



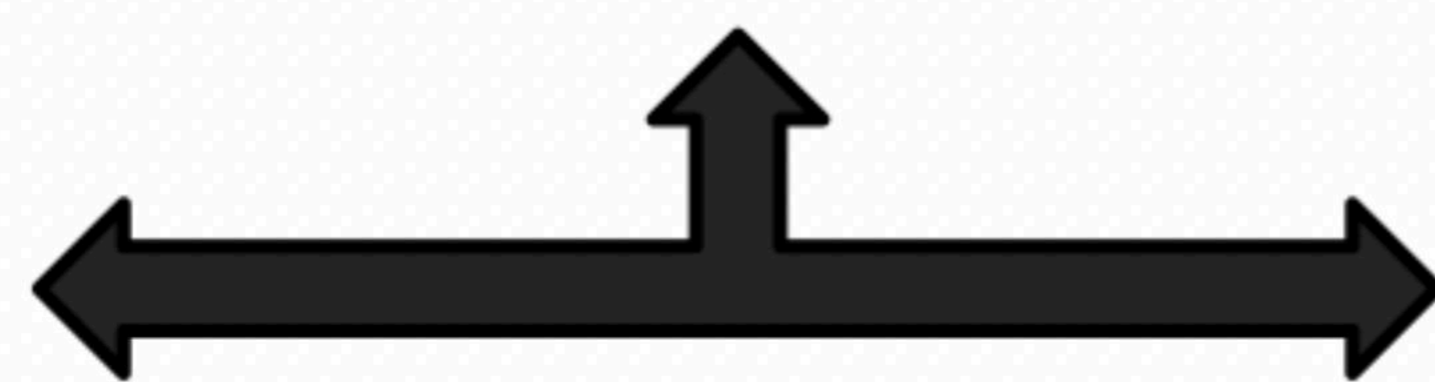
# NEAR INFRA RED SPECTROSCOPY – A Tool for Quick Feed Analysis

**Dr. A Natarajan,** M.V.Sc., Ph.D.,

Professor and Head,  
Animal Feed Analytical and Quality Assurance Laboratory,  
Veterinary College and Research Institute,  
Namakkal – 637 002, Tamil Nadu

# Analysis

## Analysis



### Wet chemical methods



**Gravimetric**

**Volumetric**



1. **Precipitating**
2. **Balancing**

**Titration**

### Instrumental methods



**Optical**

**Chromatographic**

**Electrical**



1. **Emission**
2. **Absorption**

**Chromatogram**

**Electrolysis**

## **Analysis of samples in a laboratory for any parameter is carried out**

- ▶ **Using chemicals, salts, glassware, electronic weighing balance, drying, ashing, filtration, colour development, titration, oven, muffle furnace, and high end instruments**
- ▶ **Using this wet chemistry facility**
- ▶ **Engaging qualified analysts, huge number of tools, and careful calculations apart from spending good amount of time**

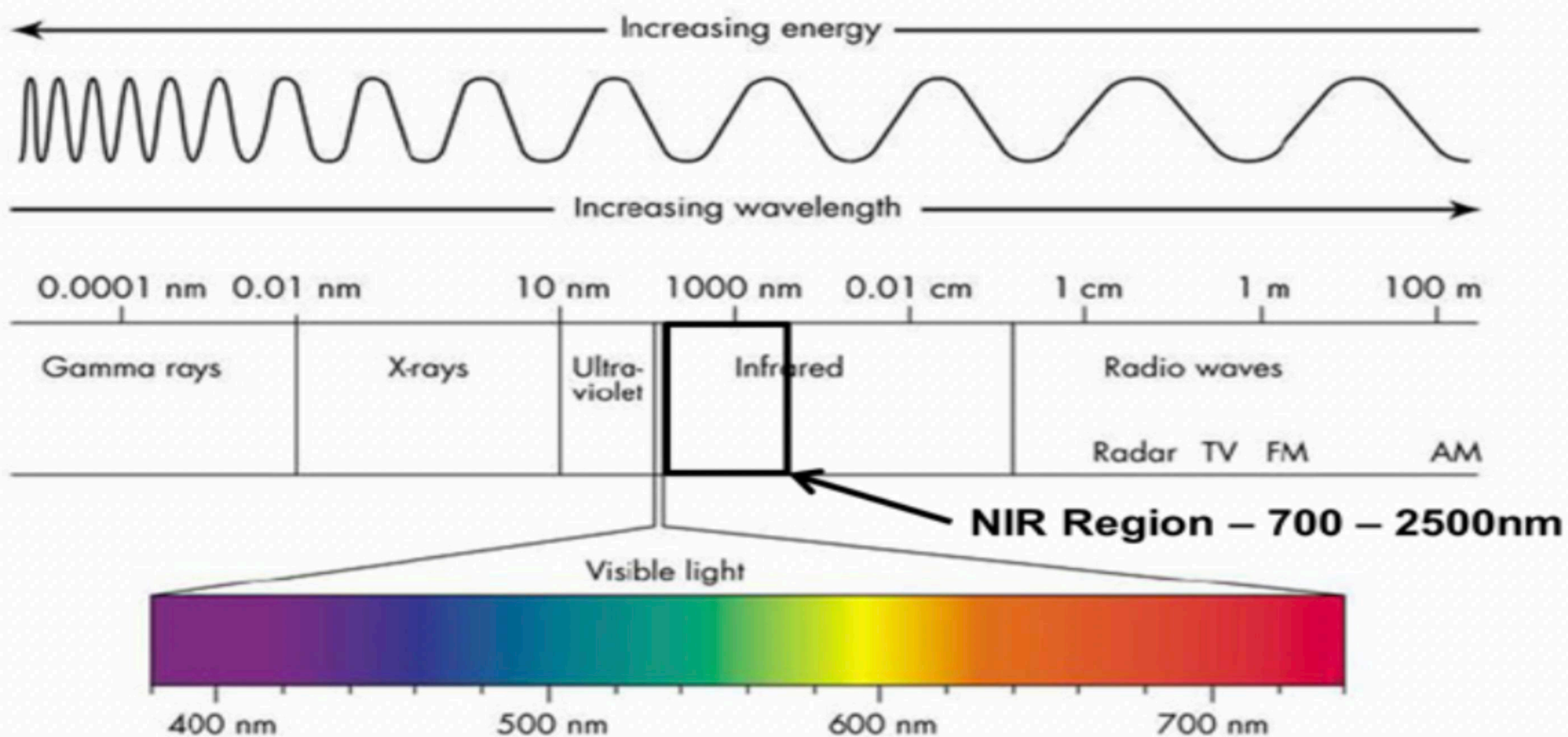
## Can wet chemistry be avoided ?

- ▶ The answer is a huge YES
- ▶ **Near-infra Red Spectroscopy** is a spectroscopic method that uses **near infra-red region of electromagnetic spectrum** (700-2500 nm)
- ▶ This lies between visible and Infra Red region

# Can wet chemistry be avoided ?

The answer is a huge **YES**

Near-infra Red Spectroscopy is a spectroscopic method that uses near infra-red region of electromagnetic spectrum (700-2500 nm)



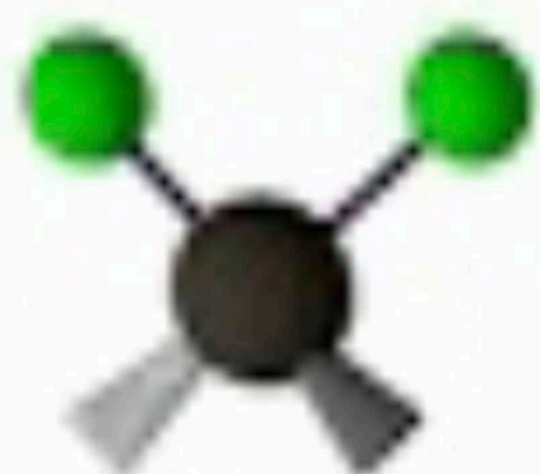


# A simple NIR machine

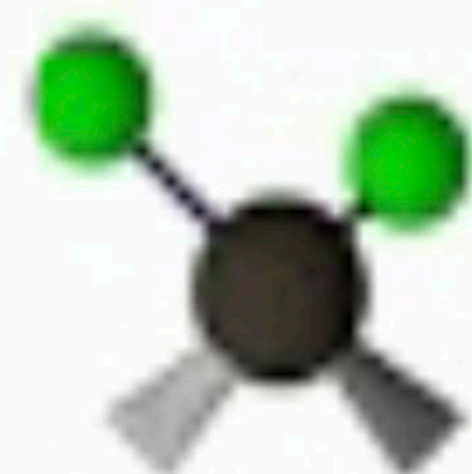




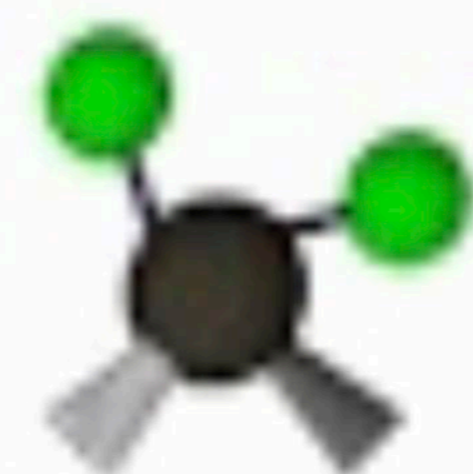
## NIR Radiation effect on the atoms



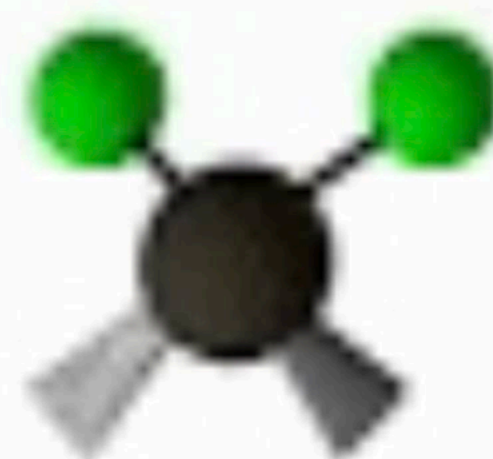
**SYMMETRIC  
STRECHING**



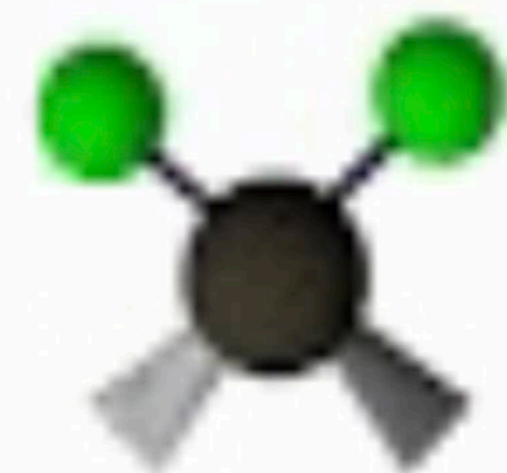
**ANTISYMMETRIC  
STRECHING**



**ROCKING**



**WAGGING**



**TWISTING**



**SCISSORING**

## How the instant analysis works ?

- ▶ NIRS utilizes 780-2500 nm spectral range of radiation which are passed over the feeds
- ▶ The plant molecules have molecular bonds O=H, C=H, C=O, and N=H
- ▶ The radiation at this spectral range creates two vibration patterns **stretch vibration** and **bent vibration**
- ▶ These vibrations are recorded as spectrum and are different for different materials with these bonds

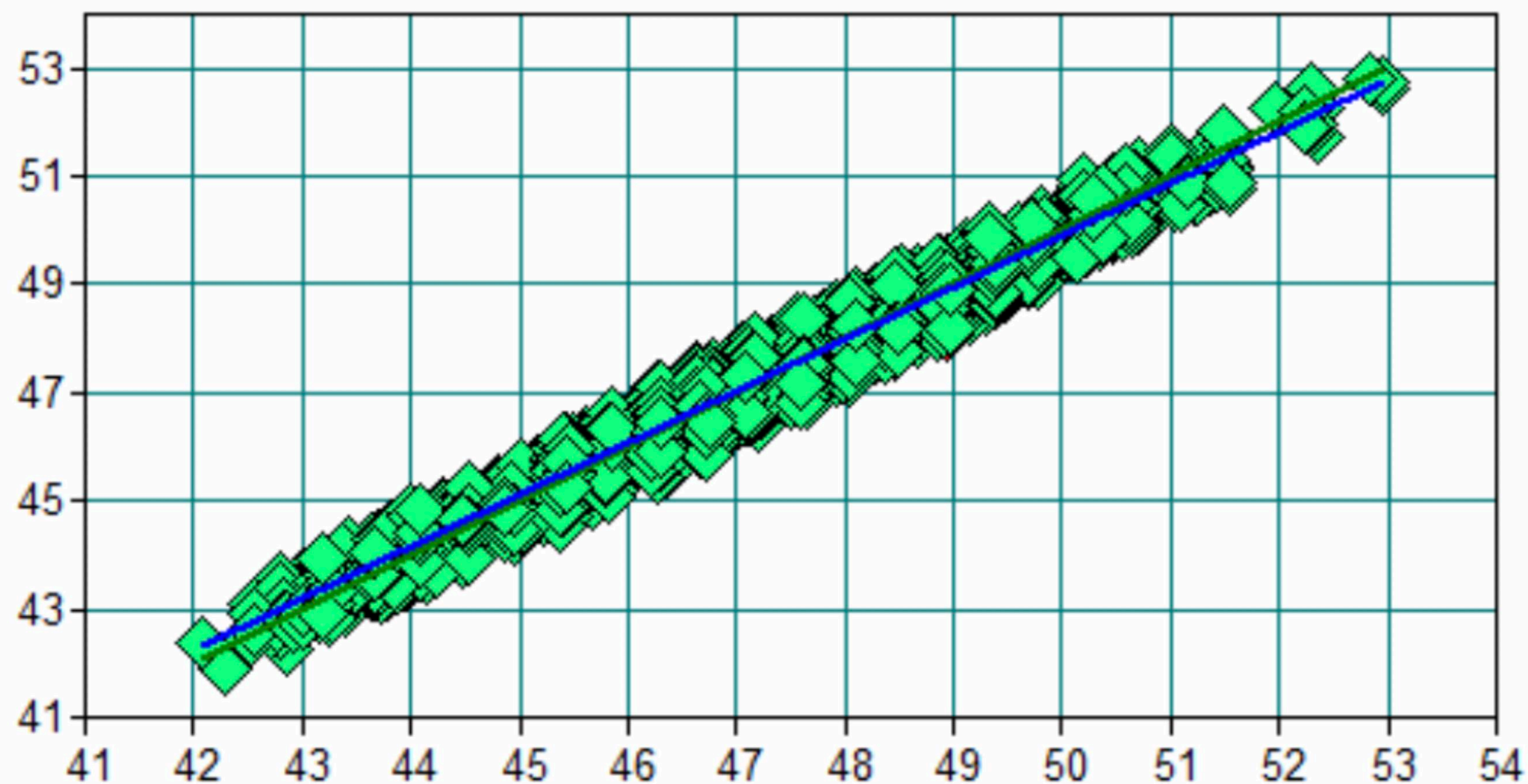




# Crude Protein Estimation using NIRS

– Appreciate the range of protein values of Soybean Meal

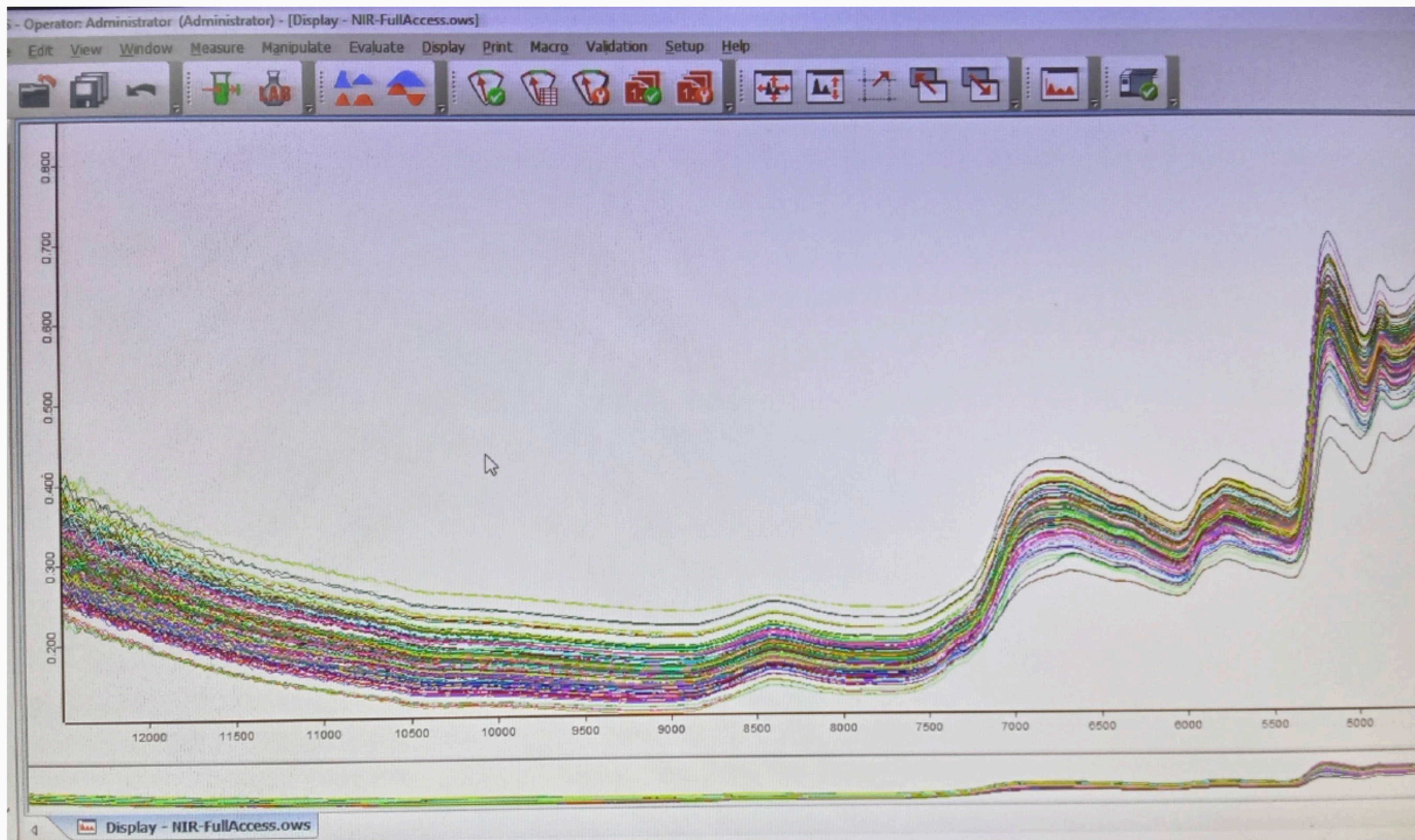
Prediction vs True / CP [%] / Cross Validation



Offset: 1.976    Slope: 0.958    Corr. Coeff.: 0.9789  
 Rank: 12    R<sup>2</sup> = 95.83    RMSECV = 0.325    Bias: -0.000714    RPD: 4.9



# A comprehensive spectrum of 174 SBM samples (superimposed spectra)



## Advantages of NIR

- ▶ **Rapid method** ( < 1min / analysis)
- ▶ **Less running expense** (no use of chemical reagents)
- ▶ **Single operator** can analyze a large number of samples
- ▶ **More accurate** result of analysis
- ▶ Sample requires **no preparation** (Non destructive method)
- ▶ **Several constituents** of the same sample can be **measured at one time**
- ▶ **Easy applicability in different environments** (like industry, laboratory, harvesters, etc.)

## Advantages of NIR...contd...

- ▶ **More useful in feed manufacturing where huge contingent of raw materials and finished feeds are used every day**
- ▶ **Once a spectrum is obtained of high reliability, application is instant and huge cost is saved apart from time and manpower**

**In NIRS, the  $R^2$  value of calibration level is important for application accuracy**

$R^2$	Classification	Application
< 50	Very poor	Not recommended
50 to 75	poor	Not recommended
76 to 85	Fair	Rough screening
86 to 90	Reasonable	Screening
91 to 93	Good	Quality control
94 to 96	Very good	Quality Assurance
97 to 98	Excellent	Any application
99	Superior	As good as reference.

## What are the factors that influence the accuracy?

**Sample preparation and sample presentation**

**Accuracy of the reference method**

**Required number of samples**

**Feasibility study: 20 sample minimum**

**Typical applications: 50-100 samples**

**Complex application: >150 samples**

**Homogenization of the sample**

**Proper immersion of the probe**

**In case of liquid samples, the presence of air bubbles will interfere in the results**

## Disadvantages of NIR

- ▶ **Low sensitivity** (substances with concentration below 0.1%, eg. mycotoxins)
- ▶ Requires accurate **reference samples**
- ▶ Needs high **trained personnel**
- ▶ Needs large **data set for accurate calibration** (which is often difficult to obtain)
- ▶ **Continuous maintenance** of the calibration data set is needed
- ▶ Difficult to **transfer calibration** between instruments between different manufactures
- ▶ **High initial investment**  
- (continuous usage avoids wet chemistry usage)

## Disadvantages of NIR

- ▶ NIRS is a method that is **simple, low running cost, quicker analysis, non-destructive analysis, more reliable** on good calibration
- ▶ Slowly but **authentically replaces** wet chemistry analysis
- ▶ Strong calibration with excellent spectra for any given feed ingredient or type of feed is the **order of the day** in the present situation of massive feed handling





## Quality control and assurance in feed manufacturing for animals / poultry

1. Feed Sampling and Processing for Analysis
2. Nutritional Quality Check of Raw Materials and Finished Feeds
3. Feed Toxins, their analysis and interpretation
4. Feed Analysis, current concepts, and developments
5. NEAR INFRA RED SPECTROSCOPY – A Tool For Quick Feed Analysis





*Thank you*