

# **Carbohydrate Nomenclature and Analysis: No Wonder We're all Confused**

**Kathryn Watts**

**Rocky Mountain Research & Consulting, Inc.**



## Plant Scientist definitions:

- Structural carbs in plant cell walls
  - cellulose, hemicellulose, pectin
- Non Structural Carbs inside the cells:
  - sugars and fructan stored in vacuoles
  - starch made and stored in chloroplast

# NSC: Plant scientist's definition

- **sugars: mono- and di-saccharides**
- **fructans-fructose chains**
  - FOS-fructo-oligosaccharides  
have very short chains
  - longer chain fructans
- **starch**



# **NSC- Lab definitions:**

- **Research labs use enzymes or HPLC to measure sugar, fructan and starch separately.**
- **Not commercially viable -\$\$\$.**
- **Labs may differ in what they are calling “NSC” as they use different methods.**
- **Water Soluble Carbs + starch comes closest to plant scientist’s definition.**





# Nutritionists view of carbs

- NSC is a good definition for agronomists, but does not fit animal nutrition as well.
- The fate or affect on the animal is more important.
- “Glycemic” “fermentable”  
“hydrolysable”



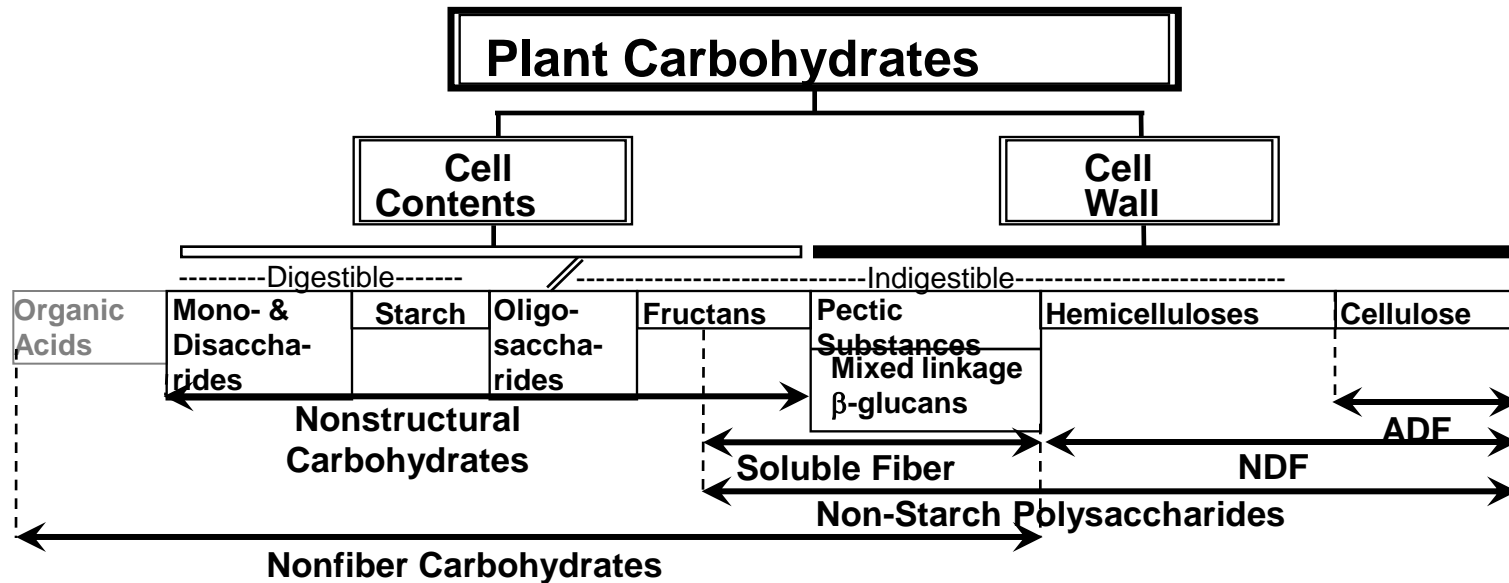
# **NSC: Nutritionist's definition**

- **Their lab's definition?**
- **Do they know their lab's definition and procedure may differ from other labs?**
- **Many nutritionists use NFC and NSC interchangeably.**
- **“ low carb” by whose definition?**

# Non Fiber Carbs by calculation

- Proximate analysis
- $NFC = NFC\% = 100 - (CP + (NDF - NDICP) + Fat + ash)$
- where CP = crude protein,
- NDF = neutral detergent fiber
- NDICP = neutral detergent insoluble crude protein.
- Fat = ether extract
- Ash = what's left after burning.
- Very old fashioned, inaccurate.





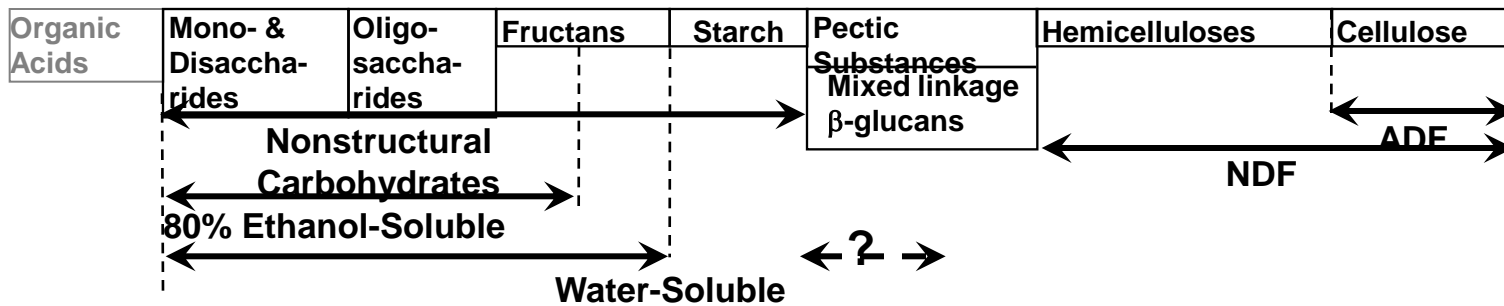
**NFC ≠ NSC** - difference is organic acids, pectin and glucans

**Pectin very high in alfalfa, clover, beet pulp and soy hulls.**

Diagram provided by Dr. Mary Beth Hall, US Dairy Research Center, Madison, WI







WSC = simple sugars + all fructans + maybe some glucans and pectin –depending on the plant

ESC = simple sugars + shorter chain fructans

WSC – ESC  $\approx$

Longer chain fructans + W soluble pectin and glucans??

Diagram provided by Dr. Mary Beth Hall, US Dairy Research Center, Madison, WI



# WSC ≠ fructan

- Support for the fructan theory of laminitis often based on WSC data.
- If the analytical procedure is not included with data, it is impossible to determine exactly what was quantified.
- Sugars must be high to induce fructan formation in grass.
- High fructan grass is always fairly high in sugar, too.



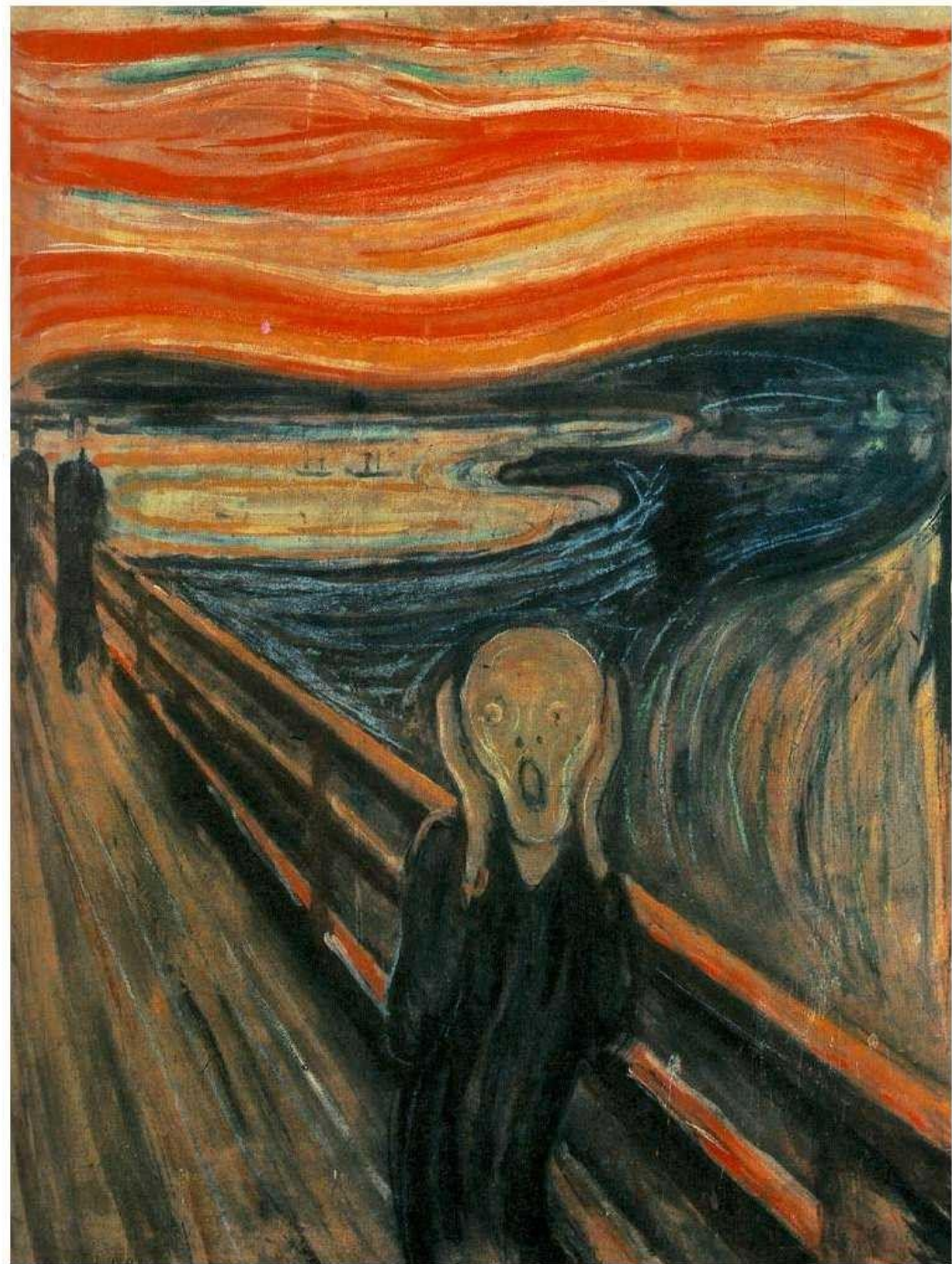
# Is ESC a 'better' test?

- Some nutritionists think so.
- simple sugars seem more important to insulin resistant horses.
- Shorter chain fructans would ferment fastest, theoretically causing more damage to GI tract.
- FOS = rise in insulin Bailey, et al, JAVMA (2007)231:1365-1373
- So.....they change the definition of NSC to (ESC + starch)



But you  
can't just  
change  
definitions!

**NSC  $\neq$  ESC + starch**





# Sugar: definitions

- simple sugars- mono or di-sac
- complex sugar or polysaccharide  
(includes fructan)
- invert sugar
- reducing sugar
- WSC (all sugars + all fructans)
- ESC (sugar + short fructans)

# Starch:

- **resistant starch- resistant to digestion**  
**- by a horse, or a cow?**
- **Is rapidly digestible starch better, or worse for laminitic horses?**
- **People don't bother to look in hay, but cool season grass with no heads can have up to 6% starch in leafy tissue.**
- **Warm season grasses can have more.**

# Variables in CHO testing

- **Sampling procedure**
- **Sample storage temperature**
- **Sample prep- oven vs. freeze dried**
- **temperature of extraction solution**
- **strength of extraction solution**
- **time in extraction solution**
- **stirred vs. non –stirred**
- **strength of hydrolyzing acid**
- **enzymes: purity, strength**
- **human error**

# “low carb” feeds

- **Who’s definition of NSC is being used?**
- **What is an appropriate amount of NSC?**
- **Is sugar, starch or fructan more important?**
- **Which dietary theory of laminitis does your feed company follow?**
- **Beware: grain processing to prevent hind gut fermentation increases glycemic response.**



# Take home message:

- **Plant scientists, analytical labs and nutritionists often don't speak the same language.**
- **Don't compare NSC tests numbers from one lab to another.**
- **We desperately need standardization of carbohydrate testing procedures.**

