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# Quality control in harvesting machinery

*Fitting combine harvesters in the future with near infrared (NIR) spectrometers will allow analysis of grain for components such as protein, starch and oil. This would enable the direct evaluation of variety trials or fertiliser experiments at harvest. The application of NIR spectrometers on combines thus leads to a substantial simplification of quality assurance in arable and forage production and represents a further step towards a quality-assured and environmentally-protective agriculture. Grain content assessment directly at harvest is, however, only practical when appropriate standardisation is assured so that the information thus received can find a wide acceptance and can also serve in certification of quality.*

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## Literature

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Recently, demands for more quality control in agriculture have greatly increased. On the one hand this has been brought about by stricter standards and mandatory labelling of food; on the other by scandals in the food and feed industry increasing consumer awareness and requirement for quality information. Servicing this last demand requires comprehensive documentation from harvest to end processing. With precision farming too, documentation of harvested product contents must be aimed for. Even now, modern agricultural engineering gives the farmer the means to determine and record grain weight and moisture content plus information regarding harvested area, the location and time. Determination of grain component properties will shortly be a further requirement asked of the manufacturers of machinery for precision farming. For this, suitable and practical analysing methods must be found for the production and harvesting processes. Such a method is NIR spectroscopy which has already been long-used for the analysis of organic contents. With the development of robust and shock-resistant NIR diode arrays for spectroscopy, the future technological requirements for application of this technology in combines will be established.

### Principle and possibilities of NIR spectroscopy

The principle of NIR spectroscopy is based on frequency-specific absorption of infrared light through molecular structures in the frequency range of near infrared. The determination of this absorption spectrum can be via reflection or transmission. Through calibration of the received spectrum the concentrations of different content materials in the harvested product can be ascertained. Through the higher absorption capacity of OH groups, the moisture content dominates the absorption performance of the grain. The influence of the concentration of other contents on the absorption performance is less but still, however, sufficient for reliable measurement.

Earlier, calibrations were done on the basis of selected wavelengths. As more modern and powerful calculation techniques have been developed multi-variant „Full spectrum methods“ have come mainly into use. These methods use all the spectral information [1]. The calibrations for the NIR spectrometer are therefore empirically determined regression models as a rule equipment and product specific. There are different methods for the transmission of NIR spectroscopy calibrations onto other instruments [1, 3].

Summarised, it can be established that NIR spectroscopy is a suitable tool for the quantitative indication of organic material components and can therefore be applied for quality control.

### NIR spectroscopy's role in harvesting machinery

The establishment of yield-oriented parameters represents state of the art technology in arable and forage production nowadays. Thus spatially-based information on weight and moisture content of harvested material can already be used. Together with the information on grain components this allows the recording of very comprehensive information for the farmer and the buyer of the product. Up until now there has been no urgent necessity for the determination of harvested material components during the actual operation, although interest in quality information has greatly increased in the meantime. On the one hand this is due to increased demand for quality in harvested material [7] as well as requirement that these qualities be documented, on the other hand there is also a wish for more information on component quantities on the part of spatially-specific husbandry. This underlines the importance of development in this aspect and indicates how it can quickly become an important theme, e.g. through new regulations regarding proof and documentation of qualities.

For plant breeding there is already a requirement for quality determination systems on harvesting machinery. In this case the determination of content material concentration takes a much higher priority. The methods for non-destructive determination of components are well distributed within plant breeding with analysing carried out in laboratories work. Application of NIR spectroscopy systems in harvesting machinery offers great cost savings here, with market-ready solutions already available [4].


*Fig. 1: The working group „Continuous quality control in harvesting machinery"*

The core problem for all users of NIR spectroscopy systems remains the involved calibration required. With harvest application especially, the main problem is the collection of reference samples [2], in that is must be reliably established that no transition takes place in the material between field and reference laboratory. Here, standards must be established that enable exact operation of NIR spectroscopy systems.

From this situation it can be concluded that quality determination only makes sense when there is full cooperation between all those for whom the quality determination of the material is of interest. For example the farmer can thus turn to the already existing experience of the breeder. Thus only a broad common use of quality control through NIR spectroscopy can lead to the required precision of the values which, in end effect, enable a broad acceptance of the content determination method and form a basis for certification of the system for quality assurance programmes.

### The working group „Continuous quality control on harvesting machinery"

The biggest problem with a continuous crop content analysis is therefore the reference ability of the measurement value [2]. Here a standardisation at least on national or, better still, on an European basis must be established. Uniform conditions applying to all manufacturers must be created in the case of the sensor systems. Initiated with these requirements in mind, the workshop „Continuous quality control on harvesting machinery" was created by the John Deere Werken Zweibrücken and all interested parties invited to partake. Represented at this workshop on 18 and 19. 2. 2002 in Homburg were universities, research institutes, sensor manufacturers and producers of agricultural machinery and livestock feed.

Among other things discussed were the problems of standardisation and system specification [3], factors influencing NIR measuring [4], the requirements for measurement precision of the NIR system in spatially-specific harvesting and with high-performance machinery [6].

Once again it was stressed that a quality control system could only be successfully introduced when the sensor system, sample handling, laboratory analysis and calibrating are all standardised. Only „accepted" values are useful for the customer [5], because these create a valuable opportunity for targeted and improved marketing of agricultural produce.

An important result was the established continued existence of the working group „Continuous quality control on harvesting machinery" formed at the workshop with all members working together and the overall group divided into four sections (*fig. 1*).

The working group Marketing, sector Grain under the leadership of Prof. Isensee, Kiel University is aimed at the target groups food industry, oil mills, agricultural contractors and farmers, the feed industry, maltsters, agricultural dealers and legislation.

The working group Marketing, sector Feed cropping, under the direction of Dr. Snell, Göttingen University is aimed at the target groups farm contractors and farmers, research institutes, producers and testers of silage additives, animal nutrition, DLG-working groups and legislation.

The working group Marketing, sector Experimental facilities, under the direction of Dr. Paul, FAL, Brunswick has target groups plant breeding, experimental stations, manufacturers, DLG working groups and legislation.

The working group Technology/Calibrating is under the direction of Prof. Bernhardt, TU Dresden. Targeted here are farm machinery manufacturers, sensor producers, VDLUFA, laboratories, „data bank operators" and research facilities.

### Aim of the working groups

Most important aim of the working groups is the clarification of the questions whether, where and how quality control can be applied in the harvest. Applying here is the recording of all data utilisation possibilities and their determination of which quality characteristics are actually important. Costings must naturally also be made for these utilisation possibilities to establish any return the accumulation of such quality data might bring for the farmer. Efforts of the working group Technology/Calibrating should make a decisive contribution towards clarification of how quality control should be applied in the harvest. Here the work concentrates on the development of sensor solutions suitable for standardisation in this sector as well as being able to meet the requirements of content analysis. Questions being tackled in this work include those of material transport to the sensor, constant conditions for sampling, automation of sample taking. Another focal point will be the further development of calibrating techniques with regard to standardisation.

A meeting in week 37 is planned in Dresden for the working group Technology/Calibrating. This meeting is aimed at planning the tasks and work within the group as well as preparing for the working group's next meeting which should take place under Dr. Paul at the end of 2002 in Brunswick.

All individual working groups are basically open to everyone. The assistance of those interested in the appropriate working groups and in the meetings themselves is definitely encouraged. Particularly important for the activity of the total working group will be the cooperation of the food industry and the DLG working groups.

### Summary

NIR spectroscopy will soon enable the determination of harvest material contents, and therefore important quality parameters, on the actual harvesting machinery. However, much work has still to be done towards solving technological as well as economical questions. Presented here in this context, along with the focal points of the work and its aims, is the working group „Continual quality control in harvesting machinery" which is to tackle this work.