Anomalies in Feed Analyses NANP Symposium –Mystery of the missing DM/OM

Fred Owens
Emeritus Professor, Okla State Univ
Zach Smith and Becca Grimes Francis
South Dakota State University

Organizing Committee; Fred Owens, Alex Hristov, Mary Beth Hall, Dairy Forage Lab, USDA

Feeds, byproducts, and diets have been assayed for nutrient content for over 130 Years; Evolution:

Weende Assays 1866

Proximate Analysis (Wet Chem)

Henneberg & Strohman in the German town of Weende

Grouped Nutrients by Chem compo:

Ash (500C)

Crude Protein (N x 6.25)

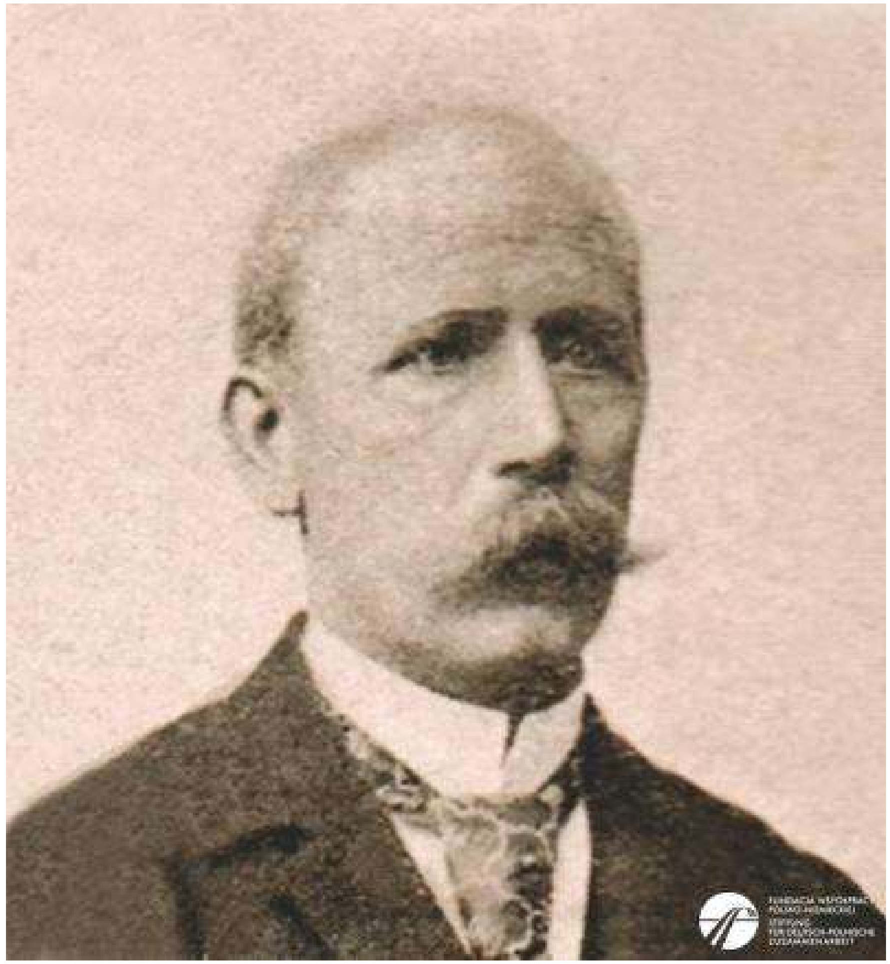
Crude fat (Ether extract)

Crude fiber (1.35% KOH & 1.25% HCl)??

NFE-Nitrogen Free Extract);Calculated: Added later

Calculated by difference

Wilhelm Henneberg



10 September 1825 – 22 November 1890

Feed Assay Process

1.Wet feed sample (Wt)

Oven Dried <70C; Freeze dried, microwave? → H2O, VFA, charring?

2.Dry feed sample (Wt) *For sub-sampling*

Grinder → fines, airborne dust, residual water?

Any weight added from hydrolysis of starch, protein?

3.Ground sample (Wt) Wiley, Udy. Sharpness? Heat?

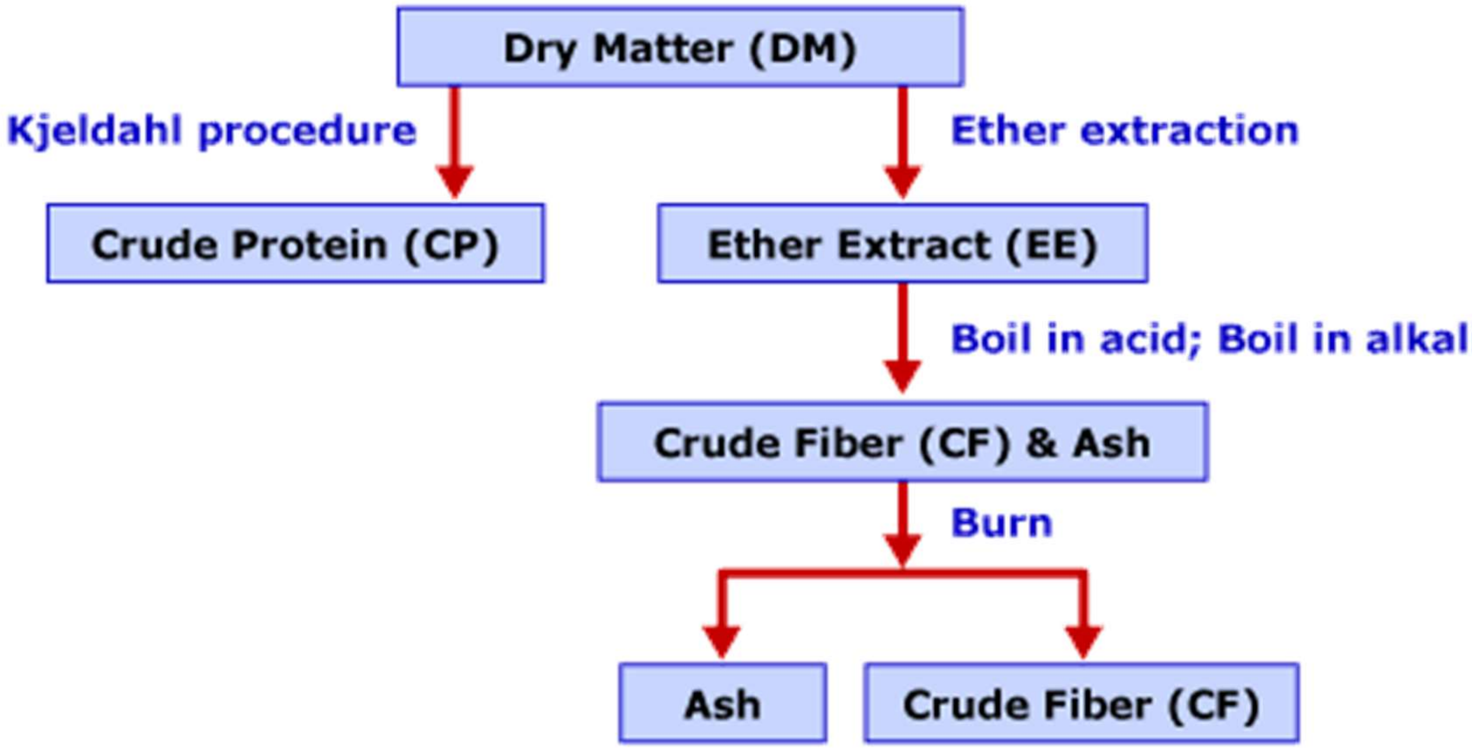
1mm, 6 mm grind or finer for NIR, NIT?

Assays, Ash, N, NDF, WSC of dried, ground sample.

Is % as a Fraction of <u>dry</u> or ground (hydrated) sample wt?

Could NIR assay for water & avoid need to dry samples?

Proximate Analysis



Proximate Principles

Fraction	Analysis	Main Contributary components
Moisture (M)	Oven-dry to constant weight at 100-105°C	Water (and volatile acids and bases)
Ash	Ignite in muffle oven at 450-550°C to remove organic compounds	Inorganic salts (minerals) (some suplhur and phosphorus from proteins and other organic compounds)
Crude protein (CP)	Kjeldahl digestion in sulphuric acid followed by distillation and NH_3 determination ($CP = N \times 6.25$)	Proteins, amino acids, amines, nucleic acids, nitrogenous glycosides, glycolipids, B-vitamins
Ether extract (EE)	Reflux extraction with petroleum ether (di-ethyl ether) (alternatively dichloromethane or hexane), sometimes following hydrolysis in strong acid	Fats, oils, waxes, sterols, lipid-soluble vitamins, organic acids, pigments (fatty acids present in polar lipids)
Crude fiber (CF)	Treatment of EE residue with boiling acid and boiling alkali	Cellulose, hemicellulose, lignin
Nitrogen-free extractives (NFE)	Estimated by difference $NFE = 100 – (M + Ash + CP + EE + CF)$	Starch, sugars, pectins, fructans, (some CF, water-soluble vitamins, resins, organic acids)

Limitations of Proximate Analysis

Components	Supposed to contain	Contains	Missing	Excess
Water	Water	Volatile fatty acids Decomposed sugars	None	Volatile Fatty Acids, Decomposed sugars
CF	Fibrous matter	Cellulose Parts of lignin	Hemicellulose Part of lignin Acid Insoluble Ash	None
NFE	Soluble carbohydrates	Soluble CHO Hemicellulose Part of lignin Acid insoluble ash	None	Hemicellulose, Lignin, Acid Insoluble Ash
Ether Extract	Crude fat (Fats, oils, Fatty acids)	Free Fats, oils, Fatty acids, Chlorophyll, sterols, Anthocyanin, Carotenoids, Resins, Volatile oils, Lecithin Cholesterol, Alkali substances	Protein bound lipids, Fatty Acids formed soaps	Chlorophyll, Sterol, Anthocyanin, Carotenoids, Volatile Oils Resins Lecithin Cholesterol, Alkali Substances

Armidale feed analysis

Weende Method	Nitrogen-Free Extract					Crude Fibre	NFE CF	Ash	Ether Ext.		Crude Protein	
Common Nomenclature	Carbohydrates											
			Polysaccharides									
				Non-starch Polysaccharides								
				True Fibre								
					Neutral Detergent Fibre							
						ADF (Wood)						
Armidale Method	**Sugars**	**Oligosac-charides**	**Starch**	**Pectin**	**Hemi-cellulose**	**Cellulose**	**Lignin**	**Ash**	**Neutral Lipids**	**Polar Lipids**	**True Protein**	**NPNC**
Sugar Units	1-2	3-12	>12		>12	>12	>12					
GE (kcal/g)	4.00	16.74	17.57	15.56	16.74	16.74	25.50	0.00	39.75	31.00	23.85	24.59
Potential Digestibility	1.00	0.90	1.00	0.70	0.50	0.10	0.00	0.00	1.00	1.00	1.00	1.00
Potential ME (MJ/g)	16.74	16.74	17.57	10.90	8.37	1.67	0.00	0.00	39.75	31.00	23.85	24.59
NE (based on ATP)	10.56	10.60	11.73	8.21	8.21	11.73	8.21	0.00	25.31	20.36	11.35	6.33

NPNC = Non-Protein Nitrogenous Compounds, the difference between Crude Protein and True Protein (~12%, TP = 0.88 x CP)

Pesti et al. (2024)

Armidale feed analysis

Recent Advances in Animal Nutrition:

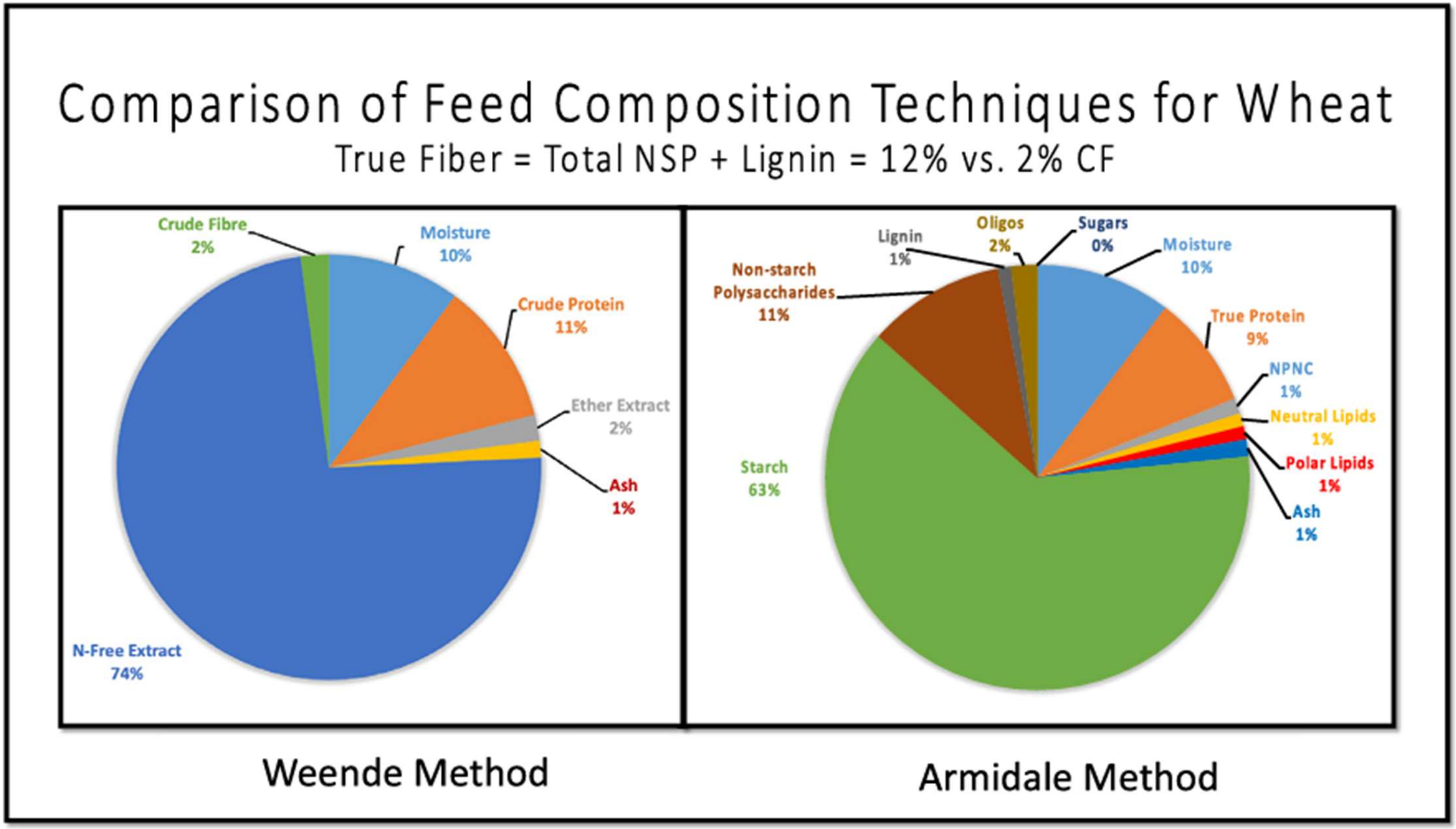
CSIRO
PUBLISHING

COLLECTION | ANIMAL SCIENCE REFLECTIONS
https://doi.org/10.1071/AN24176
ANIMAL PRODUCTION SCIENCE

A new analytical procedure to replace the outdated Weende proximal feed ingredient analysis paradigm is long overdue

Gene M. Pesti[A,*]

Armidale feed analysis



Pesti et al. (2024)

Limitations - Moisture

- Formation of artifact lignin if dried > 55°C (e.g. 170°C for 7 hr)
  - Loss of more volatile acids, alcohols
- **Solutions**
  - Lower the drying temperature
    - 50°C until weight is stable vs 170°C for 7 hr
  - NIT, NIR substitution for oven drying
  - Freeze drying
  - Add base to convert volatile acids to stable salts
  - Direct moisture measurement via Toluene distillations; Fischer titration
  - Check for energy losses by bomb calorimetry with added primers

Limitations - Ash

- Loss of organic matter at 550°C; not 600°C?
- No measurement of individual minerals, cations
- Some ash comes from NDF
- Volatile loss of some minerals, conversion of sulfides, chlorides to oxides
- Still some carbonates remain at 550°C
- **Solutions**
  - ACP for individual minerals

Merits

- It forms the basis for
  - Description of feed composition tables
  - Purchasing feeds
  - Ration formulation
  - Various equations for energy estimations
- It is the starting point for specific analysis
- Provides 1^{st} hand information about the potentiality of the feed to fulfill the required nutrient.

Merits Contd.

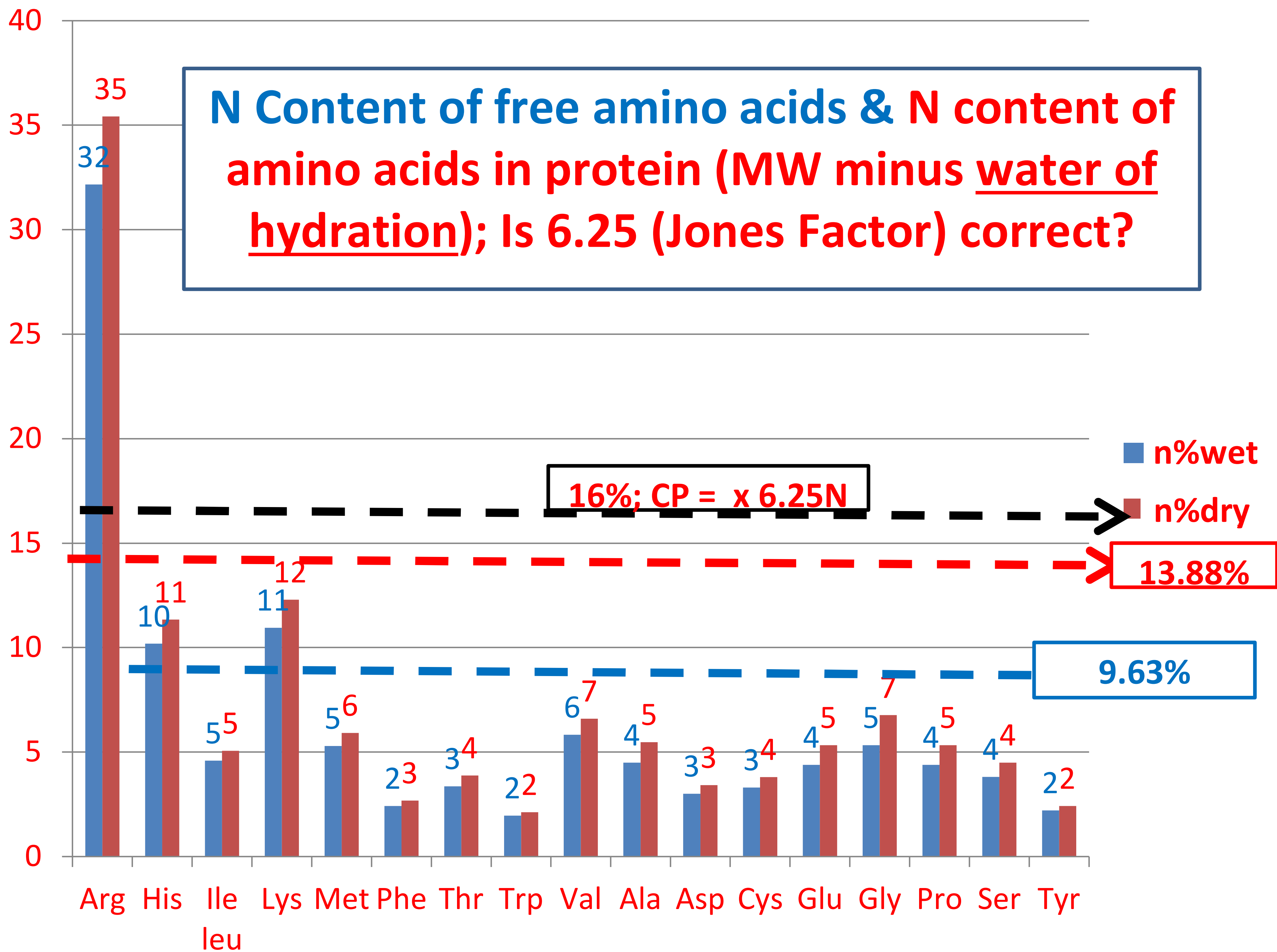
- Used for analysis of feeds, feces, urine, and body fluids
- No substitute till today except for fiber component
- Referred by Nutritionist, Chemist, Physiologists, Bacteriologists, dietitians, food processers, etc.
- Handy to handle
- The process is simple and economic.

Johan Gustav Christoffer Thorsager Kjeldahl

16 August 1849 – 18 July 1900

Limitations – Crude Protein

- Classify NPNs (nucleic acids, ammonia, N in NDF as protein.
- Inaccuracy of Jones (6.25 × N) factor for many proteins
- **Solutions**
  - Provide amino acid compositions for non-ruminants
    - Rumen amino acid escape, digestion site data based on in situ studies & data.


N Content of free amino acids & N content of amino acids in protein (MW minus water of hydration); Is 6.25 (Jones Factor) correct?
16%; CP = x 6.25N
13.88%
9.63%
n%wet
n%dry
0
5
10
15
20
25
30
35
40
32
35
10
11
5
5
11
12
5
6
2
3
3
4
2
2
6
7
4
5
3
3
3
4
4
5
5
7
4
5
4
4
2
2
Arg
His
Ile leu
Lys
Met
Phe
Thr
Trp
Val
Ala
Asp
Cys
Glu
Gly
Pro
Ser
Tyr

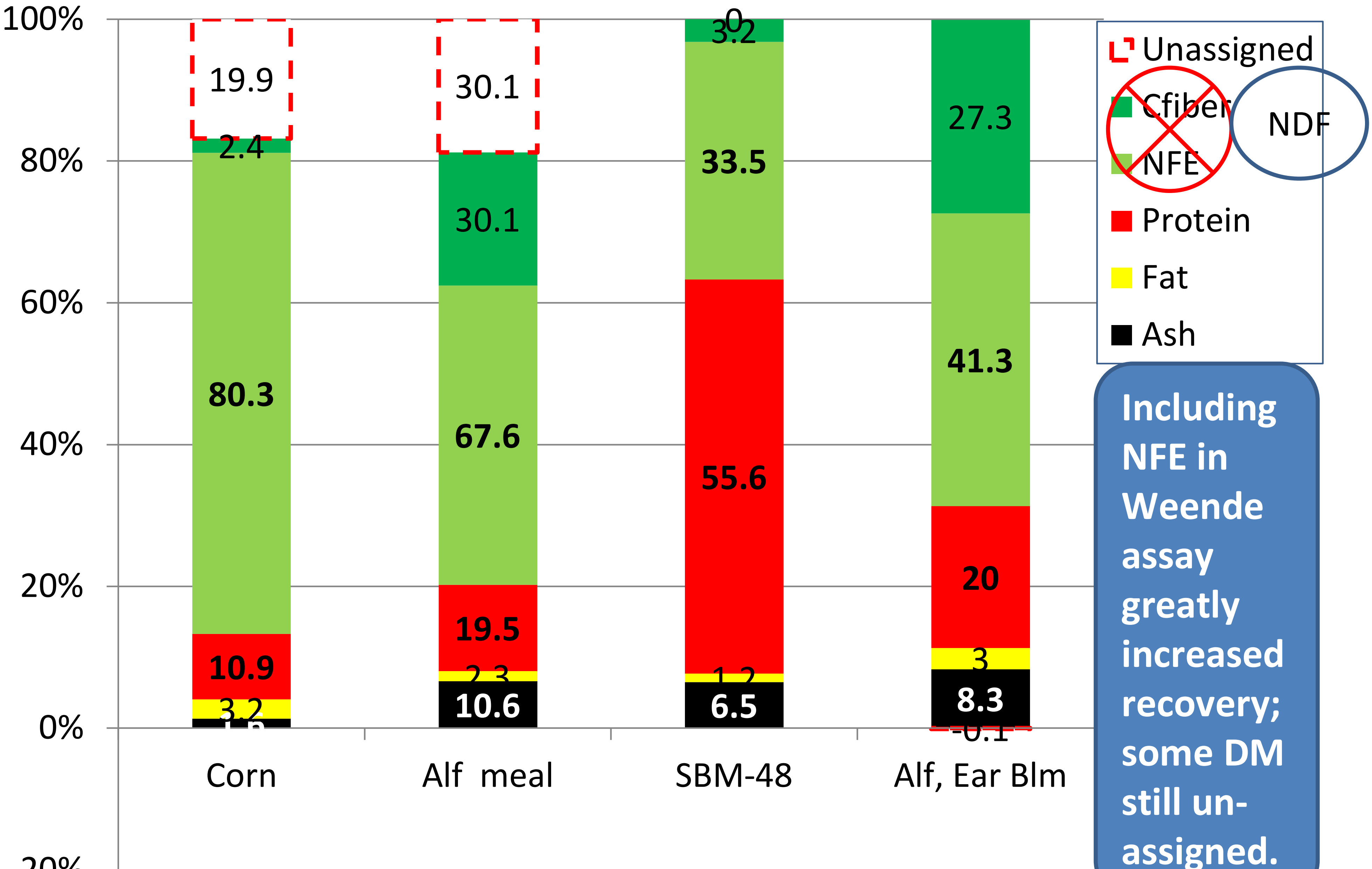
Calculating N:True Protein of feeds

As amino acids differ in N content, mixtures of amino acids in the protein of various feeds will differ in N content.

Feed	AA g/100 g DM (CP)	Sum N in AA	gN/100 gAA
Corn grain	8.79(8.8%)	6.33 g	17.4 g
Sorghum grain	10.6(11.6%)	11.64	18.0
Soybean meal	45.8(48.9%)	48.85	17.8
Casein	92.8(92.8%)	102.7	17.4
Meat meal	54.2(59.2%)	59.2	16.0

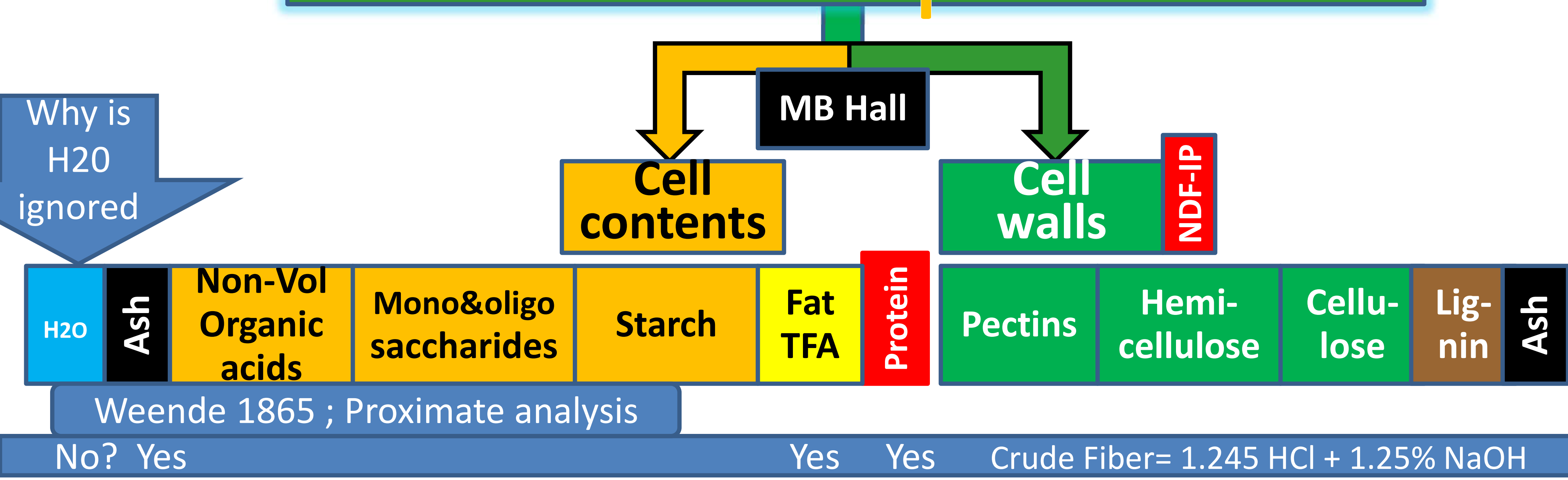
Protein content appears generally overestimated based on 16% N in protein, probably due to the presence of non-protein N in feeds from nucleic acids, amino sugars, NDF-N and ADF-N.

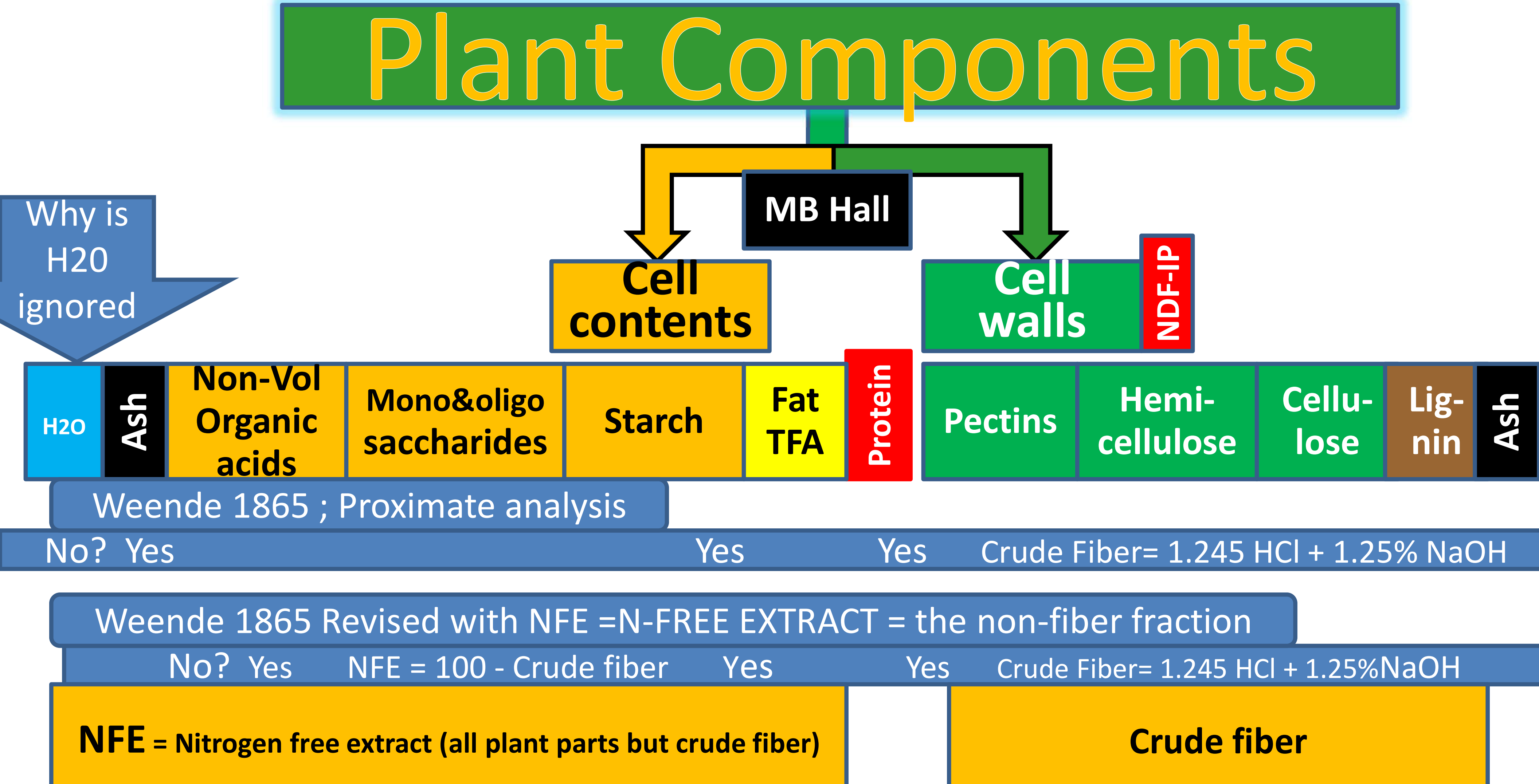
NRC Atlas 1971 Weende Analyses



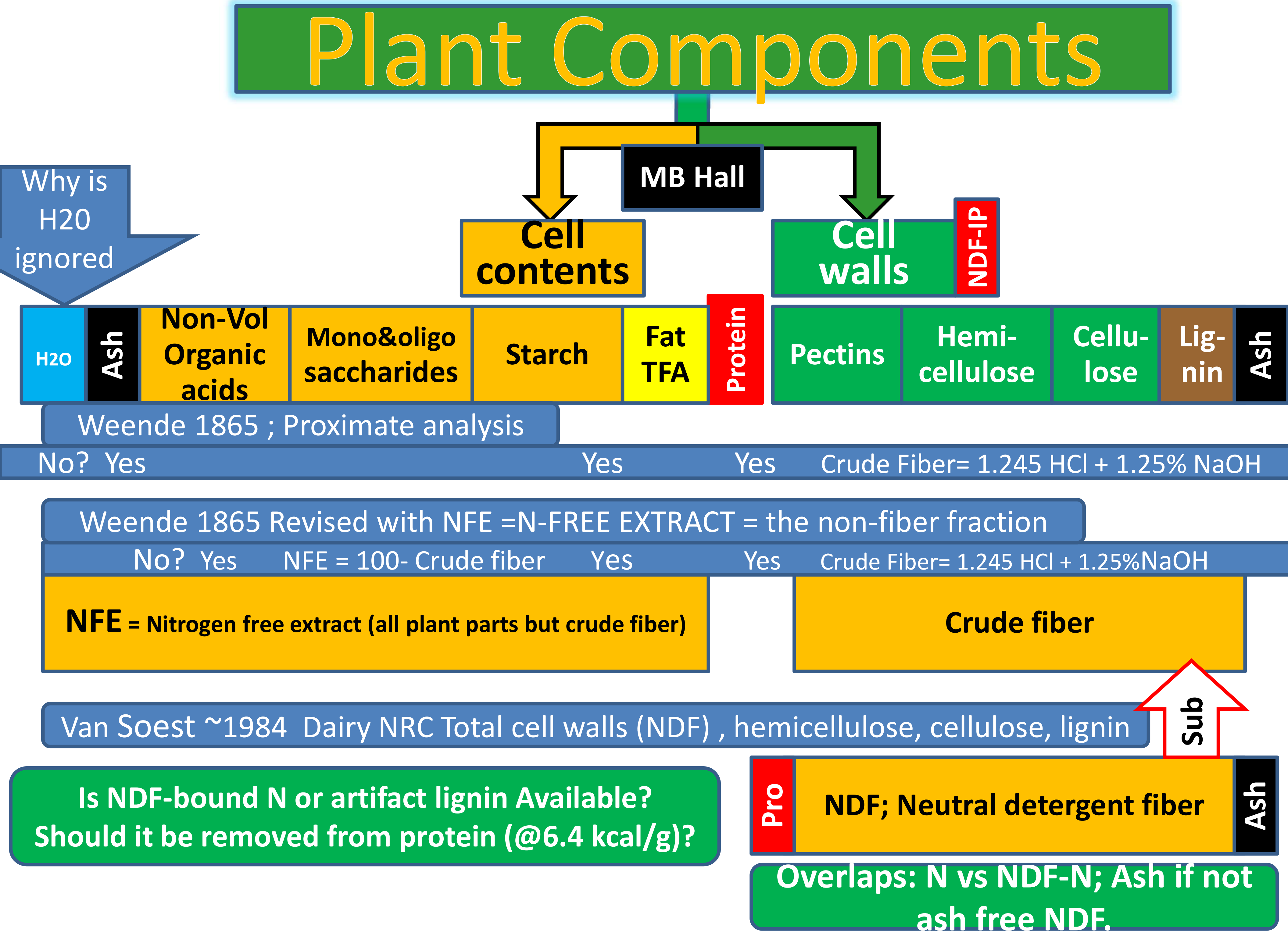
Including NFE in Weende assay greatly increased recovery; some DM still un-assigned.

Plant Components

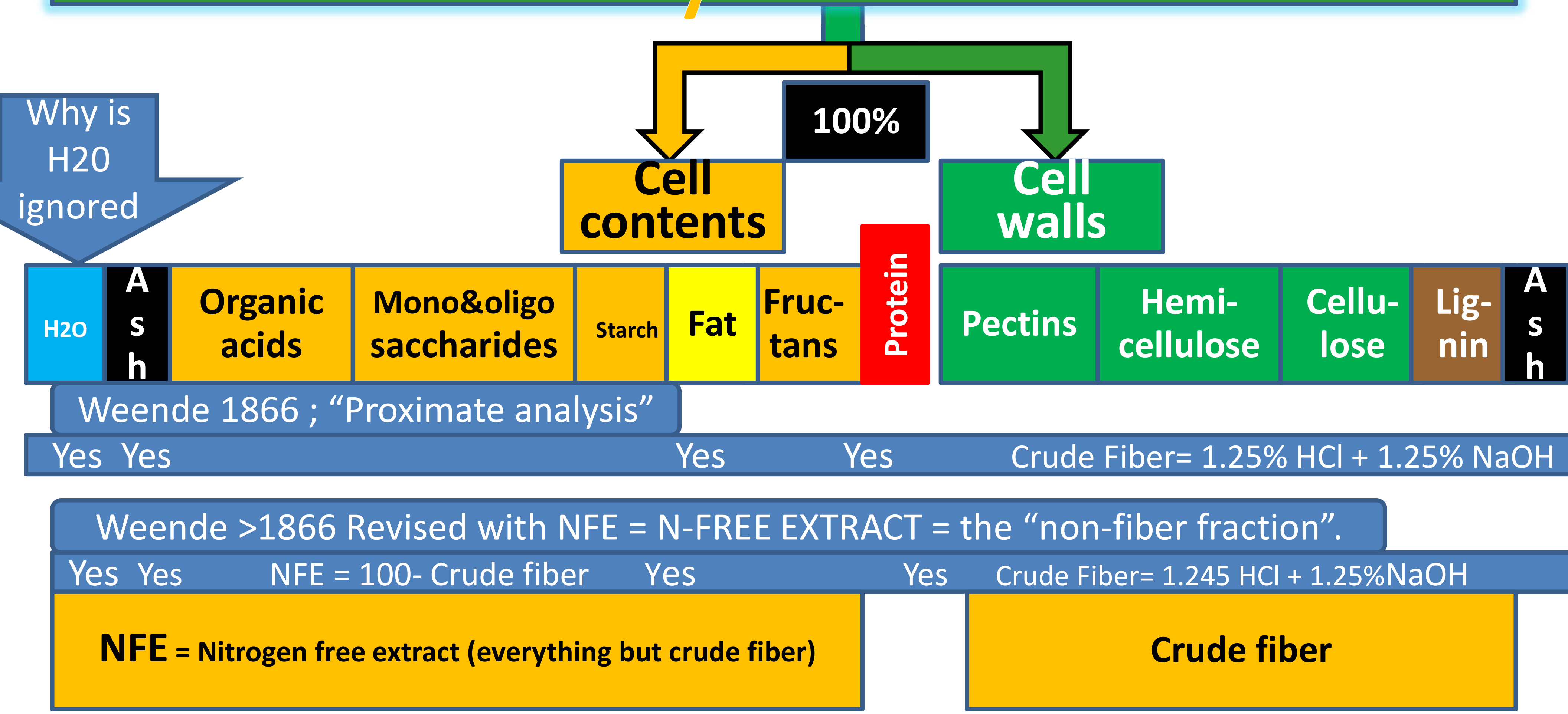




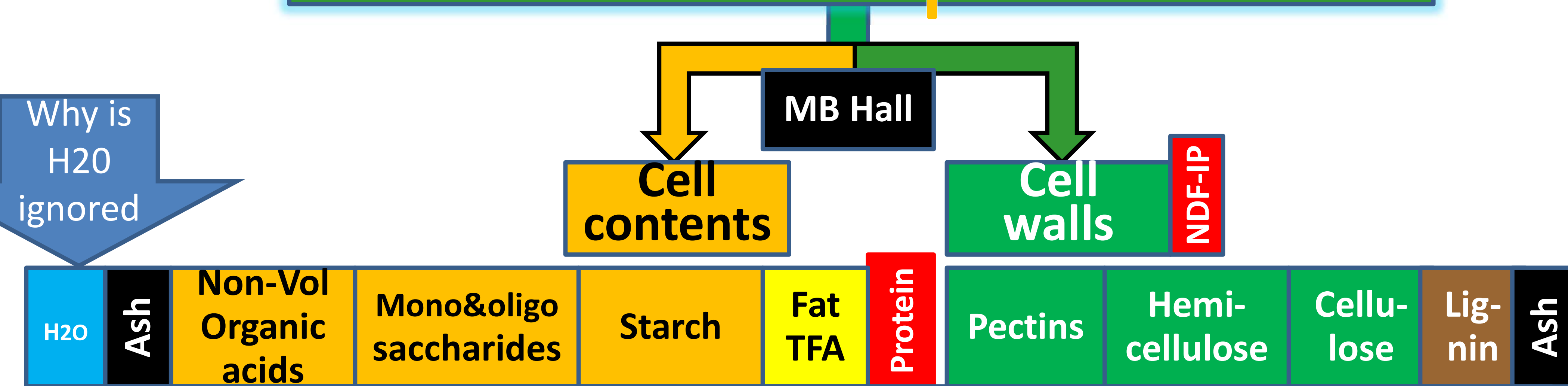
Plant Components
MB Hall
Cell contents
Cell walls
NDF-IP
Why is H20 ignored
H2O
Ash
Non-Vol Organic acids
Mono&oligo saccharides
Starch
Fat TFA
Protein
Pectins
Hemi-cellulose
Cellu-lose
Lig-nin
Ash
Weende 1865 ; Proximate analysis
No? Yes
Yes
Yes
Crude Fiber= 1.245 HCl + 1.25% NaOH
Weende 1865 Revised with NFE =N-FREE EXTRACT = the non-fiber fraction
No? Yes
NFE = 100 - Crude fiber
Yes
Yes
Crude Fiber= 1.245 HCl + 1.25%NaOH
NFE = Nitrogen free extract (all plant parts but crude fiber)
Crude fiber


Plant Components
MB Hall
Cell contents
Cell walls
NDF-IP
Why is H20 ignored
H2O
Ash
Non-Vol Organic acids
Mono&oligo saccharides
Starch
Fat TFA
Protein
Pectins
Hemi-cellulose
Cellu-lose
Lig-nin
Ash
Weende 1865 ; Proximate analysis
No? Yes
Yes
Yes
Crude Fiber= 1.245 HCl + 1.25% NaOH
Weende 1865 Revised with NFE =N-FREE EXTRACT = the non-fiber fraction
No? Yes
NFE = 100- Crude fiber
Yes
Yes
Crude Fiber= 1.245 HCl + 1.25%NaOH
NFE = Nitrogen free extract (all plant parts but crude fiber)
Crude fiber
Van Soest ~1984 Dairy NRC Total cell walls (NDF) , hemicellulose, cellulose, lignin
Sub
Is NDF-bound N or artifact lignin Available?
Should it be removed from protein (@6.4 kcal/g)?
Pro
NDF; Neutral detergent fiber
Ash
Overlaps: N vs NDF-N; Ash if not ash free NDF.

Feed Analysis- Evolution

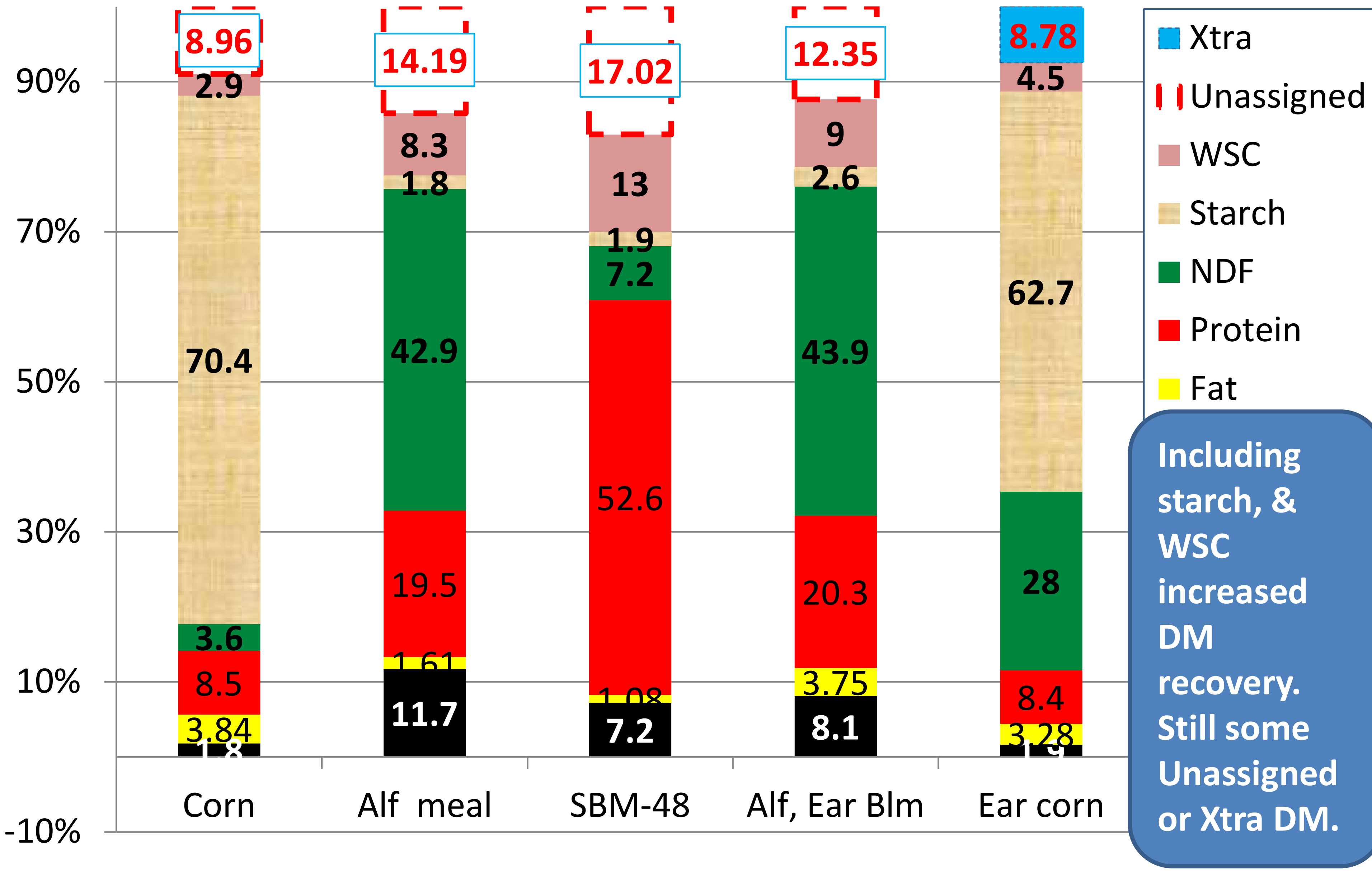


Plant Components



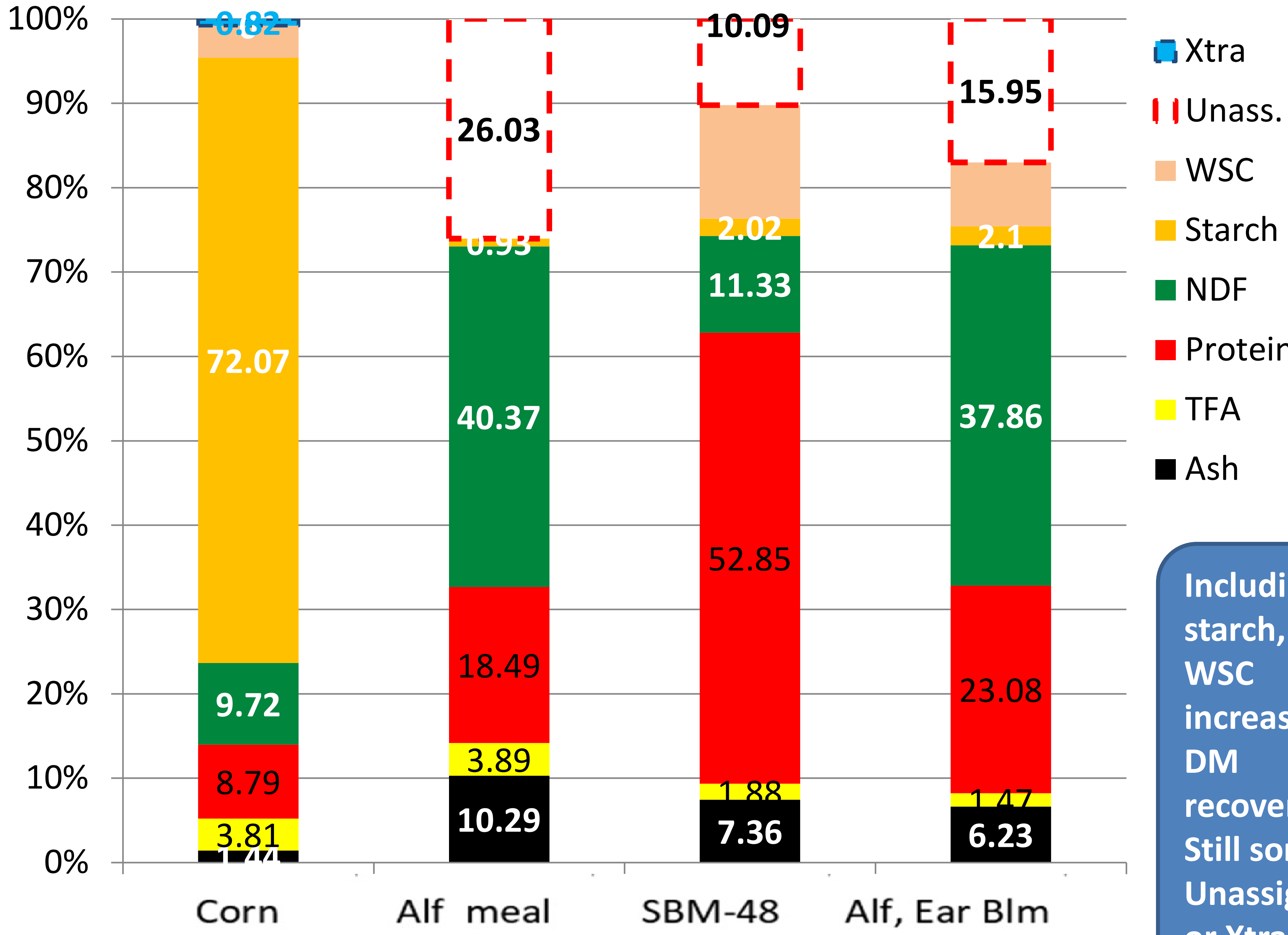
Assumption: Sum of assayed parts should equal 100% or total!
Crude Ash [% of DM] + Crude Fat[% of DM]+ Crude protein [% of DM]+Crude fiber, [% of SM] Should Sum to 100% DM of nutrients - equal 100%?
For most feeds, sum < 100%; Other cases > 100%. Why?
1. Some Components in > 1 category; 2. Assumptions: N x 6.25 = CP; 3. Artifact lignin;
4. Some Unassigned components (unidentified) – NSP Van Soest; ROM Dairy NRC 2021;

NRC Dairy 2021 Proximate Analyses



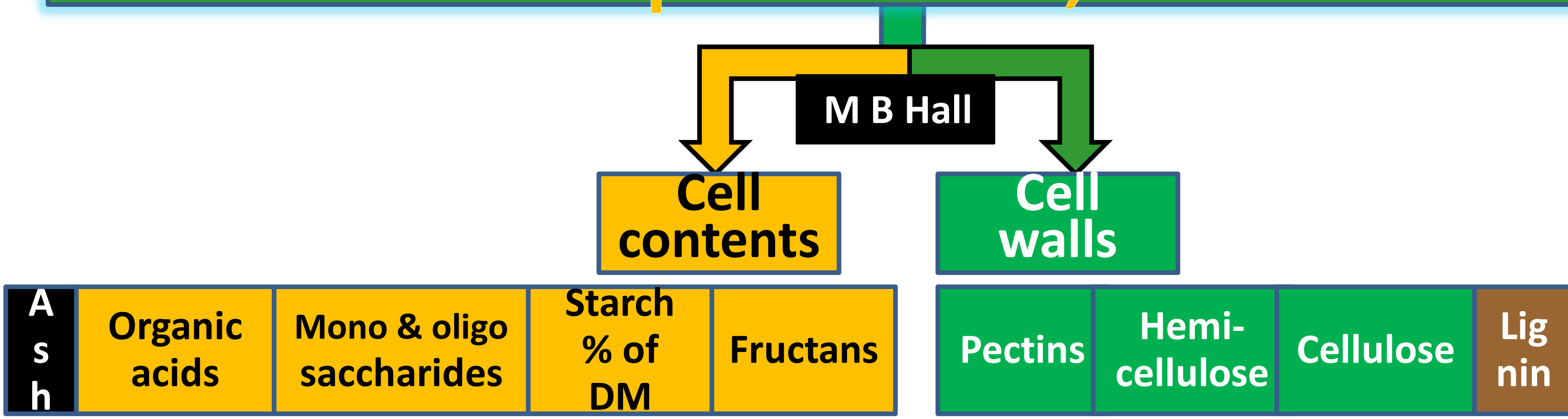
Including starch, & WSC increased DM recovery. Still some Unassigned or Xtra DM.

NRC Beef 2016 Proximate Analyses



Including starch, & WSC increased DM recovery. Still some Unassigned or Xtra.

Plant Components, % of DM



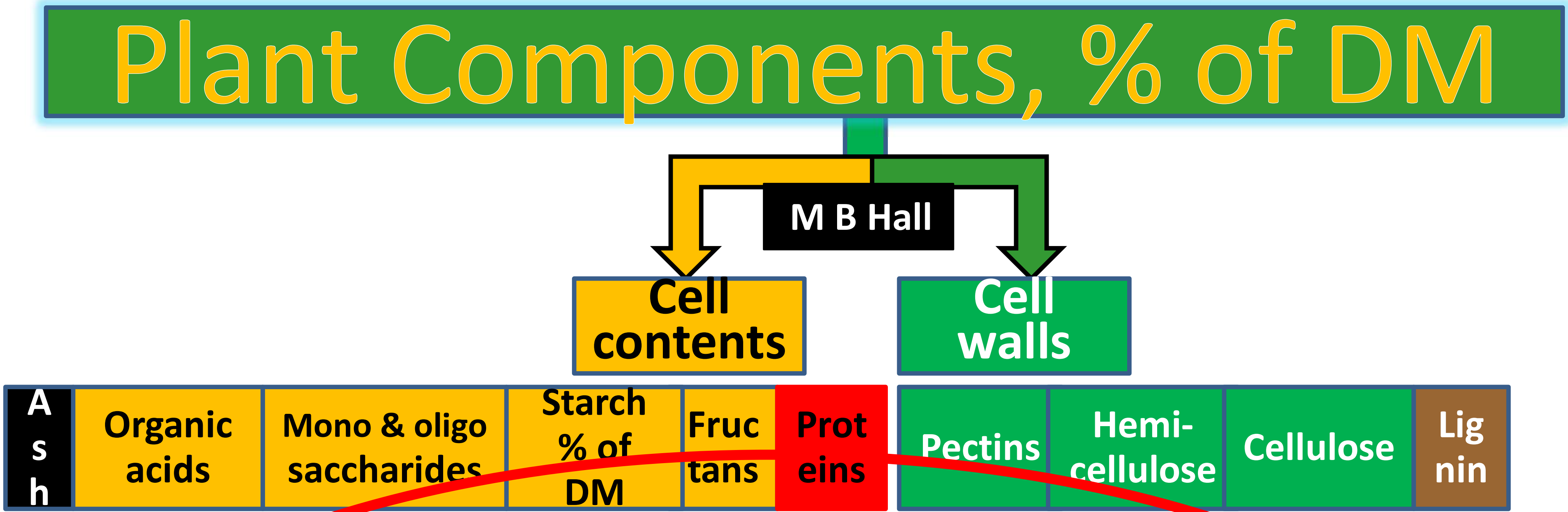
Evolution of Analyses & Data

Weende 1866 Ash, Protein Nx6.25, Crude fiber (1.25% NaOH, 1.25% HCl)

Weende Revised Ash, Proteinx6.25, Crude fiber, NFE (difference from 100%)

Detergent fiber 1989 NRC Dairy

Detergent fiber Revised Ash,Fat, Proteinx6.25(Jones Factor 1931; 50 ref, NPN?), FAT, *NDF, ADF, Lignin, Starch,Sugars (WSC, ESC)*



Sources of Data for Comparisons

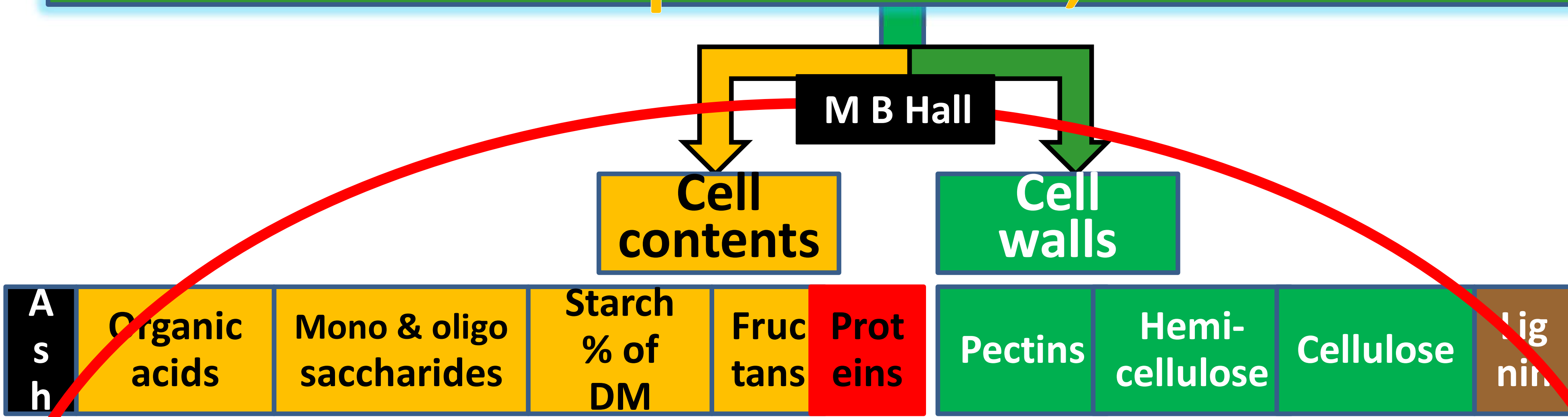
Weende 1866 NRC Atlas of US and Canadian feeds, 1971

Weende Revised Detergent fiber NRC Atlas of US and Canadian feeds, 1971

Detergent fiber NRC Dairy 1984

Detergent fiber Revised NASEM Beef 2016; NASEM Dairy 2021

Plant Components, % of DM



When Expressed as % of DM
The total should equal 100% of DM for a feed. Does it? Overlaps? Missing components?
Is undetected DM missing or Unassigned?

Limitations – Crude Fiber

- Boiling in base solubilizes some lignin
- **Solutions**
  - Fully replace crude fiber assays with detergent fiber procedures (and feed tag info with detergent fiber fractions)

Limitations – Ether Extract

- Does not differentiate polar from neutral lipids for poultry
- Includes waxes, pigment of limited value, includes glycerol
- **Solutions**
  - Added assays of extracted components

Limitations – NFE

- Various soluble carbohydrates differ in value
- **Solutions**
  - Replace with direct assays for pectin, mono- & poly-saccharides by HPLC, NIR?

Why continue sampling & Assaying?

New feeds, cultivars, by-products e.g. BMR, hi lysine; amylases; Low fat Distiller's grains, low oligo soy:

New procedures- NDF vs [Crude fiber + NFE]; NFE vs [starch & soluble CHO];

- **(Plant growth conditions – vary w/Year and location- temperature, moisture, day length,**
- **Handling: Plant age, maturity, Harvest height, new processing methods, storage time, preservatives, inoculants.**

Evolution of Analysis

Year	Source	Feeds	Basis	Analytes
1956	Morrison	927	As Fed	DM, CP, EE, CF, NFE
1989	Dairy NRC	257	DM	DM, CP, EE, NFE
1971	NRC Atlas	6,152	As Fed	DM, CP, EE, Ash, NDF, Starch, Sol. CHO
2016	NRC Beef	168	DM	DM, CP, EE, Ash, NDF, Starch, Sol. CHO
2021	NRC Dairy	180	DM	DM, CP. EE. TriG, Ash, NDF, Starch, Sol. CHO
2025	Pesti	25	DM	DM, CP, N lipid, P Lipid, True CP, NPN, Mono-, Di-, & Oliogosaccharide, Starch, Pectin, Lignin, Hemicellulose, Cellulose

Analytical changes since 1866

NIR vs. wet chemistry; Varies with data origin.

1. **Detergent fiber analysis (Reed & Van Soest) FAO: Nutritive value of crop residues.**

2. Van Soest, Robertson, & Lewis 1991 JDS 74:3583-3507 Advantages of detergent fiber assays versus crude fiber and NFE.

3. Starch

4. Sugars & soluble carbohydrates.

4. 5. Non-fiber polysaccharides, Residual OM

Does the sum of a feed's components (ash, fat, protein, NDF, starch, WSC] all expressed as the [% of feed DM] sum to 100%? If < 100%, something must be missing; if the sum > 100%, some part may be included in more than one nutrient class? (i.e. double-counting N crude protein or N-bound NDF)

Proximate Principle

- Water or moisture
- Crude Protein (CP)
- Ether Extract (EE)
- Crude Fiber (CF)
- Nitrogen Free Extractives (NFE)
- Ash

Plant Components, % of DM

M B Hall

Cell contents

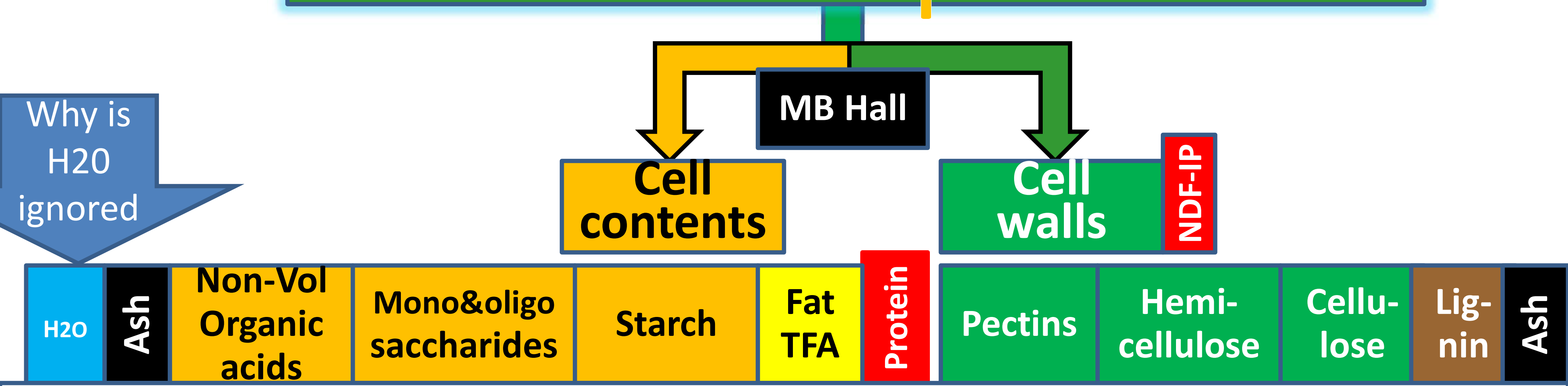
- Ash
- Organic acids
- Mono & oligo saccharides
- Starch % of DM
- Fructans

Cell walls

- Pectins
- Hemi-cellulose
- Cellulose
- Lignin

When Expressed as % of DM
The total should equal 100% of DM of any feed.
Does it?

Plant Components

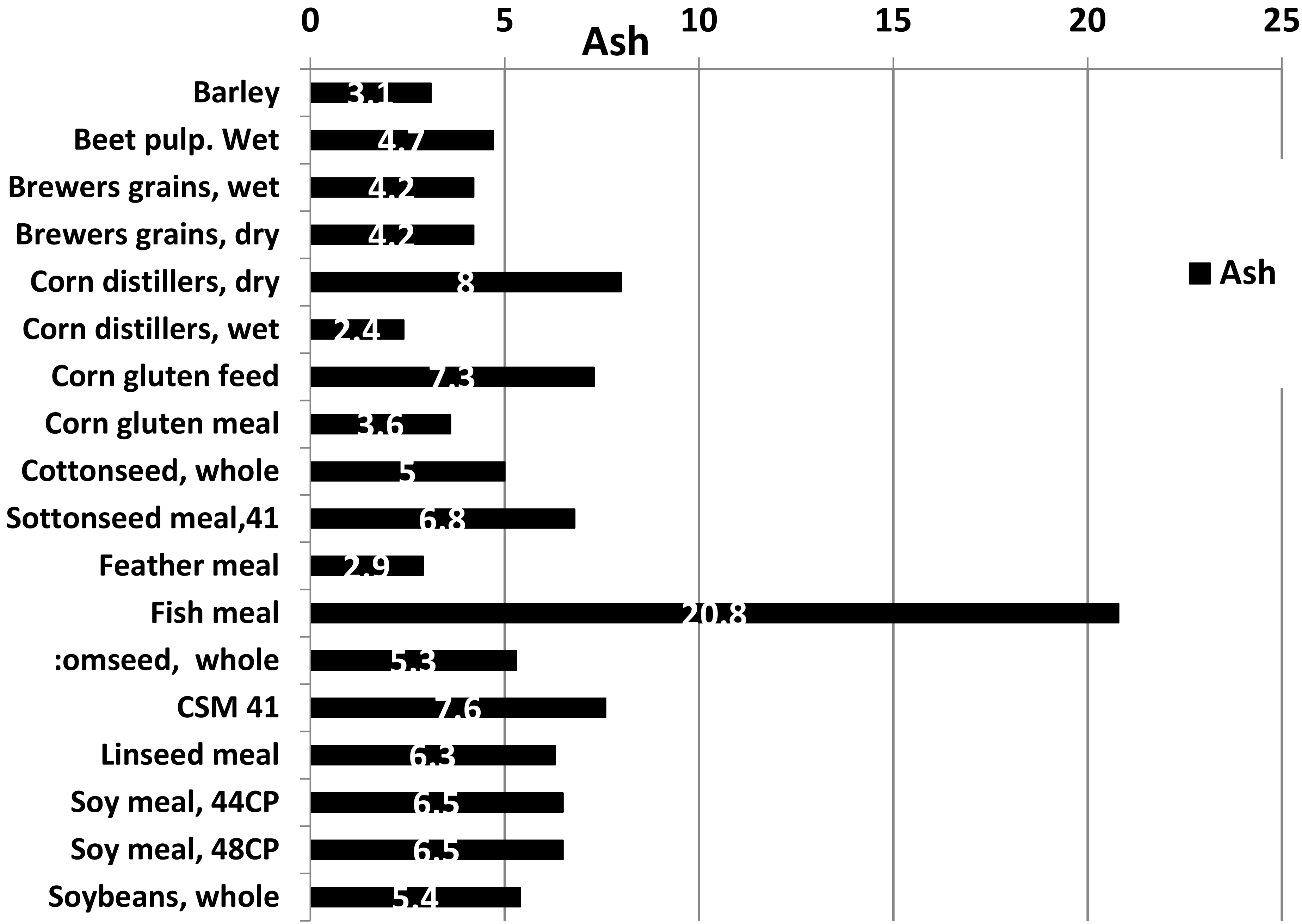


Are components independent or is there overlap (esp. NDF)?

- NDF- Contains some ash -unless it is ash-free NDF.
- NDF usually Contains some N, so not independent from protein. (N x 6.25)
- Should N associated with NDF or ADF be considered part of total N in a feed, or due to low accessibility as a source of N, should N bound to fiber be deducted from total N because of it's low digestibility? (Sniffen et al. 1992. NDF IP can equal 52 to 63% of crude protein in certain feed ingredients – Beet pulp; Distillers).

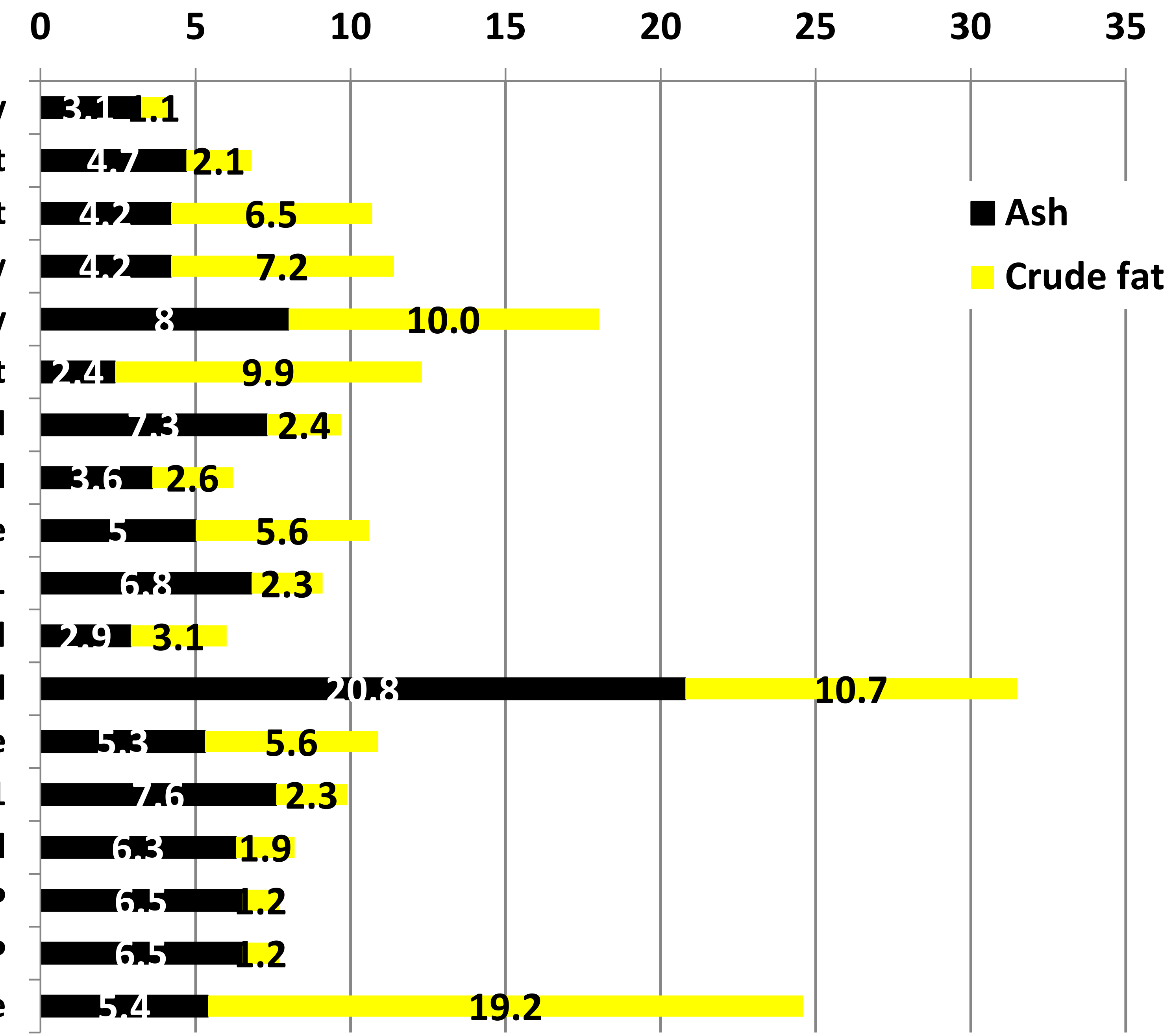
Grain Components, Composition (Weende components)

NRC Atlas of Feed Composition (1971) +ASH



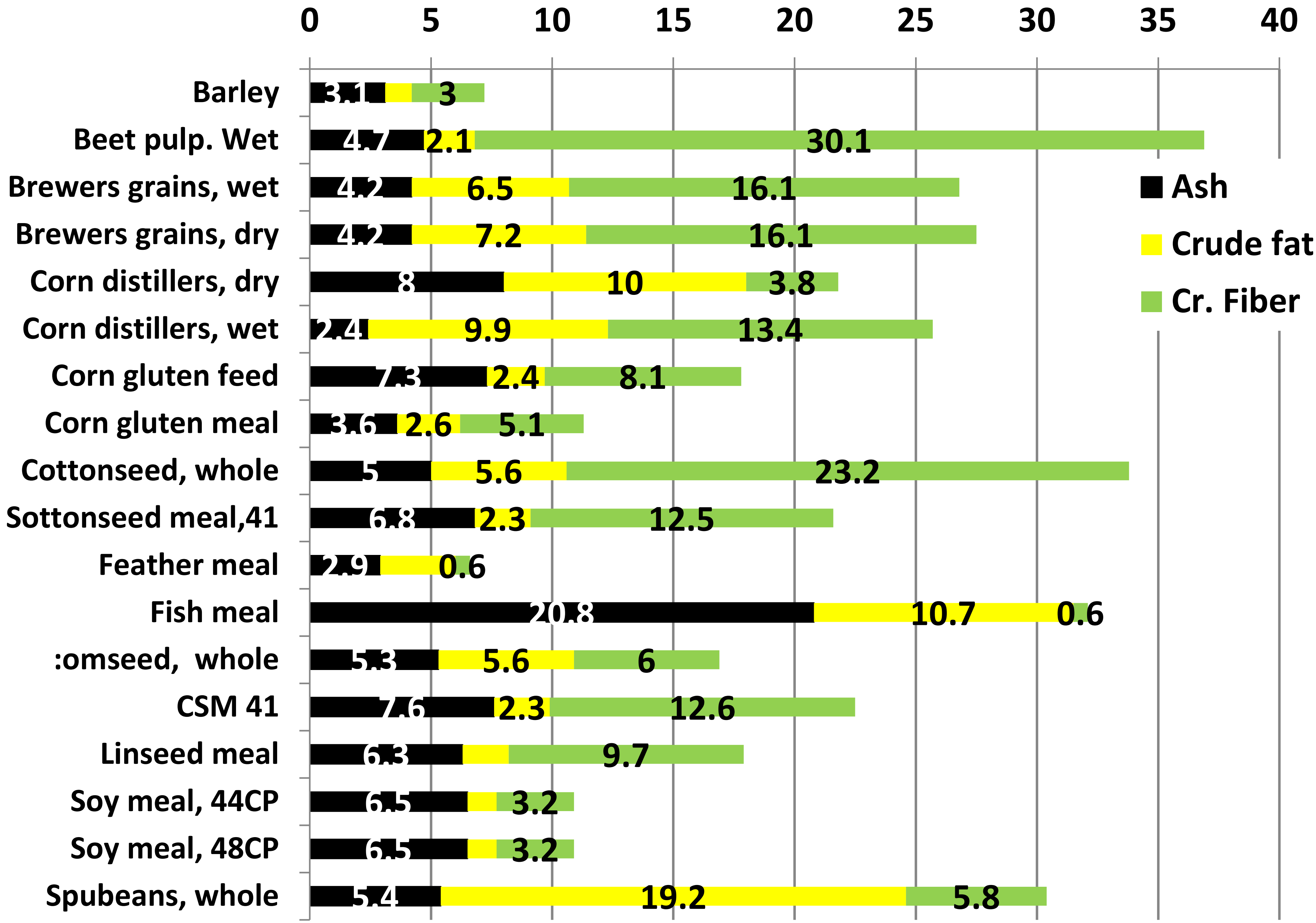
Protein Components, Composition (Weende components)

NRC Atlas of Feed Composition (1971) + ee



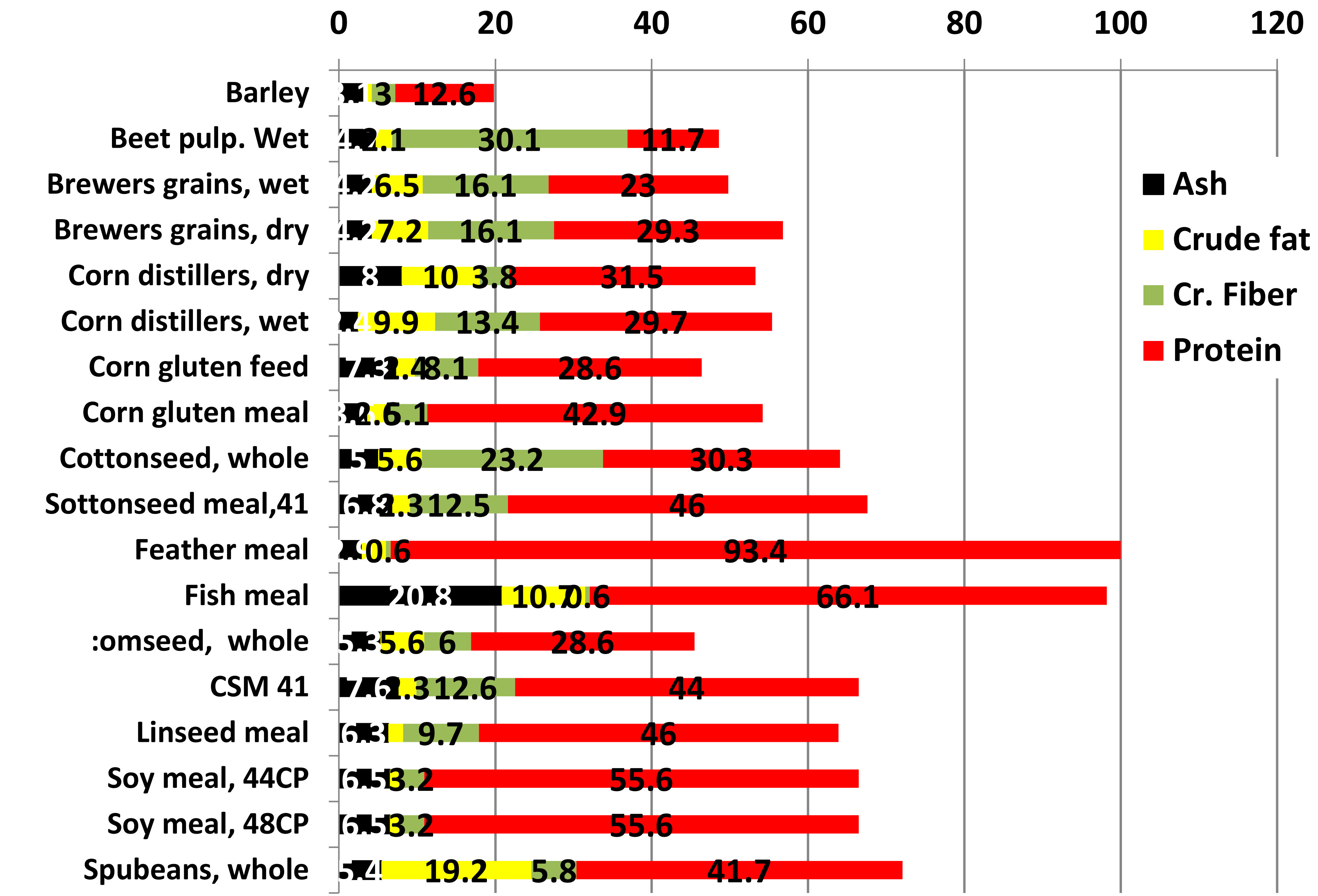
Grains Composition (Weende components)

NRC Atlas of Feed Composition (1971) =crude fiber



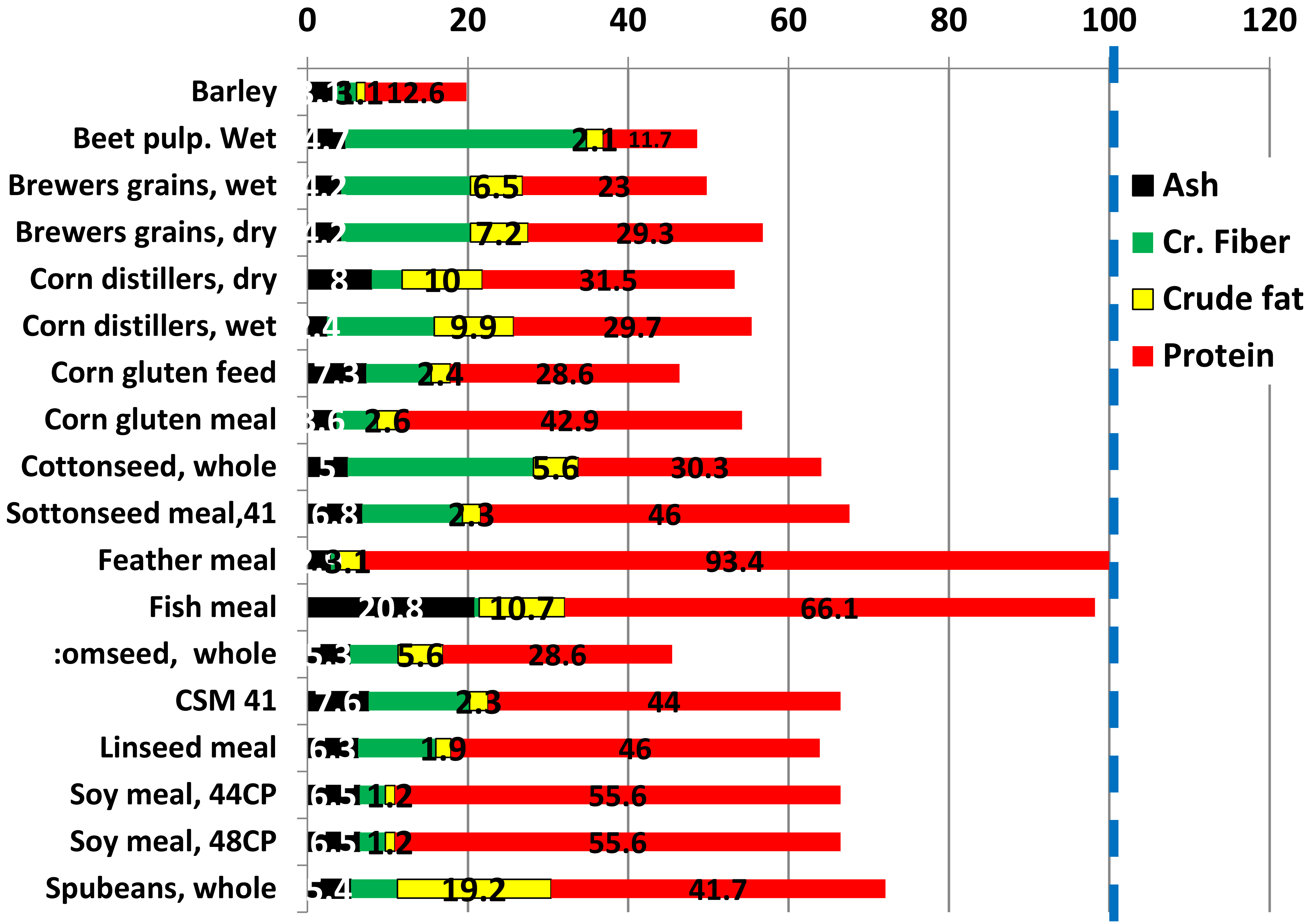
Grains, Composition (Weende components)

NRC Atlas of Feed Composition (1971) New



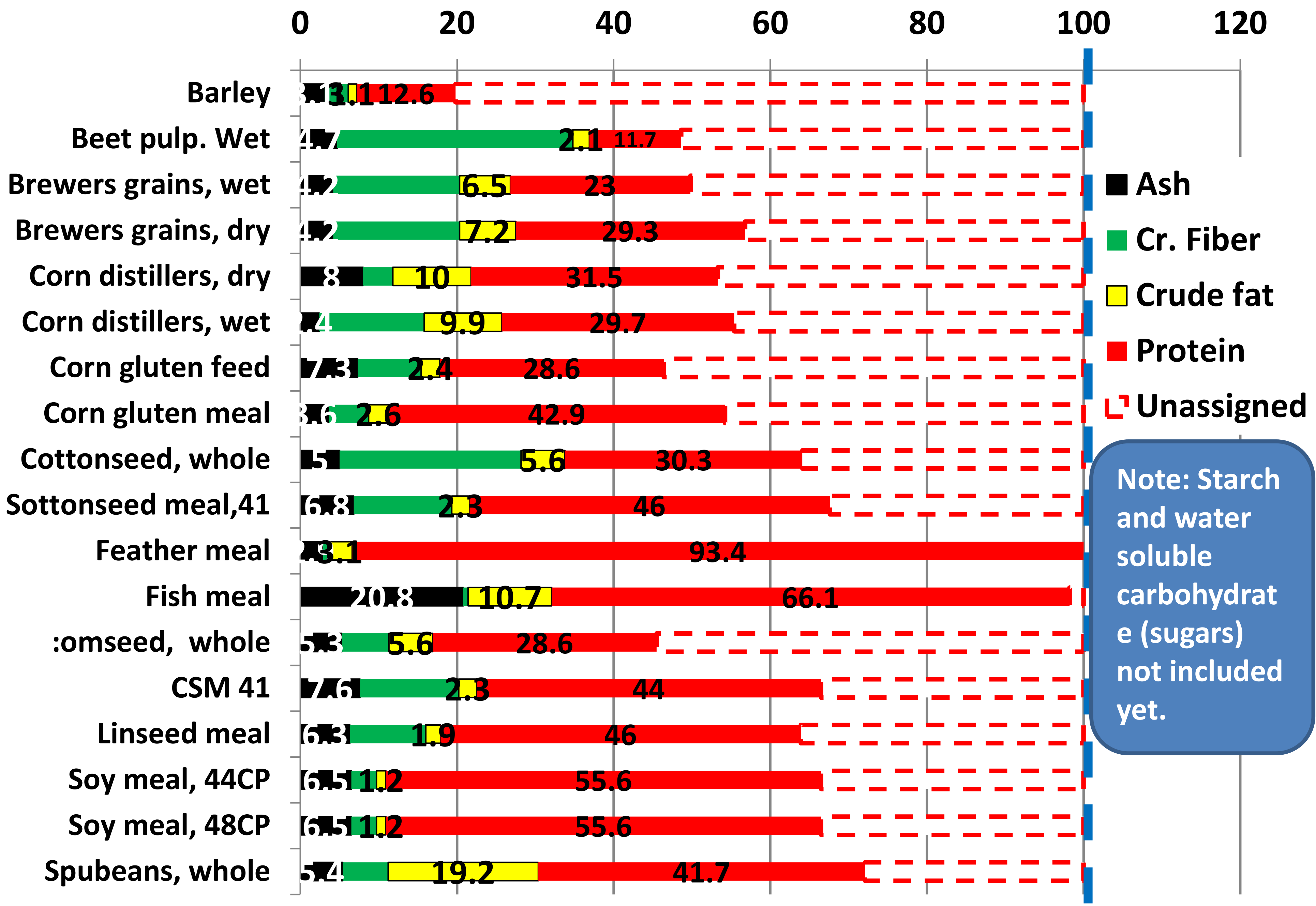
Grains Composition (Weende components)

NRC Atlas of Feed Composition (1971) New

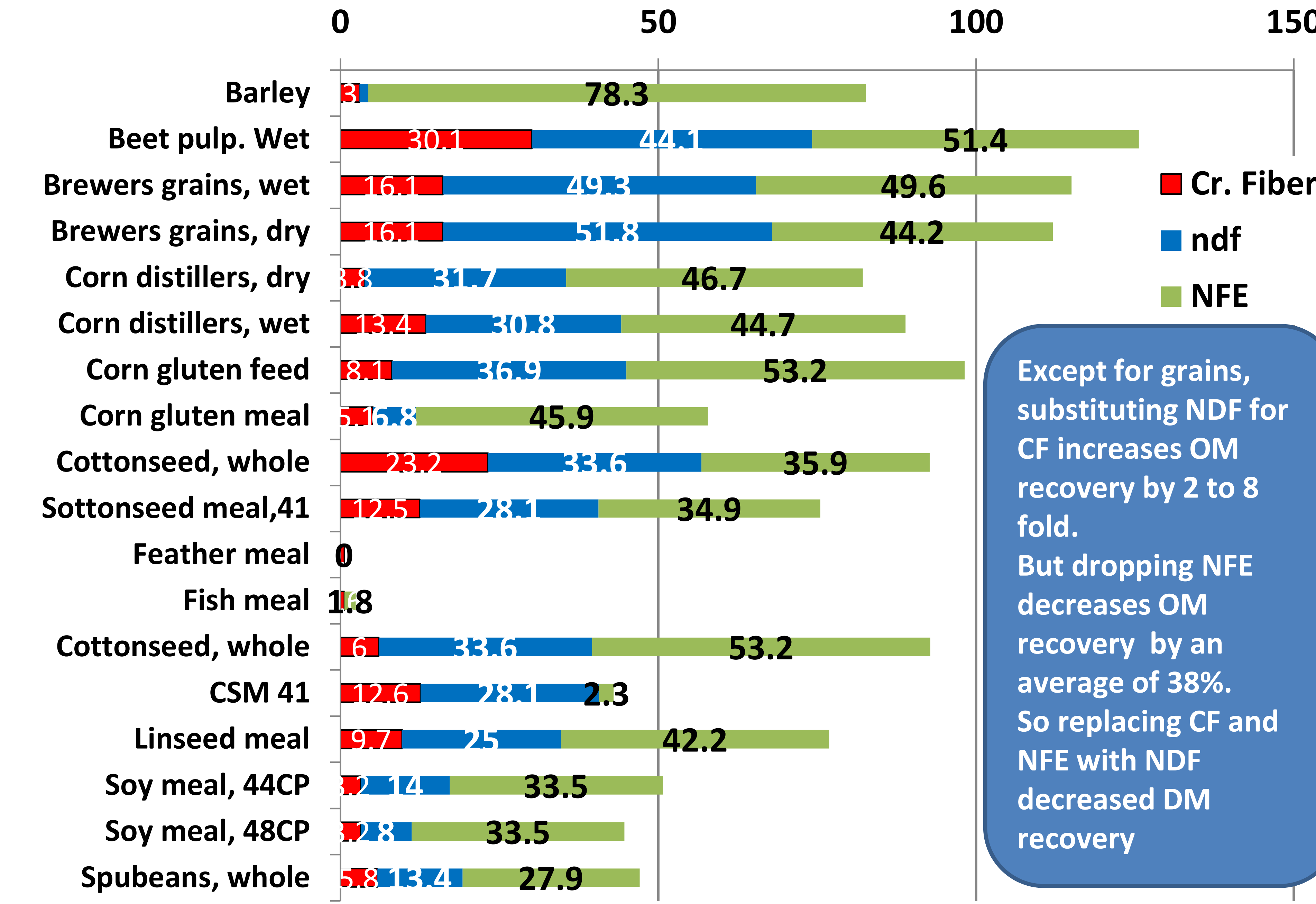


Grains (Weende components)

NRC Atlas of Feed Composition (1971) New



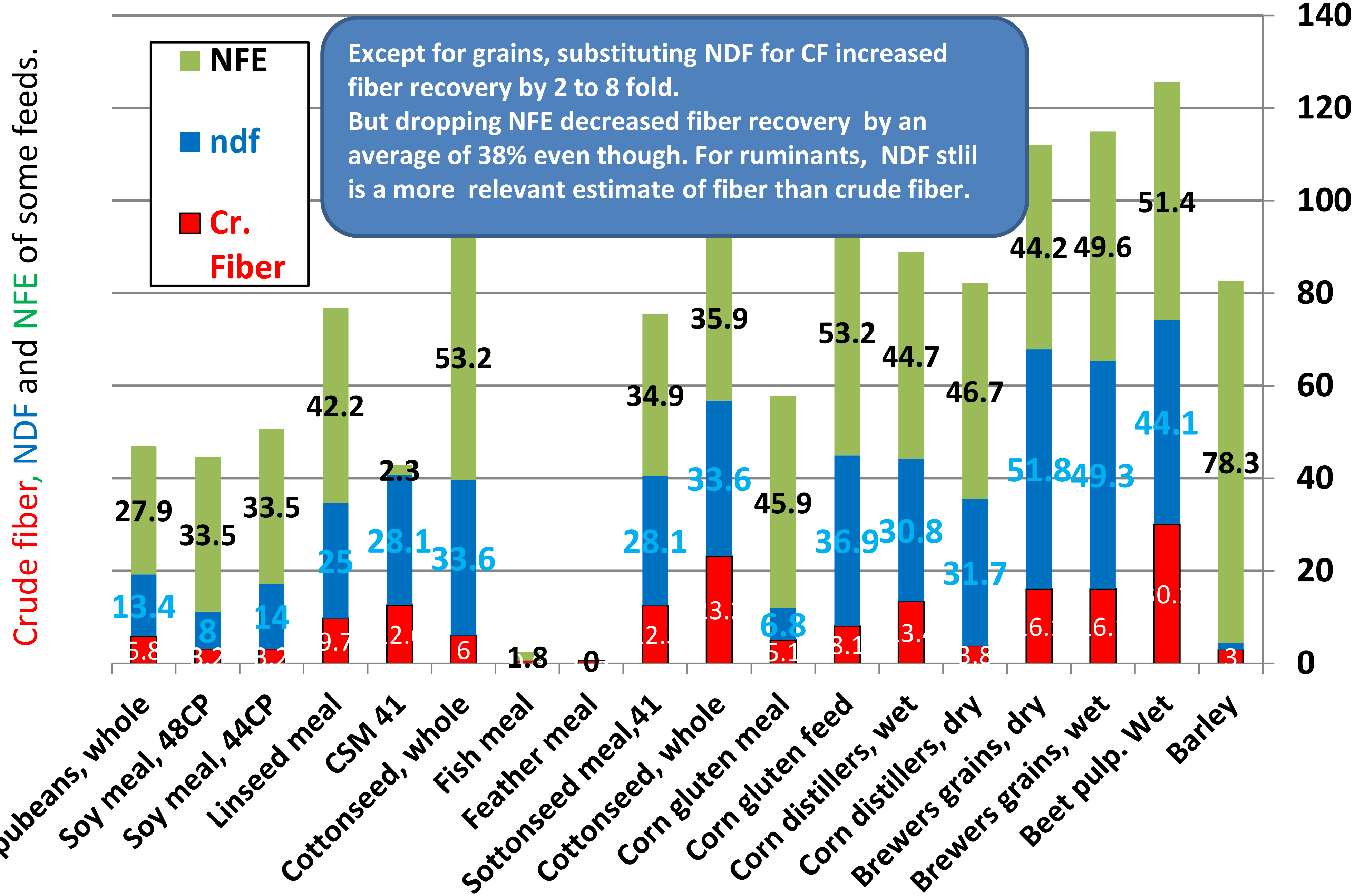
Crude Fiber vs. NDF and NFE Changes with NDF Substitution (1982 Dairy NRC, 2021 Dairy)



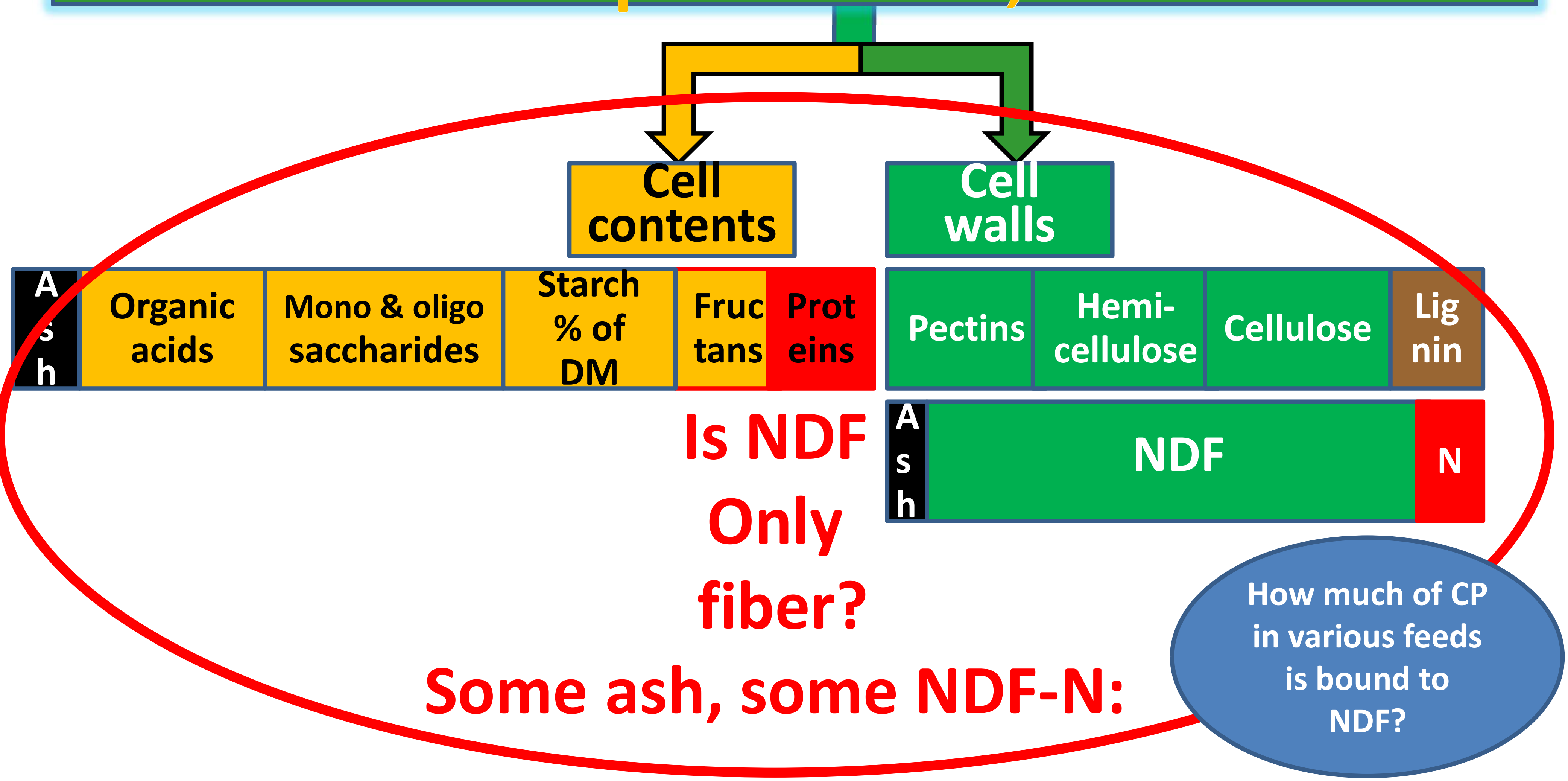
Except for grains, substituting NDF for CF increases OM recovery by 2 to 8 fold.
But dropping NFE decreases OM recovery by an average of 38%.
So replacing CF and NFE with NDF decreased DM recovery

How does replacing [Crude Fiber and NFE] with NDF Change fiber recovery? (1982 Dairy NRC vs. 2021 Dairy)

Except for grains, substituting NDF for CF increased fiber recovery by 2 to 8 fold.
But dropping NFE decreased fiber recovery by an average of 38% even though. For ruminants, NDF stlil is a more relevant estimate of fiber than crude fiber.



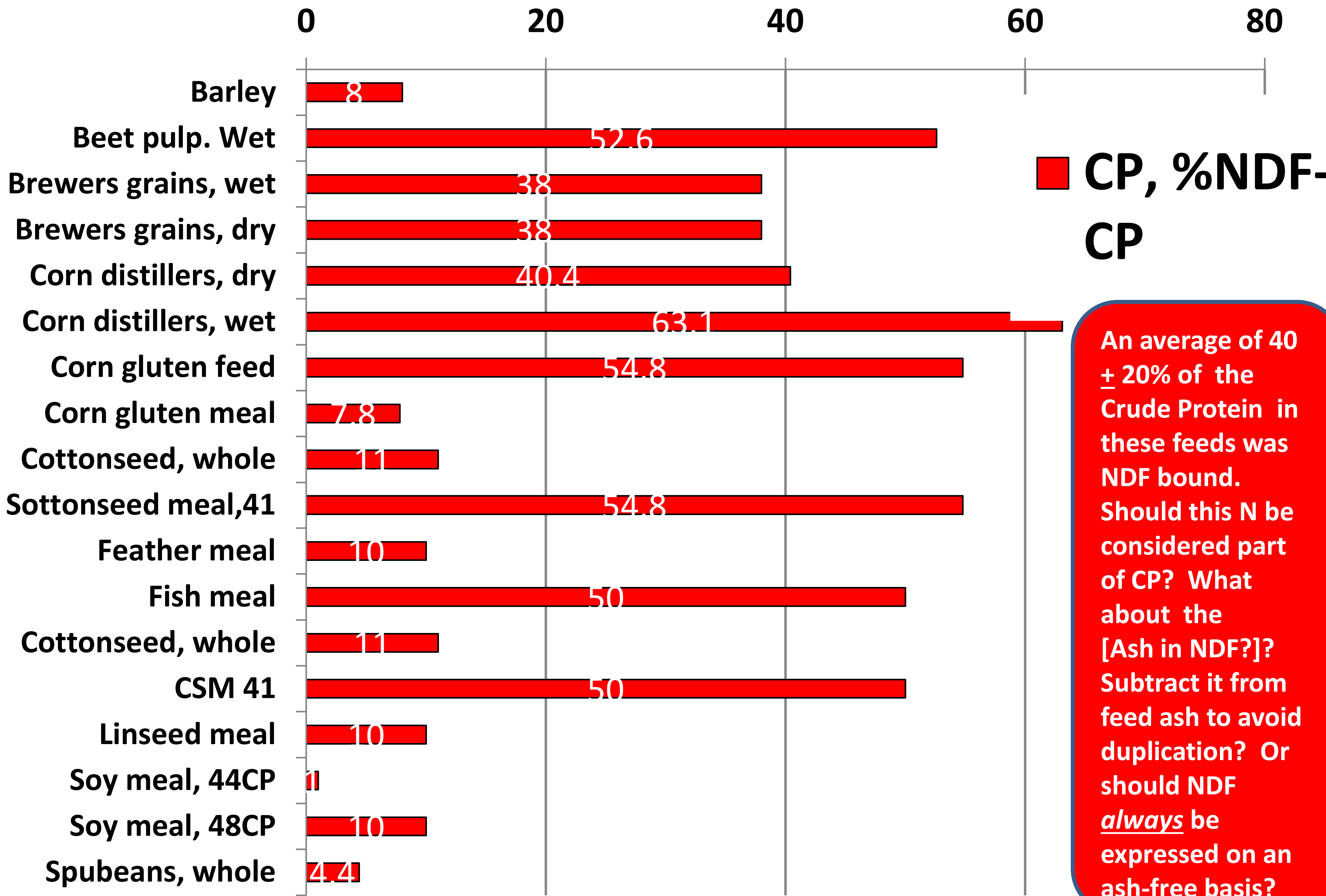
Plant Components, % of DM



If > 100% , some constituent(s) may be doubly-counted.
If < 100%, something may be either missing or under-assayed!

How much of Protein from various feeds is bound to NDF?

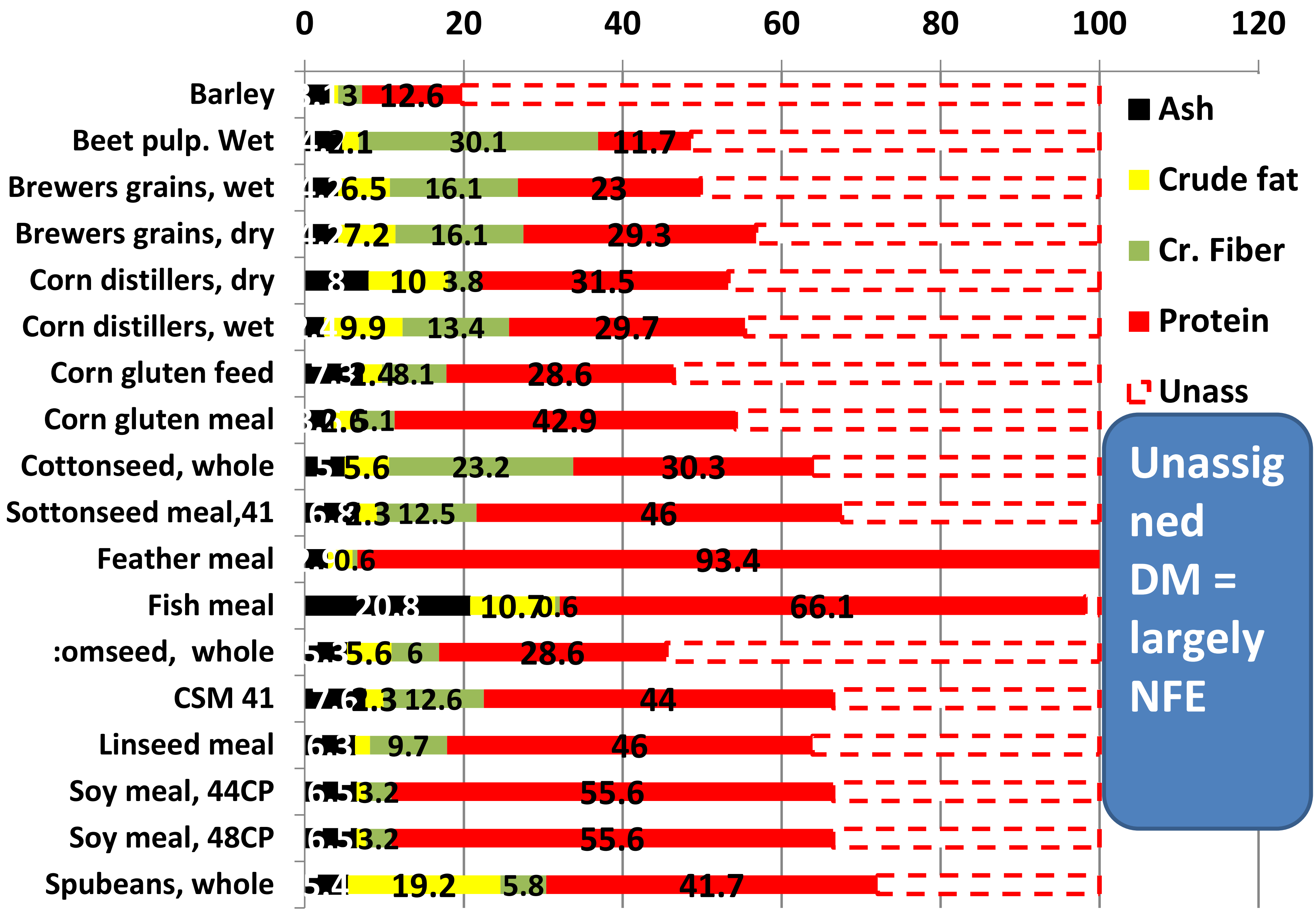
Fraction of N as NDF-N, % (Sniffen 1992)



An average of 40 + 20% of the Crude Protein in these feeds was NDF bound. Should this N be considered part of CP? What about the [Ash in NDF?]? Subtract it from feed ash to avoid duplication? Or should NDF ***always*** be expressed on an ash-free basis?

Grains Composition (Weende components)

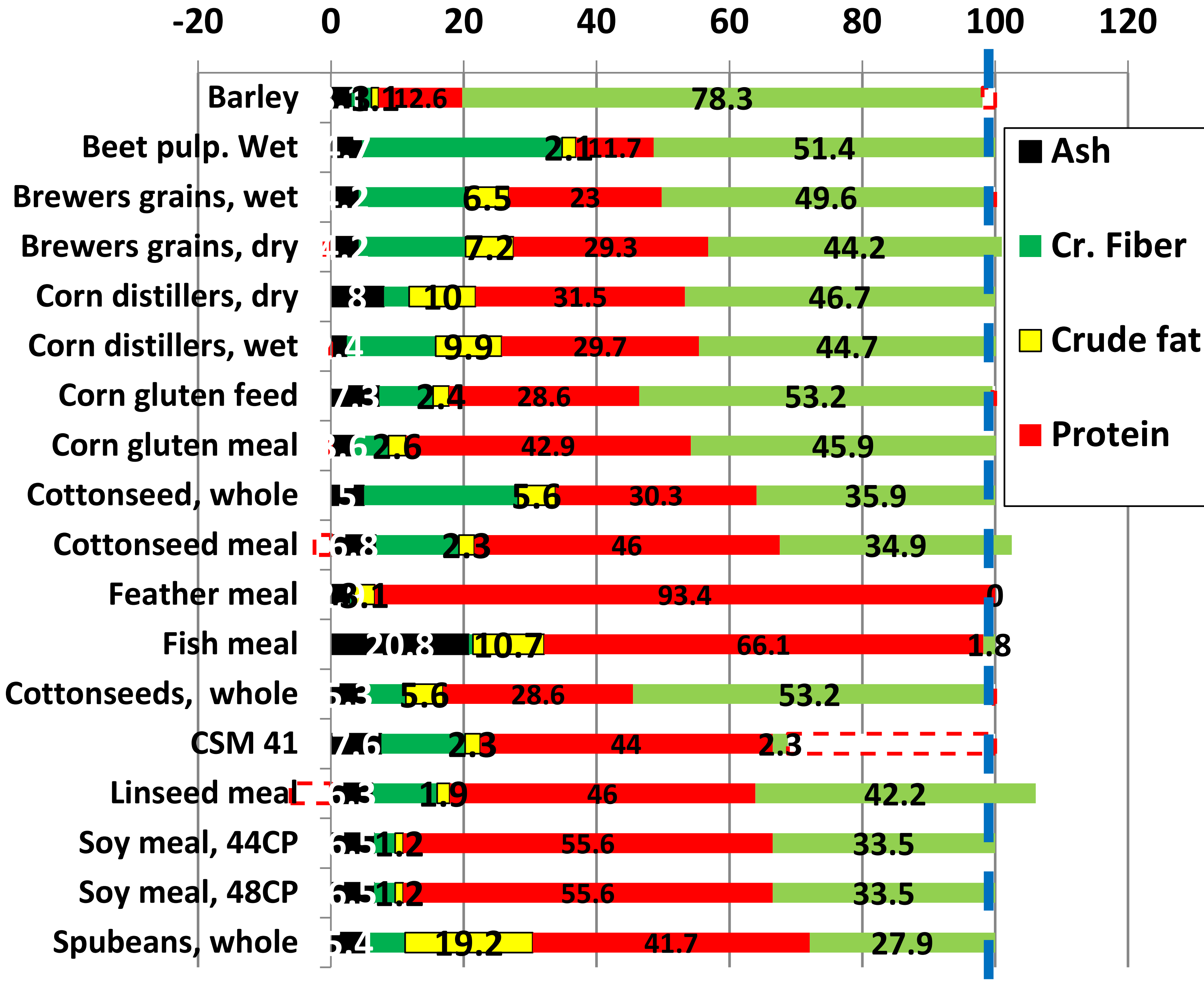
NRC Atlas of Feed Composition (1971) +CP



Grains, Composition (Weende components)

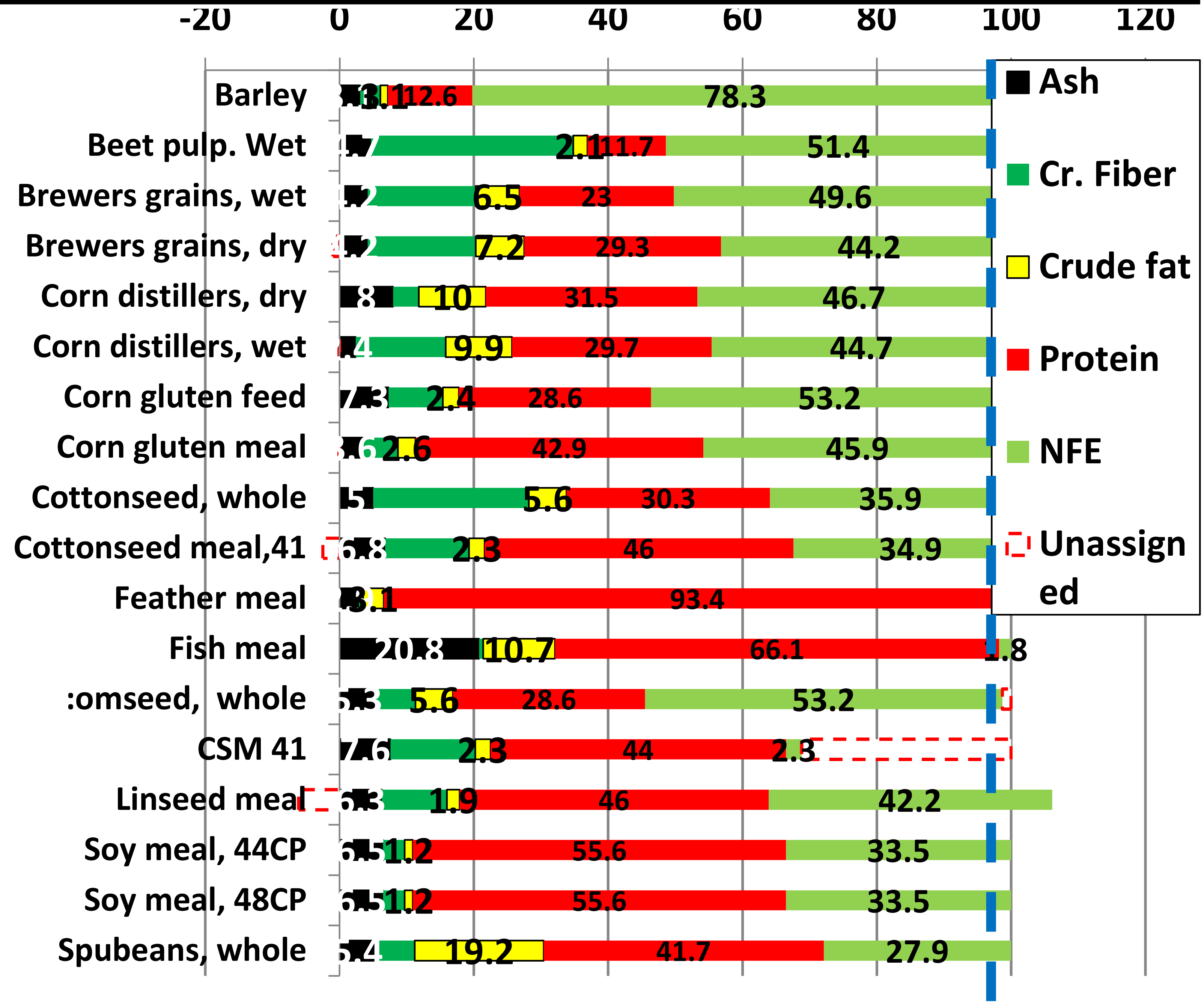
NRC Atlas of Feed Composition (1971) +NFE

Unassigned Mean =+1.4% of OM. Range= -6.3% (Linseed) to 31+% of CSM.



Grain Components, Composition (Weende components)

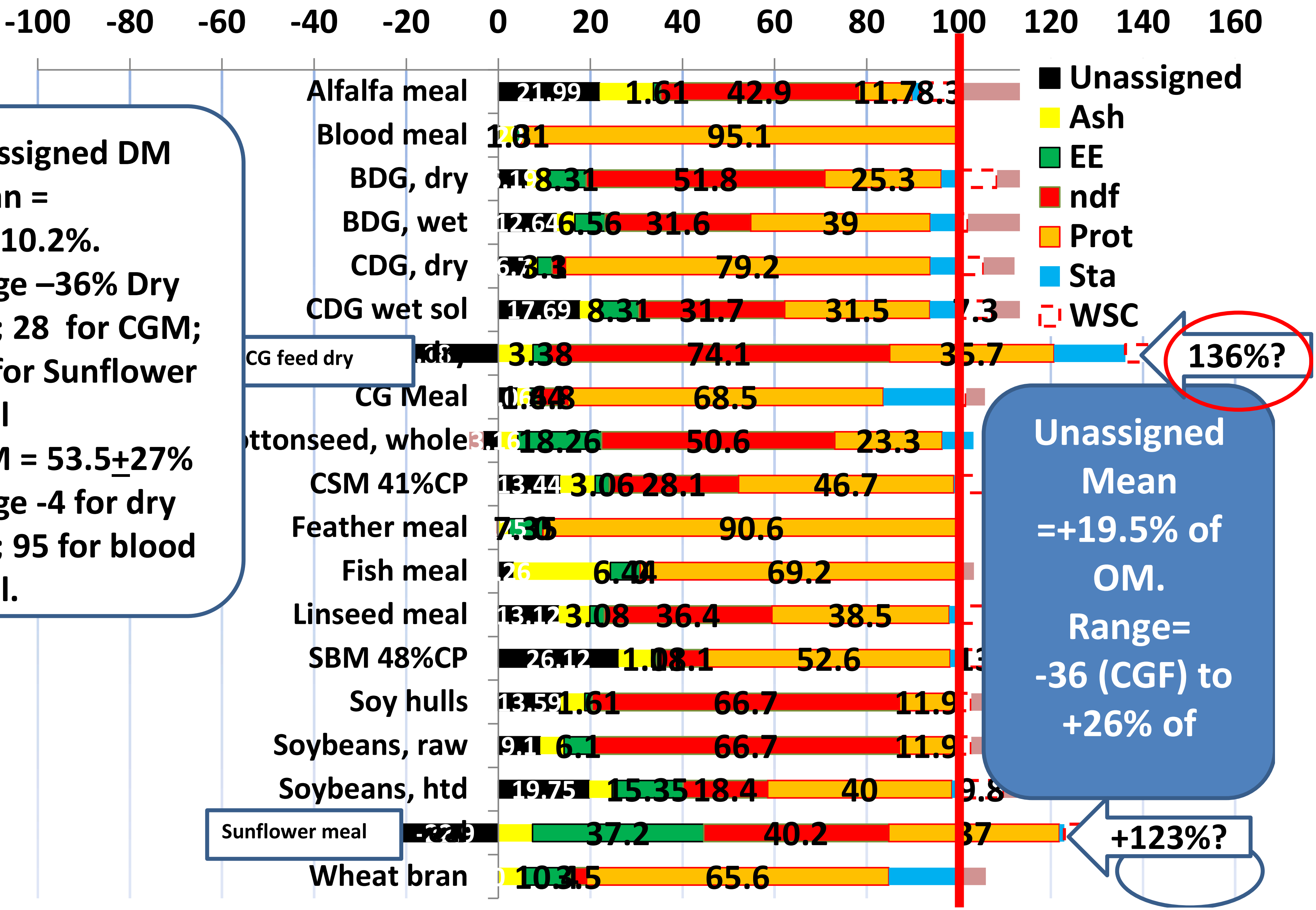
NRC Atlas of Feed Composition (1971) +NFE FROM Sniffen et al 1992



Unassig ned Mean =+1.4% of OM. Range= -6.3% (Linsee d) to 31+% of CSM.

Protein Concentrates (Components)

NASEM Dairy (2021)



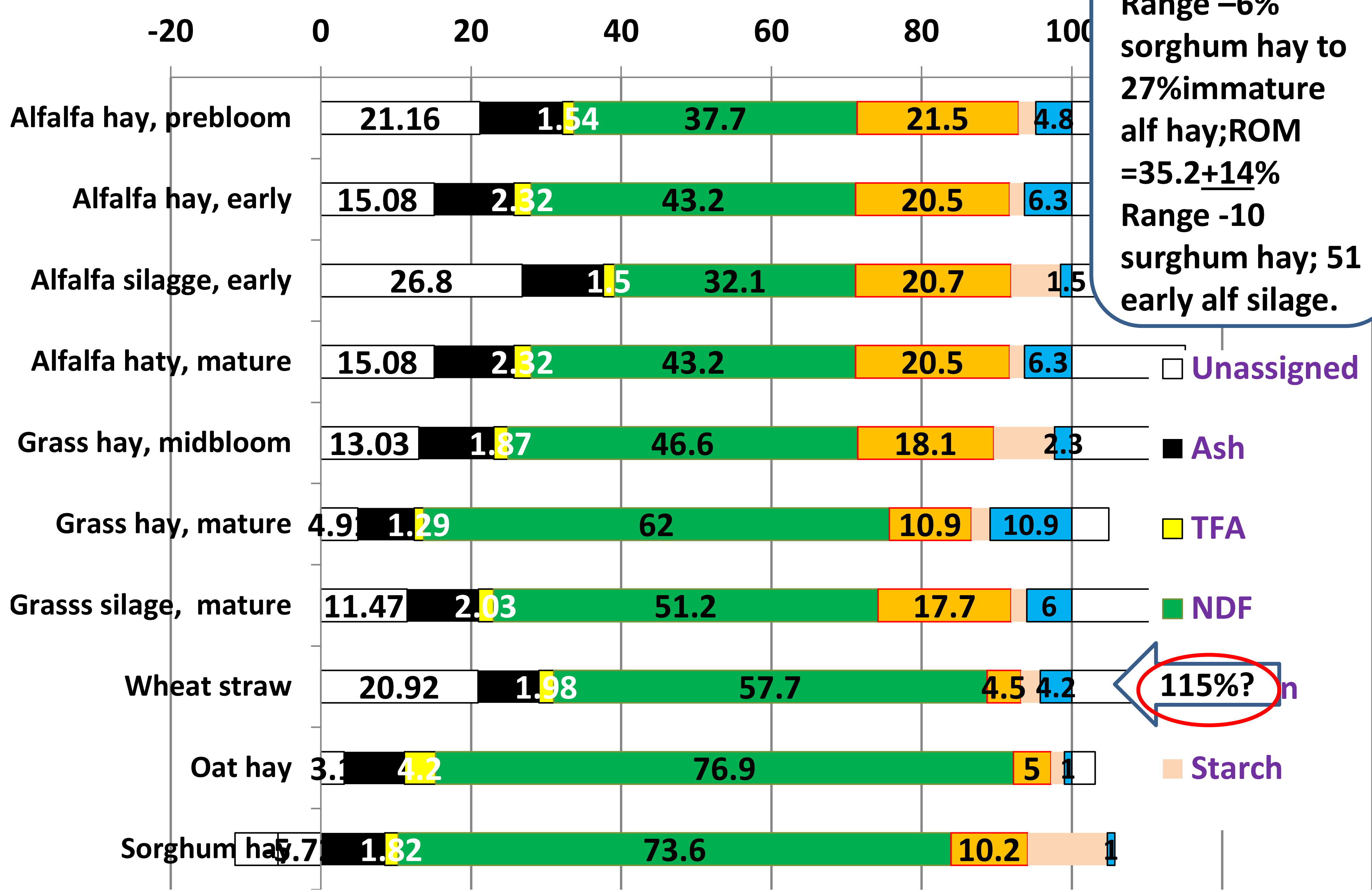
Unassigned DM Mean = 5.8±10.2%. Range –36% Dry CGF; 28 for CGM; -23 for Sunflower meal

ROM = 53.5±27% Range -4 for dry CGF; 95 for blood meal.

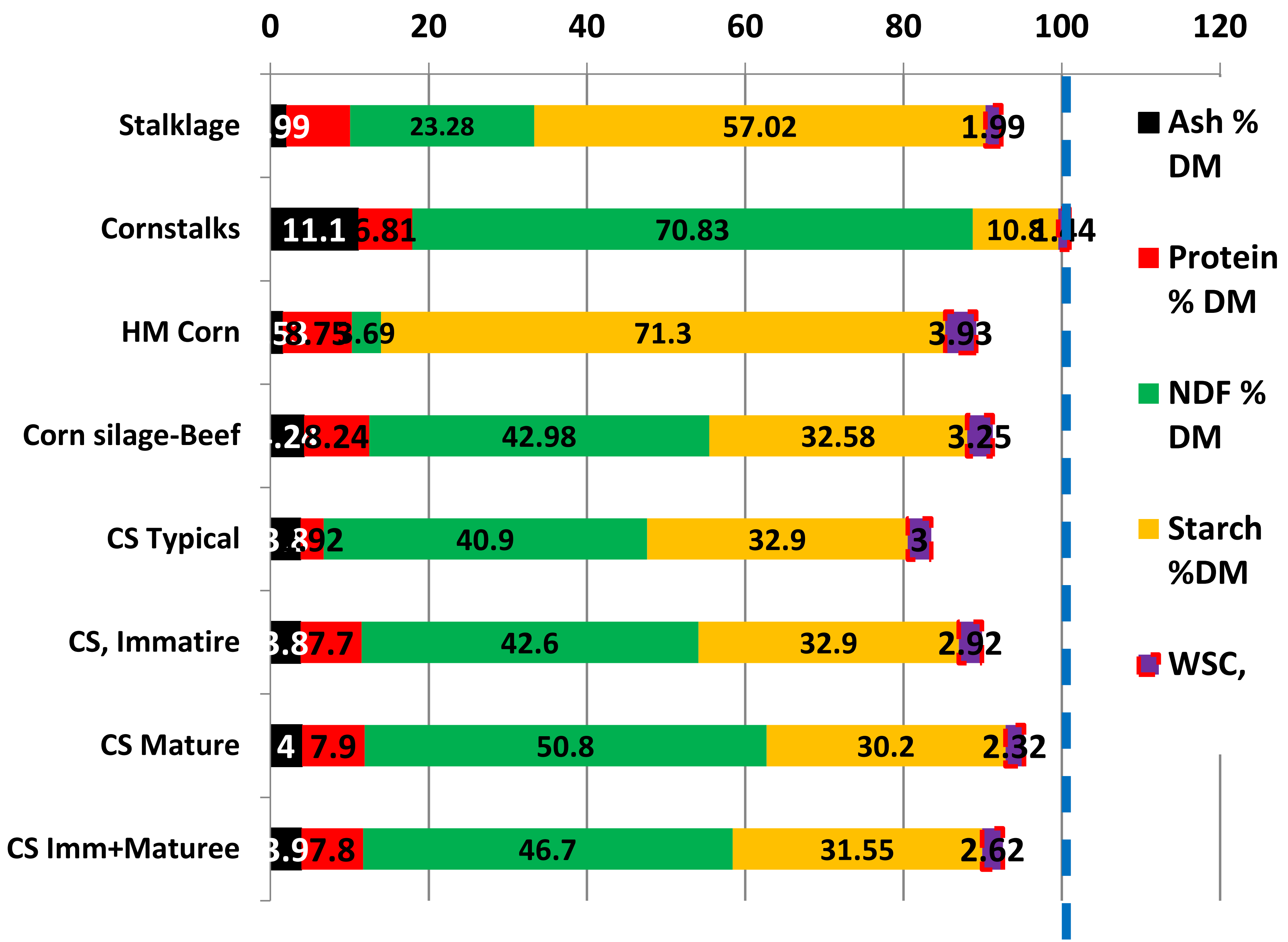
Unassigned Mean =+19.5% of OM. Range= -36 (CGF) to +26% of

Hays and Silages: Feed Composition NASEM DAIRY 2021

Unassigned DM Mean = 12.6+14%. Range –6% sorghum hay to 27%immature alf hay;ROM =35.2+14% Range -10 surghum hay; 51 early alf silage.

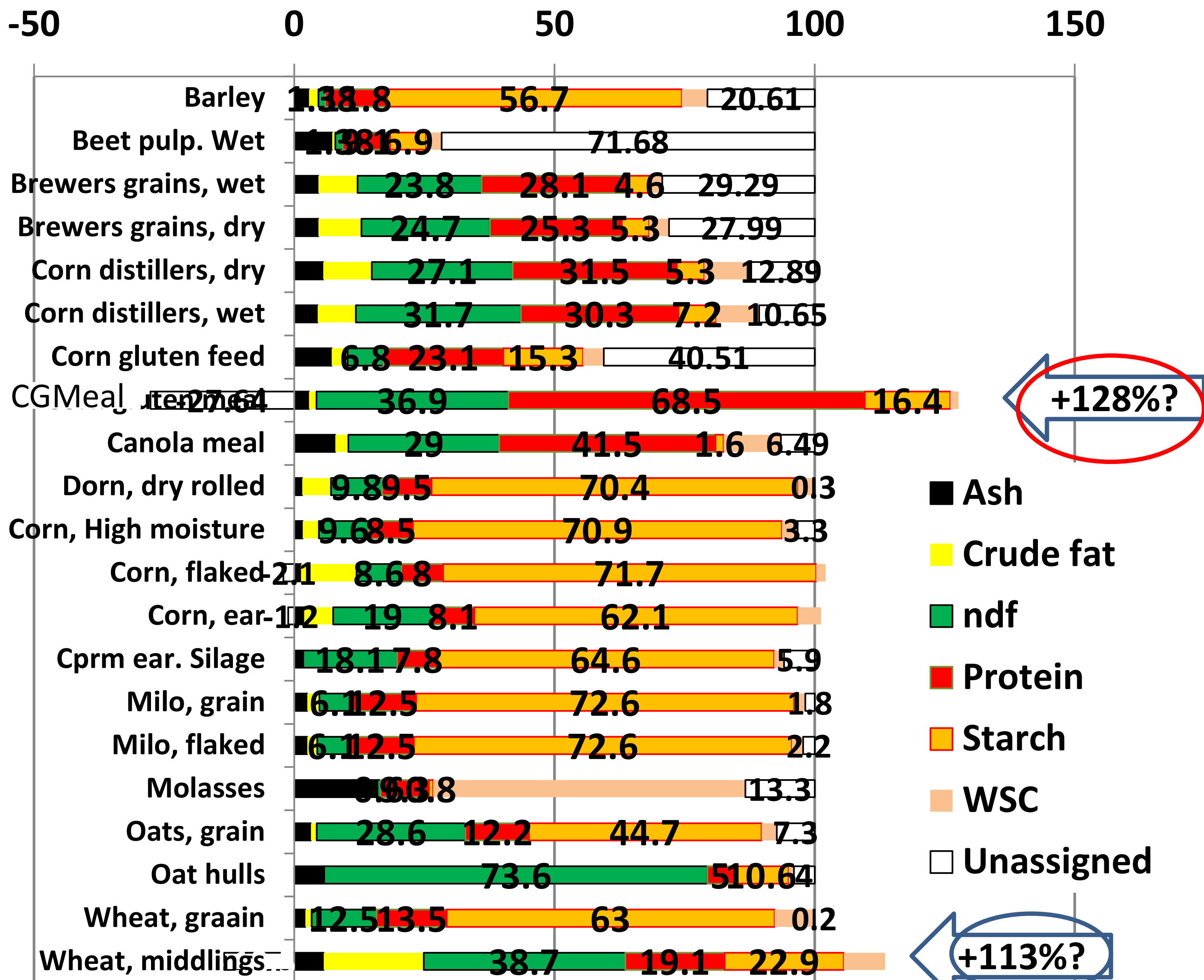


Silage Composition (Dairy NRC 2021)



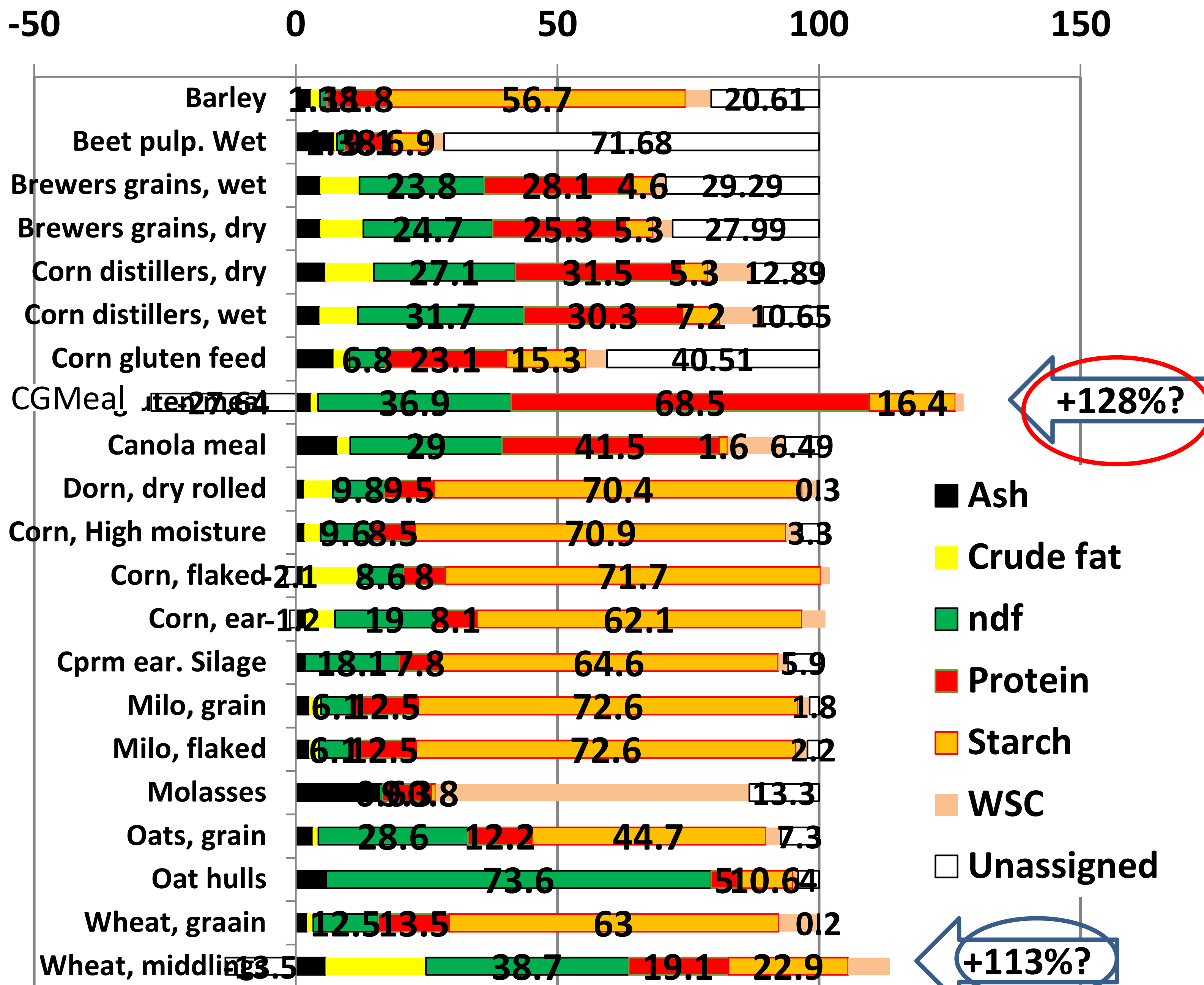
GRAINS: Feed Compositions
NASEM DAIRY 2021

Unassigned DM
Mean = 10.2 ± 21
Range -28 for CGM; 71.7% for wet beet pulp.
ROM = 37.25±25%
Range 8.8 for flaked corn; 84 for wet beet pulp.

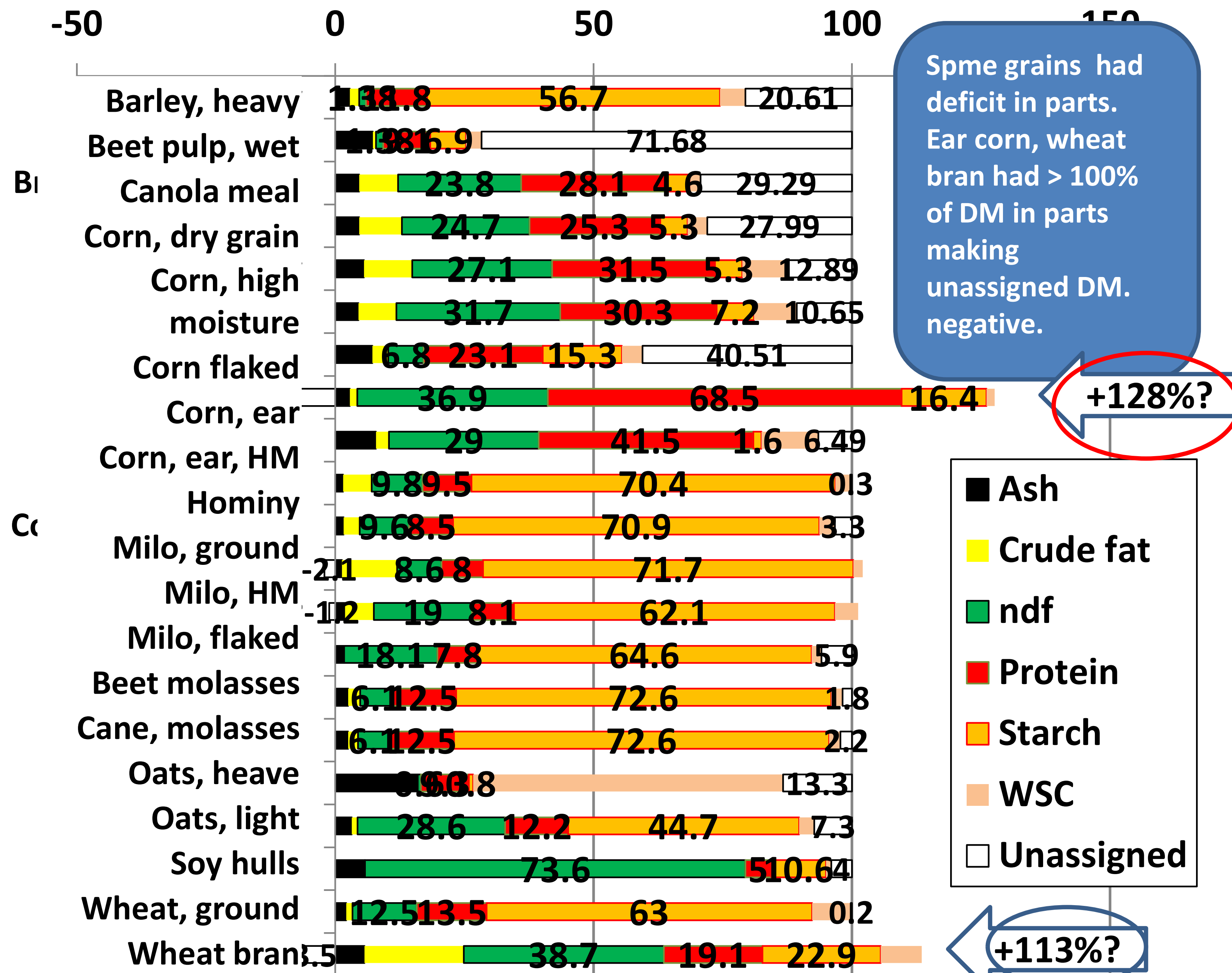


GRAINS: Feed Compositions
NASEM DAIRY 2021

Unassigned DM Mean = 10.2 ± 21 Range -28 for CGM; 71.7% for wet beet pulp. ROM = 37.25±25% Range 8.8 for flaked corn; 84 for wet beet pulp.



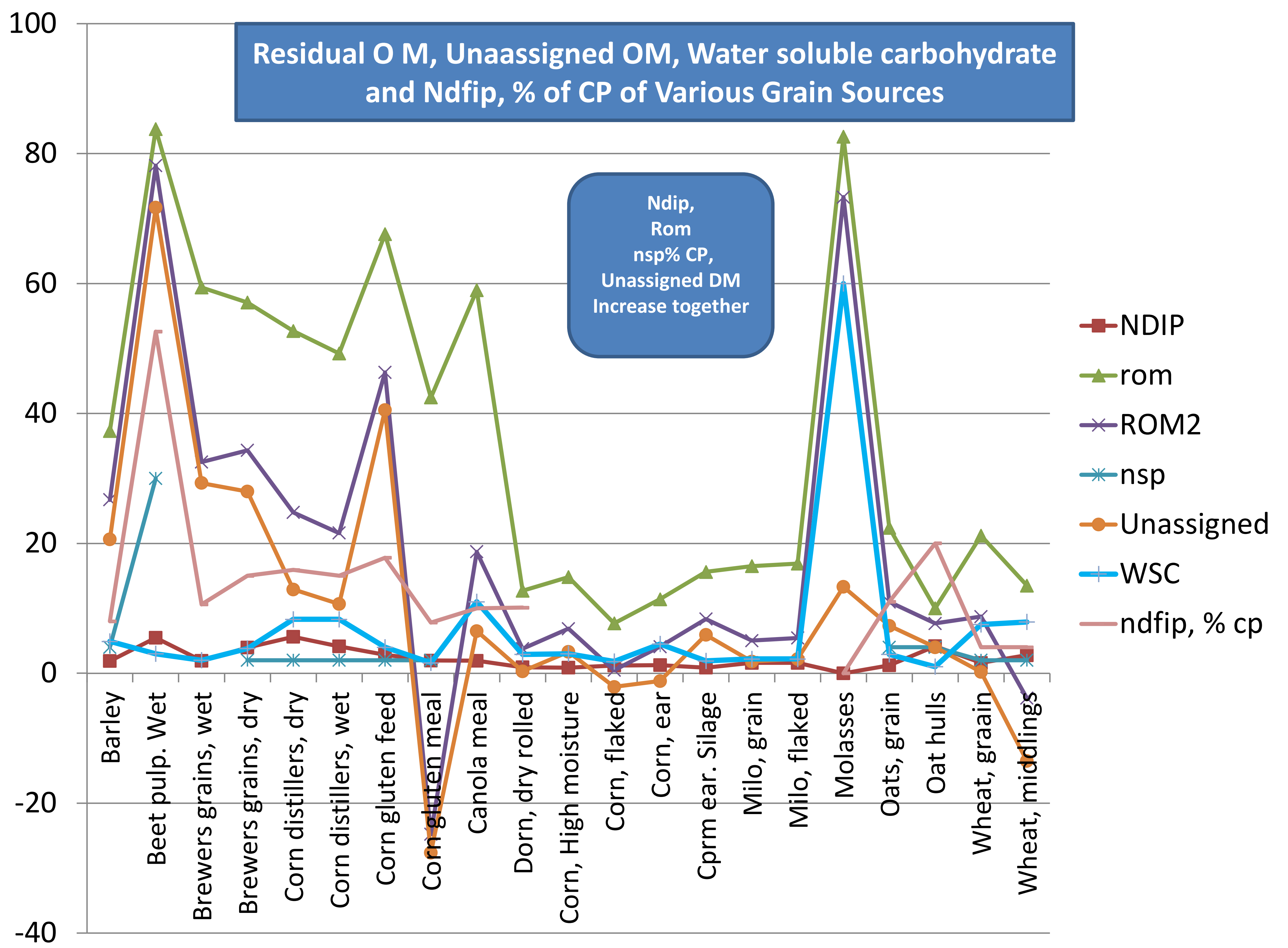
GrainsHays and Silages: Feed Compositions NASEM DAIRY 2021



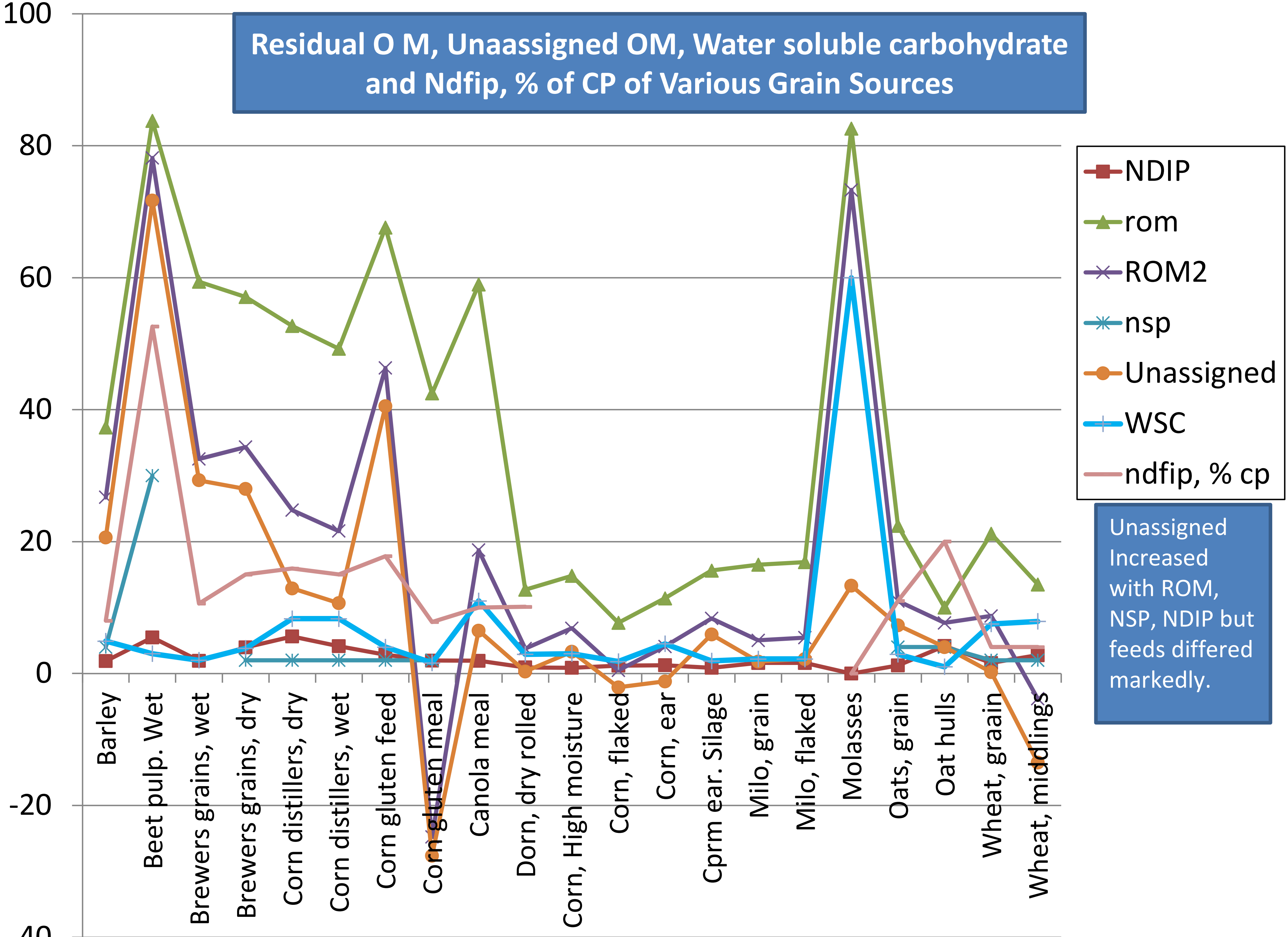
What corrections for unassigned DM have been proposed? NFE, ROM & NSC

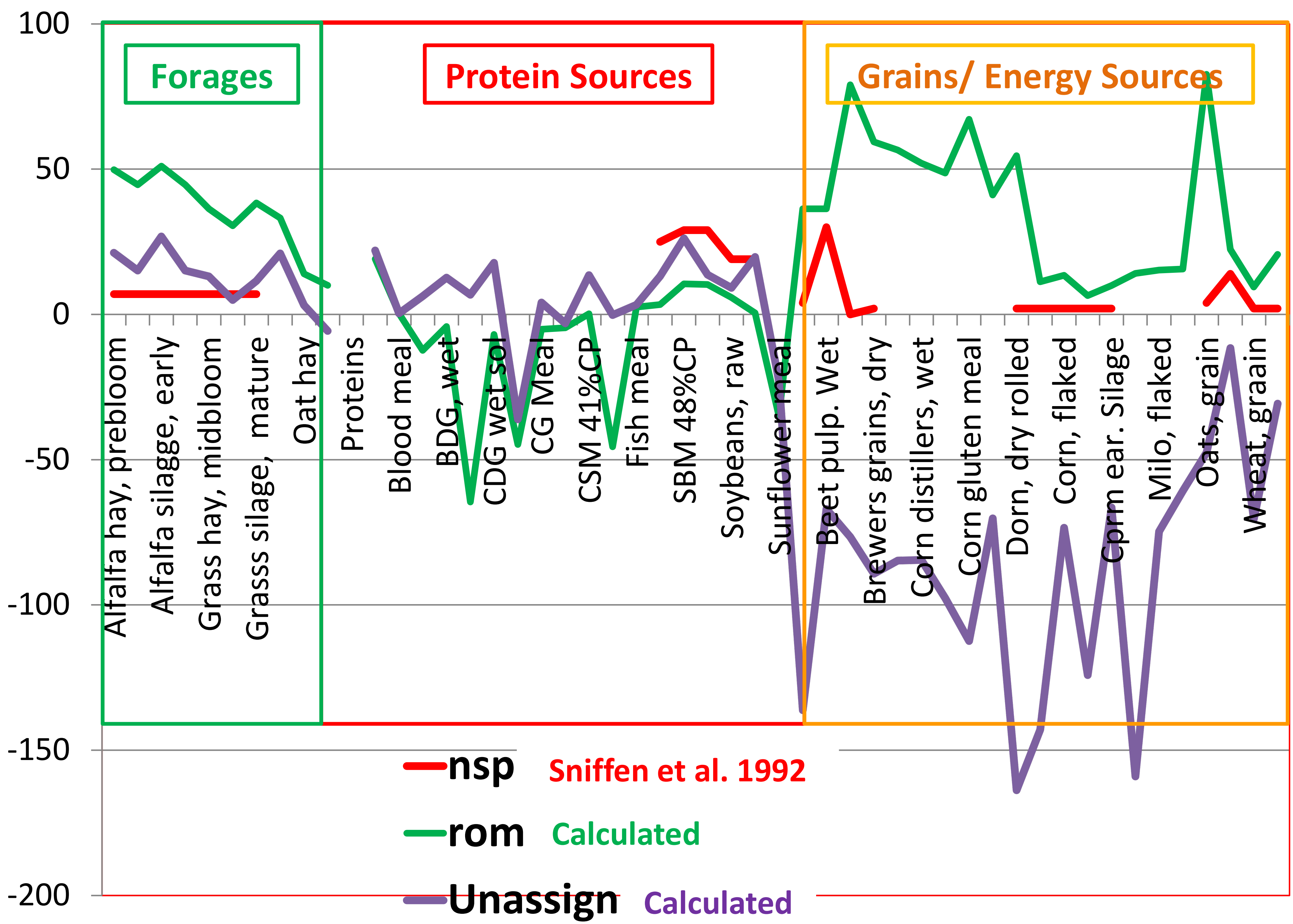
1. ROM: Describes all unassigned OM as ROM (Residual organic matter) as discussed in NRCEM Dairy 2021 to theoretically include water soluble carbohydrates, fermentation products and short chain fatty acids, glycerol, tannins, waxes, pectins, beta-glucans, pigments and oligosaccharides but subtracts ash and NDF-N from ash and N to avoid overlap of components; assigns ROM a gross energy value of 3.9 mcal/kg and a digestibility of 96% based on apparent digestibility of non-NDF Omas cited by Van Soest text . Presumably all WSC and starch are handled are included in ROM and not considered independent. Yet separate digestibility values for starch for dairy are summarized and tabulated.

2. NSC: Include a value called non-structural carbohydrate or polysaccharides (NSC or NSP) that a) substitutes ash-free NDF for NDF and b) adjusts NDF to subtract overlapping NDF or ADF-boundN. Suggested formula for NSC (Sniffen et al. 1992) is NSC = 100- [ndf-ndfip}+ash + fat]; theoretically NSC would include WSC and starch that might be considered independently and could be assayed separately; sources and processed starch sources are now are assigned separate digestibilities.



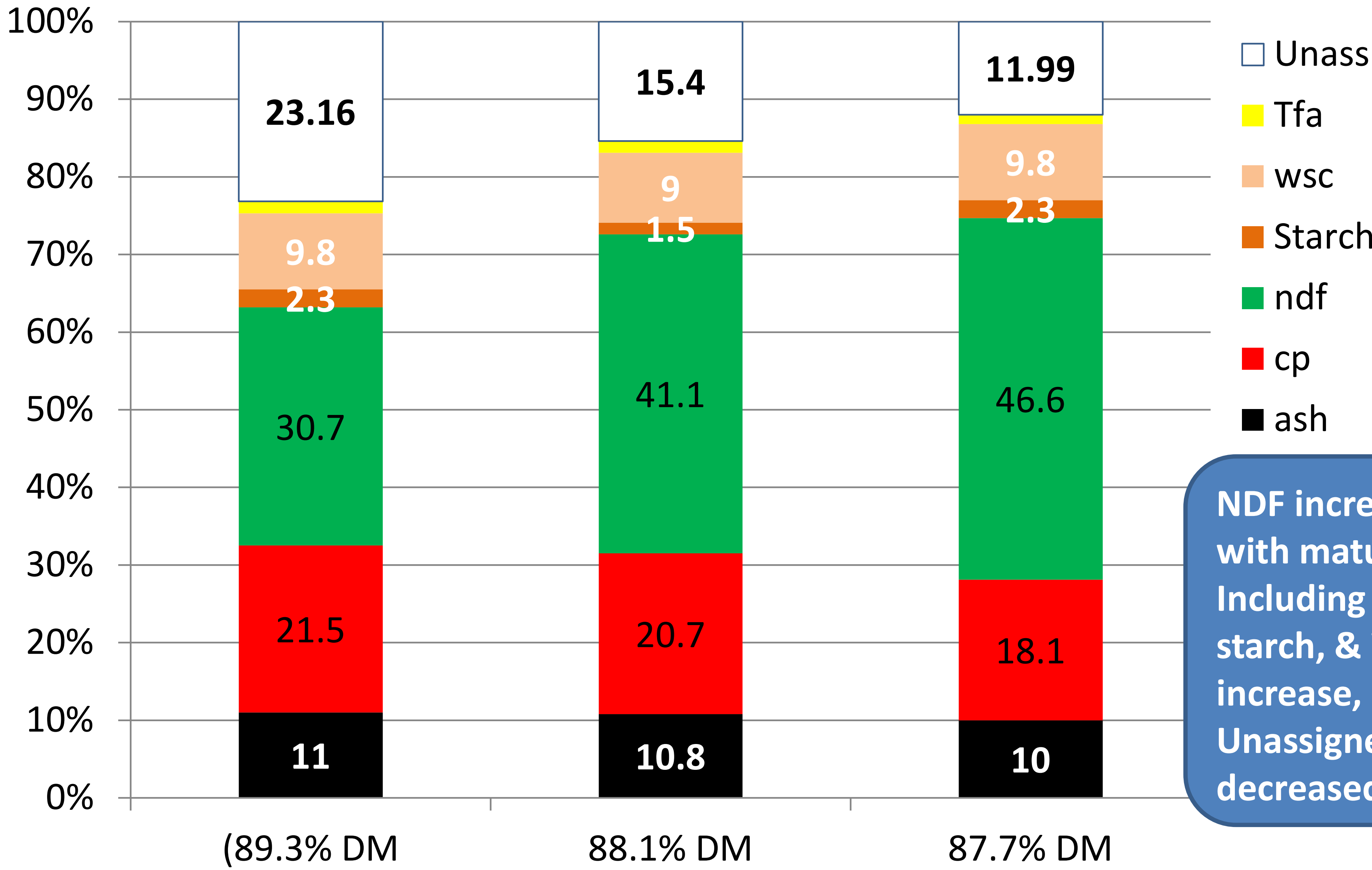
Residual O M, Unassigned OM, Water soluble carbohydrate and Ndfip, % of CP of Various Grain Sources
Ndip,
Rom
nsp% CP,
Unassigned DM
Increase together
NDIP
rom
ROM2
nsp
Unassigned
WSC
ndfip, % cp
100
80
60
40
20
0
-20
-40
Barley
Beet pulp. Wet
Brewers grains, wet
Brewers grains, dry
Corn distillers, dry
Corn distillers, wet
Corn gluten feed
Corn gluten meal
Canola meal
Dorn, dry rolled
Corn, High moisture
Corn, flaked
Corn, ear
Cprm ear. Silage
Milo, grain
Milo, flaked
Molasses
Oats, grain
Oat hulls
Wheat, graain
Wheat, middlings


Residual O M, Unassigned OM, Water soluble carbohydrate and Ndfip, % of CP of Various Grain Sources
100
80
60
40
20
0
-20
-40
NDIP
rom
ROM2
nsp
Unassigned
WSC
ndfip, % cp
Unassigned Increased with ROM, NSP, NDIP but feeds differed markedly.
Barley
Beet pulp. Wet
Brewers grains, wet
Brewers grains, dry
Corn distillers, dry
Corn distillers, wet
Corn gluten feed
Corn gluten meal
Canola meal
Dorn, dry rolled
Corn, High moisture
Corn, flaked
Corn, ear
Cprm ear. Silage
Milo, grain
Milo, flaked
Molasses
Oats, grain
Oat hulls
Wheat, graain
Wheat, middlings



100
50
0
-50
-100
-150
-200
Forages
Protein Sources
Grains/ Energy Sources
Alfalfa hay, prebloom
Alfalfa silagge, early
Grass hay, midbloom
Grasss silage, mature
Oat hay
Proteins
Blood meal
BDG, wet
CDG wet sol
CG Meal
CSM 41%CP
Fish meal
SBM 48%CP
Soybeans, raw
Sunflower meal
Beet pulp. Wet
Brewers grains, dry
Corn distillers, wet
Corn gluten meal
Dorn, dry rolled
Corn, flaked
Cprm ear. Silage
Milo, flaked
Oats, grain
Wheat, grain
nsp Sniffen et al. 1992
rom Calculated
Unassign Calculated

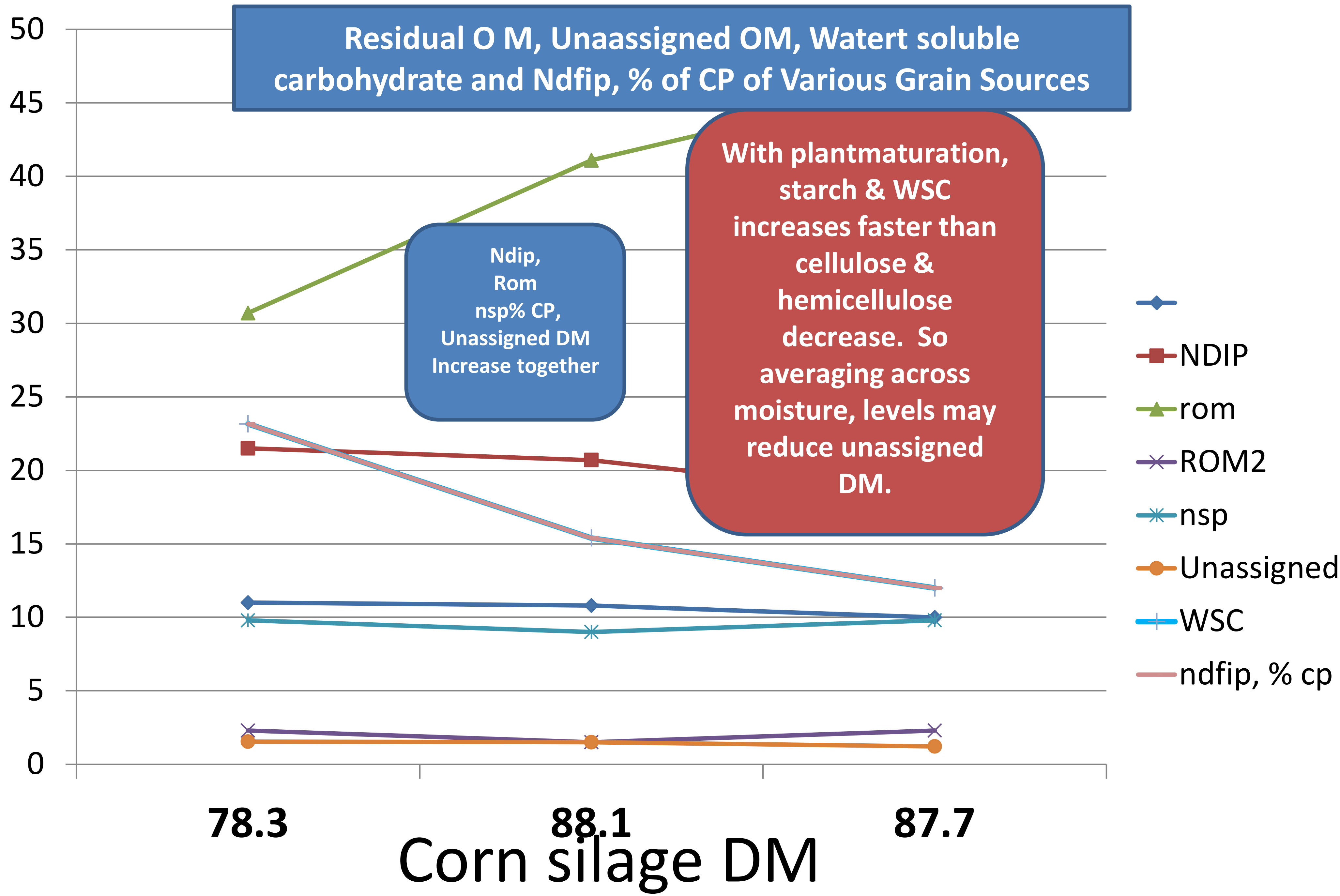
NRC 2021 Proximate Analyses . Alfalfa Hay, Immature; Mid-mature; Mature;



NDF increase with maturity; Including starch, & WSC increase, Unassigned decreased

Unassigned DM by Feed Group

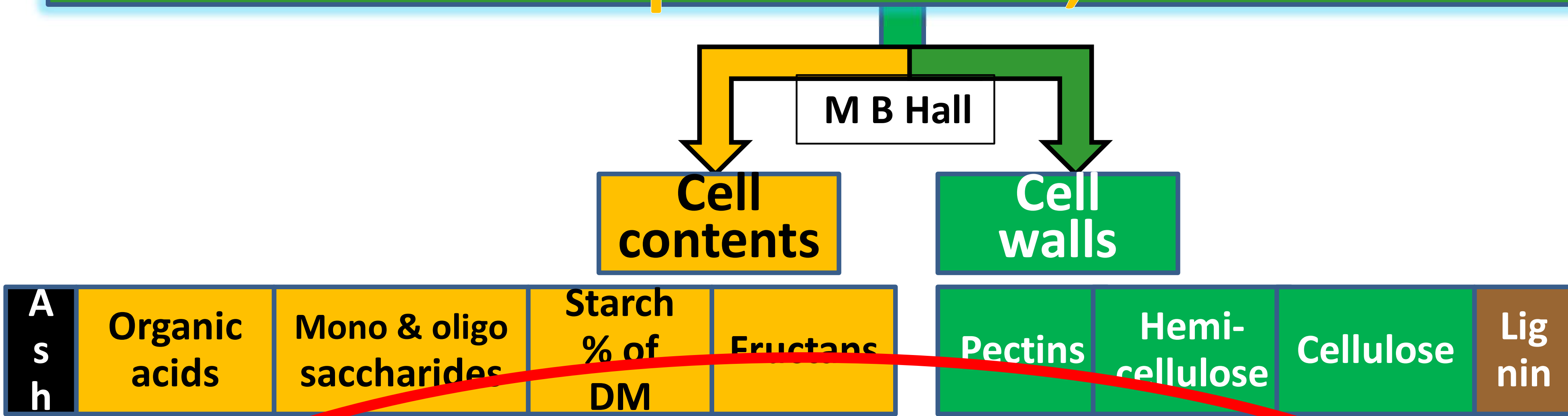
Data set	Weende (NDF)	Dairy 21	Dairy 21	Dairy 21
Group	Grains	Grains	Proteins	Hay/Silages
Average	39.15	10.18	5.85	12.58
StDev	18.41	20.3	36.18	9.67
Min	0	-27.64	-36.2	-5.72
Feed	Feathers	CGM	CGF	Sorg hay
Max	80.2	71.68	26.12	26.8
Feed	Barley	Wet beet pulp	SBM 48	Alf sil. Early
Feeds, N	19	22	19	11


Residual O M, Unaassigned OM, Watert soluble carbohydrate and Ndfip, % of CP of Various Grain Sources
With plantmaturation, starch & WSC increases faster than cellulose & hemicellulose decrease. So averaging across moisture, levels may reduce unassigned DM.
Ndip, Rom nsp% CP, Unassigned DM Increase together
50
45
40
35
30
25
20
15
10
5
0
78.3
88.1
87.7
Corn silage DM
NDIP
rom
ROM2
nsp
Unassigned
WSC
ndfip, % cp

Recommended Changes in Assays

1. Define, describe, include numbers for feeds in assay tables for NSC, ROM, Unassigned DM.
2. Avoid double counting
    1. Report NDF only on ash-free basis. [doublecounting]
    2. Report CP as CP – NDF bound N.
3. Develop, & report results for pectins, B glucans.
4. Searchable assays by assay date, NIR vs wet chem, location as being developed currently.
5. Develop and publish all assay methods (AOAC).
6. Separate NDF fractions for estimating relationships.
    1. Responses to Lignin differ from hemi & cellulose.

Plant Components, % of DM



Recommended New Analyses

Detergent fiber Recommendations:

Include ROM and NSP values in tables.

Avoid overlaps: Report NDF on an Ash free basis; Protein= (N-NDF-N)x5.6 (Marriotti2008), Add pectins, & Beta glucan asssays

Locating Unassigned DM/OM

DM basis

OM basis

Weende & NFE

100 - **ash**

- Crude Prot = N x 6.25

- Crude Fat

- Crude Fiber??

NFE =*Nitrogen free extract*

Van Soest et al. 1991

100 – **ash - urea**

- Crude Prot = N x 6.25

- Crude Fat

- NDF

- NSC = *Non-structural CHO*

- Starch

- WSC= sugars or -ESC=Oligosacch

- NDFSF= *NDF Soluble fiber*

= Pectins, tannins

Dairy NASEM, 2021

100 – **ash - urea**

- Crude Prot = N x 6.25

- Total fatty acids

- [NDF-lignin-NDF

- Starch

ROM = *Residual organic matter*

- WSC or - ESC

- Glycerol

- NDFSF

Diet Formulation

Feed-centric

Least cost energy

Animal-centric

Addition

- Butyrate
- Essential AAs

Delete

- Gluten
- Lactate
- Oligosaccharides
- Prolamins

Summary

- Recommended to include mean values for ROM and NSNSC within tabular feed tables
  - Index of the extent of unidentified substances
  - Degree that E values and digestibility may be altered to compensate for missing/excess DM or OM.
- Nutritional values are imperative to diet formulation
  - Discrepancies in actual vs estimated values may be underestimated and pose significant performance and economic detriments.