

- Horses can eat about 20 to 25 lbs of hay per 1000 lbs of body weight.
- Horses eat 2-2.5% of body weight as average to good quality hay.
- They may eat 3.0% or more of excellent hay or pasture.
- Use wet cubes for colicky horses or older horses.
- Consider super fibers for older horses/EMS
- Put horses on spring pasture after a full feed of hay to avoid colic.
- Allow two weeks for changes if possible.

# Hay Intake



## Grass Hays

- Grass hays store their energy as sugars in leaves and stems.
- Grass hays can be very high in sugars if dairy hays selected for high fructans
- Grass hay can be low in protein high in sugar if not fertilized.
- Vary in energy level
- Lower in calcium/ph (minerals) and vitamins, and trace minerals.
- Drought can raise sugars as can long days and cold nights and high altitude

## Legume Hay

- Higher in protein and energy
- They store their energy as starch and sugars in the leaves. No fructans!
- Ideal for rehabilitating starving horses
- High in Calcium and K+ and Ph, can be low in trace minerals
- A natural buffer

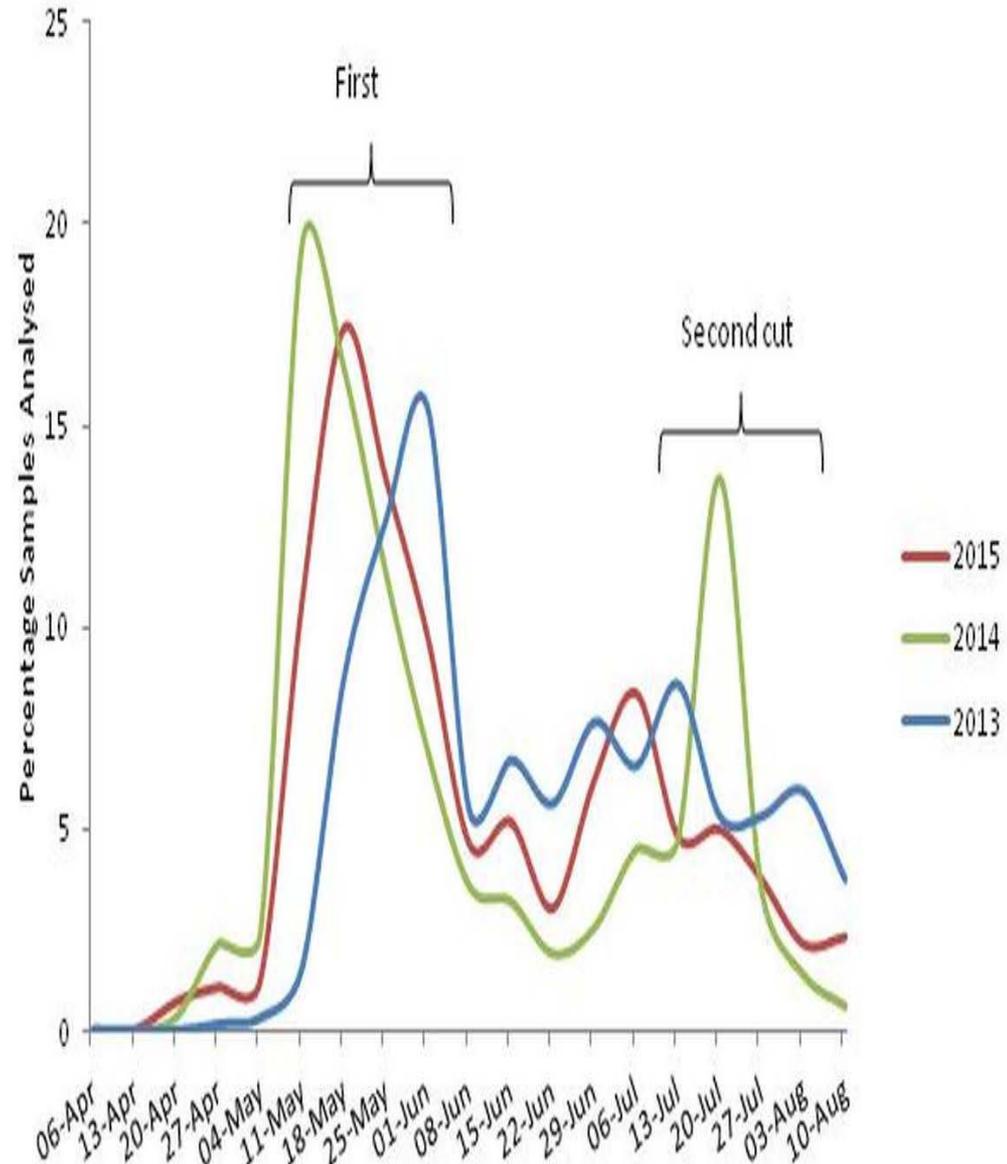
# Moisture #1

- Median average is 10-12%
- Excessive moisture leads to hay heating, quality losses, nutrient losses and even fires >18%
- Excessive moisture leads to spoilage, unpalatable
- Control storage- ventilation – lge. Quantities
- Mould – antigen – consumes nutrients and heat stress will produce toxins
- Mould spores are tiny and invisible
- Once inhaled they cause respiratory problems
- If too dry it can also cause impaction colic <5%



# Dry Matter (DM) #2

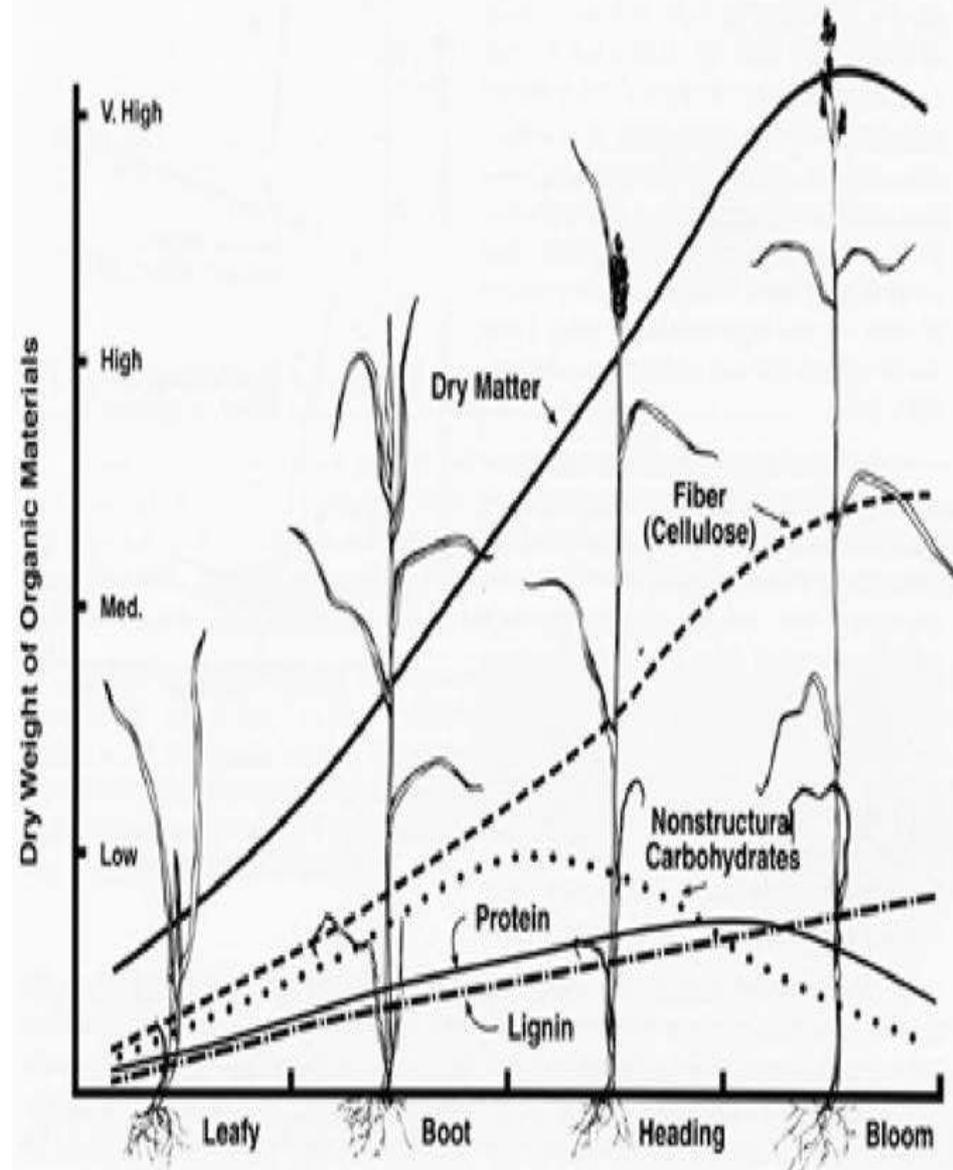
- Dry Matter is fundamental and an important analytical procedure, this is total solids once moisture is removed
- To calculate DM content simply subtract moisture content from 100
- Forage evaluation is on a DM or as fed basis (sample received). As fed includes moisture in each nutrient and always smaller values
- But, nutrients are used on a dry matter basis regardless of a concentrate or forage



# Crude Protein (CP) #3

- Protein is second most important nutrient behind water
- Hays fall anywhere between 4-20% on average depending on maturity at harvest
- Effects on Crude Protein - fertilization, environmental conditions, forage species, yield, soils, resistance to disease
- Maturity offers more yield, but lowers quality
- Alfalfa Stages – Bud, early bloom mid bloom, full bloom
- Timothy Stages – Joint, pre-bloom head, fully headed

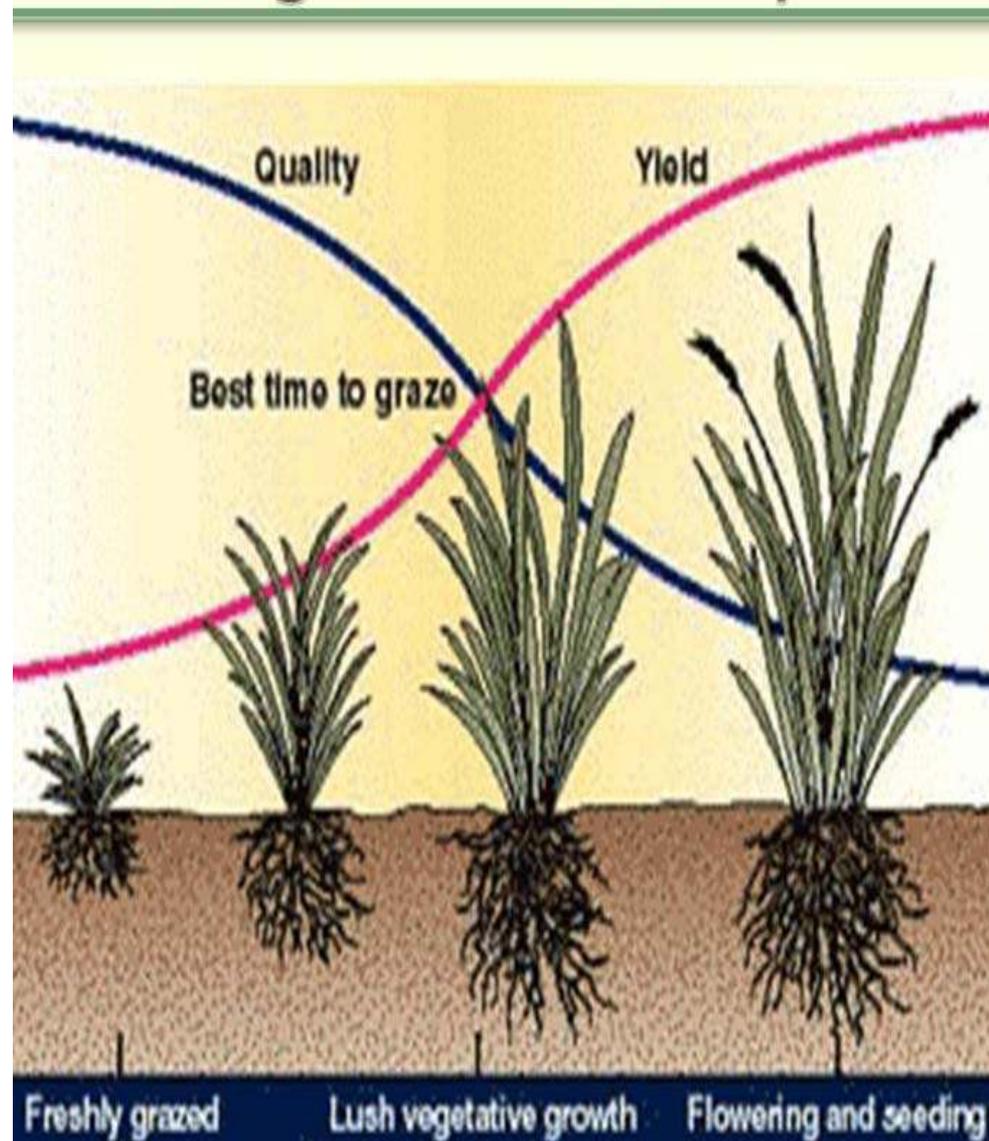
# Stage of Maturity



- Protein is necessary for producing enzymes, muscle tissue and bone density
- Every cell in the body contains hundreds of proteins that function as enzymes driving the cellular functions
- If protein is low <4%, it lacks the necessary enzymes to break down sugars, fibre is insoluble and necessitates additional amino acids to improve protein quality
- Standard protein for grass hays 8-10%, alfalfa 16-18%
- If grass hays are >16%, may be high in nitrates and pushes insulin levels and this is a caution for founder, as the amino acids push the protein into muscle tissue and insulin is a body building hormone.

# Crude Protein (CP) #3

## Stage of Maturity



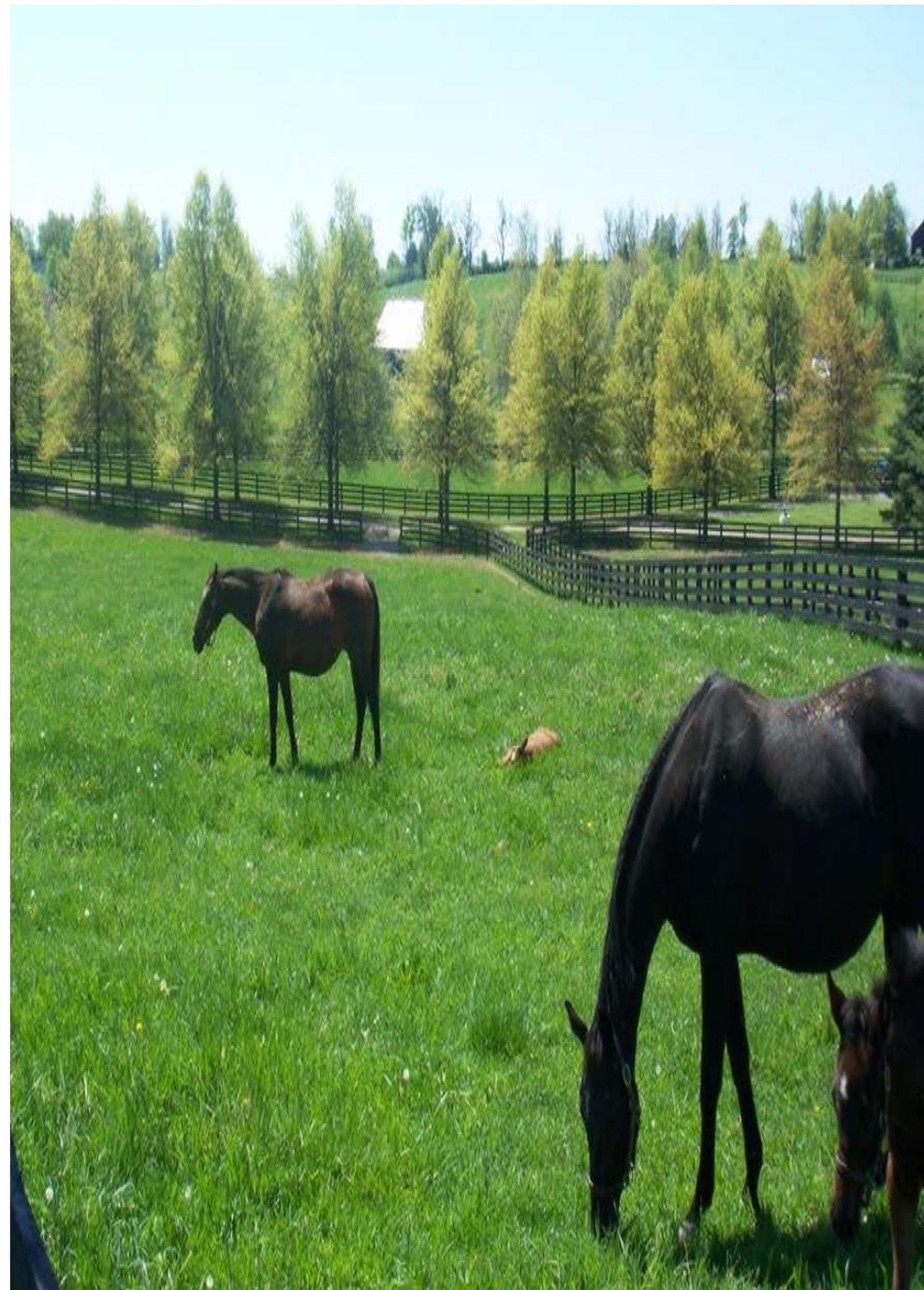
# Crude Protein (CP) #3

- Not all protein is available
- It can also lead to higher urinary and urea loads causing respiratory issues in a stall bound horse as the main end product is ammonia
- Conversely, protein is used in diets for re-feeding syndrome (starving horses) (alfalfa/ration balancer)
- Calculate protein in diet as: 453.6 grams (1 lb.) x .12 CPDM = 54.43 grams of protein, 18 lbs. of hay = 979.74 grams per day

Forage	Dry Matter %	Digestible Energy (Mcal/lb DM)	Crude Protein (%DM)	Calcium (% DM)	Phosphorus (% DM)
Legume Hay	84	1.2	20	1.5	0.3
Grass Pasture, Cool Season	20	1.1	26	0.6	0.4

## Acid Detergent Fibre (ADF) #4

- Measures fibre concentration in hay
- Less digestible carb found in cell walls, includes lignin and cellulose - difficult to digest – releases endotoxins
- Microbes needed to ferment hay
- >41%, digestibility decreases and protein is less available
- <32%, higher energy and intake, nutrients are more available, more palatable
- If more palatable, sugars more available - if overfed



## Neutral Detergent Fibre (ADF) #5

- Often considered indicator of forage quality
- Total plant cell wall carbs, ADF, hemi-cellulose
- >60%, digestibility decreases and lowers intake
- <52%, higher energy and intake, nutrients are more available, more palatable, more calories
- If NDF is high, reject, too much waste and not desirable

Forage Grade	Description	If the ADF is:	If the NDF is:	Then the RFV is:
Prime	Excellent	Under 30	Under 40	Over 151
1	Premium	31-35	41-46	150-125
2	Good	36-40	47-53	124-103
3	Fair	41-42	54-60	102-87
4	Poor	43-45	61-65	86-75
5	Reject	Over 46	Over 66	Under 74

# Lignin #6

- Provides strength and protection to plant
- Indigestible
- As plants mature – increases- stiffening agent
- We hope for approx. 5% on grass hays, 6% Alfalfa
- Too soft – quidding /wadding - impaction (dry and dusty, watch for colic)
- Too stiff, very difficult to chew
- Substitute cubes or super fibres (non lignified) - if fibre is not desirable



# Ethanol Soluble Carbohydrates ESC #7

- Carbs dissolved in ethanol solution
- Primarily digested in the small intestine (glucose, sucrose)
- Higher glycemic response – (high blood sugars)
- Generates short term energy
- Some benefits for hard working horses, not so much for horses that are sensitive to blood sugar changes, IR
- Sugar sensitivities – Cushings (PPID), tying up
- Abdominal stress associated with ESC (short chain fructans) as this sugar ferments rapidly
- If acute laminitis or very high insulin, suggest keeping <8%



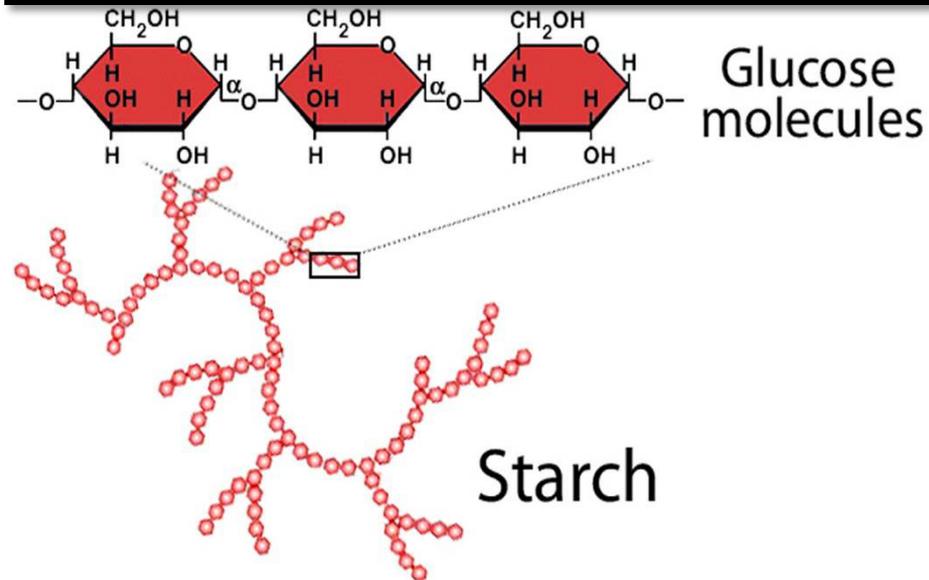
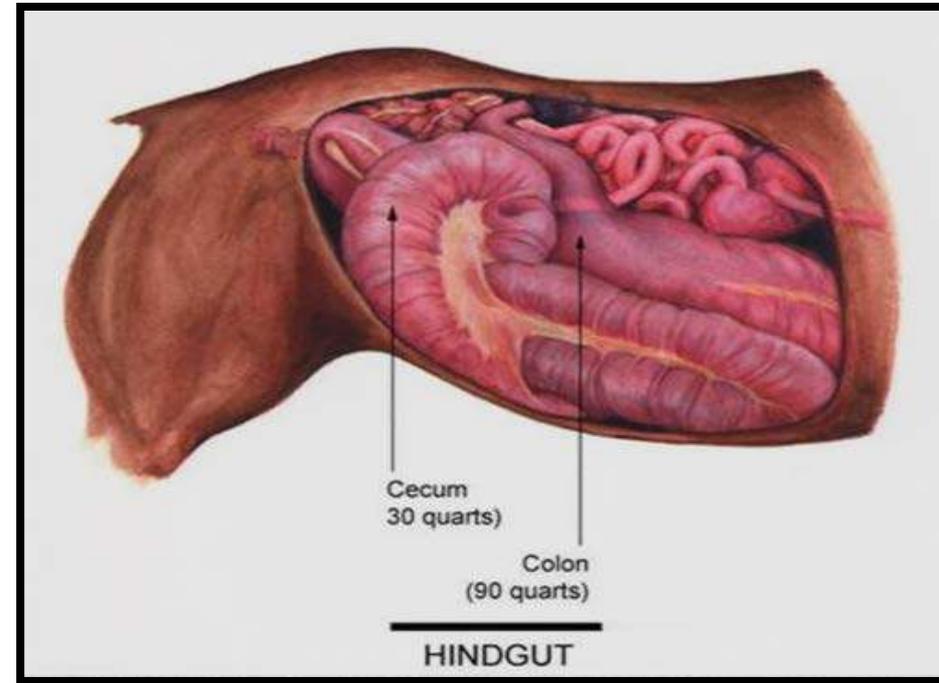
# Water Soluble Carbohydrates WSC #8

- Carbs that are extracted with water includes simple sugars and fructans
- High levels might indicate high fructans in grass hay or high simple sugars in non-grass
- Good for endurance, not laminitis
- If watching for colic, diarrhea, laminitis, need to keep this value <10%
- Wise to feed by weight and not volume
- Saying – 2% of BW



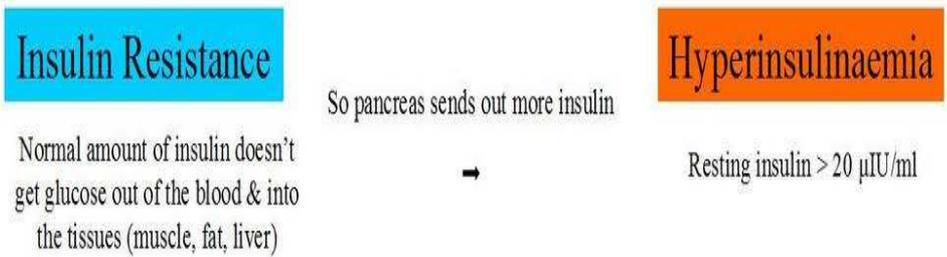
# Starch #9

- Mostly digested in small intestine broken down and absorbed as glucose (simple sugar)
- Low Starch – for IR
- High Starch – for quick energy
- Problems arise when excess reaches/ferment in the hind gut
- Rapid buildup of acid
- Hindgut acidosis leads to laminitis
- Destroys B Vitamins

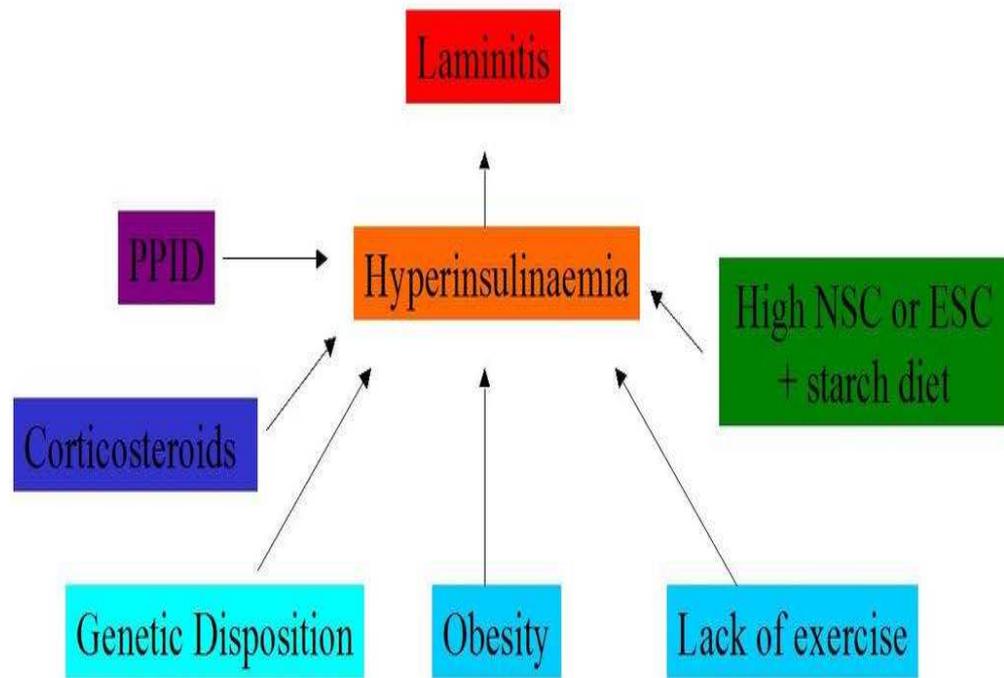


# Starch #9

- 70% of starch is dumped into hind gut
- Gas production during starch fermentation causes pain and colic
- Fibre digestion reduced
- Manure – soft and vomit smell (acidic aroma)
- Feed little and often - oats
- Grams per hour



## Possible causes of hyperinsulinaemia



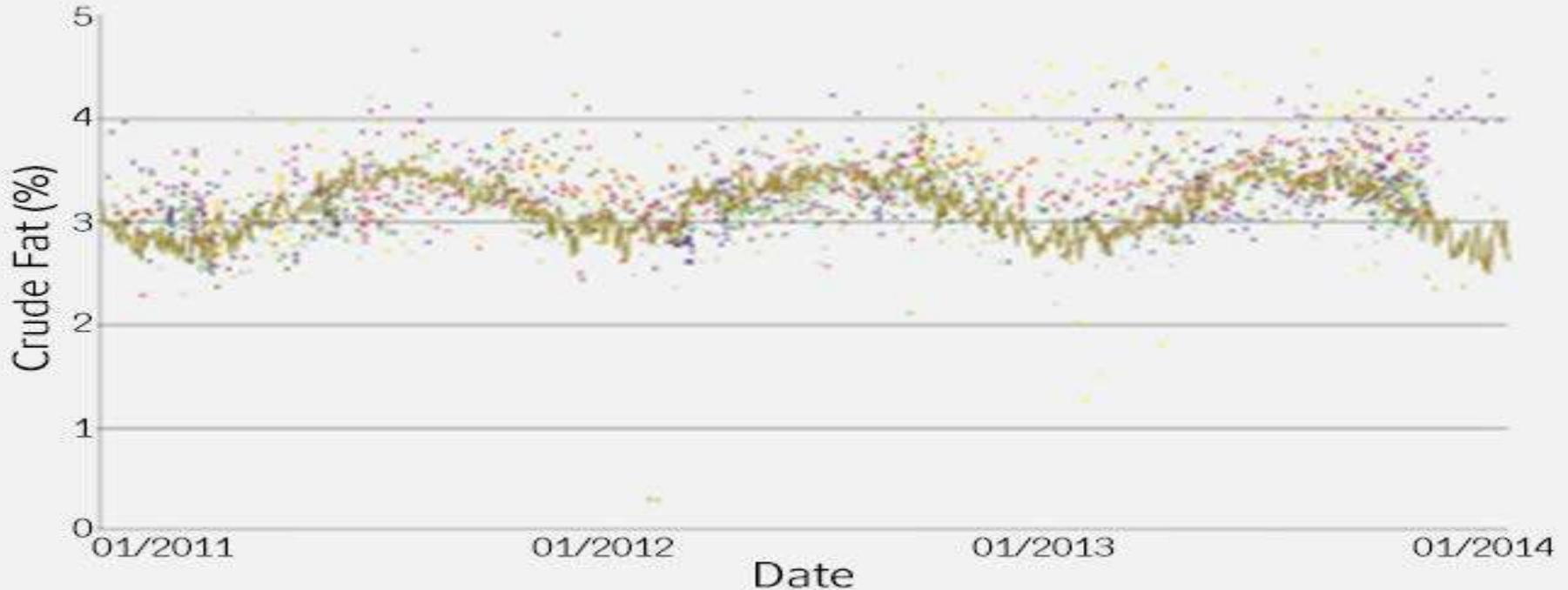
# Fructans #9A

- Can trigger colic or laminitis from toxic effects from a lower PH level
- Fructans can be 30-40% and they only ferment in the hind gut. Fructans vary in type and fermentation rate.
- Lactic acid forms from low ph and then good microbes die (D and L)
- Not digested in small intestines only hind gut
- Excessive caloric intake, obesity #2 behind colic
- Found in cool season grasses but not alfalfa
- Try and avoid being without any forage for longer than 4-5 hours or problems may occur



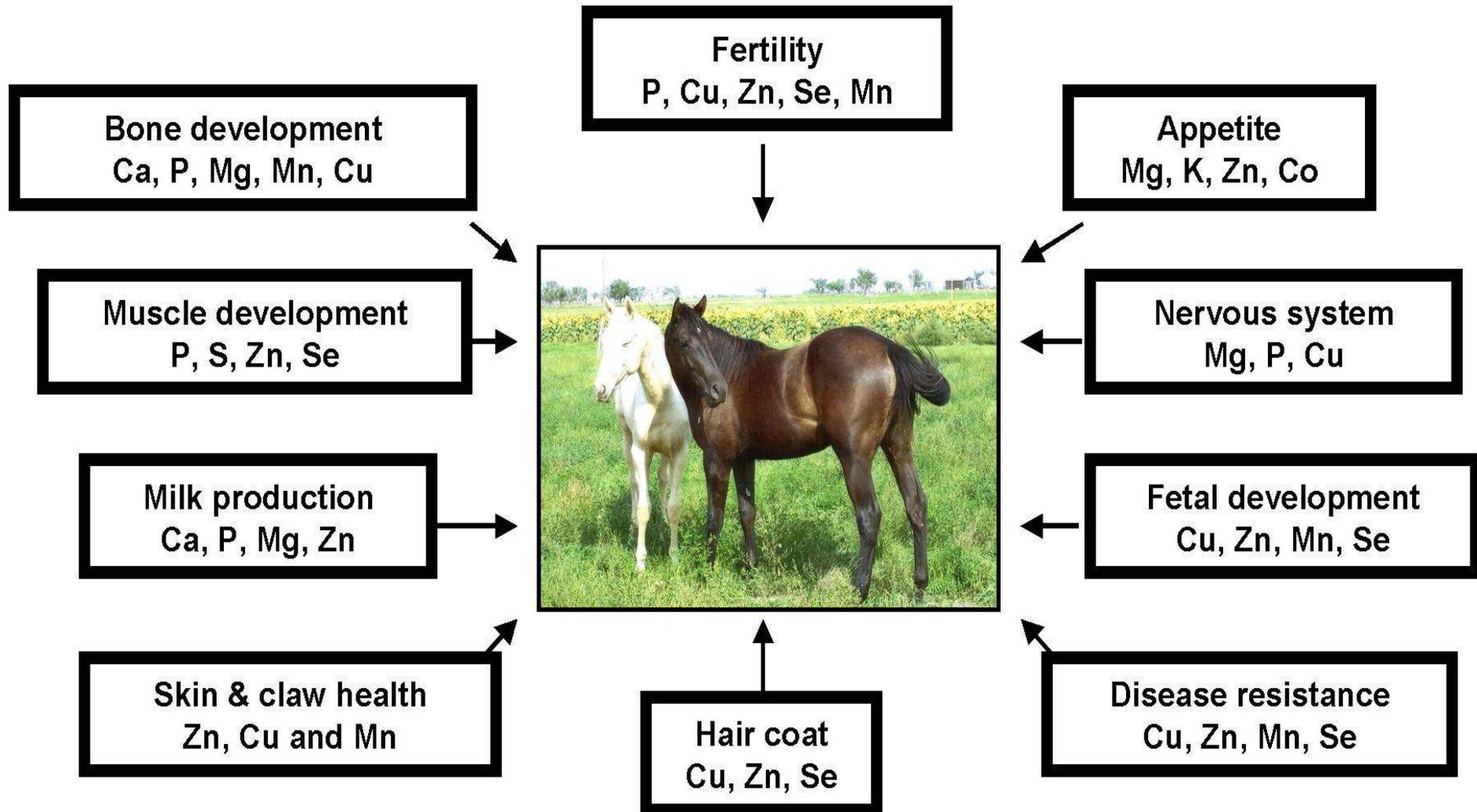
# Crude Fat #10

- Is a measure of energy and caloric intake
- Baled hay usually contains lower amounts of fat – not a concern
- However, when insulin is elevated it leads to fat storage and next on the list is laminitis
- Every nutrient can play a role
- Harvesting can affect nutrient density



# Minerals #11

## WHY ARE MINERALS IMPORTANT?



# Energy #12

- Expressed as either Mcal/Kg or Mcal/lb
- Calculate Mcal/lb in diet
- $DE = \text{Horse's weight (500kg)} \times 0.0333$
- 16.65 Mcals per day
- Depends on workload and metabolism
- Easy Keepers / Hard Keepers
- Activity factors can influence these numbers greatly

## Digestible Energy of Typical Horse Feeds on DM Basis

<b>Feed Type</b>	<b><u>Mcal/kg</u></b>	<b><u>Mcal/lb</u></b>
Forages	1.6-2.4	0.8-1.1
Cereal Grains	2.8-3.4	1.3-1.6
By-Products	2.5-3.0	1.1-1.5
Fats/Oils	9.1	4.1
Commercial Feeds	2.0-3.7	0.9-1.8

Components	As Sampled Basis	Dry Matter Basis
% Moisture	8.04	
% Dry Matter	91.96	
% Crude Protein	4.41	4.80
% ADICP	.66	.72
Soluble Protein % CP		46.49
% NDICP	1.41	1.53
% Acid Detergent Fiber	34.67	37.70
% aNDFom	52.12	56.67
% Lignin	3.75	4.08
% NFC	29.69	32.29
% Starch	.93	1.01
% WSC (Water Sol. Carbs.)	19.83	21.56
% ESC (Simple Sugars)	7.21	7.84
% Crude Fat	1.81	1.97
% Ash	4.15	4.51
% TDN	58.23	63.32
NEL, Mcal/Lb	.54	.58
Relative Feed Value		96
% Calcium	.24	.26
% Phosphorus	.15	.16
% Magnesium	.12	.13
% Potassium	1.03	1.12
% Sulfur	.10	.11
% Chloride Ion	.26	.28
Milk Kg/Ton, 48h		1,572
% uNDFom 240hr		21.5
NDFDom 30hr, % of NDF		42.2
NDFDom 120hr, % of NDF		57.7
NDFDom 240hr, % of NDF		62.1
% C18:1, Oleic Acid		.05
% C18:2, Linoleic Acid		.07
% C18:3, Linolenic Acid		.17
% RUFAL		.29
% TFA		.65
Horse DE, Mcal/Lb	.98	1.06

# Forage for Horses

**SAMPLE INFORMATION**

Lab ID:	19548 040	Version:	2.0
Crop Year:	2016	Series:	
Feed Type:	MMG FORAGE	Cutting#:	2
Package:	BASIC NIR		

**NIR ANALYSIS RESULTS**

Moisture	12.0
Dry Matter	88.0

**PROTEINS % SP % CP % DM**

Crude Protein			12.1
Adjusted Protein			
Soluble Protein	25.4		3.1
Ammonia (CPE)			
ADF Protein (ADICP)	7.5		0.90
NDF Protein (NDICP)	27.6		3.33
NDR Protein (NDRCP)			
Rumen Degr. Protein	62.7		7.6
Rumen Deg. CP (Strep.G)			

**FIBER %NDFom NDFom %DM % NDF % DM**

ADF			61.0	28.8
aNDF		44.5		47.3
NDR (NDF w/o sulfite)				
peNDF				
Crude Fiber				
Lignin			5.76	2.72
NDF Digestibility (12 hr)				
NDF Digestibility (24 hr)				
NDF Digestibility (30 hr)	74.2	33.0	69.8	33.0
NDF Digestibility (48 hr)				
NDF Digestibility (120 hr)	82.1	36.5	77.2	36.5
NDF Digestibility (240 hr)	87.7	39.0	82.5	39.0
uNDF (30 hr)	25.8	11.5	30.2	14.3
uNDF (120 hr)	17.9	8.0	22.8	10.8
uNDF (240 hr)	12.3	5.5	17.5	8.3

**CARBOHYDRATES % Starch % NFC % DM**

Silage Acids			
Ethanol Soluble CHO (Sugar)		39.0	12.5
Water Soluble CHO (Sugar)			
Starch		9.7	3.1
Soluble Fiber			
Starch Dig. (7 hr, 4 mm)			
Fatty Acids, Total			1.85
Fatty Acids (%Fat)			60.5
Crude Fat			3.06

**MINERALS**

Ash (%DM)	8.99
Calcium (%DM)	0.52
Phosphorus (%DM)	0.25
Magnesium (%DM)	0.19
Potassium (%DM)	2.40
Sulfur (%DM)	0.18
Sodium (%DM)	
Chloride (%DM)	
Iron (PPM)	
Manganese (PPM)	
Zinc (PPM)	
Copper (PPM)	
Nitrate Ion (%DM)	
Selenium (PPM)	
Molybdenum (PPM)	

**QUALITATIVE**

Total VFA (%DM)	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Butyric Acid (%DM)	
1, 2 Propanediol (%DM)	
Titrateable Acidity (meq/100gm)	
Soil Contamination Probability	Probable low to none
Nitrate Probability	Probable low nitrate level
NIR Statistical Confidence	Excellent prediction potential

**ENERGY & INDEX CALCULATIONS**

pH	0.00
Equine TDN (%DM)	56.54
Equine DE (mcal/lb)	1.13
Net Energy Lactation (mcal/lb)	0.69
Net Energy Maintenance (mcal/lb)	0.53
Net Energy Gain (mcal/lb)	0.27
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	4.97
NDF Dig. Rate (Kd, %HR, uNDF)	9.13
Starch Dig. Rate (Kd, %HR, Mertens)	
Relative Feed Value (RFV)	131
Relative Feed Quality (RFQ)	214
Milk per Ton (lbs/ton)	3322
Dig. Organic Matter Index (lbs/ton)	1350
Non Fiber Carbohydrates (%DM)	32.0
Non Structural Carbohydrates (%DM)	15.5
DCAD (meq/100gdm)	
CNCPS / CPM Lignin Factor	3.4
Summative Index % (Mass Balance)	
Additional sample information, source and lab pictures	



# Forage for Horses

**03BH ALFALFA****SAMPLE INFORMATION**

Lab ID:	19548 039	Version:	2.0
Crop Year:	2016	Series:	
Feed Type:	LEGUME FORAGE	Cutting#:	2
Package:	BASIC NIR		

**NIR ANALYSIS RESULTS**

Moisture	20.9
Dry Matter	79.1

**PROTEINS % SP % CP % DM**

Crude Protein			17.5
Adjusted Protein			
Soluble Protein		40.6	7.1
Ammonia (CPE)			
ADF Protein (ADICP)		7.9	1.38
NDF Protein (NDICP)		16.5	2.89
NDR Protein (NDRCP)			
Rumen Degr. Protein		70.3	12.3
Rumen Deg. CP (Strep.G)			

**FIBER %NDFom NDFom %DM % NDF % DM**

ADF			85.3	41.2
aNDF		47.8		48.3
NDR (NDF w/o sulfite)				
peNDF				
Crude Fiber				
Lignin			16.5	7.95
NDF Digestibility (12 hr)				
NDF Digestibility (24 hr)				
NDF Digestibility (30 hr)	36.4	17.4	36.0	17.4
NDF Digestibility (48 hr)				
NDF Digestibility (120 hr)	41.8	20.0	41.4	20.0
NDF Digestibility (240 hr)	44.1	21.1	43.6	21.0
uNDF (30 hr)	63.6	30.4	64.0	30.9
uNDF (120 hr)	58.2	27.8	58.6	28.3
uNDF (240 hr)	55.9	26.7	56.4	27.2

**CARBOHYDRATES % Starch % NFC % DM**

Silage Acids			
Ethanol Soluble CHO (Sugar)		26.0	7.1
Water Soluble CHO (Sugar)			
Starch		6.6	1.8
Soluble Fiber			
Starch Dig. (7 hr, 4 mm)			
Fatty Acids, Total			1.18
Fatty Acids (%Fat)			57.0
Crude Fat			2.07

**MINERALS**

Ash (%DM)	7.86
Calcium (%DM)	1.22
Phosphorus (%DM)	0.21
Magnesium (%DM)	0.25
Potassium (%DM)	2.39
Sulfur (%DM)	0.26
Sodium (%DM)	
Chloride (%DM)	
Iron (PPM)	
Manganese (PPM)	
Zinc (PPM)	
Copper (PPM)	
Nitrate Ion (%DM)	
Selenium (PPM)	
Molybdenum (PPM)	

**QUALITATIVE**

Total VFA (%DM)	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Butyric Acid (%DM)	
1, 2 Propanediol (%DM)	
Titrateable Acidity (meq/100gm)	

Soil Contamination Probability	Probable low to none
Nitrate Probability	Probable moderate nitrate level
NIR Statistical Confidence	Excellent prediction potential

**ENERGY & INDEX CALCULATIONS**

pH	0.00
Equine TDN (%DM)	51.77
Equine DE (mcal/lb)	1.04
Net Energy Lactation (mcal/lb)	0.59
Net Energy Maintenance (mcal/lb)	0.47
Net Energy Gain (mcal/lb)	0.22
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	2.88
NDF Dig. Rate (Kd, %HR, uNDF)	3.71
Starch Dig. Rate (Kd, %HR, Mertens)	
Relative Feed Value (RFV)	110
Relative Feed Quality (RFQ)	108
Milk per Ton (lbs/ton)	2427
Dig. Organic Matter Index (lbs/ton)	969
Non Fiber Carbohydrates (%DM)	27.2
Non Structural Carbohydrates (%DM)	8.9
DCAD (meq/100gdm)	
CNCPS / CPM Lignin Factor	11.3
Summative Index % (Mass Balance)	
Additional sample information, source and lab pictures	

# Forage for Horses



# The End

