FORAGE AND PASTURE MANAGEMENT

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UAF CES, KENAI PENINSULA

WILDLAND, RANGELAND, PASTURE, CROPS
=
FORAGE

WHAT IS FORAGE?

- SOMETHING YOUR LIVESTOCK WILL EAT
- ABUNDANT ENOUGH TO PROVIDE NUTRITION
- MEETS THE NEEDS OF YOUR ANIMALS

FORAGE SPECIES

- SOMETHING THAT YOU CONTROL LONG-TERM
- RIGHT NOW, YOU HAVE WHAT IS ESTABLISHED. A DOMINANT STAND OR A MIXED PASTURE.
- TIMOTHY AND SMOOTH BROME ARE COMMON
- ANNUAL OATS, BARLEY, OR RYE…
- EVALUATIONS FOR RESEARCH POTENTIAL

Variety	Yield[2] lb/a	Crude Protein (%)	Acid Detergent Fiber (%)	Metabolizable Energy (Mcal/lb)
Rhizominous Alfalfa	916	20.5	19.7	1.33
1-BMR-1 Rye	3126	12.3	27.6	1.16
Juan Triticale	5396	21.2	32.5	1.02
Brome Hay[3]	2353[4]	12.5	35.7	0.97

[1]Only stands of forages having heights of 12 inches or more were considered harvestable.
[2]Yield calculated at 85% dry matter and reduced 30% from sampled yield to approximate field yields (based on personal observation).
[3]Delta averages offered as a quality comparison (Quarberg and Comeau, 1992).
[4]Alaska average yield for all established stands of grass hay in the Tanana Valley for 1988-1995 (Brown, 6/96).

QUARBERG 90'S, DELTA JUNCTION AREA

Table 2. Yield and quality analysis of forage crops produced at the Agricultural and Forestry Experiment Station, Pt. MacKenzie

Crop	Yield[1] *T/a*	Protein %	Phosphorus %	Potassium %	Calcium %	ADF[2] %	IVDM[3] %	Metabolized Energy *Mcal/lb*
Rondo Turnip	7.1	11.88	0.42	4.21	1.46	23.74	84.91	1.49
Purple Top Turnip	7.6	16.00	0.61	4.60	1.68	23.93	85.16	1.50
Civasto-R Turnip	7.3	10.81	0.40	3.65	1.18	17.27	90.01	1.60
Fresia Turnip	8.5	14.06	0.51	5.05	1.37	24.68	84.85	1.49
Forage Star Turnip	8.8	14.75	0.49	5.03	1.89	24.13	84.84	1.49
Emerald Rape	5.6	9.50	0.29	3.68	1.04	30.20	78.49	1.36
Winfred Rape	6.3	14.81	0.40	5.00	1.20	22.17	86.86	1.53
Tyfon	5.6	9.50	0.42	4.63	1.25	22.67	86.04	1.52

[1] dried to 0% moisture and adjusted to 12% moisture
[2] acid detergent fiber
[3] in vitro dry matter disappearance

PURSER 90'S, PALMER AND SOUTHCENTRAL

Crop	Yield[1] T/a	Protein %	Phosphorus %	Potassium %	Calcium %	ADF[2] %	IVDM[3] %	Energy Mcal/lb
Rondo Turnip	6.3	16.31	0.23	1.94	1.97	25.81	81.98	1.43
Purple Top Turnip	8.9	19.56	0.41	2.53	1.44	27.21	82.69	1.44
Civasto-R Turnip	8.4	16.88	0.38	2.34	1.52	22.90	87.14	1.53
Fresia Turnip	5.9	17.08	0.33	2.60	1.44	20.05	87.92	1.55
Forage Star Turnip	4.4	19.38	0.26	2.05	2.42	21.54	84.39	1.48
Emerald Rape	5.6	16.75	0.30	2.81	1.33	28.89	83.04	1.45
Winfred Rape	4.8	15.25	0.27	2.44	1.16	20.24	88.13	1.56
Tyfon	5.9	10.63	0.19	1.59	1.34	26.68	82.50	1.44
Premier Kale	3.6	12.75	0.15	1.43	1.05	22.40	75.73	1.30
Triticale	7.7	11.50	0.26	1.91	0.29	41.18	59.55	0.96
Cisca Pea	2.3	16.81	0.17	1.08	1.04	19.57	83.70	1.47
Tessa Pea	6.9	16.69	0.22	1.66	0.57	21.60	83.80	1.47
Poneka Pea	7.4	16.81	0.15	1.39	0.70	27.10	74.51	1.27
Canadian Field Pea	8.6	22.69	0.29	1.82	0.71	27.24	74.88	1.28

FORAGE TYFON (STUBBLE TURNIP – SMALL BULBS)

Table 4. Yield and quality analysis of forage crops produced at Little Nelchina Farm, mile 135 Glenn Highway

Crop	Yield[1] T/a	Protein %	Phosphorus %	Potassium %	Calcium %	ADF[2] %	IVDM[3] %	Metabolized Energy Mcal/lb
Rondo Turnip	7.8	14.56	0.31	2.15	1.75	40.50	55.97	0.88
Purple Top Turnip	8.5	15.19	0.37	1.72	1.56	37.83	58.89	0.94
Civasto-R Turnip	4.1	18.00	0.37	2.62	2.46	26.88	71.93	1.22
Fresia Turnip	5.2	12.31	0.31	2.35	1.90	29.53	60.18	0.97
Forage Star Turnip	3.7	17.25	0.32	2.85	2.78	17.96	86.00	1.51
Emerald Rape	2.5	21.38	0.38	3.67	1.44	14.47	89.54	1.59
Winfred Rape	1.7	23.00	0.45	2.98	1.21	11.38	90.18	1.60
Tyfon	5.8	18.75	0.36	4.10	1.84	18.53	82.30	1.44
Triticale	3.7	15.75	0.31	2.72	0.26	17.77	71.54	1.21
Cisca Pea	0.8	21.88	0.27	2.37	1.61	14.88	84.77	1.49
Tessa Pea	2.2	17.06	0.17	1.55	1.71	14.04	86.63	1.53
Sela Pea	1.7	26.63	0.37	2.85	1.23	17.71	83.30	1.46
Poneka Pea	7.1	20.13	0.20	2.70	1.22	27.33	71.69	1.21
Maxi Pea	1.2	18.75	0.36	4.10	1.84	14.14	84.36	1.48
Mangles	7.1	13.00	0.25	3.48	1.14	37.08	57.23	0.91

[1]dried to 0% moisture and adjusted to 12% moisture
[2]acid detergent fiber

EMERALD RAPE

At all locations the purple top turnip was one of the top 3 producers; with yields that ranged from 7.6 to 8.9 T/a. The Rondo turnip also performed consistently well at all sites and yielded 6.3 to 7.8 T/a. The Poneka pea produced 7.4 T/a in forage trials in 1988. It performed well again this season with a yield averaged from the 2 Pt. Mackenzie locations of 7.3 T/a. Another crop which provided consistently high yields from all 3 locations was tyfon, it produced between 5.6 and 5.9 T/a.

This study seems to indicate that even under unfavorable conditions, including low pH soils and drought, there are a number of forages that can perform quite well.

RONDO TURNIP

JAHNS 90'S KENAI PENINSULA

Yield and Quality of Alternative Forage Crops from Warren Larson Memorial Test Site, Kenai, AK, 1996

Forage Variety (Type)	Harvest Date	Yield[1] (lb/a)	Quality (100% Dry Matter Basis)[2] Crude Protein (%)	Acid Detergent Fiber (%)	TDN[3] (%)	Metabolizable Energy (Mcal/lb)
Good Hunt (Chickory)	9/3/96	128	8.4	10.1	33	0.6
Puna (Chickory)	9/3/96	1237	17.9	13.2	65	1.1
Dovey (Tall Fescue)	9/3/96	2985	13.2	23.4	63	1.1
Fure (Meadow Fescue)	9/3/96	1130	19.4	20.2	63	1.1
Forage Star (Forage Turnip) - top	9/3/96	7441	19.5	17.3	67	1.2
Forage Star - turnip	9/3/96	22,430	N/A	N/A	N/A	N/A
Matua (New Zealand Brome)	9/6/96	2196	11.4	25.5	57	1.0
Apellsvoll (Orchardgrass)	9/3/96	4115	15.6	24.2	61	1.1
BARLP6BRA (Perennial Ryegrass)	9/3/96	2431	17.2	18.0	68	1.2
Barmaco (Perennial Ryegrass)	9/3/96	2601	16.2	18.0	68	1.2
BG3-Super (Perennial Ryegrass)	9/6/96	704	17.2	17.6	63	1.1
Moy (Perennial Ryegrass)	9/6/96	2985	13.1	26.2	59	1.0
Cerestonic (Plantain)	9/3/96	1535	12.5	15.7	65	1.2
Lancelot (Plantain)	9/3/96	2900	13.2	18.9	66	1.2
Lara (Reed Canarygrass)	9/3/96	597	19.3	12.0	61	1.1
Palaton (Reed Canarygrass)	9/3/96	2175	18.7	22.3	63	0.6
Venture (Reed Canarygrass)	9/3/96	917	19.2	18.8	63	1.1
Vega (Timothy)	9/3/96	810	22.4	18.3	62	1.1

[1]Yield: Calculated on a 100% dry matter basis.
[2] Michaelson et.al., 1992.
[3] TDN: Total digestible nutrients

CHICORY

NARROWLEAF PLANTAIN

The results of this alternative forage crop demonstration indicate that at least one variety of all of the species tested show some promise for Kenai Peninsula forage production. This is especially promising considering that precipitation was approximately 66% lower than normal (see precipitation figure); and soil temperatures at the time of planting were extremely cold, the result of little snow cover and subsequent deep freezing of soils during the winter of 1995.

The annual forage turnip Forage Star, made a rapid and impressive showing. This forage crop may find a useful home in future no-till pasture renovations currently being planned on the Kenai Peninsula.

In evaluating species and varieties, it should be noted that lower yields were usually correlated with lower ADF values indicating slower germination, poorer stands, and subsequently later maturing (less mature) crops.

While yields are included for comparative purposes, it should be noted that this was an establishment year for all species and varieties tested, and the entries were not replicated. Production potentials of the species and varieties tested require multi- year evaluations and should not be judged on a single year's data. Yield comparisons should be made among grass species or forbes, not across all species. Overwintering potential must also be evaluated to determine overall forage crop potential.

COVER CROPS

FIREWEED?

- Nutritional value of fireweed varies depending on season and site. Fireweed crude protein averaged 20 percent throughout the second summer following fire; dry matter digestibility was over 80 percent. In another study, crude protein content was 13.7 percent, and protein digestibility (dry matter) was 13 percent. Fireweed collected in July in Alaska had 11.9 percent protein, 62.2 percent dry matter digestibility for moose, and 64.7 percent dry matter digestibility for dairy cow.

WILLOWS

WILLOWS

NUTRITIONAL VALUE :
Bebb willow has been rated as fair in energy value and poor in protein value [9]. Leaves and twigs collected from northeastern Minnesota had the following energy and nutrient values (percent dry weight) [16]:

	June (leaves/twigs)	August (leaves)	Sept (leaves)	Dec (twigs)
Energy (cal/g)	---/4,740	4,838	---	5,094
Ash	4.9/6.2	5.7	5.2	2.1
Protein	17.9/9.7	11.5	9.4	6.3
Ether extract	3.6/2.1	3.7	4.6	4.8
Crude fiber	11.4/23.8	12.2	13.6	29.6
N-free extract	62.2/58.3	66.9	67.2	57.3

Nutrient composition (percent) of Bebb willow bark collected in the spring from Denali National Park and Preserve, Alaska, was as follows [29]:

Neutral detergent fiber: 35.5
Acid detergent fiber: 34.4
Lignin: 13.1
Cellulose: 20.4
Ash: 2.8
In vitro dry matter digestibility: 45.0
Crude Protein: 3.8
Phosphorus: 0.1
Calcium: 0.8

ASPEN AND COTTONWOOD

ASPEN AND COTTONWOOD?

NUTRITIONAL VALUE :
Overall energy and protein values of quaking aspen are rated "fair" [48]. Nutritional content of quaking aspen browse varies seasonally, by plant part, and by clone [11,40,159]. Protein content drops as the growing season progresses [42,179]. On a Utah site, average leaf protein dropped from 17 percent in early June to 3 percent at abscission. Clonal variation in leaf protein ranged from 13.4 to 20.9 percent in June and from 10.1 to 14.6 percent in September. Average twig protein dropped from 17 percent in spring to 6 to 7 percent in winter. Twig nitrogen, phosphorus, and potassium levels dropped from spring to winter, but twig calcium, magnesium, sodium, and fat levels increased. Phosphorus values in September averaged only 58 percent of those in June [159].

Mean composition of quaking aspen terminal shoots, collected in March and April in Soldotna, Alaska, was as follows [149]:

dry matter (%)	43.6
gross energy (kcal/g)	5.1
crude protein (%)	7.9
neutral-detergent fiber (%)	54.9
acid-detergent fiber (%)	40.1
lignin (%)	10.5
ash (%)	1.9
in-vitro digestibility for moose (%)	42.0

CANADA REEDGRASS

NUTRITIONAL VALUE:
Bluejoint has been rated as fair in energy value and poor in protein value [8,15]. In July of 1974, nutrient and mineral composition of this grass on Alaska's Kenai Peninsula were as follows [29]:

IVDMD(%)*		Fiber %			Protein %
Moose	Dairy Cow	Cell walls	ADF*	Lignin	
48.1	55.9	69.8	37.8	3.7	9.8

* IVDMD=in vitro dry-matter digestibility
* ADF=acid detergent fiber

macronutrients (ppm)				micronutrients (ppm)			
Ca	K	Mg	Na	Cu	Fe	Mn	Zn
617.0	9799.0	1481.0	74.0	22.3	58.0	30.9	21.6

WHAT FACTORS AFFECT PRODUCTION AND QUALITY?

- Before Harvest: Species of forage chosen
- Before Harvest: Soil Fertility and Precipitation
- At Harvest: Stage of maturity at time of grazing or baling
- At Harvest: Moisture content at time of grazing or baling and storage
- After Harvest: Handling and Storage conditions

HARVESTING: STAGE OF MATURITY

- Most Important Yield and Quality Factor
- Something you control every year.
- Plants do not mature at the same time every year (climate variability)
- Different species have different times of maturity
- In mixed stands, need to estimate an average best time of maturity

1. Stem Elongation
2. Boot Stage / head within the leaf sheath
3. Early Head Emergence / first spikelet visible
4. Head Emerged / spikelets all visible / no peduncle yet
5. Fully Headed / spikelets all visible / peduncle fully elongated
6. Anthesis / anthers present **(bloom)**
7. Anthesis complete / anthers gone
8. Seeds visible
9. Milk Stage / Seeds filling / milky and soft
10. Soft Dough Stage / no longer milky but soft
11. Hard Dough Stage / no longer soft
12. Seeds mature / fully developed but not dry
13. Seeds mature / fully developed and dry (shatter)

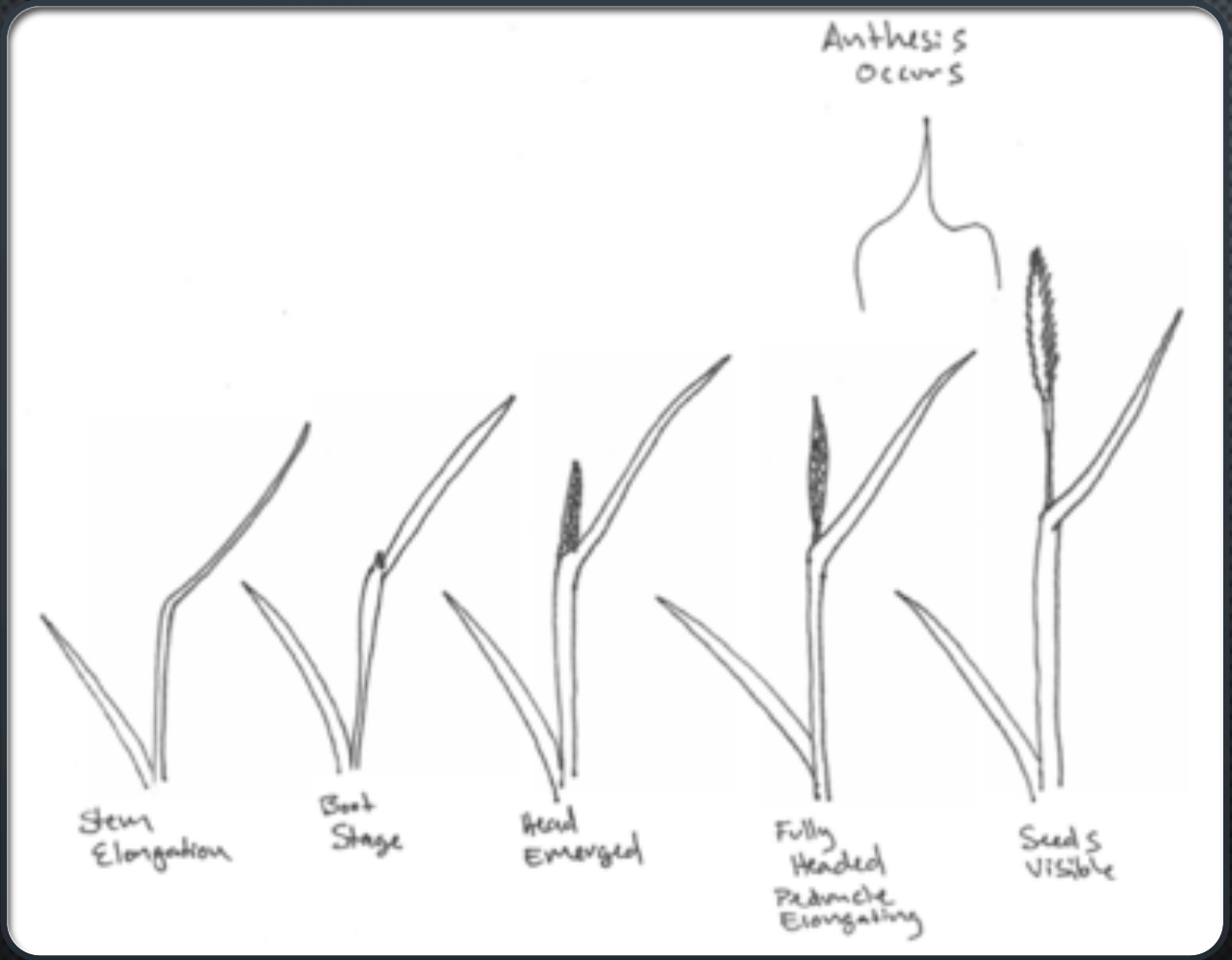

Anthesis Occurs
Stem Elongation
Boot Stage
Head Emerged
Fully Headed
Peduncle Elongating
Seeds Visible

Table 3. Quality and Quantity of Bromegrass Harvested at Different Stages of Maturity

Date	Stage of growth when harvested	Crude Protein (%)	Yields Hay (lb/a)	Protein
5/28	3 to 6 inches of early growth	27.4	1080	237
6/12	Internodes elongating, 10 inches high	22.1	1835	324
6/26	Still growing, 27 inches high	13.7	3600	394
7/10	Panicles emerged, full bloom	12.2	4364	426
8/07	Seeds developing	10.2	5079	414
8/28	Seed ripened, leaves yellow	5.4	6030	259
9/25	Leaves dry and shattering	4.2	3392	113

Reference: Sweetman & Brundage, 1960

STAGE OF MATURITY

Table 1. Yield and Quality of Bromegrass Hay Harvested on Different Dates at Delta Junction, Alaska in 1992

Date	Stage of plant maturity	Height (in.)	Yield[1] (lb/ac)	Crude protein (%)	IVDMD[2] (%)	TDN[3] (%)	ME[4] (Mcal/lb)	ADF[5] (%)	Proposed hay Grade
6/2	Immature	15	422	24.49	70	68	1.17	27.2	1
6/10	Elongation and boot	26	1525	19.44	61	59	0.99	33.7	1
6/18	Early head emergence	37	2140	14.82	56	54	0.89	37.9	2
6/26	Headed to early bloom	39	3050	14.84	56	53	0.88	38.1	3
7/5	Full bloom to dough	42	4370	8.13	52	49	0.80	42.1	5

1 Maximum projected yield (15% moisture) assuming a plant population density of 25 stems/ft^2
2 Digestibility measured through in vitro dry matter disappearance
3 Total digestible nutrients
4 Metabolizable energy in megacalories per pound
5 Acid detergent fiber

Table 4. Yield, crude protein (CP), and digestible dry matter (DDM) data for Engmo timothy herbage grown in southcentral Alaska trials.

Location	Harvest date	Harvest stage#	Yield tons/ac.	% CP	% DDM
Fritz Creek (Homer)	7/10/79	e. hd.	3.66	11.1	61.7
	7/8/80	em.	2.14	15.1	60.4
Lookout Mt. (Homer)	7/12/76	em.	1.96	14.8	63.4
	7/9/79	b.-em.	1.45	17.3	67.5
Funny River (Soldotna)	7/9/84	e. hd.	3.13	13.4	59.4
	7/9/85	b.-em.	1.59	18.4	64.5
	7/14/86	e. hd.	1.53	20.2	68.2

SMOOTH BROME, NITROGEN AN EXAMPLE

Table 2. Response of Bromegrass to Different Nitrogen Treatments With 80 lb P_2O_5 and 40 lb K_2O per Acre

Pounds of nitrogen per acre per year	Crude Protein in crop (%)	Crude Protein in crop (lb/a)	Dry Matter (lb/a)	Approximate yields Hay (ton/a)	Approximate yields Silage (ton/a)
None	11.2	100	878	0.5	1.5
16	11.4	132	1,158	0.7	2.2
32	12.4	182	1,467	1.0	3.0
64	14.6	324	2,213	1.7	4.5
128	18.3	636	3,480	2.3	7.0

Reference: Sweetman and Brundage, 1960

Table 2. Ninilchik Location

Treatments lb/a Sulfur applied)	Yield (lb/a)	N:S Ratio (Total N:Total S)[2]
Check (0 lb/a)	1879 a[1]	28:1
20 lb/a	2446 ab	20:1
40 lb/a	3308 b	20:1
80 lb/a	3008 b	19:1

[1]Numbers followed by different letters are significantly different at p<0
[2]Mean separation analysis is not available at this time.

TIMOTHY, SULFUR AN EXAMPLE 7/25

Table 1. Funny River Location

Treatments (lb/a Sulfur applied)	Yield (lb/a)	N:S Ratio (Total N:Total S)
Check (0 lb/a)	1670 a[1]	34:1 a
20 lb/a	3285 b	22:1 b
40 lb/a	3203 b	20:1 b
80 lb/a	4791 c	15:1 c

[1] Numbers followed by different letters are significantly different at p<0.01. (LSD=868).

TIMOTHY, SULFUR AN EXAMPLE 8/23

HARVEST TIME

- Choose your harvest timing to meet your forage quality / market goals
- Depending on weather, sometimes you don't have a lot of flexibility

Grade, stage of maturity & definition	Physical description	CP (%)	ADF (%)	TDN (%)	ME (Mcal/lb)	Value[a] (%)
1. PREMIUM; pre-head; late vegetative to early boot	Green; less than 5% impurities; free of mold musty odor, dust	>16	<36	>56	>0.94	108%
2. GOOD; early head; boot to early head	Light green to green; less than 10% impurities; free of mold, musty odor, dust	13–15	36–37	54–55	0.90–0.93	105%
3. AVERAGE; head; head to milk, seeds are well formed but soft immature	Yellow green to green; less than 15% impurities; free of mold, musty odor, dust	10–12	38–39	52–53	0.85–0.89	100%
4. FAIR; post-head; dough to seed	Brown to green; less than 20% impurities; slightly musty odor, dust	8–9	40–45	49–51	0.80–0.84	94%
5. POOR; sample grade	Contains more than a trace of harmful impurities or definitely has objectionable odor or is under cured, heat damaged, hot, wet, musty, moldy, caked, badly broken, badly weathered or stained, extremely overripe, dusty, which is distinctly low quality, or contains more than 20% foreign material or more than 22% moisture	<8	>45	<49	<0.80	92%

Adapted from Wickwire et al., 1991; Rohweder et al., 1978

MOISTURE CONTENT

- At harvest, as long as there isn't a drought or the forage hasn't been allowed to fully mature, forage grasses will have relatively high moisture content
- After cutting, the plant will go through respiration (losing carbohydrates) until the plant reaches approximately 40% moisture
- Respiration leads to normal dry matter losses of 5% to 6%
- In extreme cases, respiration can cause losses of up to 15%

MOISTURE CONTENT

- After the grass has reached 40% moisture, respiration losses cease and some losses occur to raking and baling
- Raking and baling usually leads to dry matter losses of 1/10TH to 1/4 , primarily due to the shatter/loss of leaves
- Using hay conditioners / crimpers / crushers can reduce dry matter losses by reducing the amount of time it takes to cure, exposure to weather, reduces respiration time, and can reduce leaf shatter

MOISTURE CONTENT

- Small bales should be baled when moisture levels are below 18-20% moisture
- Large bales should be baled when moisture levels are below 16-18%.
- Hay with moisture levels higher than above at the time of baling are at risk of mold
- A good all around number to aim for is 15% moisture
- Hay is usually baled between 12% to 16% moisture
- At lower moistures however, there is more risk of leave shatter and dry matter losses

MOISTURE CONTENT

- MOISTURE LEVELS CAN BE RAPIDLY ASSESSED USING A MICROWAVE AND A GRAM SCALE
- PROBES AND OTHER ESTIMATES OF MOISTURE ARE NOT AS RELIABLE AS WEIGHING AND DRYING SAMPLES
- WEATHER FORECASTS ARE LESS ACCURATE MORE THAN 3 DAYS OUT. AVOID RAIN DAMAGE, BUT DON'T WAIT TO LONG. EACH DAY MATTERS AND AFFECTS QUALITY.
- TAKE FULL ADVANTAGE OF DRYING CONDITIONS.

MOISTURE CONTENT

- Wider swaths dry faster
- A narrow swath can keep more forage elevated though if the ground is wet
- A tedder can be used to dry forage, but don't let it be too dry before using so there aren't losses
- Organic acids (propionic-acetic and propionic) are sometimes used to preserve hay (to reduce molding at upper moistures) – cost and method of application is a factor. 10 to 30 lbs needed per ton, according to moisture levels.

TESTING FORAGE

- Always a good idea
- Can help you market your hay
- Gives you an idea of how you are doing
- Calibrates what you visually see in the field and the bale with what is happening with nutrition

TESTING FORAGE

Name: DR CASEY MATNEY
Sample ID: 27

Lab Number: 209020

Constituent Analyzed	As Received	Oven Dry
Moisture, %	8.1	0.0
Dry Matter, %	91.9	100.0
Crude Protein, %	4.7	5.2
Acid Detergent Fiber %	39.1	42.6
Total Digestible Nutrients (TDN), %	50.5	54.9
Calculated Net Energy Lactation, Mcal/lb	0.51	0.56
Calculated Net Energy Maintenance, Mcal/lb	0.48	0.52
Calculated Net Energy Gain, Mcal/lb	0.24	0.26

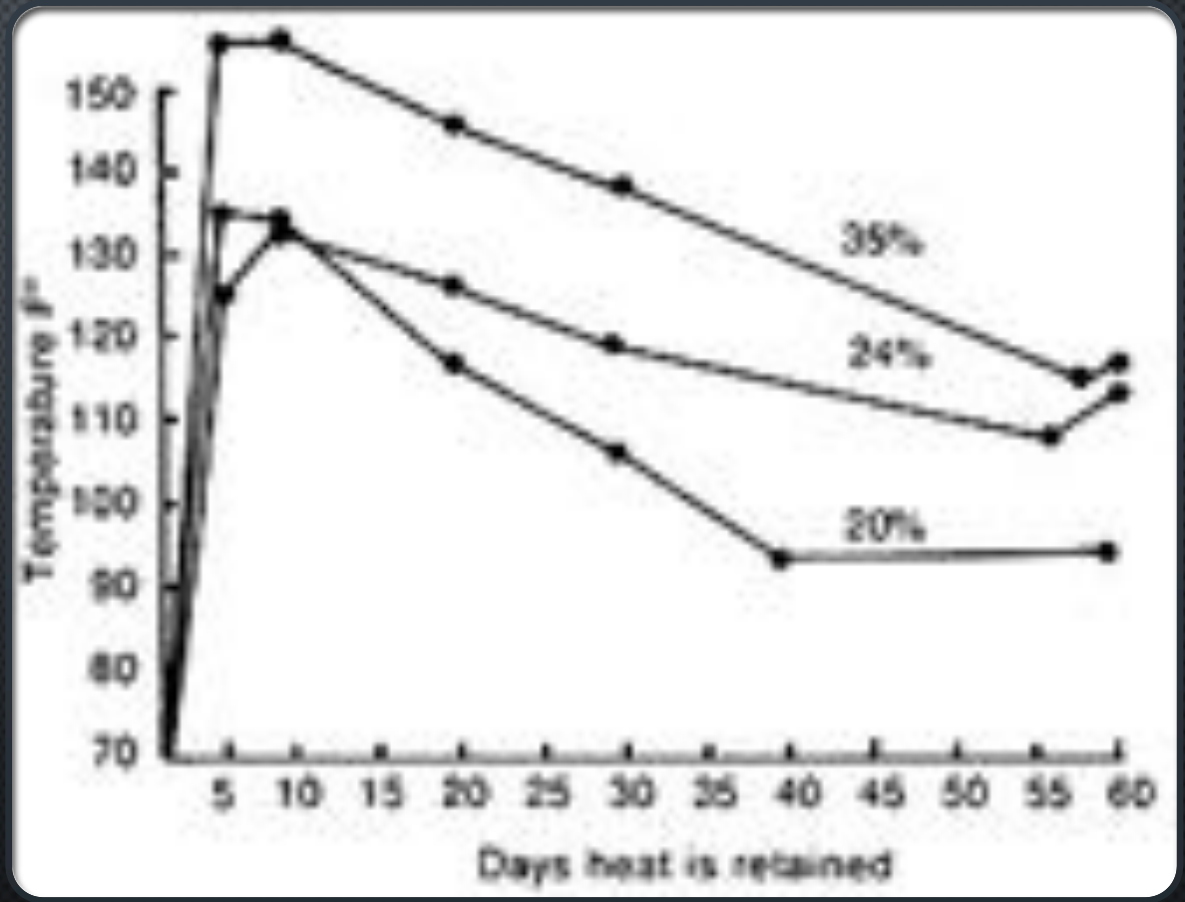
- How does this compare to the hay quality chart?

Grade, stage of maturity & definition	Physical description	CP (%)	ADF (%)	TDN (%)	ME (Mcal/lb)	Value* (%)
1. PREMIUM; pre-head; late vegetative to early boot	Green; less than 5% impurities; free of mold musty odor, dust	>16	<36	>56	>0.94	108%
2. GOOD; early head; boot to early head	Light green to green; less than 10% impurities; free of mold, musty odor, dust	13–15	36–37	54–55	0.90–0.93	105%
3. AVERAGE; head; head to milk, seeds are well formed but soft immature	Yellow green to green; less than 15% impurities; free of mold, musty odor, dust	10–12	38–39	52–53	0.85–0.89	100%
4. FAIR; post-head; dough to seed	Brown to green; less than 20% impurities; slightly musty odor, dust	8–9	40–45	49–51	0.80–0.84	94%
5. POOR; sample grade	Contains more than a trace of harmful impurities or definitely has objectionable odor or is under cured, heat damaged, hot, wet, musty, moldy, caked, badly broken, badly weathered or stained, extremely overripe, dusty, which is distinctly low quality, or contains more than 20% foreign material or more than 20% moisture	<8	>45	<49	<0.80	92%

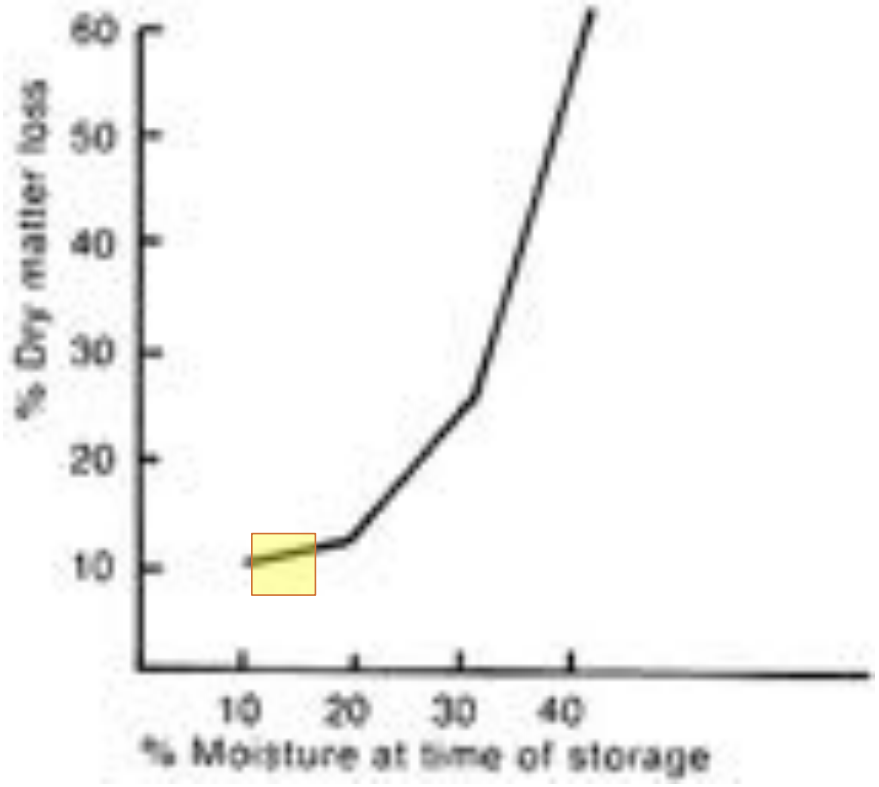
Adapted from Wickwire et al., 1991; Rohweder et al., 1978

STORAGE

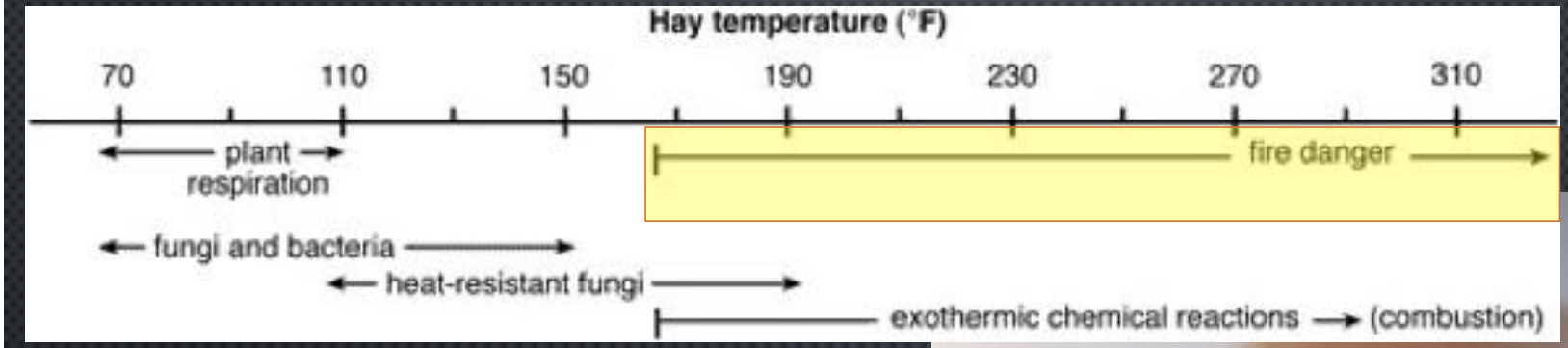
- HEATING NORMALLY OCCURS, UNLESS THE HAY IS AT OR BELOW 15% MOISTURE
- HEATING RESULTS IN DRY MATTER LOSSES



STORAGE


% Dry matter loss
60
50
40
30
20
10
10
20
30
40
% Moisture at time of storage

STORAGE


Hay temperature (°F)
70
110
150
190
230
270
310
plant respiration
fire danger
fungi and bacteria
heat-resistant fungi
exothermic chemical reactions
(combustion)

STORAGE (OUTSIDE)

- Always store bales on a well drained area.
- Good ventilation is needed the first 1 to 3 weeks after baling. Use a minimum of 3 feet between bale rows for air circulation. The more space, the better.
- If bales are stored side by side, leave at least 24 inches between bales.
- Avoid storing bales under trees and in the shade of buildings.
- Long-term - Cover your bales.
- If space is available, store bales inside, especially the higher quality hays that should be used near the end of the feeding period.

Table 5. Methods of Hay Storage and Estimated Annual Reduction in Nutrient Losses

Storage method	Estimated annual reduction in storage losses
Uncovered, outside, on ground	0%
Uncovered, outside, on gravel* or tires	20%
Uncovered, outside, on pallets	35%
Covered, outside, on ground	50%
Covered, outside, on gravel* or tires	70%
Covered, outside, on pallets	85%
Inside on a dirt floor	90%
Inside on a raised floor	95%

Thomas, 1986.

g: Gravel can become embedded in the bottom bales and adversely affect health if fed to livestock.

STORAGE

STORAGE (INSIDE)

- WELL HARVESTED-HIGH QUALITY HAY CAN BE STORED INSIDE MORE THAN ONE YEAR
- AFTER ONE YEAR, VITAMIN A VALUES WILL LIKELY BE LOW
- AFTER A YEAR, ONLY ABOUT A 5% LOSS IN DRY MATTER WILL OCCUR
- IT PAYS TO TAKE GOOD CARE OF HAY

CONSIDERATIONS FOR PRODUCERS

Improving	Improving the quality of forage by changing production management practices such as fertilization programs, time of harvest and/or storage techniques.
Continuing	Continuing to physically inspect forages as would a prospective buyer.
Conducting	Conducting chemical analyses to be used in evaluating the effectiveness of quality control methods.
Offering	Offering flexibility in pricing forages based on physical and chemical analyses.
Offering	Offering to replace forage of unusually low quality.
Determining	Determining a fair price for forage based on input costs, fixed costs, risk management, and being satisfied with a fair price that brings repeat customers.

CONSIDERATIONS FOR BUYERS

- Determine the nutrient quality of forage necessary for their specific livestock.
- Conduct a physical inspection of the forage product. Look carefully at color, maturity, mold, impurities - smell the forage to identify any off odors.
- Weigh the forage if possible.
- Take a sample of the forage and have it chemically analyzed by a competent laboratory. Your local Extension office can provide information and tools for sampling forages, handling the samples and sending them for analyses. Your Extension agent can also assist in interpreting the results of the analyses.
- Negotiate. Depending on the current supply and demand for forage, the seller may be willing to adjust the price based on the nutrient analyses.
- Investigate guarantees. Some producers will guarantee that the forage is free of mold. Should a contaminated bale be found, they will exchange it. Check with the seller.

WHAT IS QUALITY HAY?

Which bale is better?