Plant Physiology

What a rangeland manager needs to know.

Integrated Rangeland Management

Plants are the "ultimate" source of organic energy in ecosystems

Plants produce biomass through photosynthesis:

- Get raw material from soil.
- When leaves are removed from plants, food-producing capacity is reduced.
- Therefore, we manage amount of “photosynthetic material” on plant.

To manage we must understand biotic and abiotic influences on photosynthesis.

Start with Photosynthesis

$$CO_2 + H_20 + \text{Energy from Sun} \rightarrow (CH_2O)_n + 0_2$$

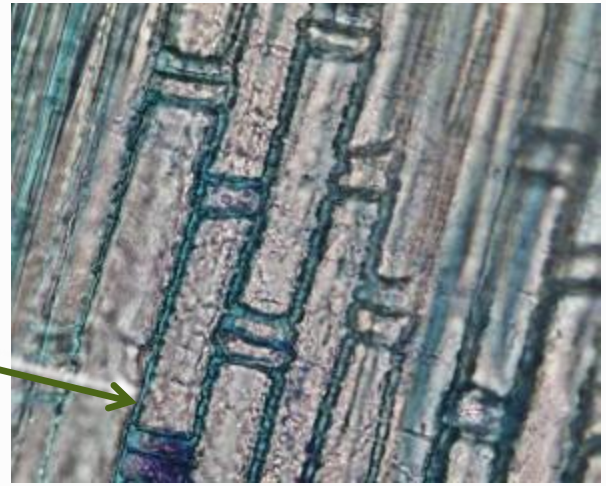
How is chemical energy stored?

Non-structural Carbohydrates (CHOs)

- Sugars & starches from photosynthesis

Structural CHO‘s

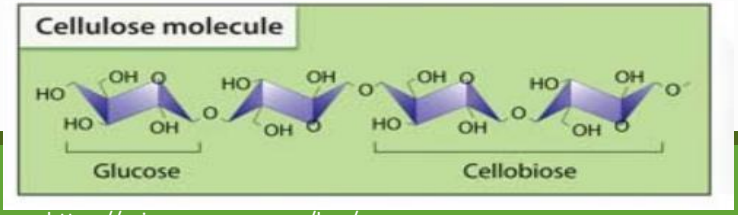
- Mostly cell walls



Products of photosynthesis

Non-structural (or soluble) Carbohydrates (CHO's):

- Immediate energy for plants & animals
- **Sucrose** is the major form in which soluble CHO's are **transported** in plants
- **Starch** is the major form in which soluble CHO's are **stored** in plants
- Structural CHOs
- Once made, cannot be used for energy by plant or mammals (except through symbiotic relationship with microbes in rumen or hind-gut).
- Cellulose is the most important structural CHO in plants –
  - **The MOST abundant CHO in world.**



https://science.energy.gov/ber/

And then there is **Respiration**

$$C_6H_{12}O_2 + O_2 \rightarrow CO_2 + H_20 + \text{Energy for plant}$$

What is energy used for?

Energy for assimilation

- Synthesize compounds (i.e., proteins and CHO's)
- Mineral uptake
- Active transport of metabolites

Maintenance

- Respiration of living tissue
- Respiration during dormancy

And then there is **respiration**.

Energy also used for?

Vegetative Growth

- regenerating leaves, stems, and roots after dormancy
- bud formation
- regrowth after grazing, mowing & fire

Reproductive Growth

- elevation of apical meristems
- produce flowers and seeds

What affects **Photosynthesis** and **Respiration?**

- Leaf area and age
- Light quality
- Temperature (air and soil)
- Soil moisture content
- Soil nutrient levels
- Carbon dioxide concentration
- Efficiency of photosynthate transport

Grazing & Fire alter physiological activities

- Removes plant photosynthetic tissue
- May remove meristems
- Changes Live:Dead ratio of tissue
- Mechanical impact:
  - Trampling of soil
  - Break branches and remove leaves
- Heat effects:
  - Kills leaves and stems
  - Damage meristems

Carbon Reserves – use of non-structural CHO's

An important concept:

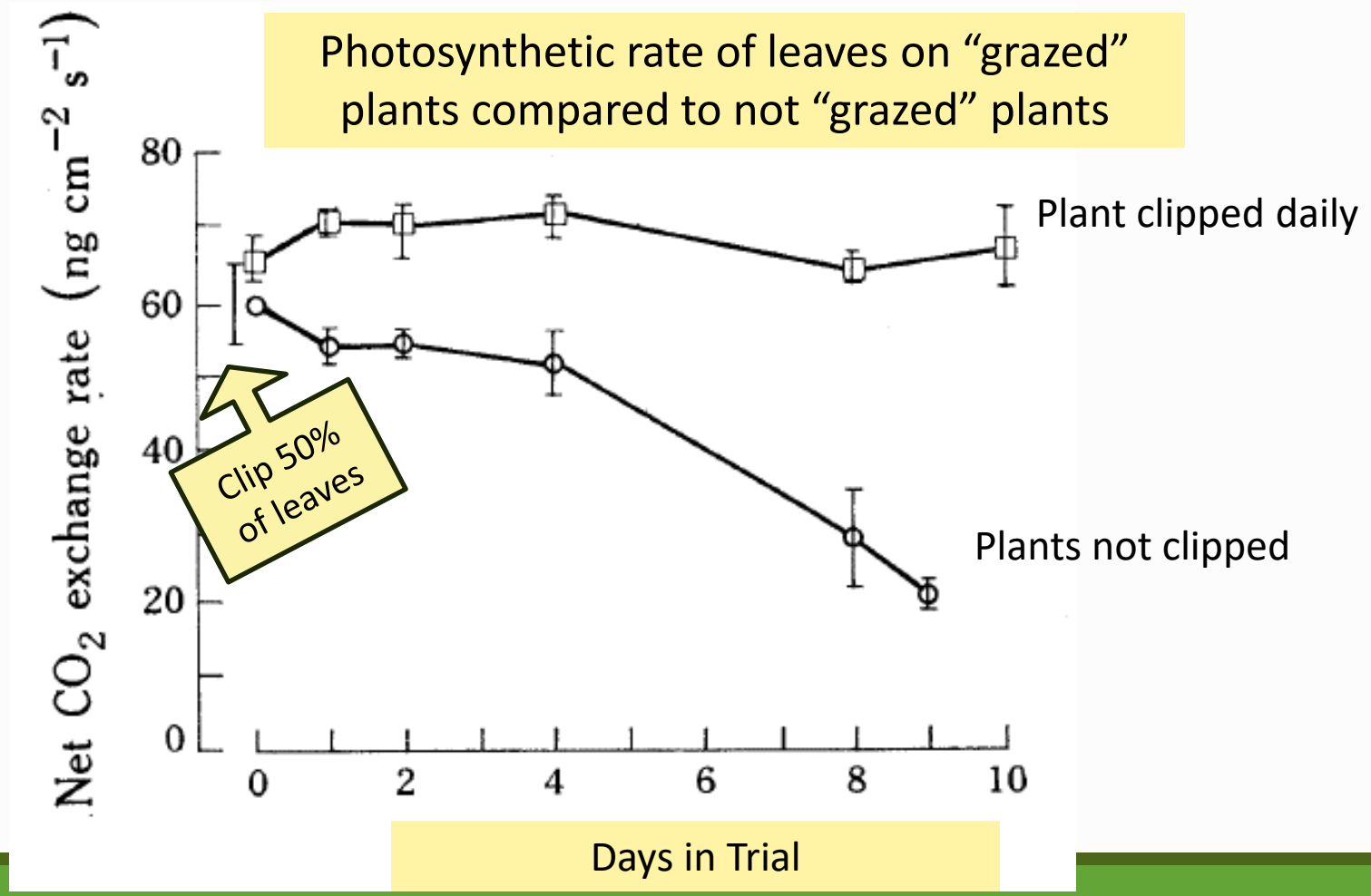
Carbon Gain = Leaf Area + Psyn Rate

After grazing the Psyn rate may increase (<15%) in some plants.

This is called …

Compensatory Photosynthesis

Compensatory Photosynthesis



Senock, R. S., Sisson, W. B., & Donart, G. B. 1991. *Botanical gazette* 152(3):275-281

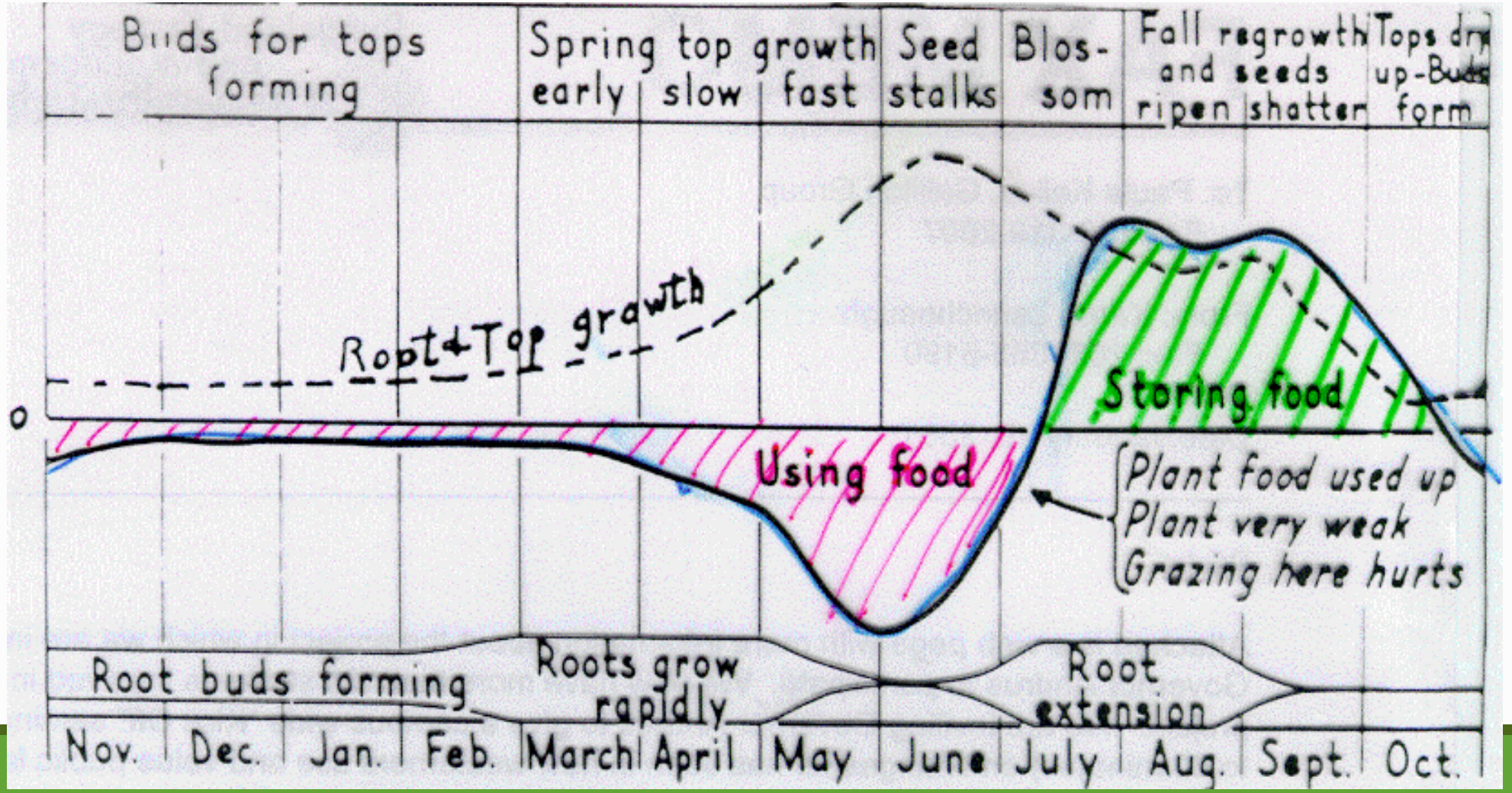
Role of Carbohydrate Reserves in Plant Recovery from Defoliation

Historic view – believed carbohydrate reserves were very important.

Contemporary view – focuses on current conditions and amount of leaf material remaining after grazing.

Historic View (until 1980s)

Premise = CHO reserve levels synonymous with plant vigor and ability to survive grazing, drought, etc.



Historic View (until 1980's)

Premise:

- CHO reserve levels were synonymous with plant vigor and ability to survive grazing and drought, etc.

Management implications:

- If you believed this theory, the **timing** of defoliation and amount of **rest** following defoliation were the key to proper grazing management.

What did scientists measure?

- Concentration or percentage of CHO's in plant tissue

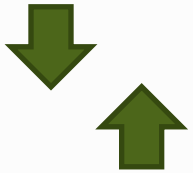
Contemporary View (after 1980's)

Recovery depends on resources well beyond stored CHO's.

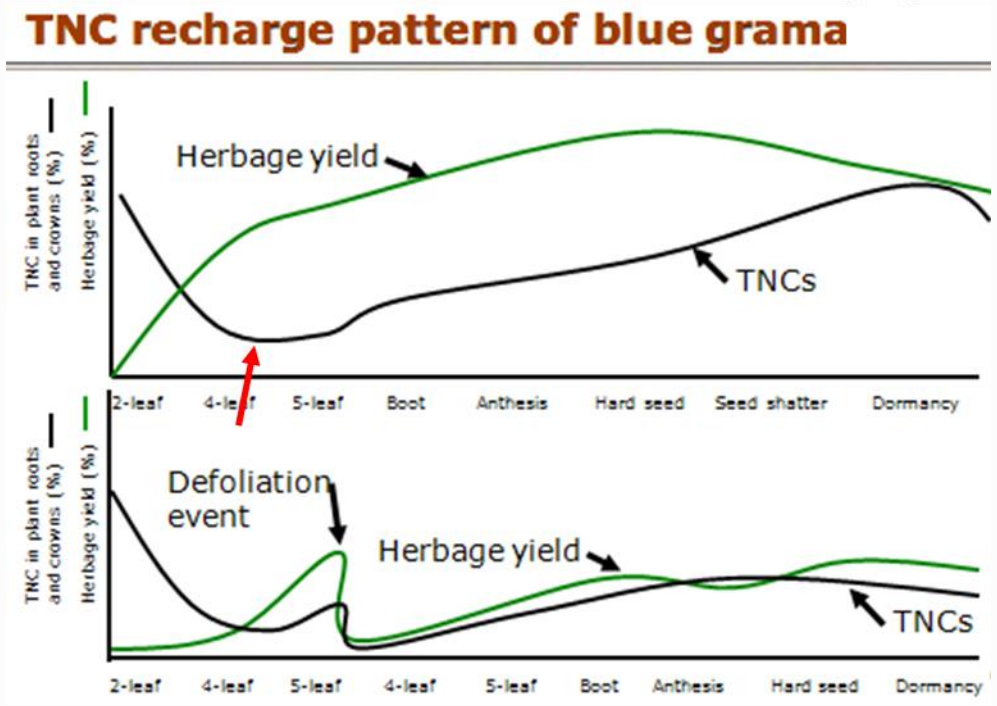
- *Some scientists challenged the view that CHO reserves were a major reservoir of energy used by the plant for regrowth.*

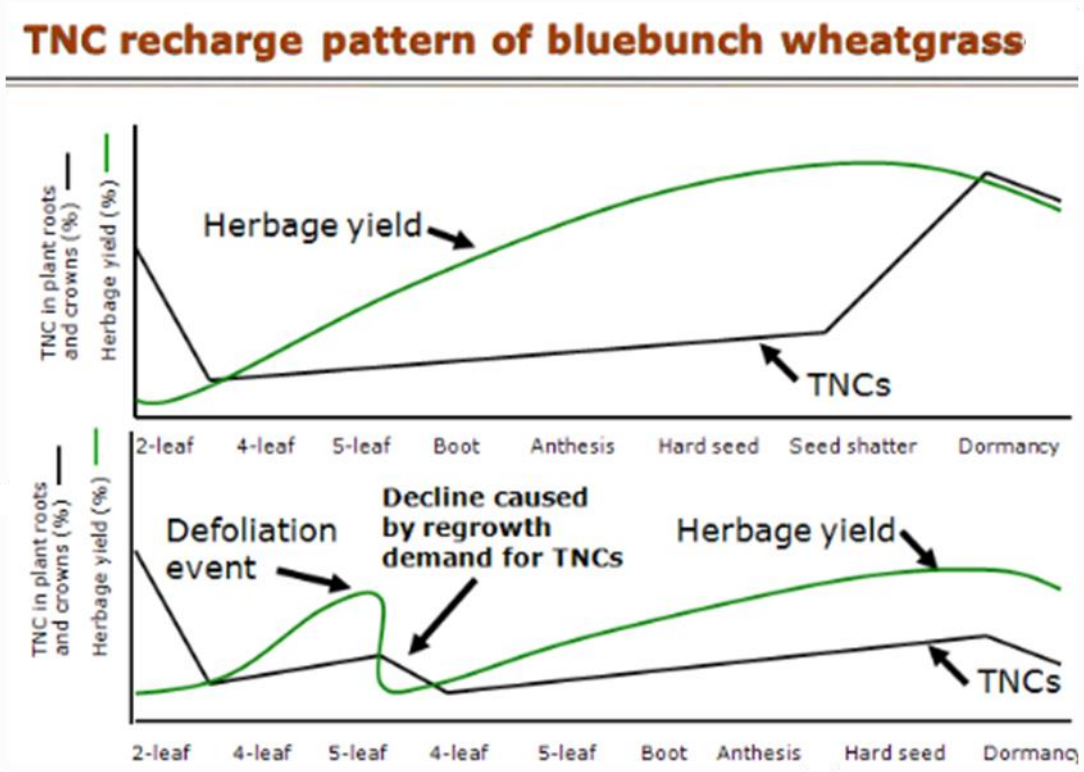
What did these scientists measure?

- CHO's Pools = **Concentration + Mass** = Total Non-Structural CHO's (TNC)
- Found out that CHO pools may be increasing during early growth.
  - Concentration
  - Mass



Contemporary View (after 1980's)





Some plants respond more quickly than others

Contemporary View (after 1980's)…

Management Implications

- *Important to manage the **intensity of defoliation**.*
- *CHO reserves less important than once believed …. just part of a complex process.*
- *CHOs are **battery** to "jump-start" growth after defoliation not a **gas tank** to sustain growth.*
- *When growing conditions are good (i.e., spring), defoliation, is not as detrimental as because most energy for regrowth comes from current photosynthesis, not stored reserves.*

2 Important Grazing Mgmt Concepts

Range Readiness = Stage of plant growth at which grazing may begin in spring plan without permanent damage to vegetation or soil."(Glossary of Terms Used in Range Management, Society for Range Management, 1974.)

- When is Range Readiness?

Range Utilization (or *Proper Use Factor*) = The proportion of current year's growth, that can be removed annually without causing damage to rangeland plants or lead to land degradation.

- What is appropriate level of Range Utilization?

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