Workshop 2: Grassland Conservation: Silage-Making for Smallholder Farmers

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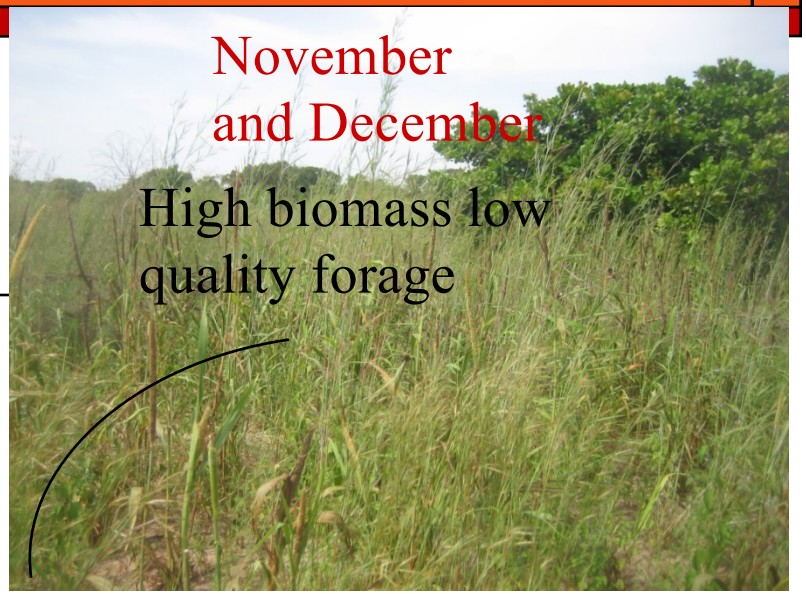
Thailand

Why forage conservation - Silage

- **Forages can be conserved to feed livestock during periods of shortage:**
  - **Caused by limited pasture growth or inadequate pasture conditions**
  - **Fed as a supplement.**

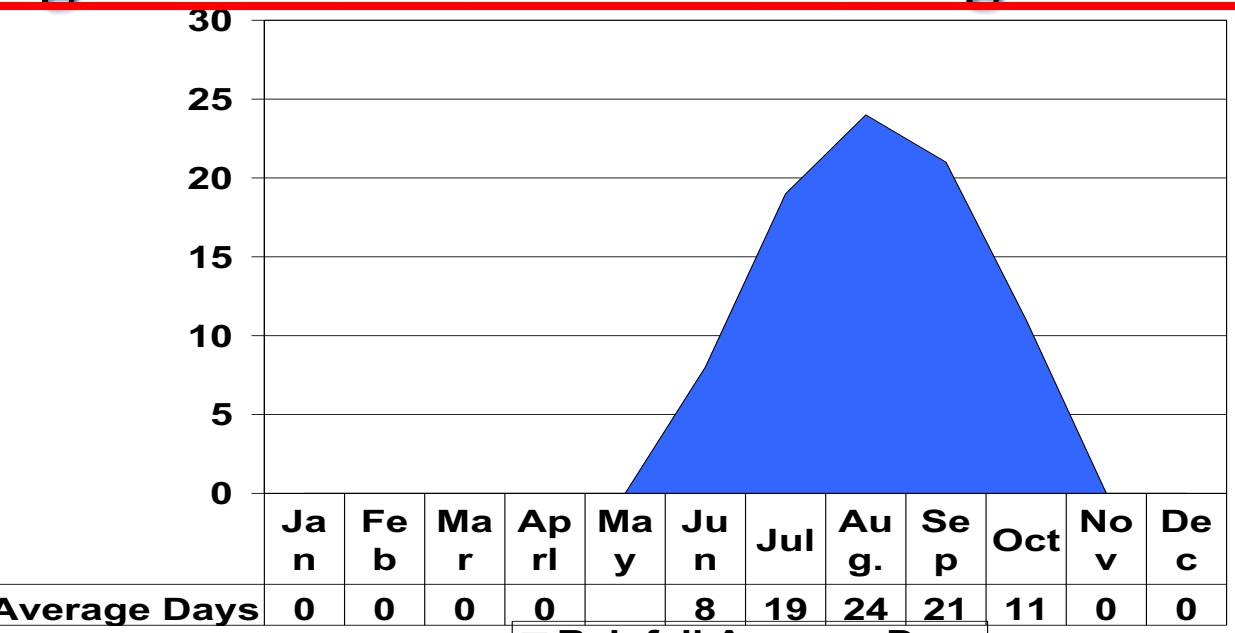
July, August, September, and October (4 months – excess feed resources

November and December



Mid February, March, April, May , June (5 month)

Forage Distribution in Most Senegal



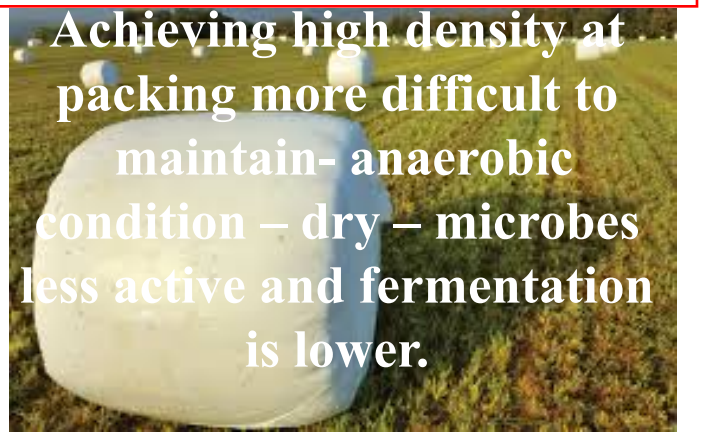
What is silage?

- **Fodder is packed in airtight condition to preserve its nutritional value, improve its quality and taste and to make it easily digestible**

Silage types

- ***High-moisture silage*** *is ≤ 30% dry matter concentration.*
  - *Potential seepage loss from silo*
  - *Undesirable 2º fermentation- butyric acid*
- ***Medium-moisture silage*** *is 30% to 40% dry matter concentration.*
- ***Low-moisture silage*** *(also called haylage/baleage, or wilted silage) is ~ 40% to 60% dry matter concentration.(*Allen et al., 2011).

Haylage vs silage
Is the initial dry matter concentration level at which the forage is clipped and packed to achieve optimum anaerobic and fermentation conditions.



Drying and conserving hay – the challenge

The Principle

- In this process, green fodder is fermented through specialized bacteria which can survive without oxygen
- The resulting fodder is become tasty and easily digestible for animals

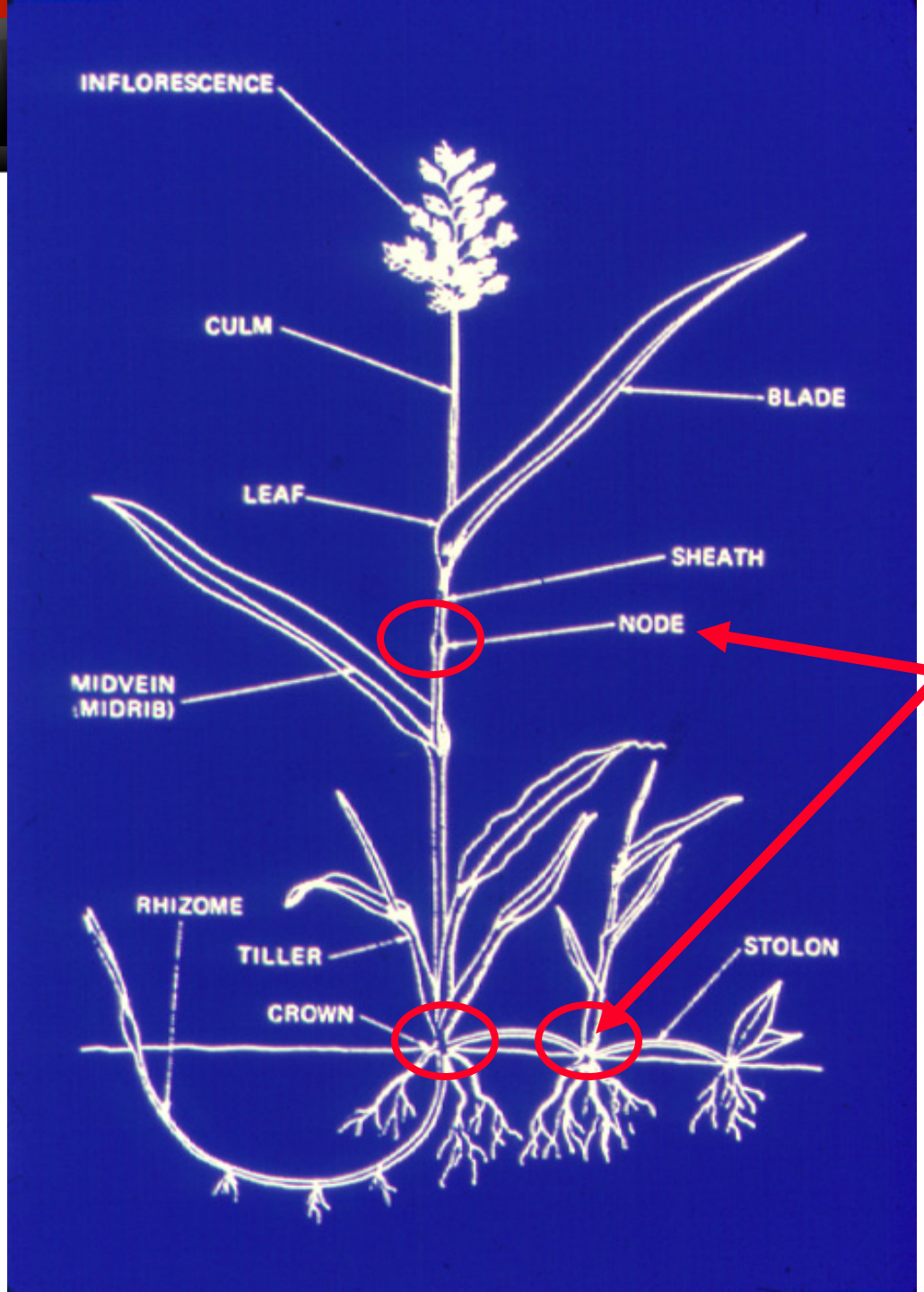
Steps for silage making

1. Selection of forages
2. Harvesting
3. Chopping
4. Packing/Pressing
5. Storage

Plant Identification- Senegal

Grasses
Legumes
Fruits and vegetables
Some weedy species

Understanding plant parts

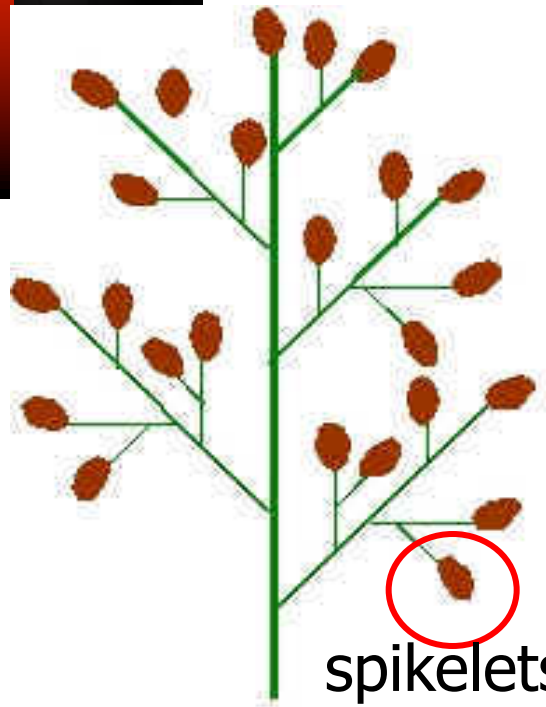


Node, the primary site of cell division & elongation (called growth)

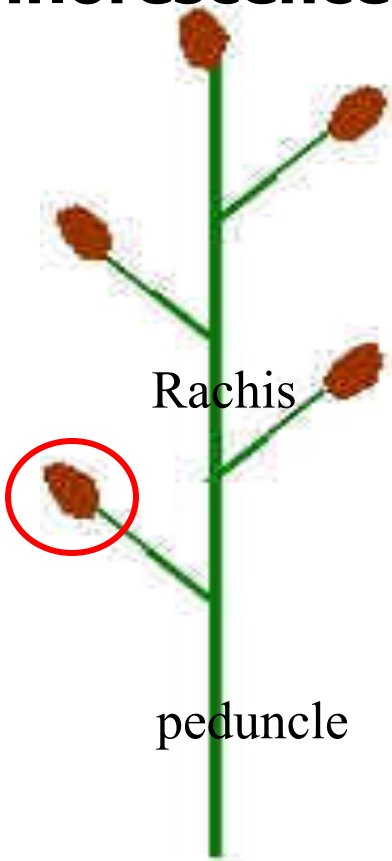
Three kinds of stems: aerial, stolon, rhizome

GRASS

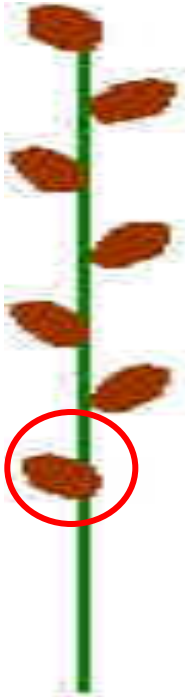
Arrangement of Spikelets into a Flower Head or Inflorescence



When the spikelets are borne on stalks on branches from the main axis, the flower-head is called a PANICLE

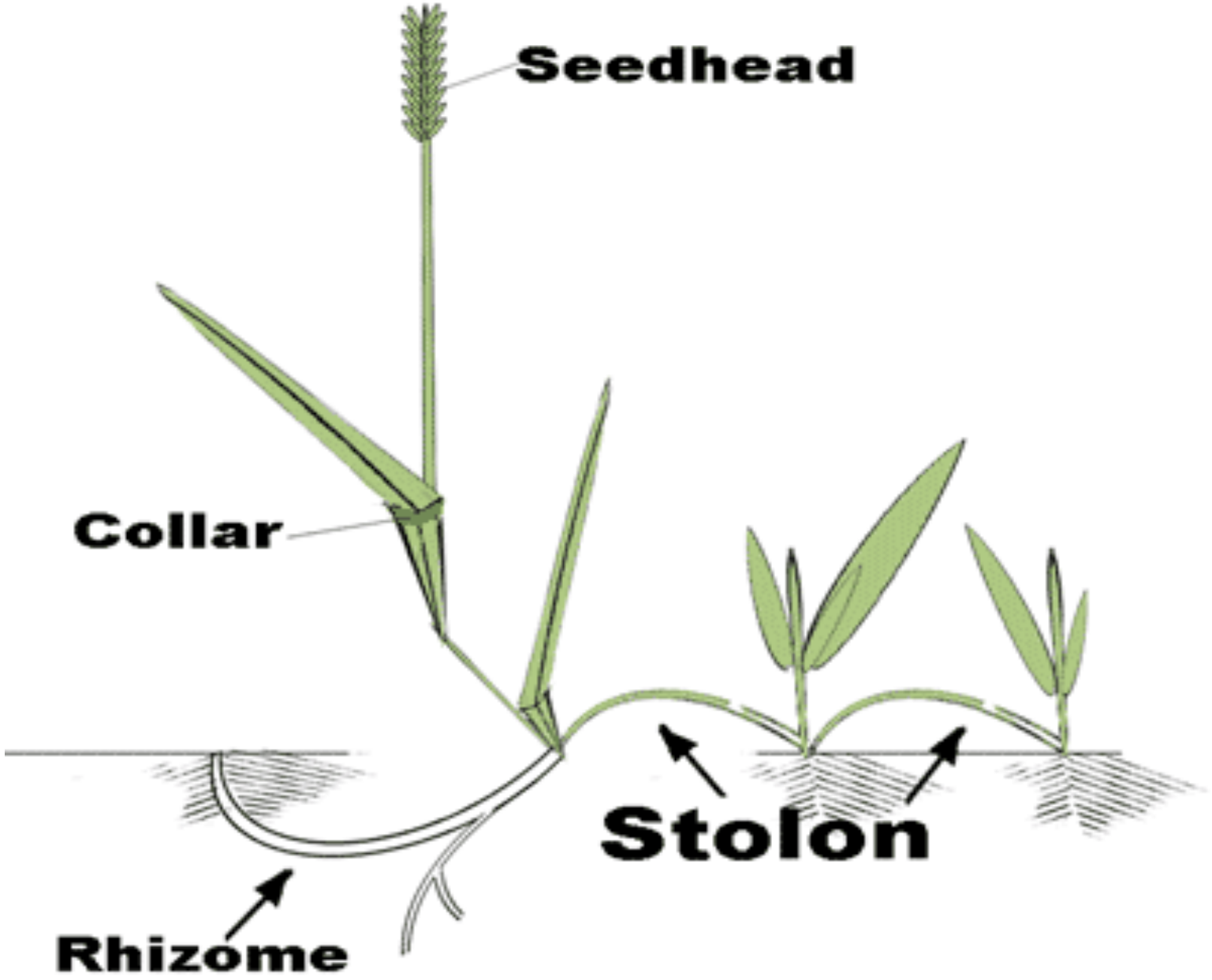


the spikelets are stalked directly on the main axis, then the flower-head is a RACEME.



Where there are no stalks, and the spikelets are seated on the main axis itself, the flower-head or ear is known as a SPIKE

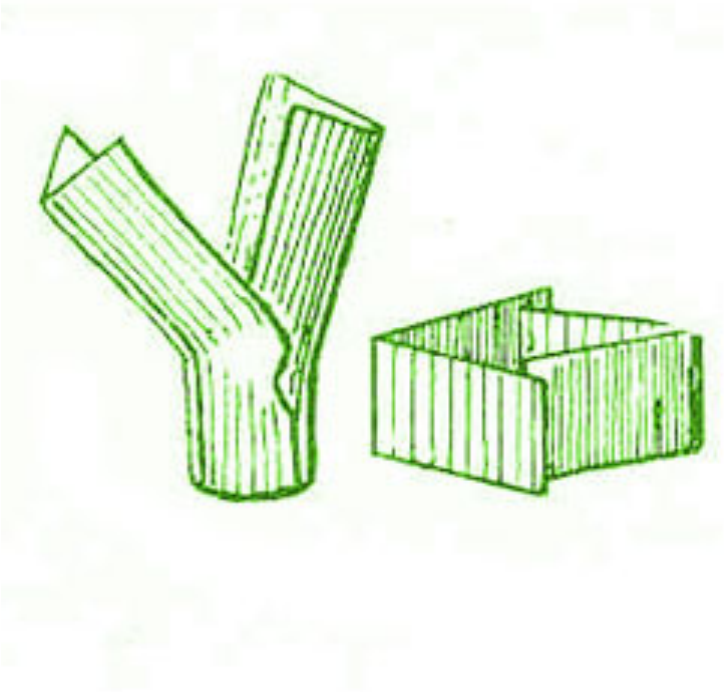
GRASS


Seedhead
Collar
Stolon
Rhizome

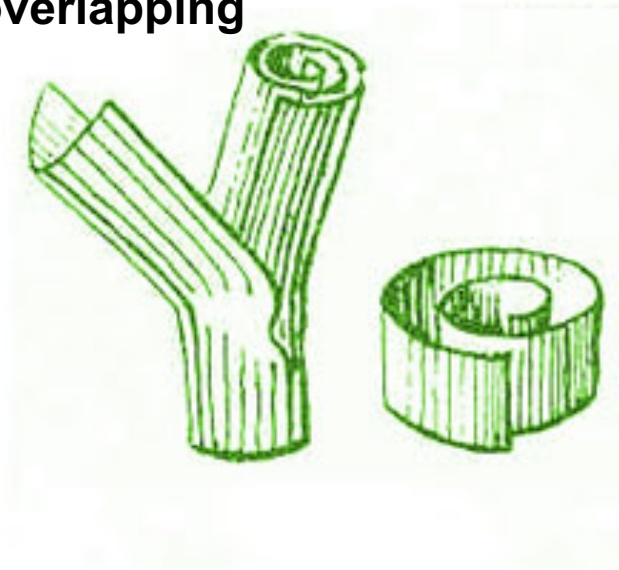
Vernation Type

The arrangement of the leaves within the bud (youngest leaf) and the surrounding sheath. Vernation can generally be described as rolled or folded, but some plants may exhibit both characteristics.

Folded – Leaves folded lengthwise in a V-shape with the margins meeting, but not overlapping.



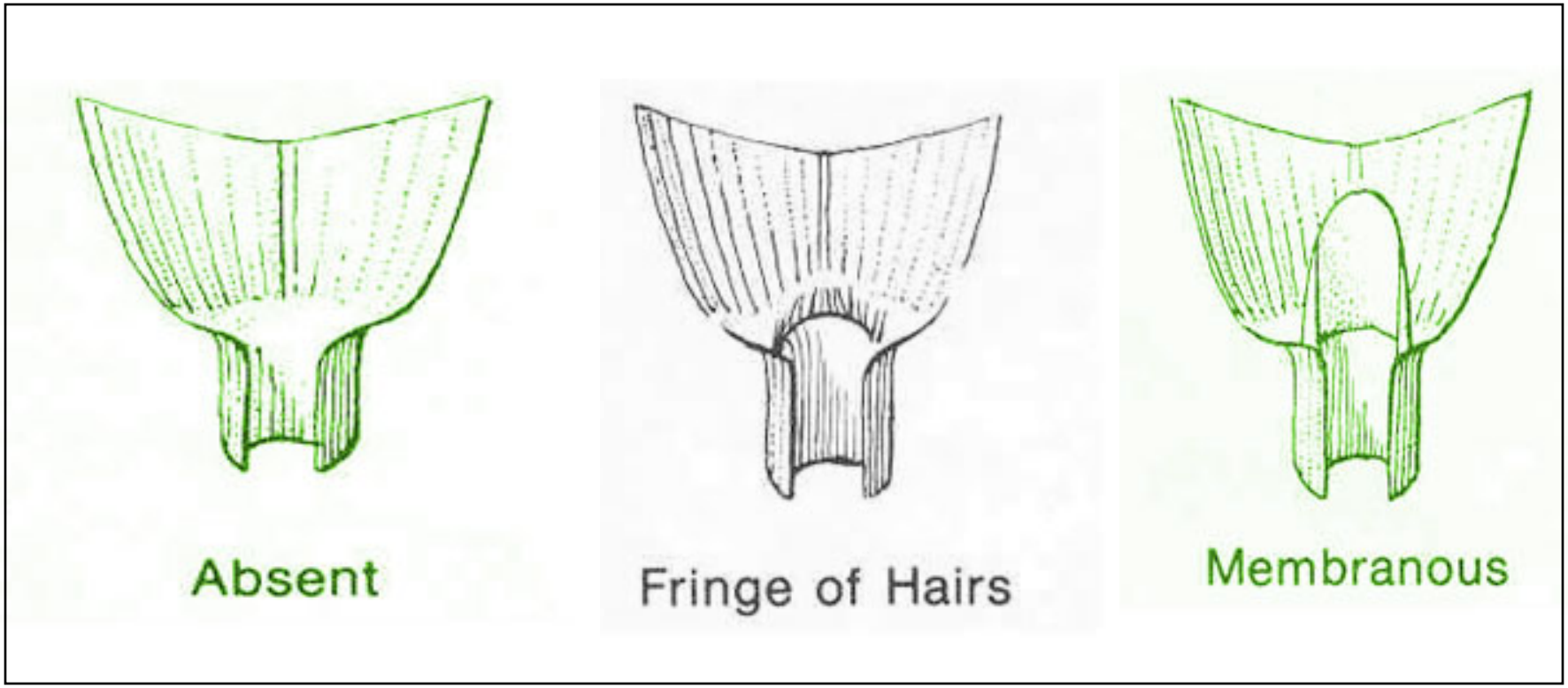
Rolled – Leaves are curved such that the margins are overlapping



Ligule Type

A thin structure that clasps the top of the leaf sheath where the blade and sheath are joined in grasses. Ligule structure arises from the auricle; it can be seen when the blade is bent backwards. If present, it may be a fringe of hairs, or membranous.

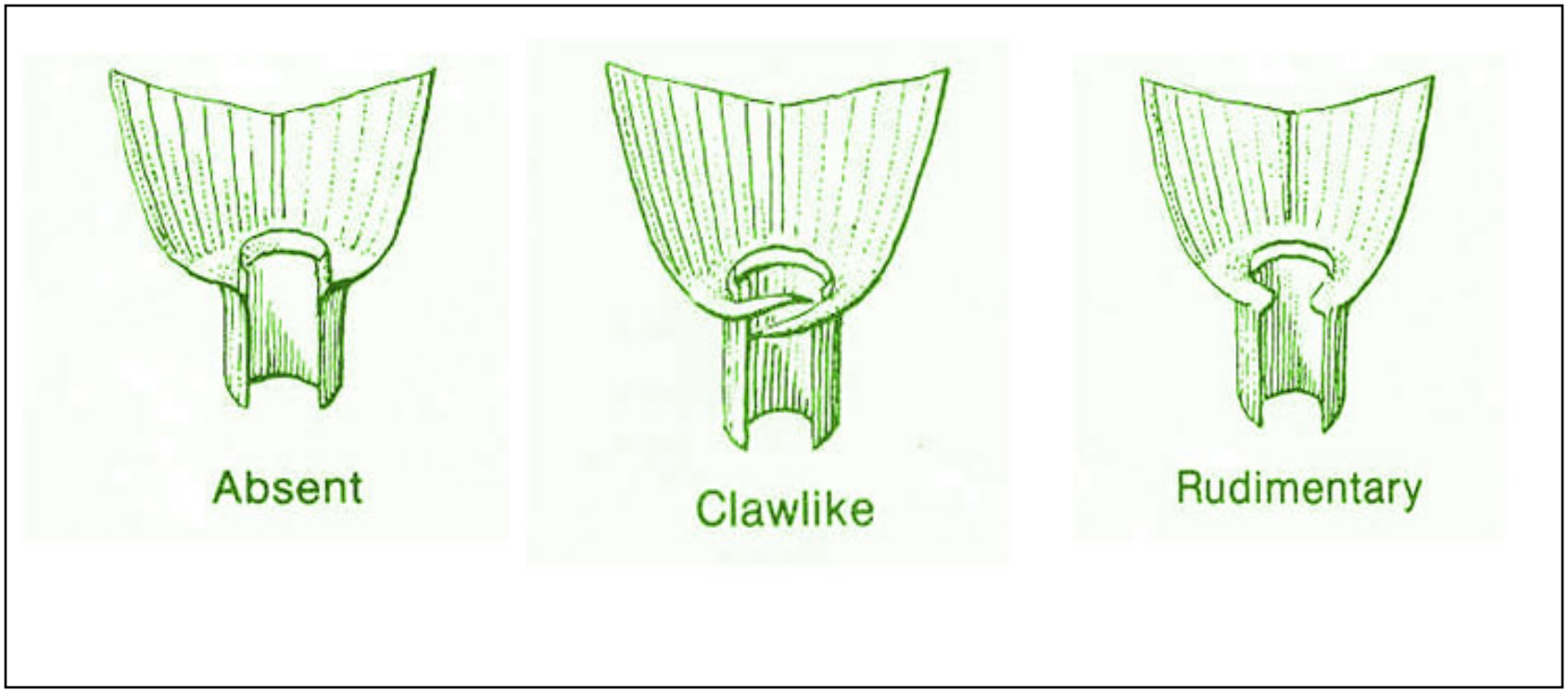
Absent - There is no obvious ligule present.
Fringe of hairs - Ligule will mostly be just a fringe of hairs.
Membranous - Will be transparent in color, and flexible like a membrane. Can be tall, short or jagged



Auricle Type

Auricle - a claw-like appendage that projects from the collar of a grass blade.

Absent - No claw-like appendages appear to surround the grass stem.
Claw-like - Pointy appendages surround the grass stem.
Rudimentary - Partial appendages appear, but do not surround the grass stem.



Leaf Blade Tip Shape

The shape of the leaf blade can vary between grass species, and are very distinguishing. For example, if the blade tip is cupped and curved slightly upwards = boat tip (also keel shaped).
Leaf blades that are rounded and end very abruptly = blunt.
If the blade ends in a long, very sharp point = sharp-pointed.

Panicum virgatum L. – Switchgrass

Preparation Prior to the Lesson

Panicum virgatum L. – Switchgrass

Switchgrass seeds

Found growing in most states in eastern USA.
Tolerant of moderate soil salinity and acidity, grows in soil with a pH ranging from 4.5 to 7.6.
Tolerant of flooding up to several days.
Tolerant of droughts and partial shade.

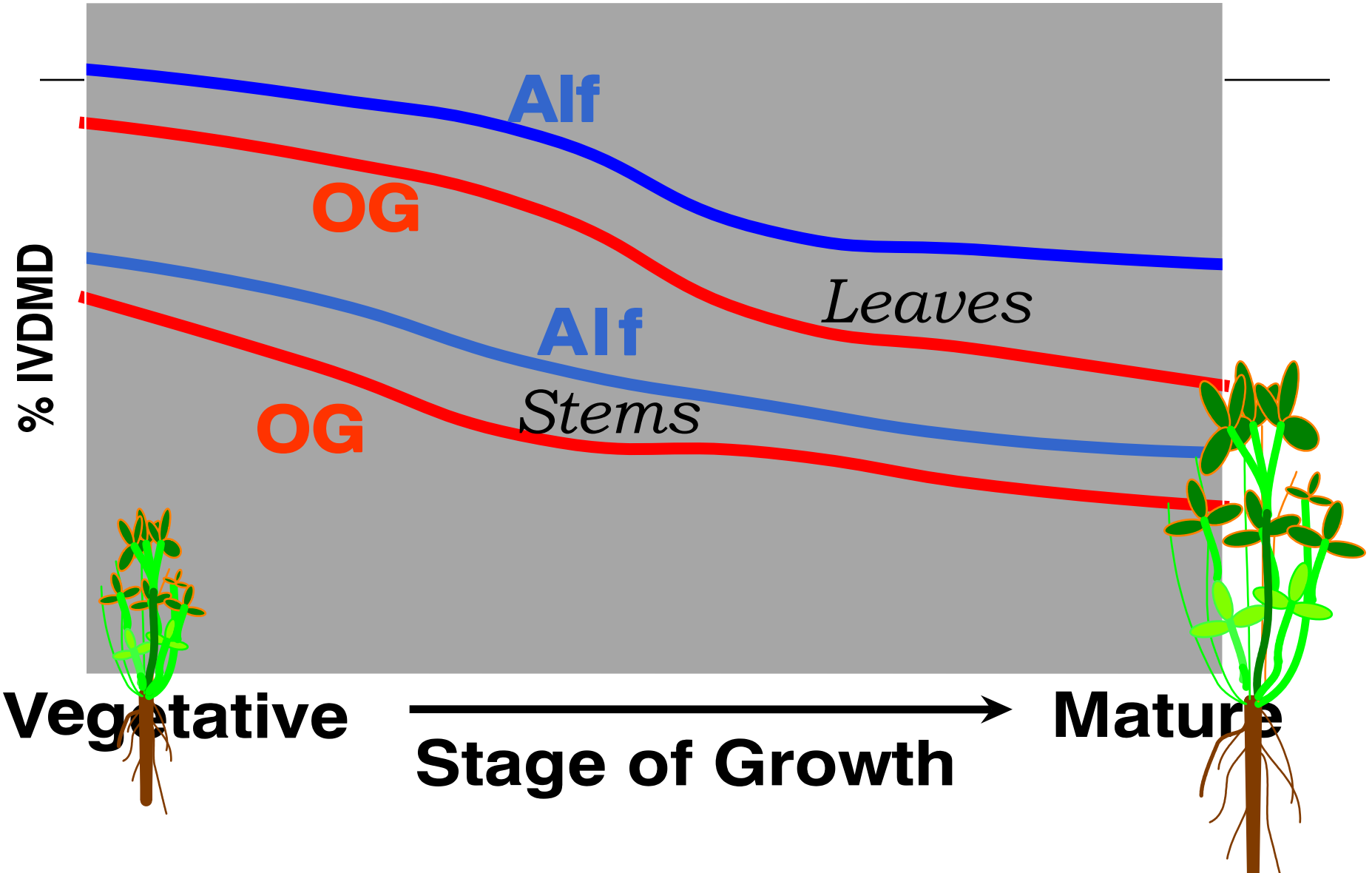
Good forage for cows and sheep in the spring and early summer; the seeds are eaten by turkeys, pheasants, quail, doves, and songbirds.
Provides excellent erosion control when used as filter strips, grass hedges, or cover such as river levee banks, seeded on roadways and waterways.

2. Harvesting

When to harvest the forage

- Harvesting the crops at the optimal stage of maturity,
  - Harvest the forage when it is at height of digestibility.
- This is at the “boot-stage” stage, where the DMD is 75 – 80%.
  - The boot-stage is the stage where half of the crop are showing their seed-heads

IVDMD OF LEAF & STEM QUALITY
GRASS vs LEGUMES



Harvesting and Welting..

- In some cases it is recommended to wilt the crop in the field in order to obtain an adequate dry matter content
  - For desirable fermentation
  - Avoid effluent
  - If the DM content is too low and the buffering capacity of the plants is high:
    - Secondary fermentation will occur by clostridia
    - Lactic acid is converted to weaker butyric acid
      - Followed by pH increase and further spoilage.

Plant Species & nutritive value

- Legumes usually better than grasses
  - Higher leaf stem ratio
  - More digestible
  - More protein
  - Higher concentration of Ca, Mg

3. Chopping

Chop length (the length-of-cut)

Silage Making – The Process

The ensiling material

- Can be grasses, legumes, non-leguminous weeds, by products
  - To assure high quality silage, cut the plants at the vegetative stage
- *The moisture content of the ensiled material*
  - At harvest, most grass species are 80% moisture.
  - Cut and wilt till forage reach at least 65% moisture.
- *Chop length (the length-of-cut)*
  - Chop the wilted forage to a length of 1-1.3 cm.
  - Chop length has an effect on the ensiling process on packing to exclude air and quality of the silage.

Chopping

Designing a Manual Vacuum System for Ensiling

Figure 2. sealable plastic bag

A manual vacuum pump can be attached to buckets or plastic bags and the air in those buckets will be vacuumed out.


Hefty


Flex
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5. Storage

Ensiling

- Process of producing silage
- Silage: the product of **fermentation** of plant tissue
  - Produced by microbial activity under **anaerobic** conditions

Plant Sugars —*fermentation*→ Organic Acids

"pickled" plant material
low pH

Silage Making - Carbohydrates

- **For good quality silage i.e. High levels of carbohydrates and the production of lactic acid is important:**
  1. **Do not cut the crop immediately after rain – *wet grass reduces carbohydrate concentration.***
  2. **Allow the crop wilt for a period of time after cutting (1 – 2 days) – *increases carbohydrate concentration.***
  3. **Using a carbohydrate rich additive (e.g. Molasses) - *to increase the chance of lactic acid production.***

Silage Making – Carbohydrates

- **High levels of Carbohydrates allow *Lactobacillus* and *Streptococcus* to produce Lactic Acid in the silage.**
- **Low levels of carbohydrates allow *Clostridium* to produce Butyric Acid.**
  - **Butyric acid silage is unpalatable to stock, less nutritious and may only last a couple of months.**

The biochemical and microbiological events

During the ensiling fermentation 4 distinct stages:

1. Aerobic stage –

- **Lasts for approximately one day.**
  - **Plant cells and microbes will metabolize sugars and starch in the presence of oxygen…heat**
  - **Silage temperature is elevated to about 90˚F**
  - **If anaerobic conditions are not achieved quickly:**
    - **High temperatures (>120˚F) and prolonged heating will occur**
    - **Due to the growth of unwanted aerobic bacteria, yeast, and molds that compete with beneficial bacteria for substrate.**

The biochemical and microbiological events

2. Fermentation stage –

- **Anaerobic conditions are achieved -lactic acid bacteria and other anaerobes start to ferment sugars into lactic acid**
- **Will drop the silage pH from about 6.0 - range of 3.8 – 5.**
  - **Rapid decrease in pH prevents breakdown of plant proteins and helps inhibit growth of spoilage microbes.**
- **The fermentation phase lasts from one week to more than a month, depending on crop and ensiling conditions.**

The biochemical and microbiological events

3. *Stable:*

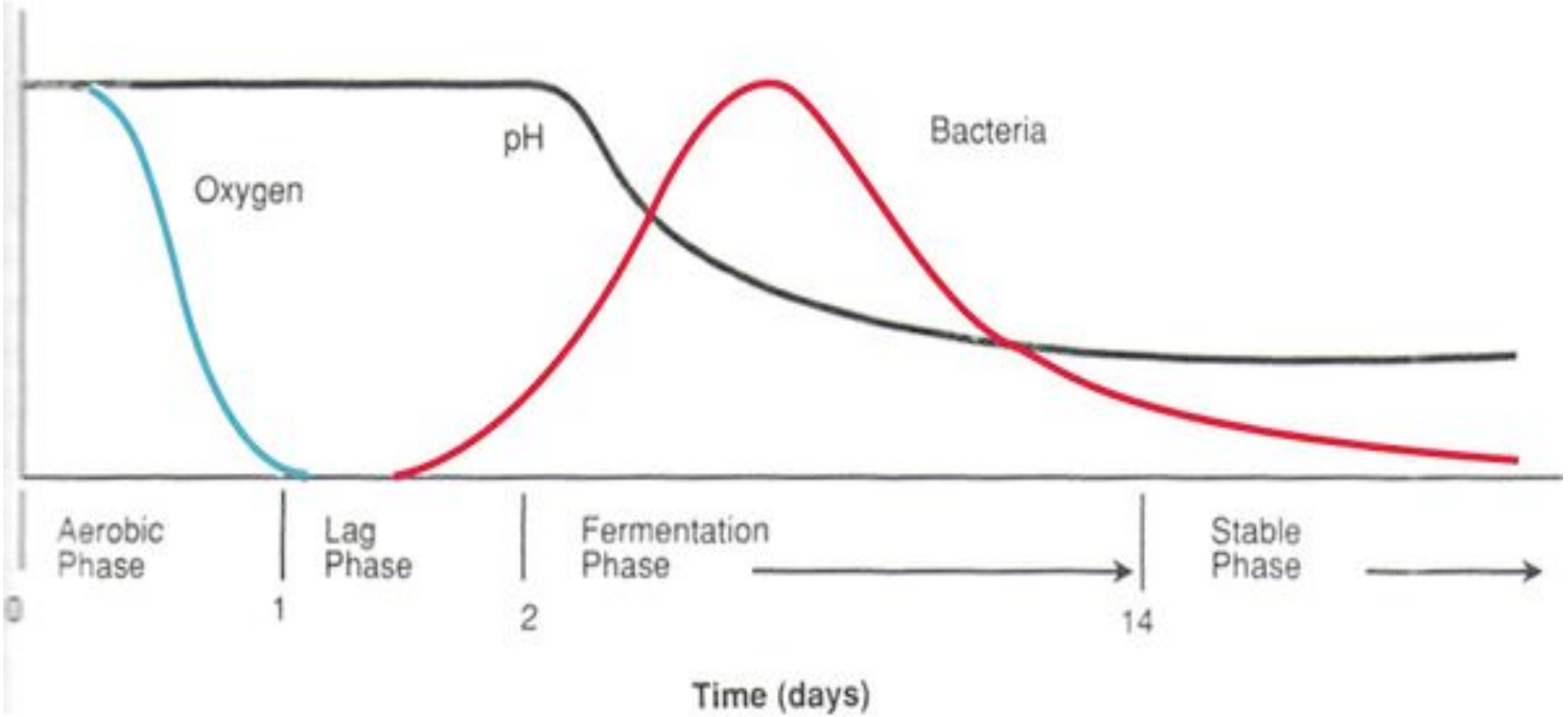
- **As long as anaerobic conditions are maintained**
  - **Silage can be stable for months and up to years.**
    - **Silage should be used within a year of its production.**
    - **Entry of air through areas that were not properly sealed can slowly deteriorate material**

The biochemical and microbiological events

4. Unloading stage

- **Feeding when the silage is re-exposed to air which re-activates aerobic micro-org., mainly yeasts and molds, which might spoil the silage.**
- **Minimize the exposure of silage to air during storage and unloading.**
- **Opening after the fermentation phase has been completed (after three to six weeks).**
  - **Wait approximately two to three months before opening a silo.**

Silage


pH
Bacteria
Oxygen
Aerobic Phase
Lag Phase
Fermentation Phase
Stable Phase
0
1
2
14
Time (days)

Factors affecting success:

- Anaerobic conditions
  - Plant water content
  - Fine chopping
  - Packing
  - Sealing
- Presence of readily fermentable carbohydrates

Major barriers to proper ensiling

- **Aerobic Conditions**
  - **Internally trapped air**
  - **External air**

Major barriers to proper ensiling

- **Undesirable fermentation**
  - **Causes:**
    - **Activity of *clostridium species* bacteria**
      - **Clostridial fermentation**
      - **Moisture > 70%, pH > 4.2**
    - **Favored by high moisture, high pH plus low levels of fermentable carbohydrates**

Good Silage Quality

Parameter	Correct Value	Factors Affecting
pH	4	Procedures at ensiling (e.g. additive etc)
DM (%)	20	Stage of growth at cutting, wetness
DMD (%)	70 – 75	Stage of growth, wetness and procedures at ensiling.
Protein	14 - 16	Stage of growth at cutting.

Silage Additives

- **Fermentation stimulants**
  - **Molasses**
    - **Makes up for lack of fermentable carbohydrates**
  - **Microbial bacteria**
    - **Silage *innoculators* – refined bacterial cultures**
- **Fermentation inhibitors**
  - **Direct acidification – mineral acids**
  - **Bacterial inhibitors**

Feed Quality

- Forage, when preserved *correctly* can be a very high quality feed for animals at all stages of production

Quality of Silage

- **Mold :** If silage while filling pit/tank, not well pressed; there will be growth of mould.
- **Odor :** Good quality silage has sweet & sour taste.
- **Color :** Good quality silage has faint green or brownish color. Rotten silage has black color.
- **pH :** Good quality silage has pH of 3.5 to 4.2.

fed per head daily to the various classes of livestock are estimated as follows:

2 - 3 year old oxen	11-14 kilos
3 - 8 year old oxen	14-23 kilos
Sheep/goat	1 kilo/45 kilo live wt.

Silage 20-25% dry matter

http://collections.infocollections.org/ukedu/en/d/Jr015ae/7.html

Silage and Hay Analysis

Abdoulaye Dieng (ENSA)

Item	Crude Protein (%)	Fiber (%)
Hay	5.4	36
Silage	14.6	28

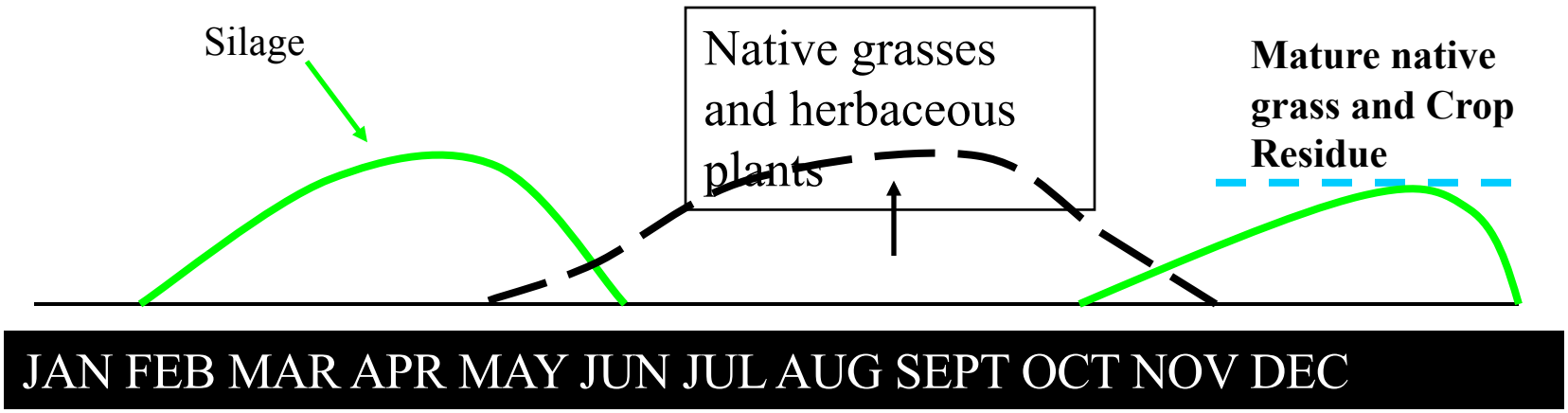
Gathering the forage

Chopping….

Make sure at least
5-6 species are included to increase the quality of the chopped forage

Silage provide 3-4 month feeding

Potential New System



Summary

- Identify gaps in feed resources
- Silage making is the best method of fodder conservation.
- Making silage involves:
  - Identifying and cutting forages at the optimum stage of development
  - Chopping to the right size and
  - Proper compaction to create an air-tight condition.
    - Various storage structures can be used by the small holder farmer.
- Feed silage soon after open storage structure