around this problem during the trials a radio LAN with transmission rate of up to 11 Mbit/s was created so that a notebook on the headland with software for remote parametric calculations could record information produced by the harvester PC. Thus, real time transmission and depiction could be achieved without obstructing the actual harvesting. However, the radio service will not be in the position to achieve such data rates in the medium term, even with improved technologies.

First trial results

In trials so far, during early potato harvest, the harvester worked faultlessly. *Figure 2* shows the pressure readings at the cleaning and separation equipment drives during differing working conditions. These measurements were carried out in two different fields. Field A had sandy soil and some, already dried out, haulm. Printouts indicated consistent pressure readings on all drives during harvesting in the field middle. Harvester settings were retained for field B. Here, the headland was lifted first whereby the slightly boggy soil was lifted in the direction of increasing haulm density caused by surrounding vegetation growth. In this context an increase in pressure in all drives was clearly seen, being attributable to the increase in haulm and soil moisture as well as the larger tubers produced there through a longer growing period. Further noted in comparison with field A was relocation of the power requirement from the second to the first separation equipment, again caused by more haulm. This tendency was also re-

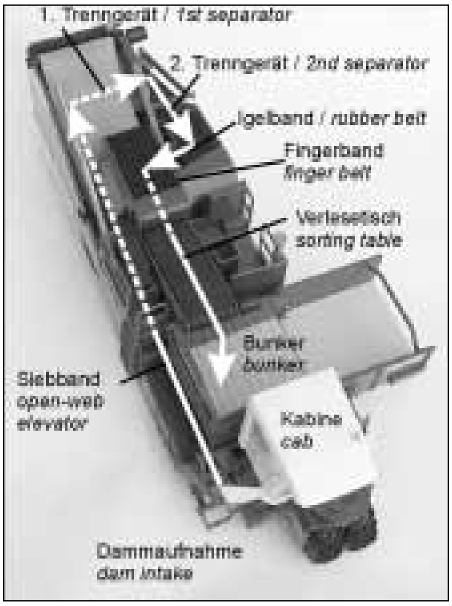

Fig. 1: Potato tracing through the harvester

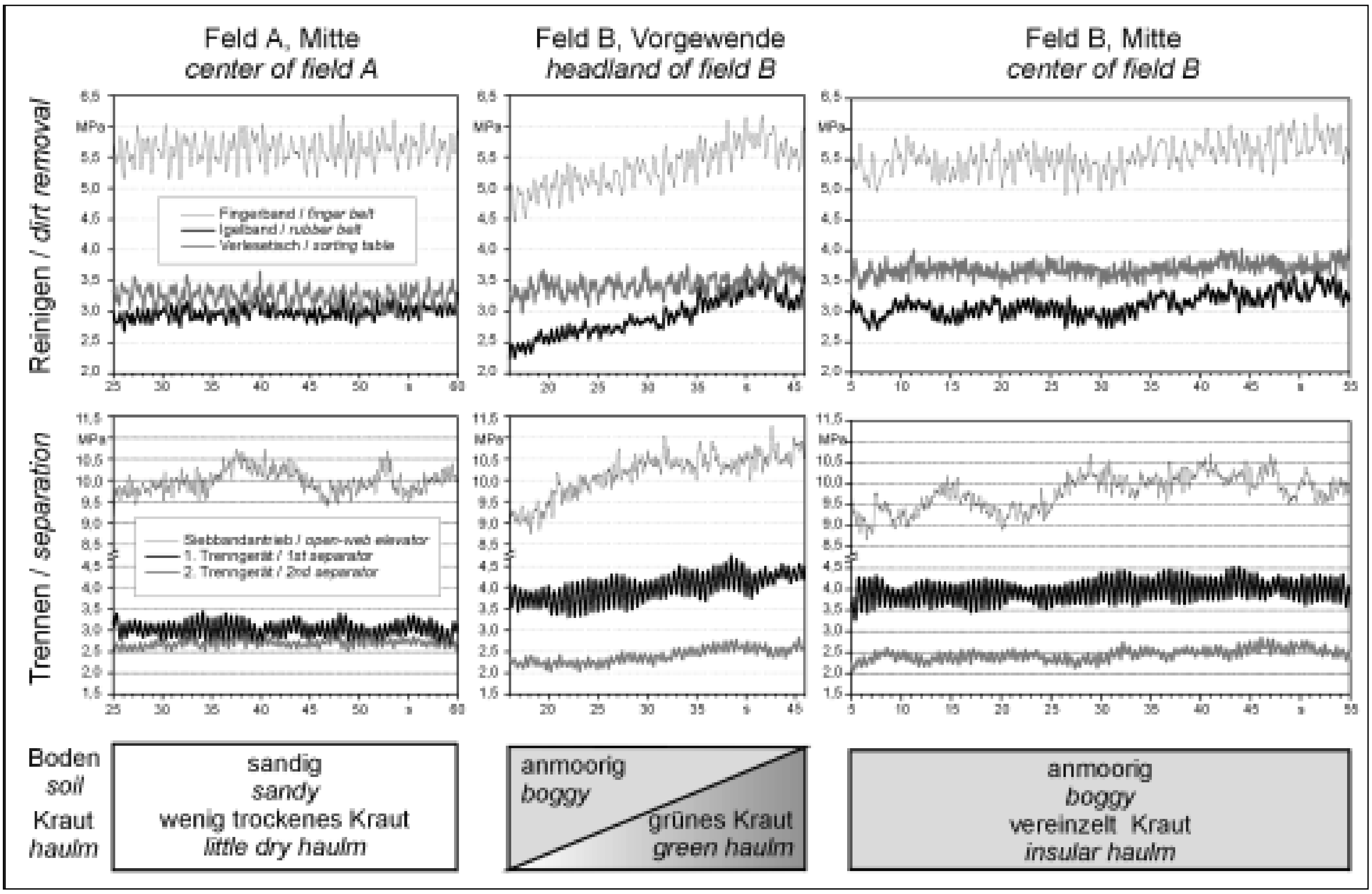

Fig. 2: Pressure readings from separation and dirt removing devices at different operating conditions

flected in the field middle measurements As in field A, the loads were consistent. This example showed that pressure measurements of individual drives could be used for describing working conditions on the harvester. This supplied, e.g., a differentiated observation for the sorting table. This consisted of many individual steel rods and because of its large mass and inertia it reacted much less sensitively compared with other construction groups. Additionally, a large proportion of non-potato material had already been separated-out.

Using the example of the first separation equipment, *figure 3* shows how a simple reduction in data amount can be achieved. The information was compressed into total loading whereby the results from figure 2 are basically to be found in the form of a classification in this presentation. However the time information is lost in this form of presentation and this means this evaluation reflects cumulative loads but can deliver no momentary recordings for diagnosis in the case of damage.

These have to be separately and automatically recorded („crash recorder“). For this, selected signals were used as trigger to automatically activate recording and saving of interesting values when chosen thresholds were exceeded or not reached. This can also occur retrospectively so that, e.g., all values up to 15 seconds before a trigger occurrence can be retained.

Summary and outlook

The long-term target of remote service is the early identification, avoidance or rapid repair of malfunctions. The continuous reception and evaluation of measurements, even during normal working, offers starting points for machinery modelling and indications of machine capacity exploitation and operational conditions. The information from the recordings and the quality of the model can thus be steadily improved and the required threshold values can be more precisely determined with greater statistical reliability.

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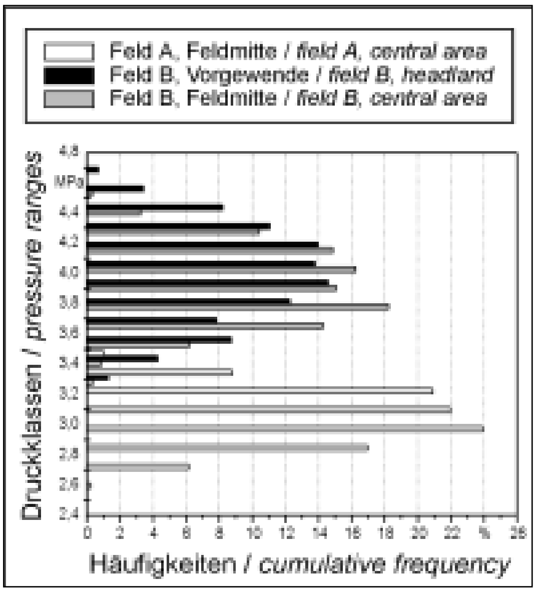

Fig. 3: Exemplary pressure ranges of the first separator