NIRS Diode Array on Agricultural Harvest Machines

Optical innovation in quality oriented crop production

Institute of Grassland and Forage Research
Federal Research Centre of Agriculture (FAL)
Bundesallee 50
D-38116 Braunschweig
Germany

Tel.: +49 (531) 596-378
Fax: +49 (531) 596-320

Dr. Christian Paul
email: christian.paul@fal.de

Michael Rode
email: michael.rode@fal.de

NIRS Diode Array on Agricultural Harvest Machines

Optical innovation in quality oriented crop production

Christian Paul and Michael Rode

The growing consumer consciousness of food quality demands procedures for quality assurance in the agricultural sector which have already become commonplace in other industries. However, an effective quality control system requires suitable instrumentation which is often not yet available as for instance in crop production.
A new methodological approach is given by the use of near infrared spectroscopy (NIRS) directly at the agricultural production level. The potential of NIRS had been developed in the sixties in the USA by NORRIS for non destructive moisture testing of grains. This technique was taken up in the eighties and promoted with high intensity using state of the art technology at the Institute of Grassland and Forage Research of the German Federal Research Centre of Agriculture (FAL) at Braunschweig. The innovation described in the following is based on a new type of sensor developed by the optical industry.

The possibility of implementing NIRS on mobile harvesting machines has arisen due to the development of fast NIRS - diode arrays with complete robustness towards temperature fluctuations and mechanical shock. In cooperation between FAL, Carl Zeiss Jena GmbH and the Danish agricultural engineering company Haldrup prototypes of grain combine harvesters and forage harvesters with integrated NIRS - diode arrays have been developed. A dismounted NIRS - diode array of the type MMS-NIR 1.7 produced by Carl Zeiss Jena GmbH for the wavelength range from 950 to 1700 nm is shown in Fig. 1.
The special advantages of the MMS-NIR 1.7 result from its high speed of measurement, mechanical robustness, temperature stability and its small size. The various conventional types of NIR - instruments which have so far been used in laboratories are unsuitable for mobile applications under the rough conditions of field cropping not only because of their slow speed of measurement but also because of their shock - sensitive filter wheels and monochromators necessary for fractionating polychromatic light.

Considering the large economic importance of the dry matter content of agricultural products it is of particular advantage that water belongs to those constituents which are most easily assessed in the near infrared. The changes in absorption in the near infrared due to increasing water content of fresh forage samples are shown in Fig. 2. While other constituents of economic importance such as starch, oil and protein in grains and seeds have a much lesser effect on NIR signals (see Fig. 3), their contents can nonetheless be assessed with

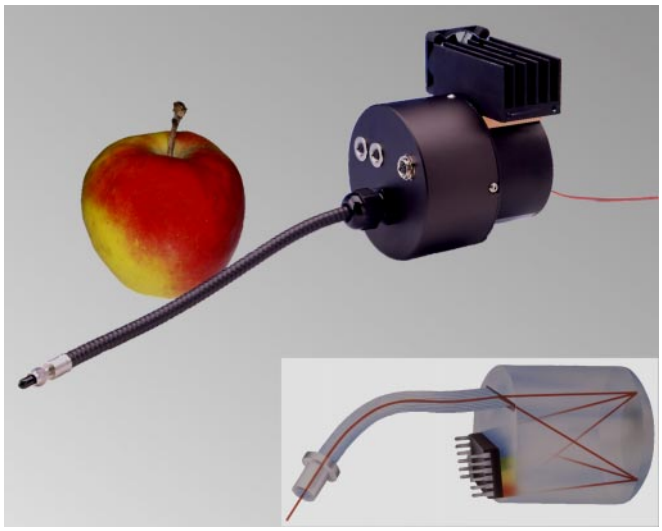

Fig. 1: MMS-NIR 1.7 (Carl Zeiss Jena GmbH) dismounted (top) and in schematic view (bottom)

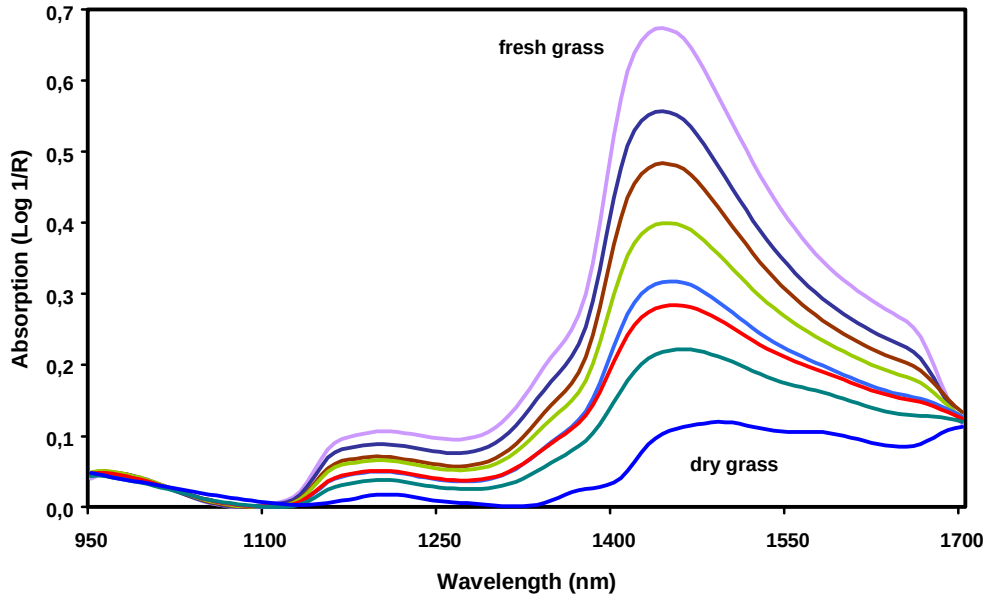

Fig. 2: NIR absorption spectra of grass at varying moisture levels

high analytical precision on freshly harvested grains and seeds.

In the summer of 1999 the first forage harvesters of the new Haldrup series „NIRS harvest line“ will be operated by the German plant breeding companies Deutsche Saatveredelung (DSV) and Norddeutsche Pflanzenzucht (NPZ) for harvesting grass and clover (see Fig. 4). A combine harvester for grain crops like cereals, oil seeds and grain legumes will be tested simultaneously.
Presently still set up for the conditions of agronomic and plant breeding experimentation it will soon be possible to characterise samples from variety tests, fertiliser and harvest time trials in real time rather than wait for the results of expensive conventional chemical analyses. It can be assumed that this result of FAL research will permit a considerable cost reduction in the quality control of crop production and thus provide a contribution to an environmentally safe and quality oriented production in agriculture.

Fig. 4: Haldrup – forage harvester

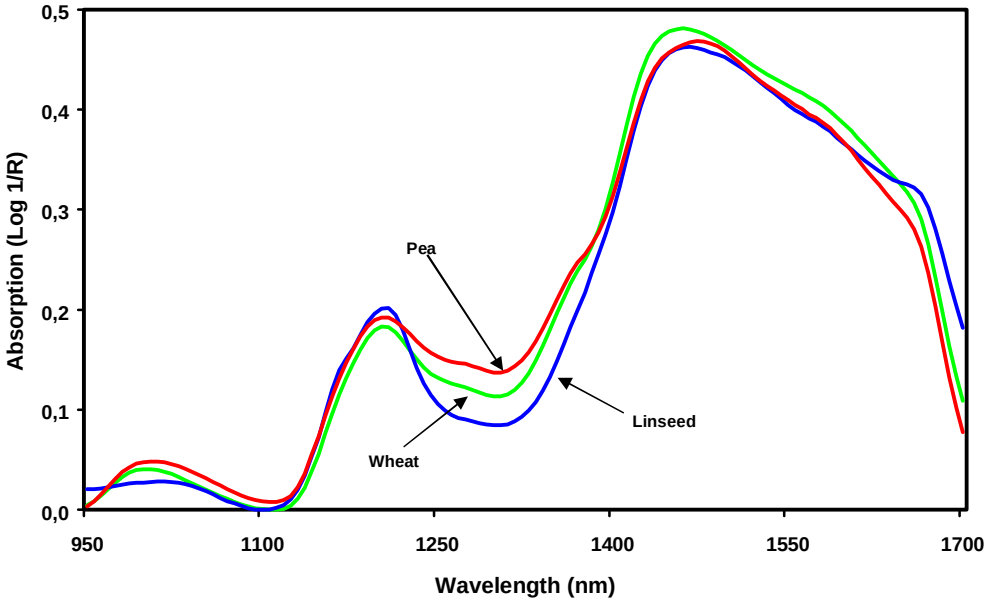

Fig. 3: NIR absorption spectra of wheat, linseed and pea

Authors address:

Institute of Grassland and Forage Research
Federal Research Centre of Agriculture (FAL)
Bundesallee 50
D-38116 Braunschweig
Germany

Tel.: +49 (531) 596-378
Fax: +49 (531) 596-320

Dr. Christian Paul
email: christian.paul@fal.de

Michael Rode
email: michael.rode@fal.de