Understanding Forage Production

Key points to remember about pasture plants:

- The leaves manufacture carbohydrates for the plant. You must reserve some leaf volume for this purpose.
- To ensure regrowth, you must preserve the growing points on your plants.
- Annually plants become dormant, leaves cease to feed the roots

George, Holly etal, *Living on the land*

Understanding forage yields

Methods for collecting forage production in pastures

- Clipping – hoops, squares
  - across pastures, obvious changes in veg. types and soils.
- Pasture plates
- Pasture sticks
- Growth charts (see pubs)

Estimating pasture productivity—two methods

Direct estimate method

Example weights are given for each step and are used in the final calculations.

1. **Clip and collect** the forage in 1 square yard of pasture. Clip at the intended grazing height; this will vary with species.
2. **Weigh and record the forage.** Take all measurements in pounds (example: 2.07 lb/sq yd).
3. **Dry a sample:**
   a. Record the weight of an empty paper plate (example: 1 oz).
   b. Take a half pound (approximately) sample of the forage. Place it on the plate and weigh it accurately (example: 9 oz).
   c. Place the sample in a microwave oven along with a cup of water. Microwave on high for 3 minutes, then weigh the sample. **Note:** It is extremely important to leave water in the microwave throughout the drying process. Water reduces the chance of ruining the microwave or possibly starting a fire.
   d. Microwave the sample for another minute, then reweigh the sample. Repeat this step until the weight remains the same.
   e. Record the final sample weight (example: 3 oz).
4. **Calculate percent forage dry matter (DM):**

$$\% \text{ forage dry matter} = \frac{(\text{final weight of sample}) - (\text{weight of plate})}{(\text{original weight of sample}) - (\text{weight of plate})}$$

$$\text{Example: } \frac{3 \text{ oz} - 1 \text{ oz}}{9 \text{ oz} - 1 \text{ oz}} = 0.25 \text{ (25\% forage dry matter)}$$

5. **Determine pasture yield:**

$$\text{Pasture yield (lb/acre)} = \frac{[\text{total weight of forage (step 2)}] \times [\% \text{ forage DM (step 4)}] \times (43{,}560 \text{ sq ft/acre})}{(9 \text{ sq ft/sq yd})}$$

$$\text{Example: } \frac{2.07 \text{ lb/sq yd} \times 0.25 \times 43{,}560 \text{ sq ft/acre}}{9 \text{ sq ft/sq yd}} = 2505 \text{ lb/acre}$$

Pasture plate method

A much faster way to estimate yield is through use of a pasture plate. You can make your own plate using the following directions:

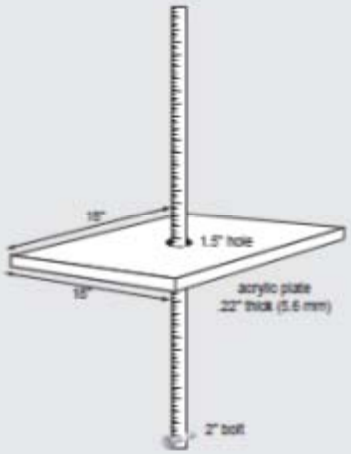
Materials: An 18-inch square sheet of acrylic (0.22-inch thick), a yardstick, and a 2-inch bolt.

Assembly: Drill a 1.5-inch hole in the center of the plate. To make it easy to lift and carry the plate and yardstick together, insert a large bolt through the bottom of the yardstick.

Procedure: Place the yardstick on the ground. Hold the plate (on the yardstick) 1 foot above the standing forage and let it drop. Record the plate's height (in inches) off the ground. Take measurements in 5 to 10 locations in the pasture and use the average height. To calculate dry matter yield (lb/acre), multiply the height by 390. For accurate results, the plants must be dry when taking measurements.

Pasture yield (lb/acre) = 390 x height (inches)

Example: 390 x 6 inches = 2340 lb/acre



From pastures for profit: A Guide to rotational grazing – Univ. Wisconsin & Univ. Minnesota

Pasture sticks

Measure stubble/grass height – equates to production

Source: Table 6 from Grazing Systems Planning Guide, Univ. Minn. & NRCS (MN)

Forage	Stand Density[1]		
	Fair*	Good**	Excellent***
	lb. Dry matter/acre-inch		
Bluegrass/White Clover	150-250	300-400	500-600
Tall Fescue+Nitrogen Fert.	150-250	250-350	350-450
Tall Fescue/Legume	100-200	200-300	300-400
Smooth Bromegrass/Legumes	150-250	250-350	350-450
Orchardgrass/Legumes	100-200	200-300	300-400
Mixed Pasture	150-250	250-350	350-450
Alfalfa or Red Clover	150-250	200-250	250-300
Native Tall Warm-Season Grasses	50-100	100-200	200-300

Multiply production X growth inches
8 inches X 350 lbs = 2800 lbs/acre

Remember – Subtract the targeted stubble height from the total forage height when computing pounds of forage available

Stubble Height Examples

Species	Plant height (inches) Start grazing	Stop grazing
Tall-growing cool-season grasses orchardgrass, quackgrass, reed canarygrass, smooth bromegrass, tall fescue, and timothy	8–10	4
Tall-growing legumes alfalfa, alsike clover, birdsfoot trefoil, kura clover, ladino clover, and red clover	8–10	4
Ryegrasses Italian and perennial	6–8	2
Short-growing cool-season grasses and legumes Kentucky bluegrass and white clover	4–6	2
Warm-season grasses big bluestem, indiangrass, sorghum/sudangrass, and switchgrass	12–14	4–6

9 Inches of growth to start – 4 inches of growth for stopping = 5 inches available

5 inches X 400 lbs = 2000 lbs/acre available

Plant Production

Production throughout the year

Month	% Forage Available*		Monthly Available forage (lbs./acre)
May	10%	(75,000 lbs. x .10)	7,500
June	30%	x .30	22,500
July	10%	x .10	7,500
August	20%	x .20	15,000
September	20%	x .20	15,000
October	10%	x .10	7,500

* From "Pastures for Profit" and NRCS Field Office Technical Guide

Production and Quality

From: Irrigated Pasture Production, UC ANR, Forero, etal

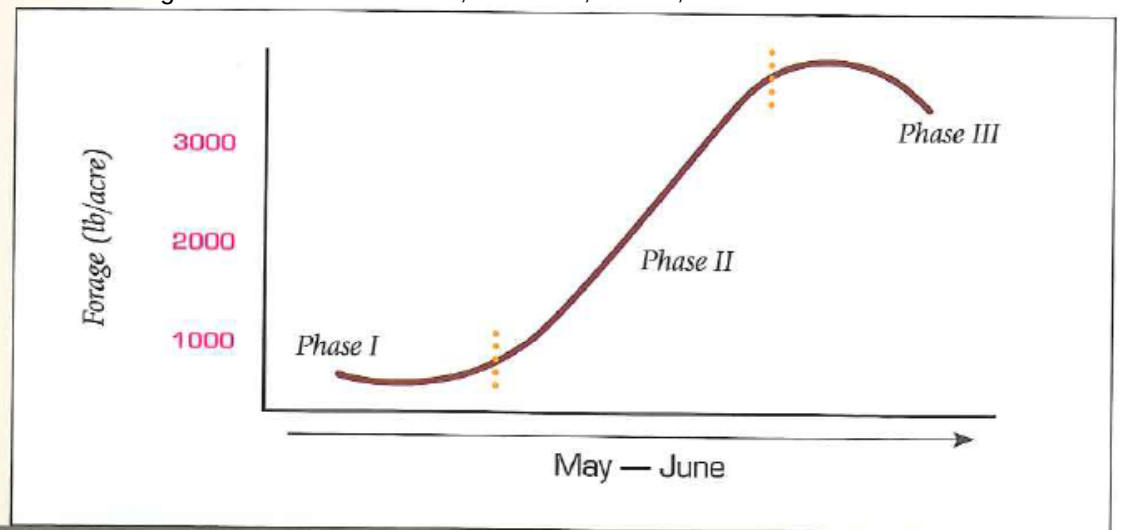
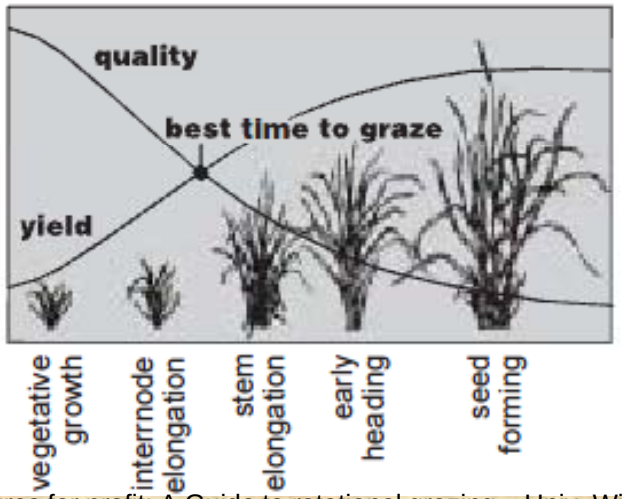
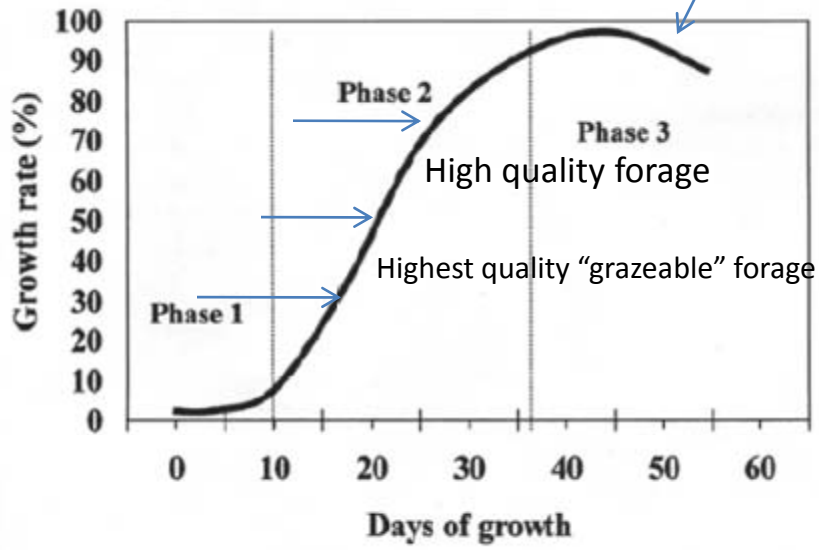


Figure 11. This curve is typical for summer growth. It is best to graze plants in the middle of phase II even if the maximum dry matter will not be harvested from the pasture. The nutritional quality of the forage is excellent, and if sufficient time is allowed for re-growth to bring the plant back to phase II again, the energy reserves in the roots of the plant will be restored.



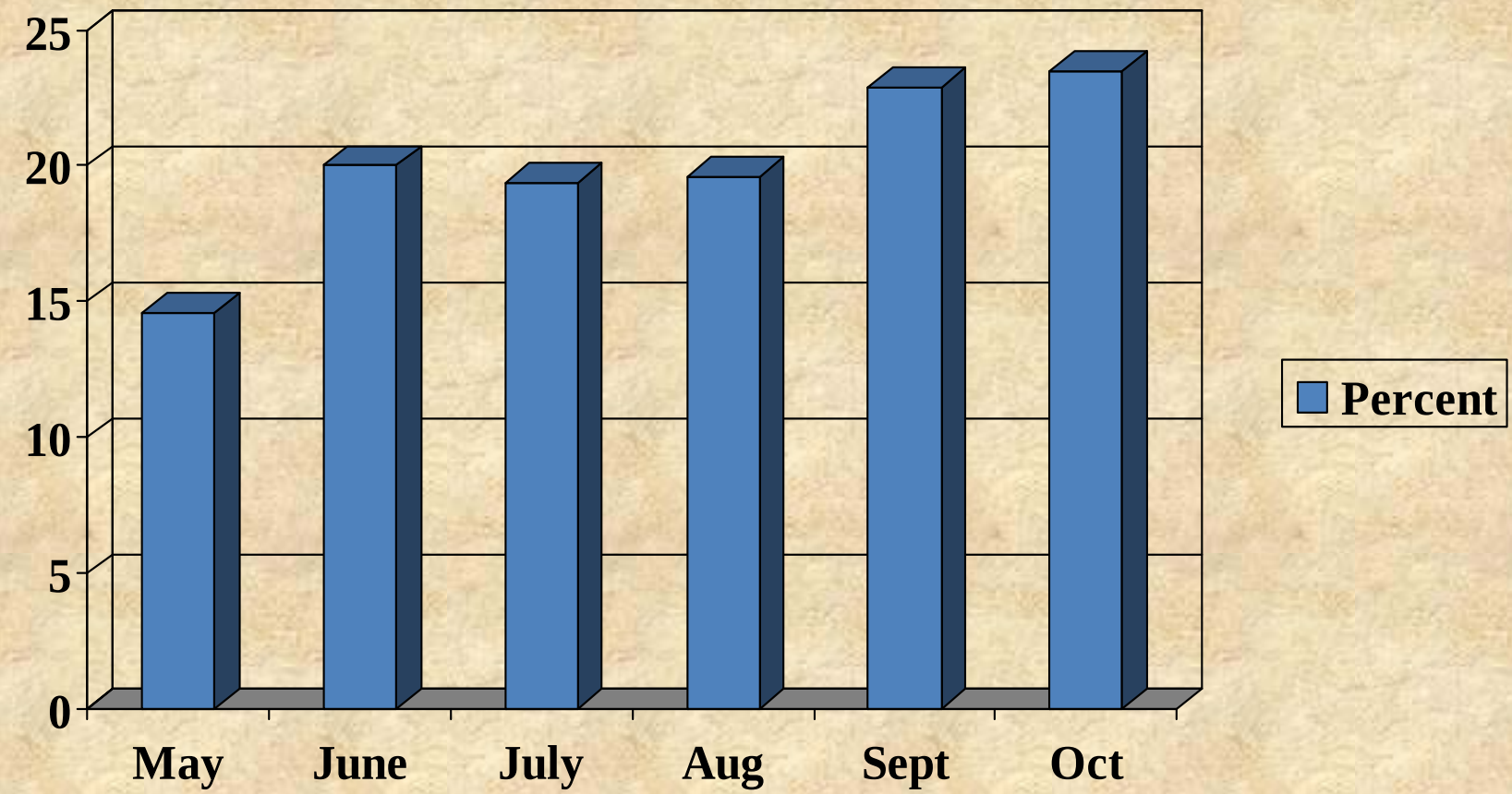
From pastures for profit: A Guide to rotational grazing – Univ. Wisconsin & Univ. Minnesota

Forage quality "drop-off"

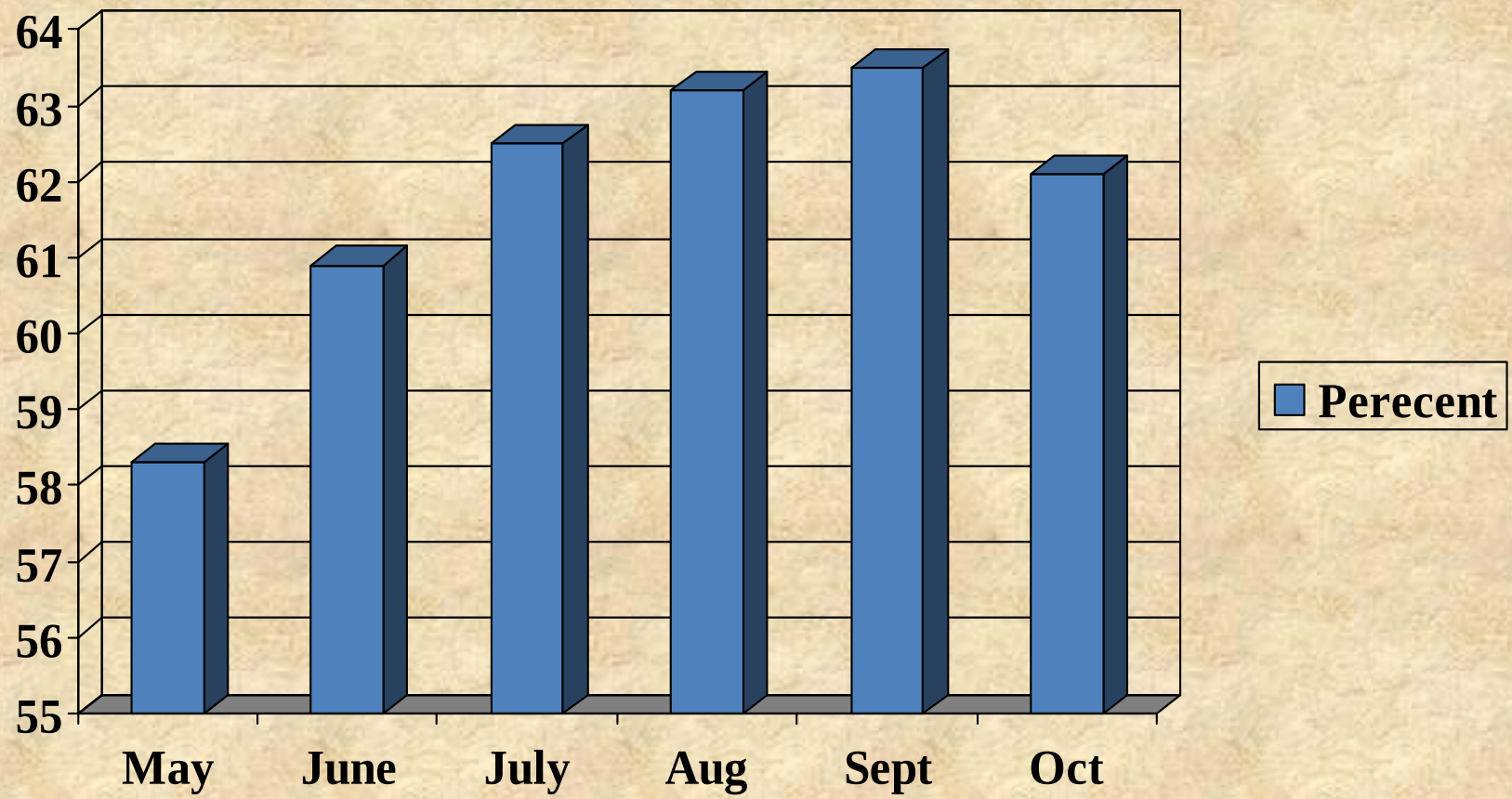


Source: Grazing Systems Planning Guide, Univ. Minn. & NRCS (MN)

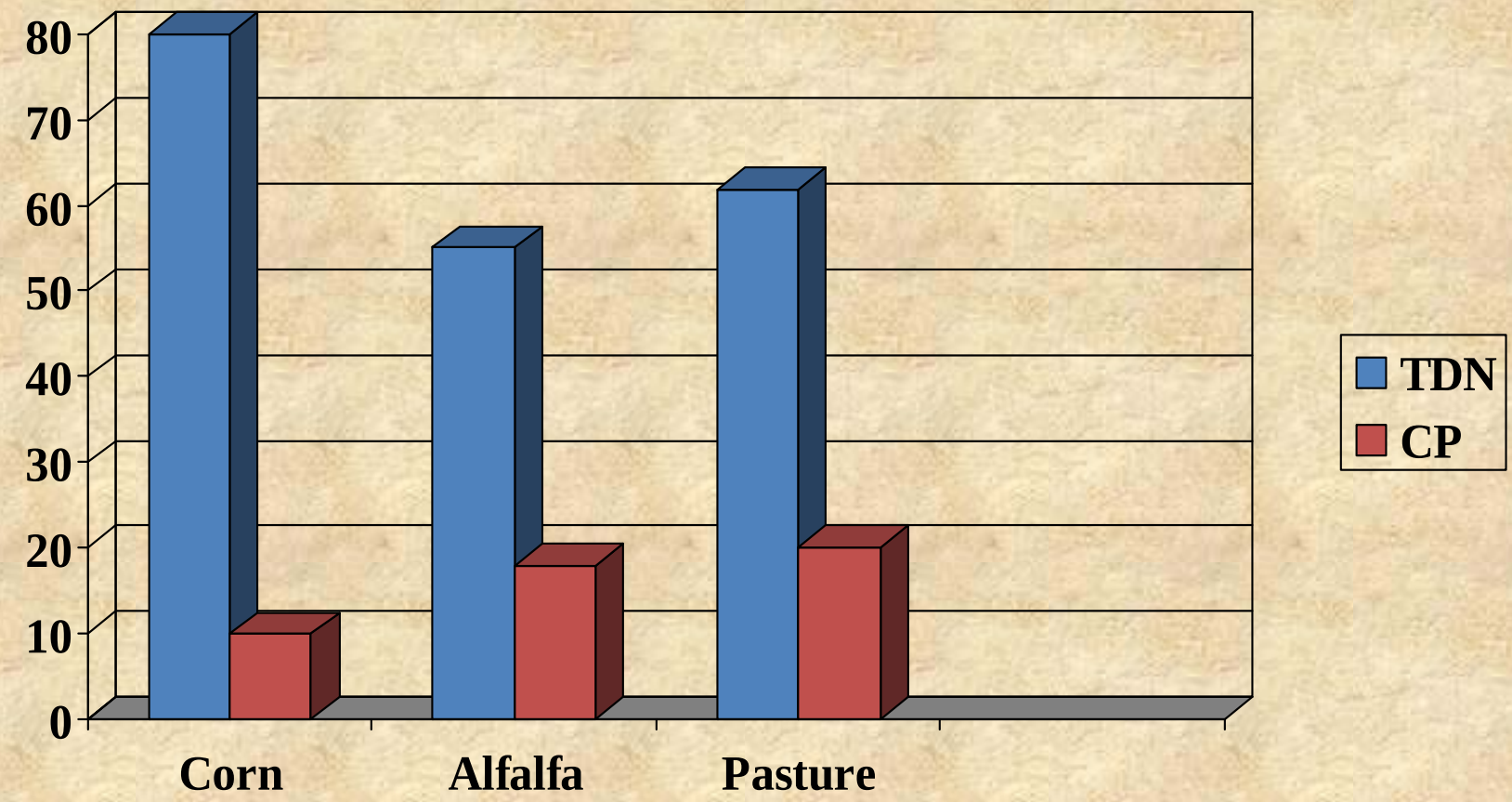
Average CP Quality-Select Shasta Co. Ranches



Average Irrigated Pasture TDN-Select Shasta Co. Ranches



Quality Comparison of Corn, Pasture and Alfalfa



What do the phases look like?

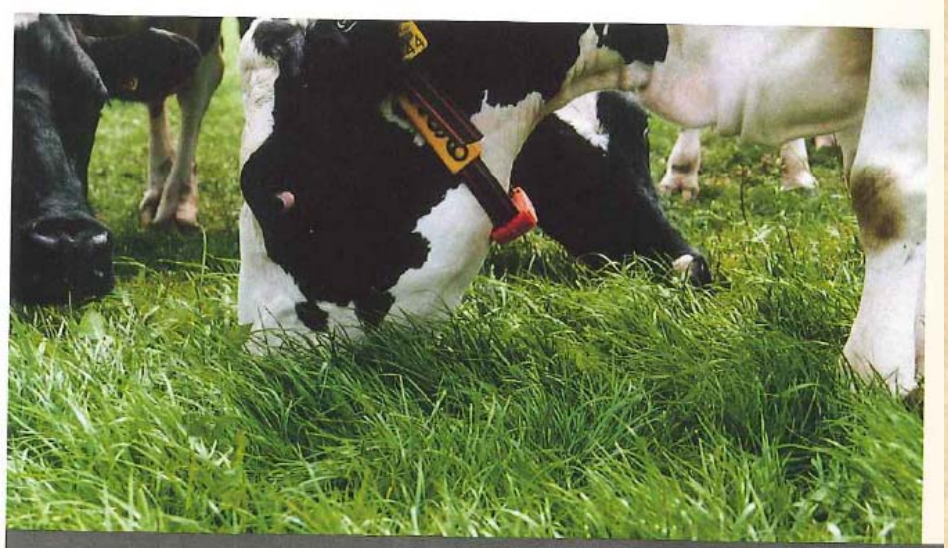


Photo 35. Grass in phase I is highly palatable and usually no more than 8 inches high.

Photo 36. Grass in phase II is storing nutrients in the root system and is growing most rapidly.

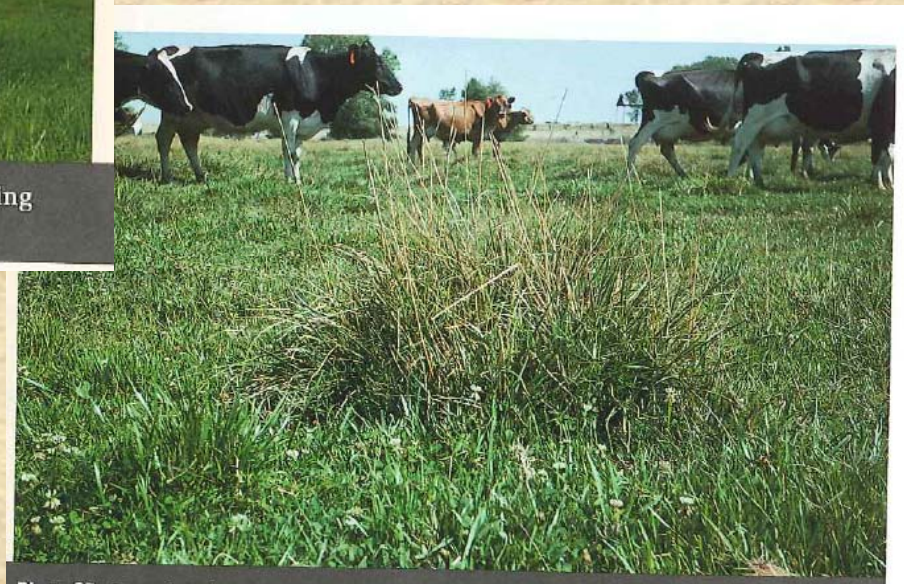


Photo 37. Grass in phase III is very fibrous and not very palatable; growth has slowed.

From: Irrigated Pasture Production, UC ANR, Forero, etal

How many animals do I want vs. how much forage do I need?

Forage requirements – use .04 utilization rate (2.5% intake, .05% trampling loss, and 1% buffer on a dry matter basis)

First

# of animals X average weight X utilization rate = daily forage requirement

Example: 30 animals X 1200 lbs X .04 = 1440 lbs/day

Second monthly and seasonal requirements

Daily forage requirements X # of days in the grazing season = monthly forage needed

Example: 1440lbs/day X 30 days = 43200 lbs monthly forage

Example: 1440lbs/day X 200 days = 288000 seasonal forage

Calculating total yield: Forage yield X acres = forage production

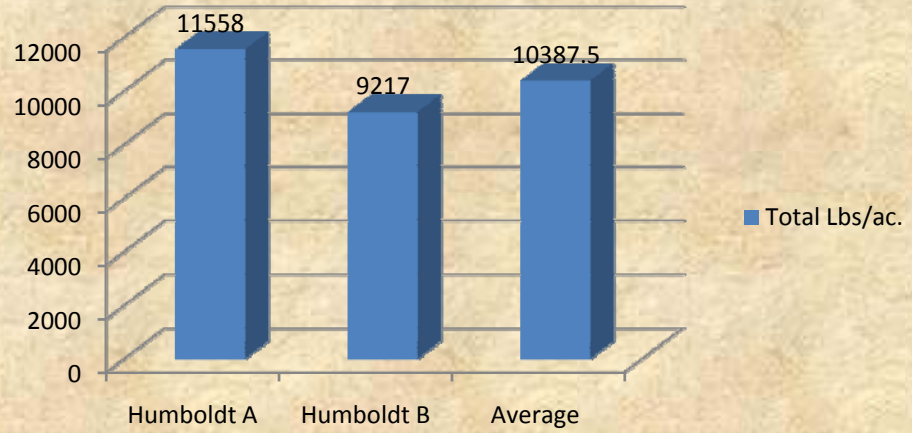
Example: 2500 lbs/ac X 30 acres = 75,000 lbs of forage

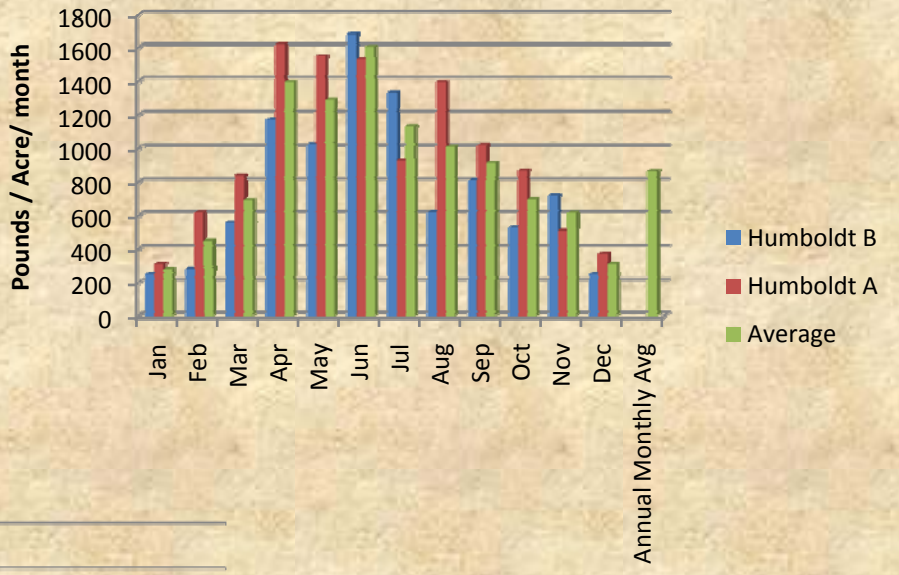
Availability per month: Total yield X % forage available per month

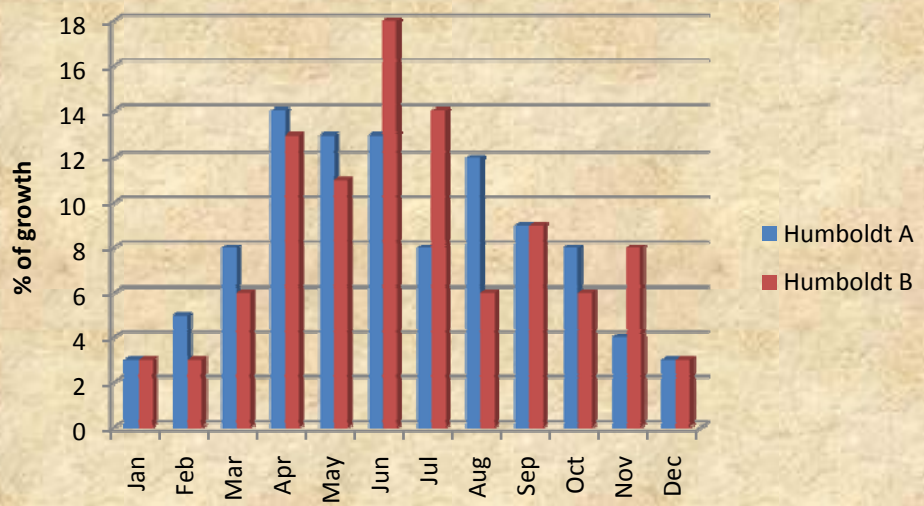
Month	% Forage Available*		Monthly Available forage (lbs /acre)
May	10%	(75,000 lbs. x .10)	7,500
June	30%	x .30	22,500
July	10%	x .10	7,500
August	20%	x .20	15,000
September	20%	x .20	15,000
October	10%	x .10	7,500

* From "Pastures for Profit" and NRCS Field Office Technical Guide

Lets Make this Local







Production in Humboldt County – 2 ranches

Let's make this local

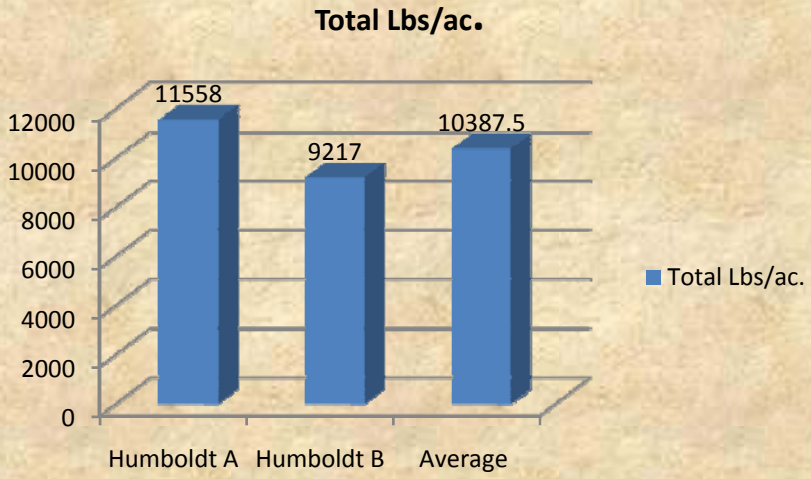
Calculating total yield: Forage yield X acres = forage production

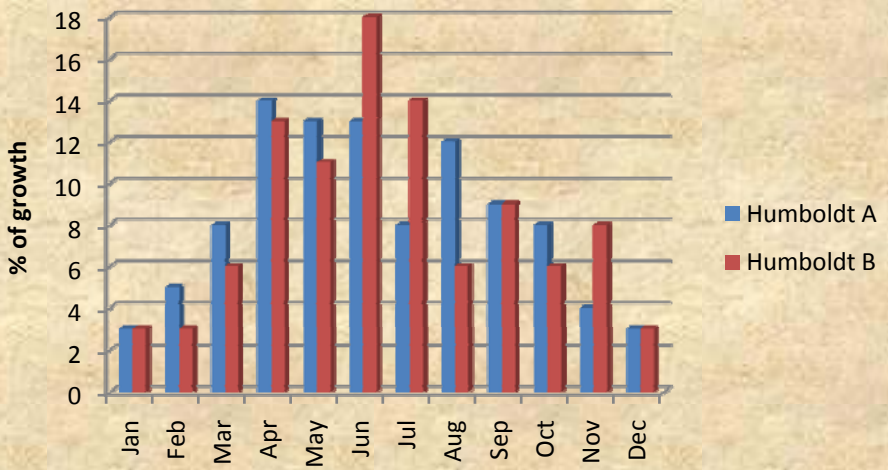
Example Ranch A: 11,558 lbs/ac X 30 acres = 346,740 lbs of forage

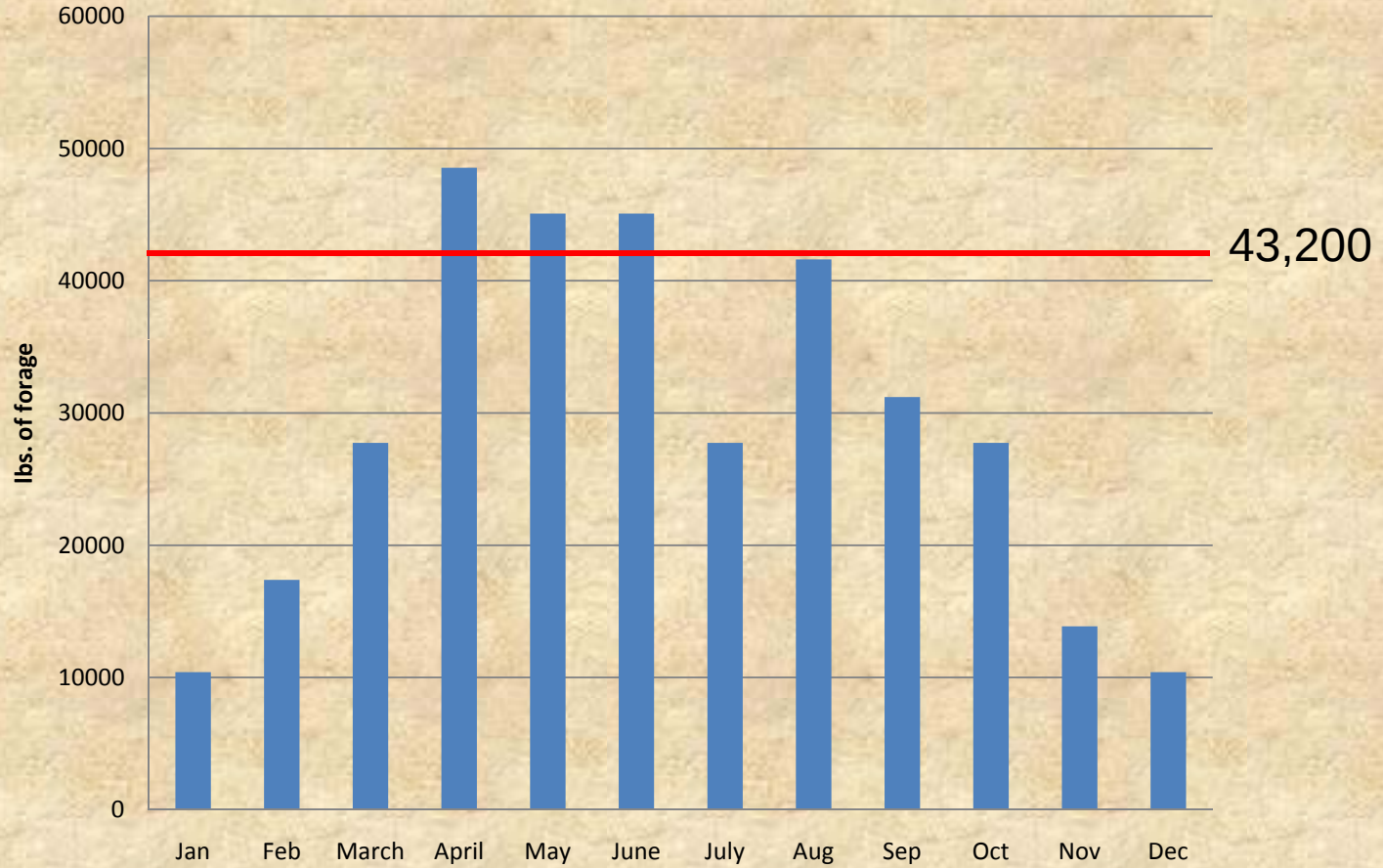
Availability per month: Total yield X % forage available per month

March: 346,740 X .08 = 27,739 lbs
April: 346,740 X .14 = 48,544 lbs

Example: 1440lbs/day X 30 days = **43,200** lbs monthly forage






60000
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lbs. of forage
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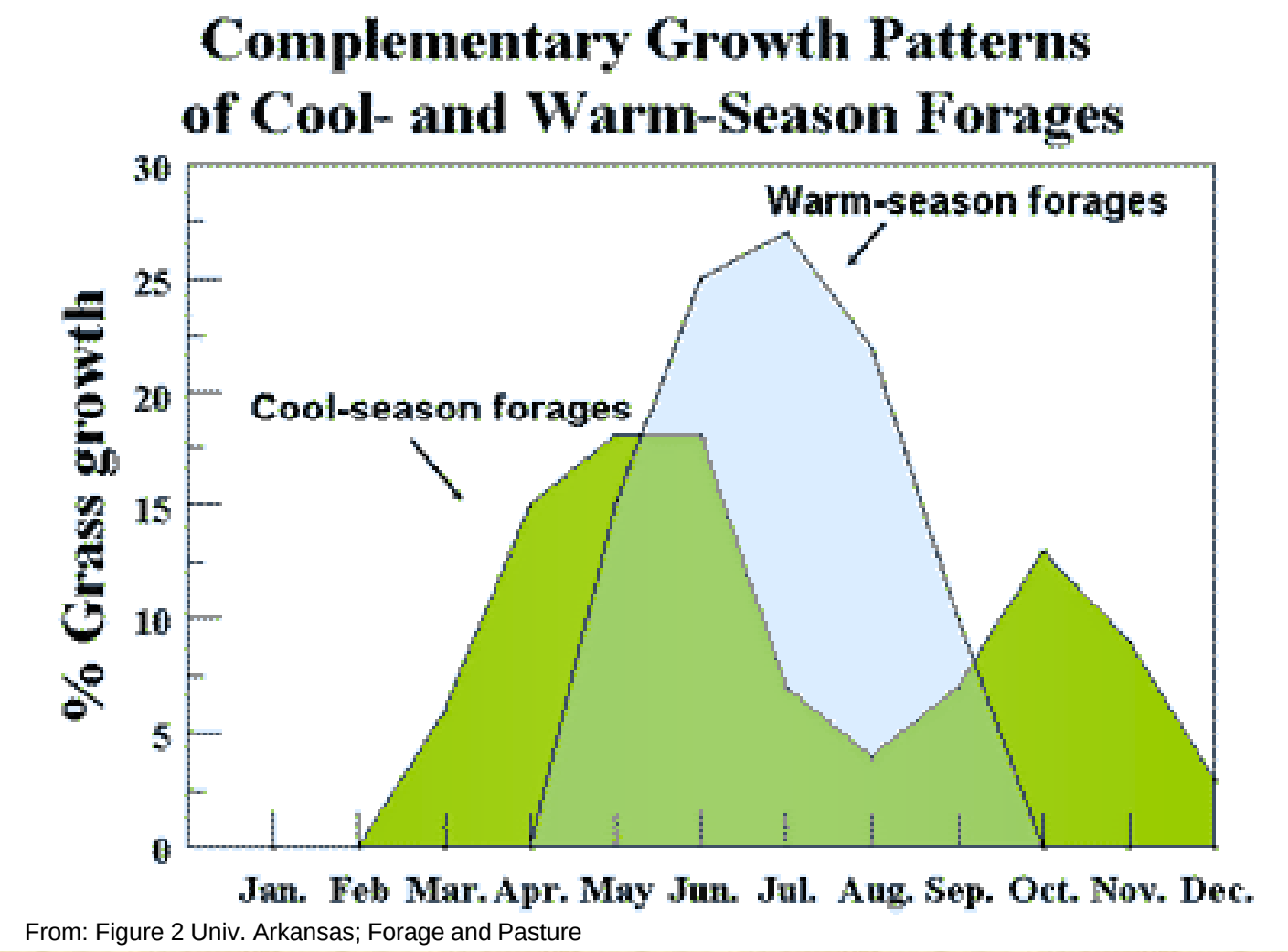


From: Figure 2 Univ. Arkansas; Forage and Pasture

Forage balance sheets

Table 12. Livestock Forage Monthly Balance Sheet – Current Livestock Summary

Kind/Class Livestock	Number of Animals	Average Weight	Monthly Utilization	Forage Requirements Per Month (lbs x 1000)					
				May	June	July	Aug	Sept	Oct
Beef cow/calf	35	1200	1.2	50.4	50.4	50.4	50.4	50.4	50.4
Herd bull	1	2000	1.2			2.4	2.4	2.4	2.4
Totals	36			50.4	50.4	52.8	52.8	52.8	52.8

*0.04 daily utilization rate (includes forage waste) x 30 days/month.

Table 11. Livestock Forage Monthly Balance Sheet – Current Forage Summary

Field	Kind of Forage	Forage Yield (lbs/acre)	Acres	Total Yield (lbs)	Forage Availability Per Month (lbs x 1000)					
					May	June	July	Aug	Sept	Oct
Rented	Red Clover/ Orchardgrass	4,500	30	135,000	33.8	54.0	27.0	13.5	6.8	0.0
Owned	Red Clover/ K. Bluegrass	3,500	38	133,000	33.3	53.2	26.6	13.3	6.7	0.0
Owned	Reed Canarygrass	3,500	17	59,500	11.9	17.9	14.9	6.0	6.0	3.0
Owned	S. Bromegrass/Alfalfa	4,500	20	49,500	for hay	for hay	31.5	18.0	0.0	0.0
Total lbs. Forage Available (x 1000)				377,000	79.0	125.1	100.0	50.8	19.5	3.0
Total lbs. Forage Required by Livestock (x 1000)				312,000	50.4	50.4	52.8	52.8	52.8	52.8
Total lbs. Forage Excess or Deficiency (x 1000)				65,000	28.6	74.7	47.2	-2.0	-33.3	-49.8

Source: Grazing Systems Planning Guide, Univ. Minn. & NRCS (MN)

Another Example of forage balance sheet

Operation Name:	Any Ranch		Location:	Dury Watershed, Some County			Date	3/7/25	
Kind/ Class Animal	Number of Animals	Months Grazing or Fed at Target Operation	Animal Unit Equivalent (AUE)	Intake Demand/Animal/Yr (lbs ADW)	AUM Demand on Target Operation	Intake Demand (lbs ADW)	Combined Days on Fed Roughage	Forage Demand Offset (tons)	Forage Demand (AUM)
Dry Cow			0.92	0	0	0	0	0.0	0.00
Cow with calf	100	4	1	3600	400	360000	0	0.0	400.00
Bull, mature			1.35	0	0	0	0	0.0	0.00
Cattle, 1 yr old			0.6	0	0	0	0	0.0	0.00
Cattle, 2 yr old			0.8	0	0	0	0	0.0	0.00
Horse, mature			1.25	0	0	0	0	0.0	0.00
Sheep, mature			0.2	0	0	0	0	0.0	0.00
Lamb, 1 year old			0.15	0	0	0	0	0.0	0.00
Goat, mature			0.15	0	0	0	0	0.0	0.00
Kid, 1 yr old			0.1	0	0	0	0	0.0	0.00
Deer, white-tailed, mature			0.15	0	0	0	0	0.0	0.00
Deer, mule, mature			0.2	0	0	0	0	0.0	0.00
Elk, mature			0.6	0	0	0	0	0.0	0.00
Antelope, mature			0.2	0	0	0	0	0.0	0.00
Bison, mature			1	0	0	0	0	0.0	0.00
Sheep, bighorn, mature			0.2	0	0	0	0	0.0	0.00
Total	100				400	360000	0	0.0	400.00

Animal Unit (AU): One mature cow of approximately 1,000 lbs and a calf up to weaning, usually 6 monts of age, or their equivalent (see Animal Unit Equivalent).
Animal Unit Month (AUM): The amount of fo… body weight intake daily X 30 days).
Animal Unit Day (AUD): The amount of forag… weight intake daily).
Animal Unit Equivalent (AUE): The portion o… animal unit.
Air Dry Weight (ADW): The weight of vegetat…
Forage Demand Offset: The estimated quanti… days by estimating the air dry weight of the fe…

	B
Available Forage (AUM)	1290.0
Forage Demand (AUM)	400.0
Balance (AUM)	890.0

Based on the data provided, forage supply and demand are potentially in balance. Continue with field by field analysis

Operation Name:	Forage Ranch			Location:	Humboldt County			Date	3/30/06	
Field Number or Name	Acres	Production (lbs/ac)	Perennial Forage System?	Utilization Target	Proper Stocking Rate Ajustment	RDM Basis		AUM Perennial System	AUM Annual System	
1	50	4000	yes	0.60	0.90			120.0	0.0	
2	100	4500	yes	0.60	0.90			270.0	0.0	
3	300	5000	yes	0.60	0.90			900.0	0.0	
4			yes					0.0	0.0	
5			yes					0.0	0.0	
6			yes					0.0	0.0	
7			yes					0.0	0.0	
8			yes					0.0	0.0	
9			yes					0.0	0.0	
10			yes					0.0	0.0	
11			yes					0.0	0.0	
12			yes					0.0	0.0	
13			yes					0.0	0.0	
14			yes					0.0	0.0	
15			yes					0.0	0.0	
16			yes					0.0	0.0	
17			yes					0.0	0.0	
18			yes					0.0	0.0	
19			yes					0.0	0.0	
20			yes					0.0	0.0	
							Total	1290.0	0.0	Total 1290.0

Animal Unit (AU): One mature cow of approximately 1,000 lbs and a calf up to weaning, usually 6 monts of age, or their equivalent (see Animal Unit Equivalent).
Animal Unit Month (AUM): The amount of forage required by animal unit (mature cow and calf) for one month (~900 lbs air dry weight or ~3% of body weight intake daily X 30 days).
Animal Unit Equivalent (AUE): The portion of forage of forage consumed by the different kind and class of animals expressed as a portion of an animal unit.

Hints

Utilization Target: Some forage plants can withstand more grazing (utilization) than others. Intering a value of 0.65 in a Utilization Target cell is translated by the tool as meaning that 65% of the current year's growth in that field will be utilized by the end of the growing season. Most range plants can tolerate having 50% of the leaf area removed during the growning season while others may be able to sustain up to 65% utilization without significantly reducing the plants ability to rapidly recover from being grazed.

Proper Stocking Rate Adjustment: This rate adjusts to compensate for known or anticipated shifts in forage production. Entering a value of 0.9 in a Proper Stocking Rate Adjustment cell is translated by the tool as meaning that the stocking rate will be 90% of maximum capacity, thereby compensating for potential drought conditions.

RDM Basis: If your fields are dominated by annual grasses and you are not managing for perennial forage species, the residual dry matter (RDM) approach is used instead of Utilization Target. If 1000 is entered into a cell in this column it is translated by the tool that you are leaving behind 1000 lbs of residual dry matter at the end of the grazing season.

Forage production – another angle

Number of Animals in a Pasture;

$$\frac{\text{total acreage X average lbs/A}}{\text{.04 X average wt./animal X days grazed}} = \text{\# of animals}$$

Example: $\frac{\text{100acres X 6000lbs}}{\text{.04 X 1200lbs X 200days}} = \frac{600{,}000}{9600} = 62$ cows

Amount of acreage needed:

$$\frac{\text{Number of animals X average wt./animal X .04 X days grazed}}{\text{Average yield/acre}}$$

Example: $\frac{\text{62 cows X 1200lb/cow X .04 X 200 days}}{\text{6000lbs/acre}} = \frac{595200}{6000} = 99$ acres

Grazing for how long?

Days = $\frac{\text{lbs of forage/acre X \# of acre}}{\text{total herd wt (30 X 1200) X.04}}$ - daily herd forage requirement

Example: $\frac{\text{6000lbs./acre X 50acres}}{\text{36,000lbs X .04}}$ = 208 days

Length of rest period

- Depends upon:
  - Period in the growing season
  - Availability of soil moisture water
  - Amount of active leaf area remaining following the grazing period
  - Cool-season grasses recover more quickly in spring and autumn
  - Species – warm vs. cool season
  - Climate

General "rule of thumb" 25-30 days

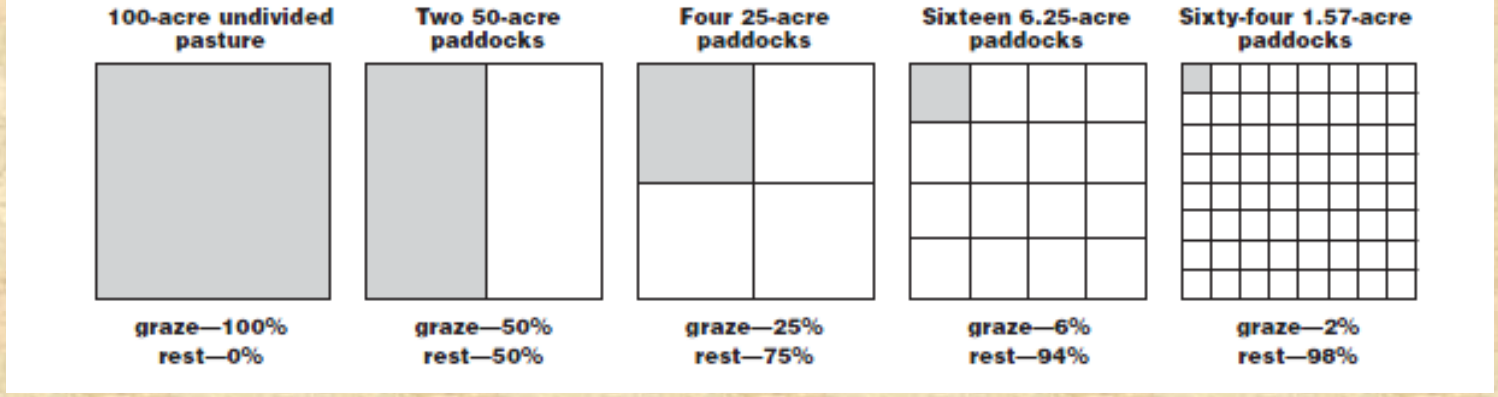
George, Holly, etal, *Living on the land*

How many paddocks/pastures are needed of a rotational grazing system?
What grazing system is best?

Continuous grazing
is a one-pasture system where livestock have unrestricted access throughout the grazing season.

Simple rotational grazing
is a system with more than one pasture in which livestock are moved to allow for periods of grazing and rest for forages.

Intensive rotational grazing
is a system with many pastures, sometimes referred to as paddocks. Livestock are moved frequently from paddock to paddock based on forage growth and utilization.



Source: Grazing Systems Planning Guide, Univ. Minn. & NRCS (MN)

The ***minimum*** number of paddocks ***for each herd*** in the pasture system is equal to:

$$\text{Paddock Number} = \frac{\text{Rest period (days)}}{\text{Grazing period (days)}} + 1$$

Source: Grazing Systems Planning Guide, Univ. Minn. & NRCS (MN)

$$\frac{\text{28 days of rest}}{\text{4 days of grazing}} + 1 = \text{8 paddocks}$$

Proper paddock/pasture size – its not all math

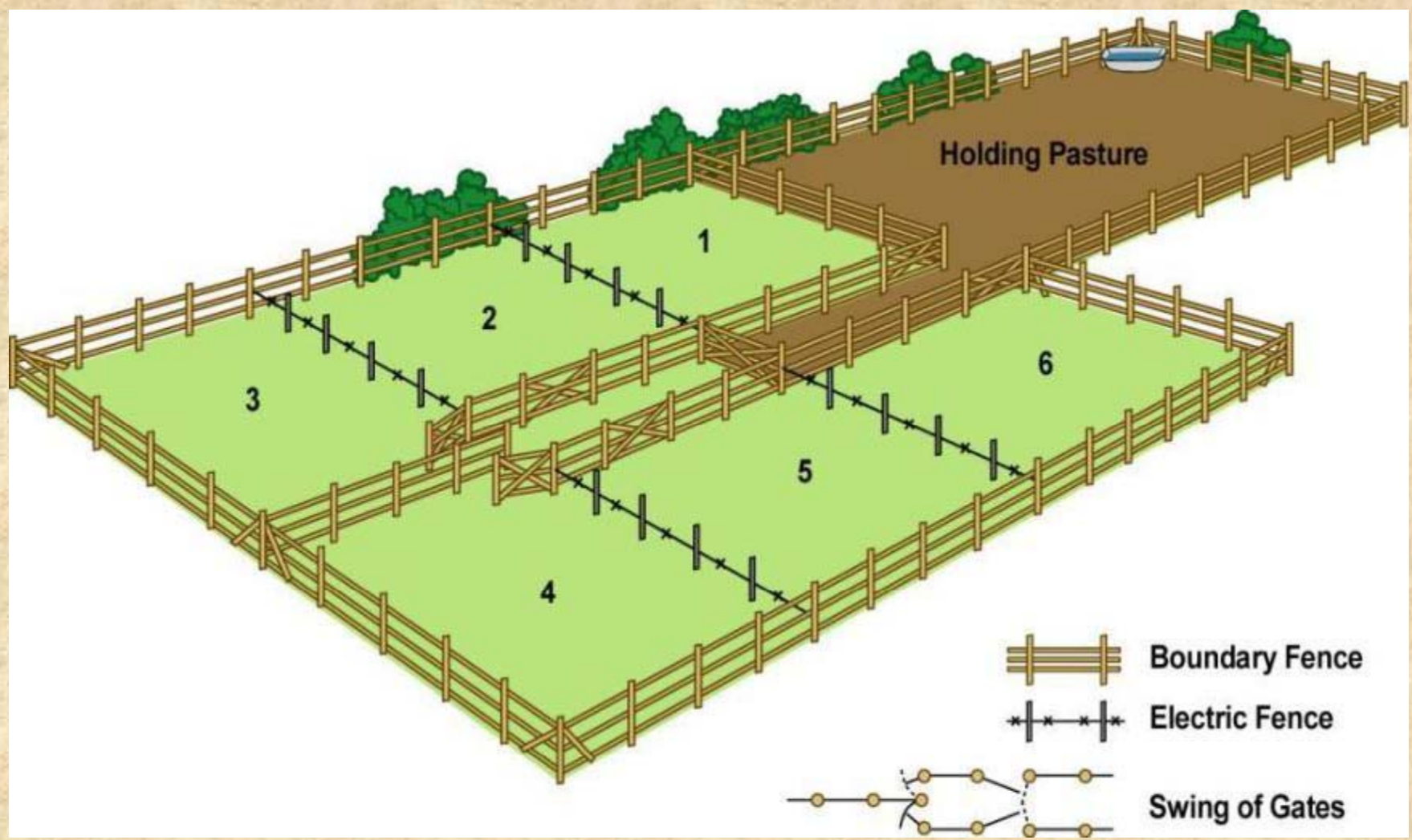
Function of:

1. Forage production – total
2. Seasonal production
3. Animal requirements
4. Landscape
5. Labor

Thus;

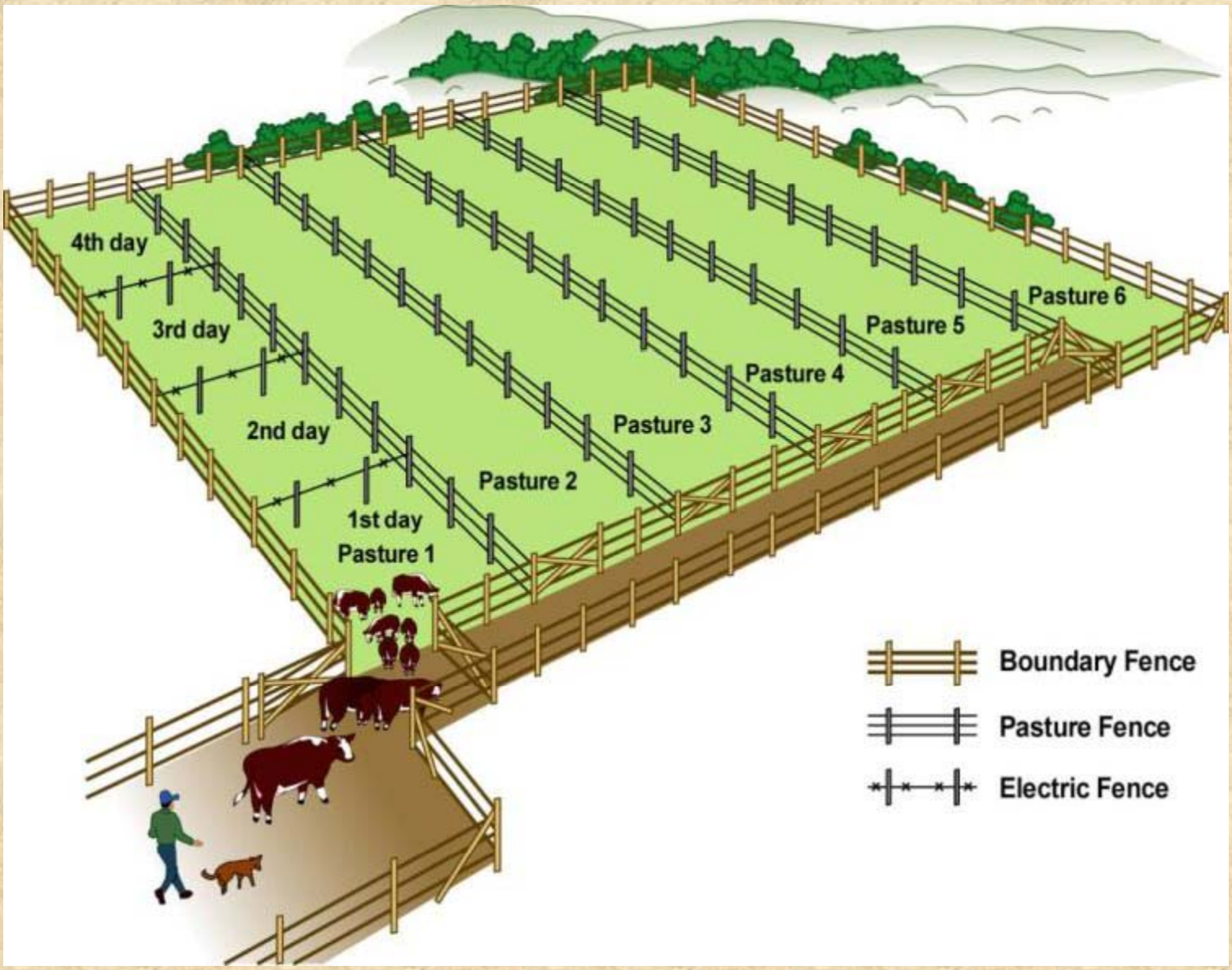
- Factor in varying growing conditions
- Vary the length of grazing period
- Vary the size of the paddock, where possible

Pasture configurations



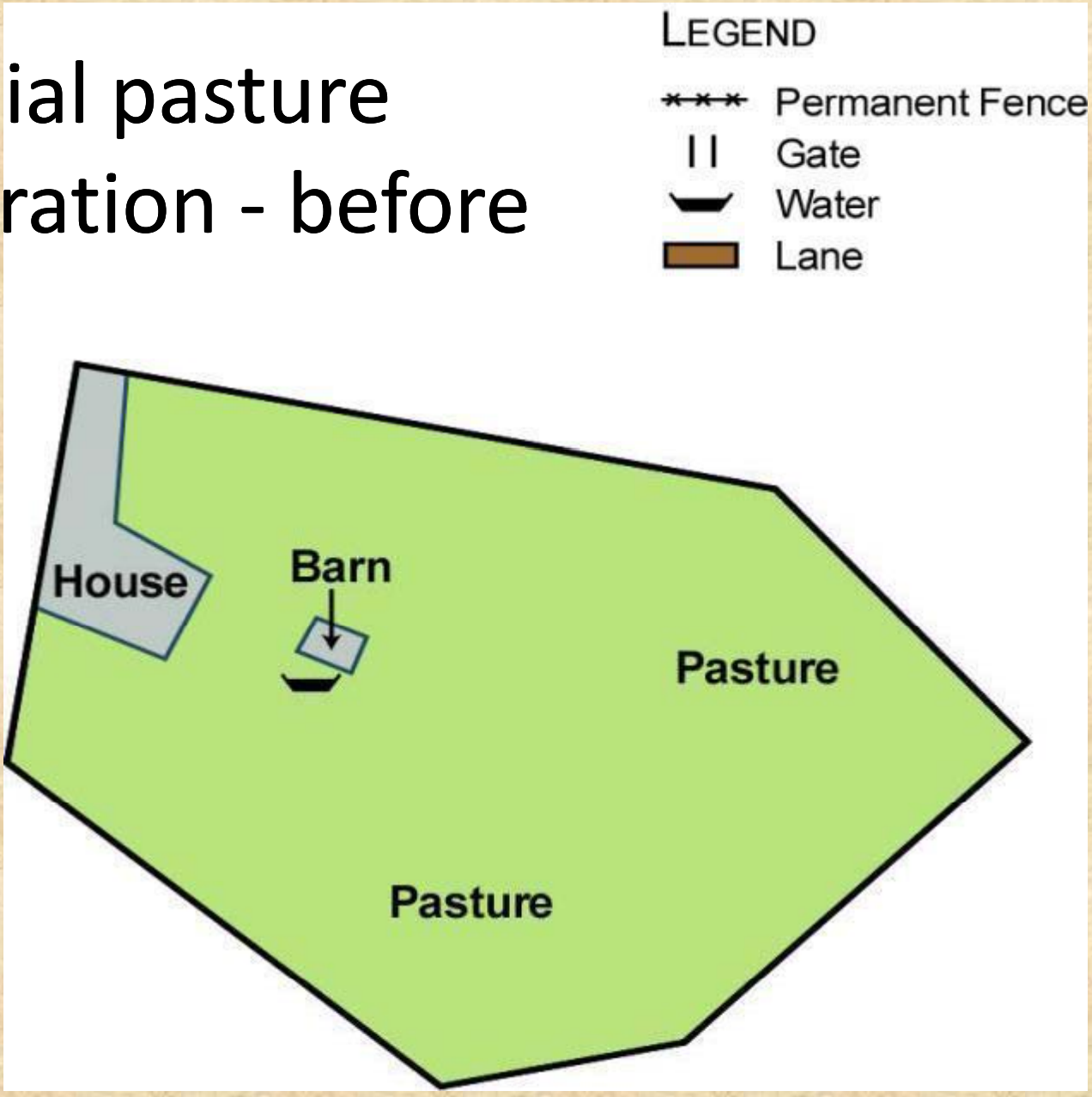
NRCS, Bozeman, Mont.

Pasture configurations



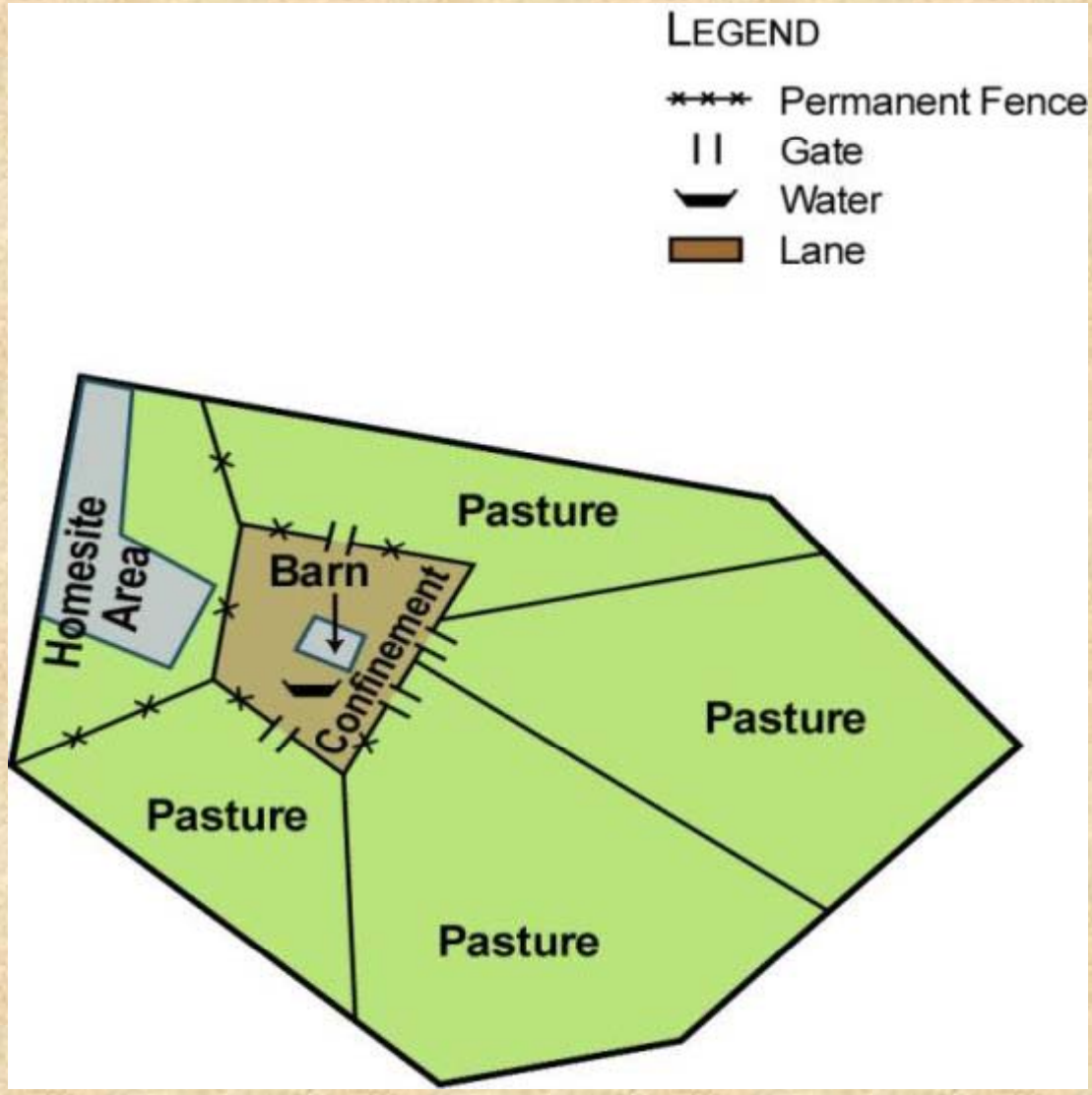
NRCS, Bozeman, Mont.

Radial pasture configuration - before



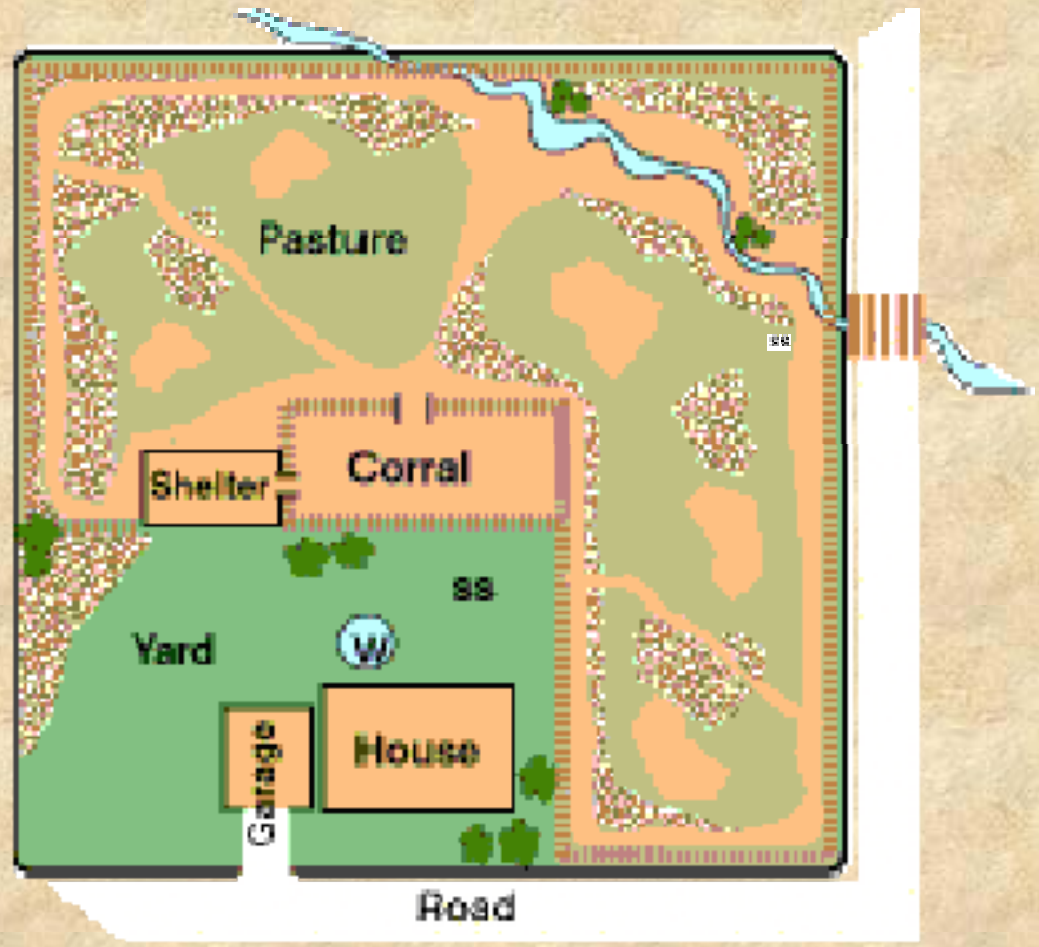
NRCS, Bozeman, Mont.

Radial pasture configuration – after



NRCS, Bozeman, Mont.

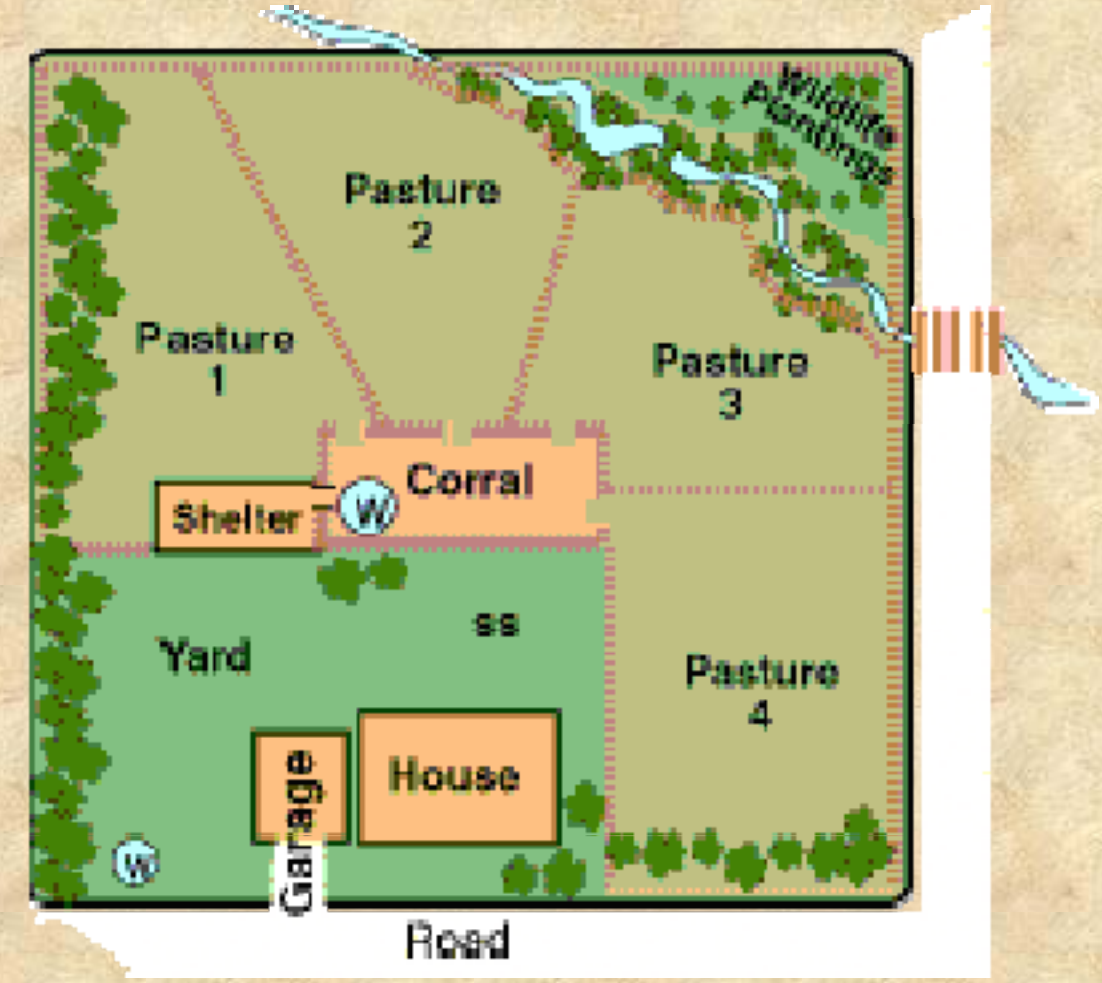
Another pasture configuration - before



Explanation

- Bare
- Buildings
- Fences
- Lawn
- Property
- Streams
- Trees
- Water
- Weeds

Another pasture configuration - after



Explanation

- **Bare**
- **Buildings**
- **Fences**
- **Lawn**
- **Property**
- **Streams**
- **Trees**
- **Water**
- **Weeds**

Considerations for layout

Whenever possible;

- Look for similar soils
- Similar slope aspects
- Similar topography

Adjustments may be necessary – be flexible as possible

Monitoring & Evaluate

- Use observations and common sense
- If there isn't enough feed in your pasture, you are either overstocked or not allowing enough rest, regardless of what the calculations said

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George, Holly, etal – *Living on the land*

Thank you