Measuring Crop Plant Quality in the Field

INTRODUCTION

For the short period between harvesting and the next sowing, plant breeders need rapid, cost-effective and meaningful analytical techniques to be able to develop crop plants with improved quality. The advances achieved obtained in, for example, the dry matter content of forage grass, the oil content of oilseed rape and the protein content of feed barley depend directly on the intensity of selection from a starting material which consists of thousands of foundation stocks. Instead of conventional „wet chemical" analytical procedures, spectroscopy in the near infrared (NIRS) has proved to be successful for this purpose and can now be transferred from the laboratory to the field as a consequence of newly developed instruments.

Fig.1 MMS NIR

Fig.2 Forage harvester from the company Haldrup (Denmark).

THE METHOD

The water content of field crops determines their stability during storage, partially characterizes their nutritional value and is also a crucial factor in fixing their trading price. Water is the constituent which can be most easily determined in the near infrared While other constituents of economic importance such as protein, oil and carbohydrates display lower absorptivity in the near infrared , their contents can nonetheless be determined with high analytical precision by a single, non-destructive measurement of freshly harvested grains and seeds.

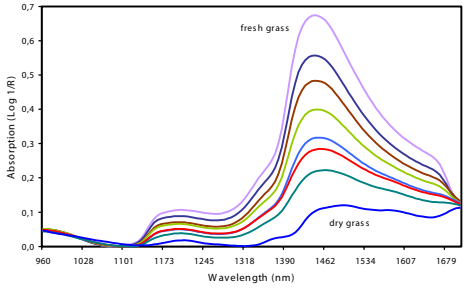

Fig.3 Absorption spectra of grass with different levels of moisture.

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THE SYSTEM

On the basis of the equipment devised and the chemometric research carried out by Norris in the USA, spectroscopy in the near infrared (NIR) has now made its way into plant cultivation. So far, however, the current status of the NIRS instrument technology has limited this analytical procedure to stationary use in the laboratory. The availability of diode arrays for the spectral range of the near infrared now makes it possible to the use NIRS directly on agricultural harvest machines. The company Carl Zeiss, the Danish agricultural engineering company Haldrup and the Institute of Crop and Grassland Science of the German Federal Agricultural Research Center have jointly developed a forage harvester for trial plots which allows NIRS measurements on representative samples of the crop during harvesting. The **CORONA NIR** sensor module installed in the harvester is based on the **MMS-NIR** 1.7 diode array spectrometer (Fig. 1) and has been specially designed for the rough conditions of field use.
The particular benefits of the **CORONA NIR** result from the high measuring speed of the **MMS-NIR** 1.7, its high temperature stability, small size and total insensitivity to vibrations and shock. These features clearly distinguish this unit from the NIR measuring instruments used in the laboratory which are unsuitable for mobile use in the rough conditions of field cropping, not only because of their slow measuring speed but also because of their moving, shock-sensitive gratings or filter wheels required for the dispersion of polychromatic light. In the summer of 1999, the first Haldrup forage harvesters of the new „NIRS harvest line“ for such forage plants as grass and clover were purchased by the German plant breeding companies Deutsche Saatveredelung (DSV) and Norddeutsche Pflanzenzucht (NPZ) and tested in the field (Fig. 2). The chemometric calibration of the sensor in field conditions is being continued together with these plant breeding companies. In addition, a combine harvester equipped with a **CORONA NIR** will be available for such grain crops as cereals, oil seeds and grain legumes for the first time in the year 2000.
The integration of NIR diode array spectrometers in agricultural combine harvesters will initially increase the efficacy of plant breeding and testing aimed at creating cultivars with improved properties. In addition, it should not be overlooked that this type of „mobile analysis” can also be transferred to practical agriculture where a wide variety of approaches to so-called „precision farming” are increasingly being tested. Thus, the NIR diode array spectrometers could one day make an effective contribution to quality assurance in environmentally compatible plant production.

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