Feed Evaluation

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PENGAWASAN MUTU PAKAN

KEGIATAN	⟷	INFRA STRUKTUR

-Pengadaan Bahan

-Pencampuran

-Penyimpanan

-Pengangkutan

-UU dan PP

-Pengawas/Inspektur

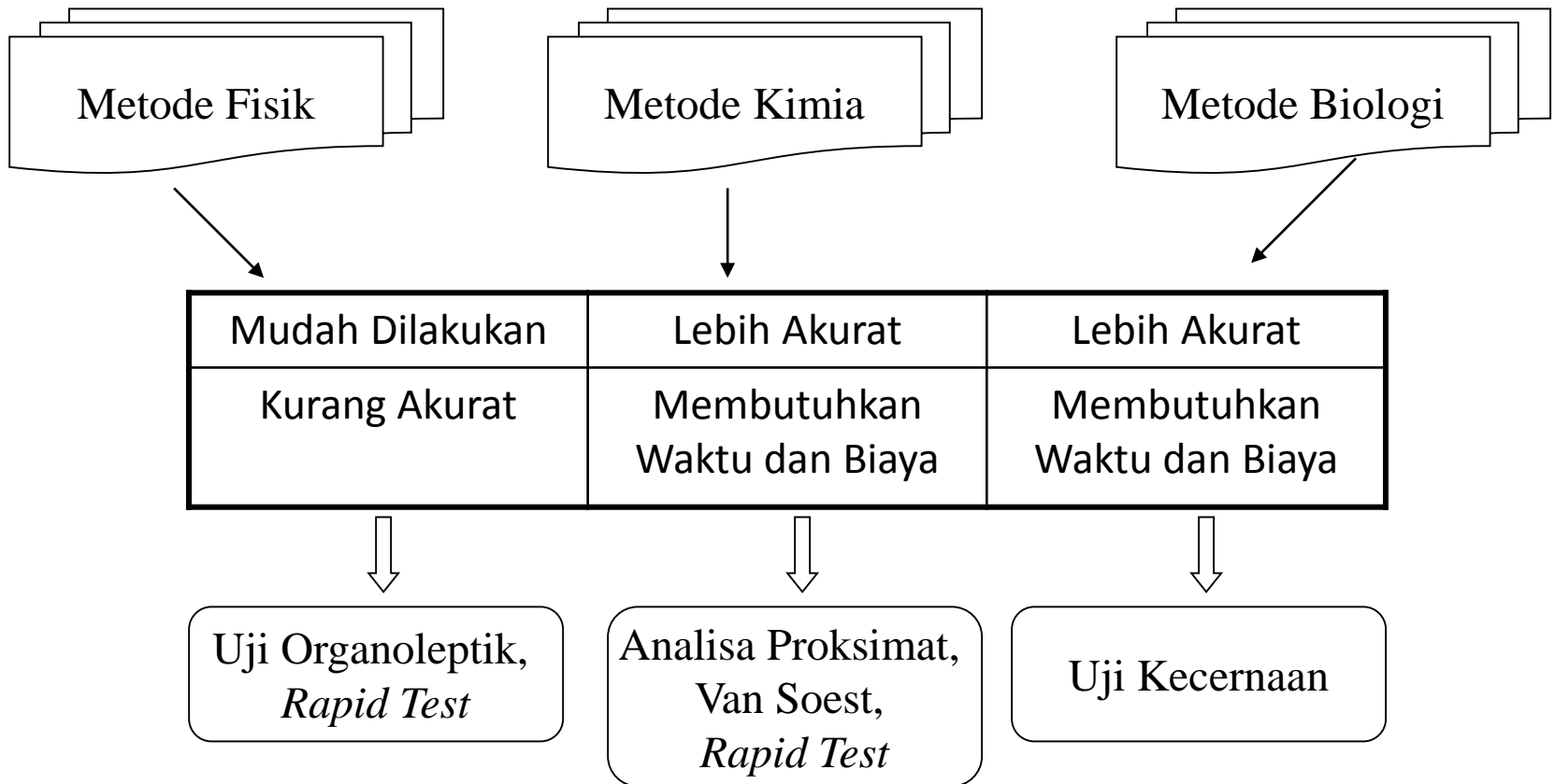-Laboratorium Analisa
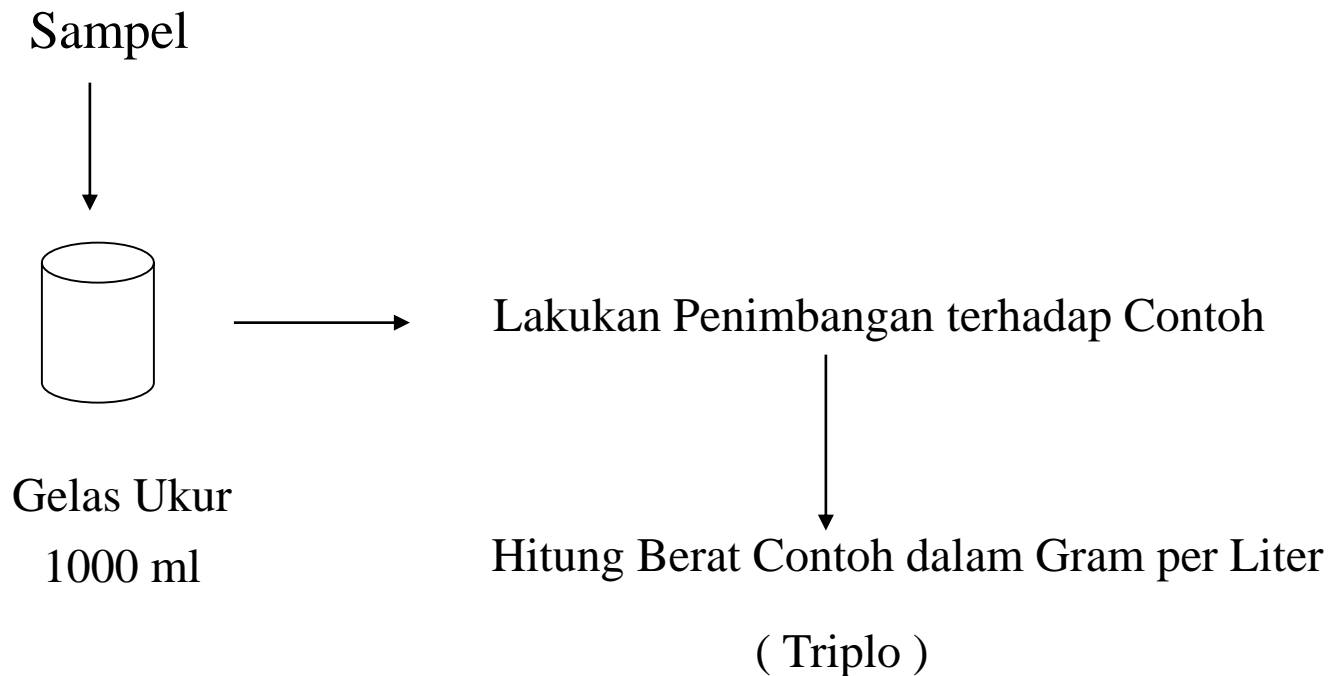
STANDAR MUTU
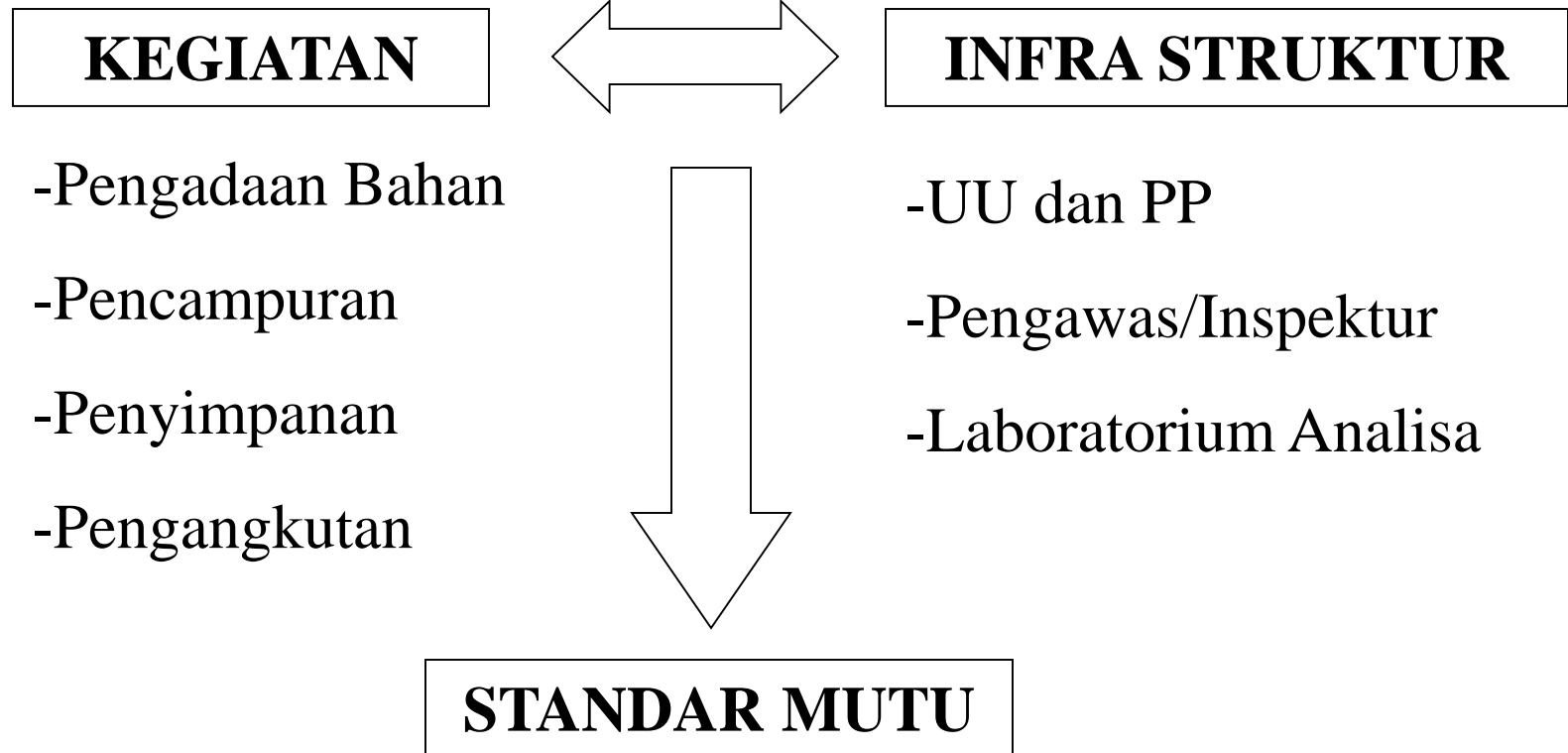
Feed evaluation

A. **Physical methods** --> bulk density, sensory (organoleptic) analysis

B. **Chemical methods** --> proxymate analysis, Van Soest's analysis, energy

C. **Biological methods** --> *in vitro* fermentation systems, *in vivo* feeding trials

Metode Fisik	Metode Kimia	Metode Biologi
Mudah Dilakukan	Lebih Akurat	Lebih Akurat
Kurang Akurat	Membutuhkan Waktu dan Biaya	Membutuhkan Waktu dan Biaya

Uji Organoleptik, *Rapid Test*

Analisa Proksimat, Van Soest, *Rapid Test*

Uji Kecernaan

A. Physical methods

Bulk Density

Sampel

Gelas Ukur
1000 ml

Lakukan Penimbangan terhadap Contoh

Hitung Berat Contoh dalam Gram per Liter

(Triplo)

UJI ORGANOLEPTIK/SENSORI

UJI ORGANOLEPTIK

Tangan, Mata, Hidung, Lidah

Tekstur

Warna

Bau

Rasa
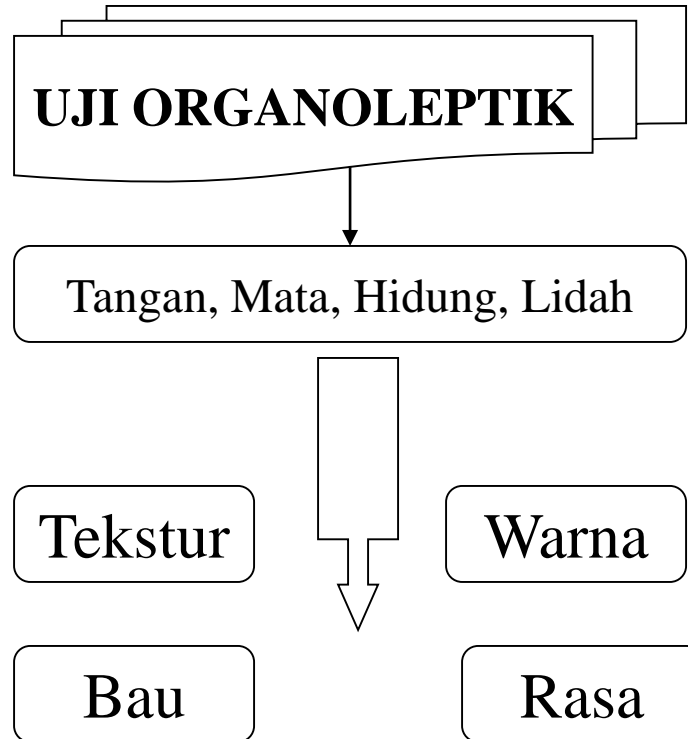
B. Chemical methods

Nutritive Value of Feed

Fraction	Nutritional Availability	
	Monogastric	**Ruminant**
Sugars, Starch	Complete	Complete
Protein	High	High
Lipids	High	High
Pectin	High	Complete
Hemicellulose	Low	Partial
Cellulose	Low	Partial
Lignin / Cutin	Indigestible	Indigestible

(adapted from Van Soest, 1966 and 1967)

Crude Nutrients

Proximate (Weende) system of analysis, Henneberg & Stohmann 1862

Feedstuff (FS) → Drying (4h, 103°C) → **Water content**

Drying → **Substrate** (DM)

Kjeldahl

Substrate (DM):
- Acid hydrolysis NH_3 distillation → **Crude protein** (XP)   CP=N x 6.25
- Ether extraction → **Crude lipid** (XL)
- Hot acid and base → **Crude fibre** (XF)
- 500°C → **Crude ash** (XA)   OM=DM-XA

(estimated by mass difference)   **Nitrogen free extract** (NFE, XX)
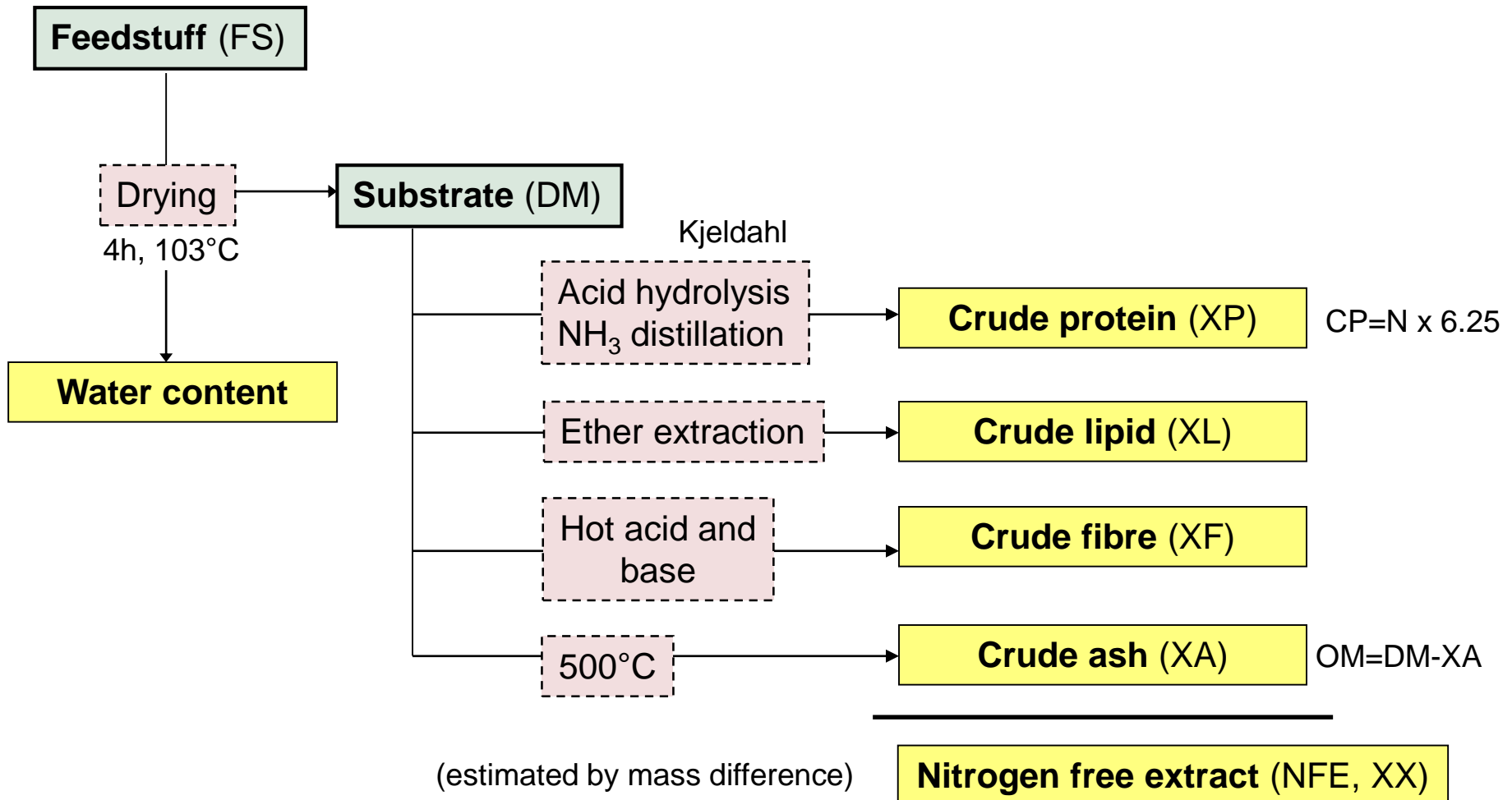
Crude protein (XP)	protein, amino acids, ammonium compound, amides od acides, nitrogenous glycosides, B vitamins
Crude lipid (XL)	fats, oils, waxes, organic acids, pigments, sterols, vitamins A, D, E, K
Crude fibre (XF)	cellulose, hemicellulose, lignin
Crude ash (XA)	macro- and microminerals
Nitrogen free extract (NFE, XX)	starch, sugars, fructosans, hemicellulose, pectin, organic acids, resins, tannins, pigments, water soluble vitamins

Cell Wall Components: Detergent Fibre System

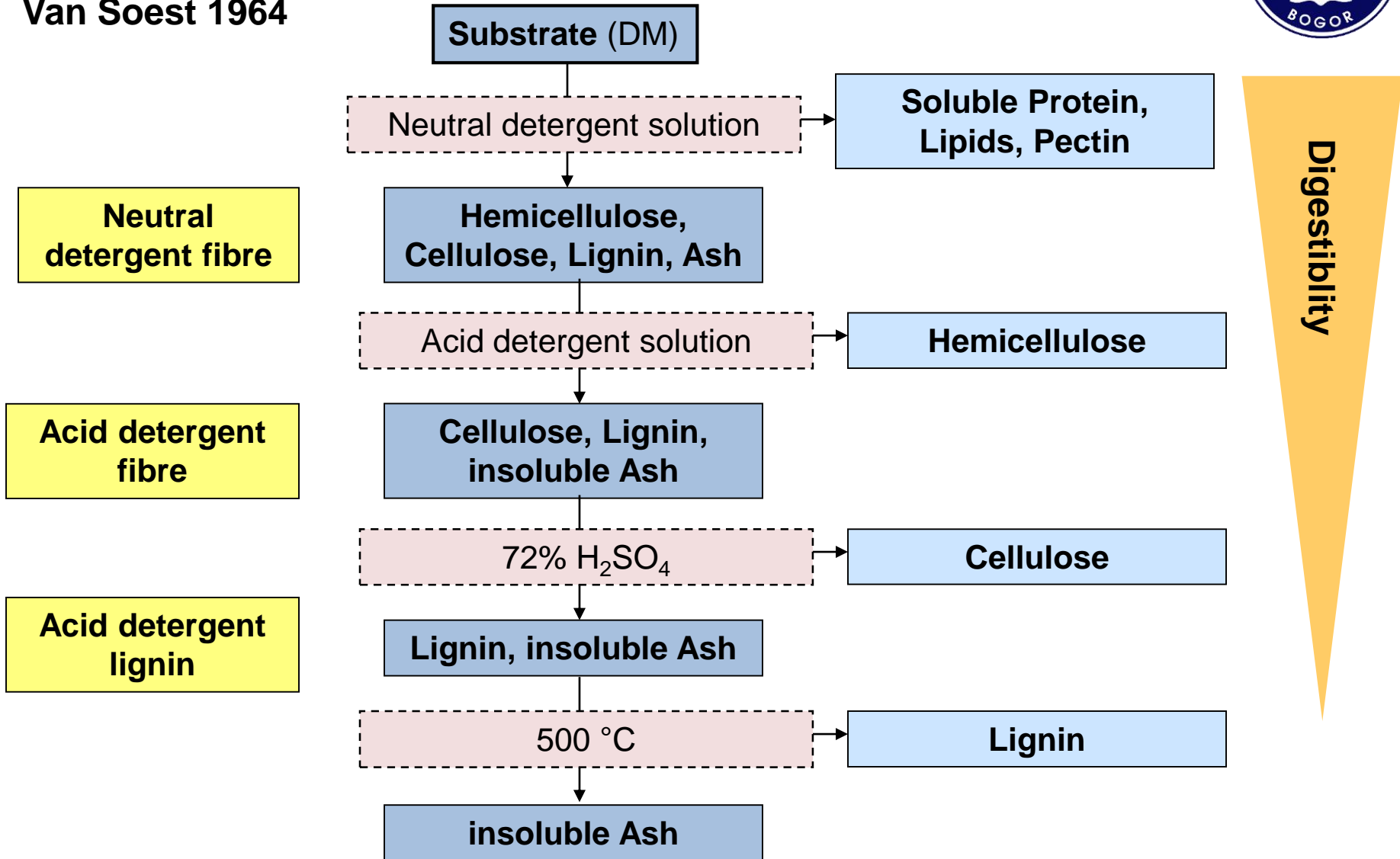| Cellulose	β-1,4-glucan, cellobiose + residues, forms microfibrils by intra-molecular and inter-molecular H-bonds, mechanical strength, highly crystalline or „amorphous" regions
Hemicellulose	(„*Cross-linking glycans*"), diverse group of carbohydrates, common xyloglucans and glucuronarabinoxylans, soluble in strong alkali, β-1,4 backbone + short side chains, form H-bonds with cellulose
Pectin	(pectic polysaccharides), easiest to remove from wall (hot water, dilute acid), form gels, function: determining wall porosity, providing charged wall surface for cell-cell adhesion, cell-cell recognition, pathogen recognition etc.
Protein	glycoproteins (polypeptide backbone + carbohydrate side chains), cross-linked to pectic substances, may have sites for lignification, extraction requires destructive conditions, function: structural role, cell signalling (growth and guidance of pollen tube)
Lignin	Lignin: Polymer of phenolics, esp. phenylpropanoids, strengthening agent, resists fungal/pathogen attack
Lipids	Suberin, wax, cutin: variety of associated lipids for strength and waterproofing

Van Soest 1964

Substrate (DM)

Neutral detergent solution → Soluble Protein, Lipids, Pectin

Neutral detergent fibre

Hemicellulose, Cellulose, Lignin, Ash

Acid detergent solution → **Hemicellulose**

Acid detergent fibre

Cellulose, Lignin, insoluble Ash

72% H_2SO_4 → **Cellulose**

Acid detergent lignin

Lignin, insoluble Ash

500 °C → **Lignin**

insoluble Ash

Digestiblity

Comparison of Detergent & Proximate System

Detergent system		Nitrogenous	Non-nitrogenous	Proximate system
		NPN compounds, proteins		CP
ND soluble (cell contents)			lipids, ether soluble substances	CL
			water soluble substances, pectins, starch	
ND insoluble (cell wall) (NDF)	AD soluble	insoluble proteins	hemicellulose	NFE
	AD insoluble (ADF)	H$_2$SO$_4$ soluble lignified proteins	alkali soluble lignin	
			cellulose	
		H$_2$SO$_4$ insoluble	insoluble lignin (ADL)	CF

Other Methods to Determine Plant Contents

Starch/
Cell wall
Enzymatic: Degradation and quantification of glucose/sugar monomers (degradability of different sources, solubilisation)

Refractometer: Estimation of the concentration of a starch solution by its refraction index (solubility, co-extractions)

Protein
Colorimetric assays: (Bradford, Neuhoff) reaction of protein with dyes relative to standard (different staining, extractability)

Amino acid composition: Hydrolysis and quantification of AA by mass spectrometry (expensive, time consuming)

Lipids
Chromatography: Extraction and quantification by HPLC (extractability, oxidation, quantification)

Estimating the Feeding Value from Substrate Composition

Monogastric animals:

- Limited amount of enzymes involved in digestion (Pepsin, Trypsin, Amylase and Lipases)
- Enzymes are known and well characterised

Ruminants:

- Primary degradation of the substrate in the rumen by microbial fermentation
- Nutrient composition reaching the lower gastrointestinal tract is different from the feed nutrient composition
- Detoxification processes
- Estimation of the feeding value by substrate composition is limited due to lack of methods to predict transformations by the rumen fermentation
- Often cooperation of enzymes and enzyme complexes needed, many still unknown or poorly characterized

Energy: Maintenance and Production

Growth MJ/kg		**Lactation** MJ/kg		**Reproduction** MJ/kg	
Cattle	34	Cattle	5.3	Cattle	25
Calf	15	Calf	--	Calf	--
Pigs	26	Pigs	7.3	Pigs	15

Maintenance MJ/ $kg^{0.75}$

Cattle	0.48
Calf	0.52
Pigs	0.44

- **Fasting metabolism**
- **Maintenance requirements**

Energy Content of the Main Nutrients

Source	Energy content (MJ/kg)	
	gross	physiological
Polysaccharides (starch)	17.6	17.6
Fat (triglycerides)	39.8	39.8
Protein	23.9	18.4

Determination of energy requirements

Gross energy

Digestible energy

Metabolisable energy

Heat loss due to energy conversion

Basal metabolic rate

Protein gain

Fat deposit

Milk energy (protein, fat)

Energy in foetus, placenta...

Urine and Gas energy

Faecal energy
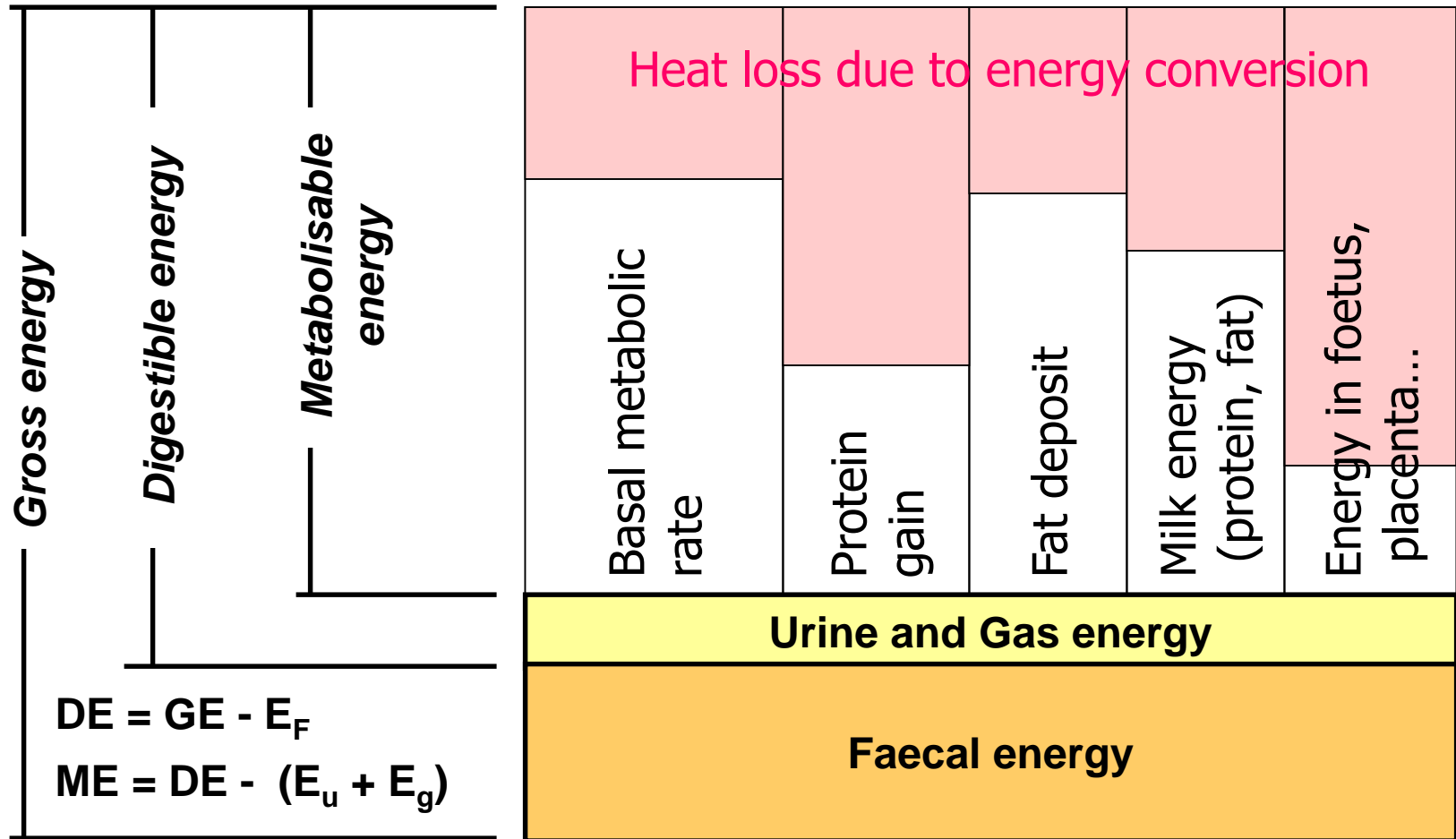
DE = GE - E_F

ME = DE - (E_u + E_g)

$$IME = ME_m * W^{0.75} + ME_{pf} * \Delta W + ME_c * \Delta Wc + ME_l * L\ (+ ME_o * n_o)$$

Factors influencing Energy Value of Feed

- **Feed composition:** digestibility closely related to chemical composition, degree of digestibility dependent upon crude fibre content and extent of structural/non-structural carbohydrates; variation due to source, e.g. barley little changes in digestibility, roughages variable

- **Ration composition:** „associative effect", apparent digestibility of mixture not neccessarily weighted sum of apparent digestibilities of ingredients, ANF, balance of nutrients

- **Feed preparation:** processing (crushing, chopping, cooking,...)

- **Animal factors:** digestive tract, ruminants/ non-ruminants

- **Feeding level:** increase causes faster passage rate through intestinal tract, shorter period of exposition to digestive enzymes

Next:

C. Biological methods (*in vitro* and *in vivo* techniques)

Thank you for your attention!

"Tawazun itu optimum"