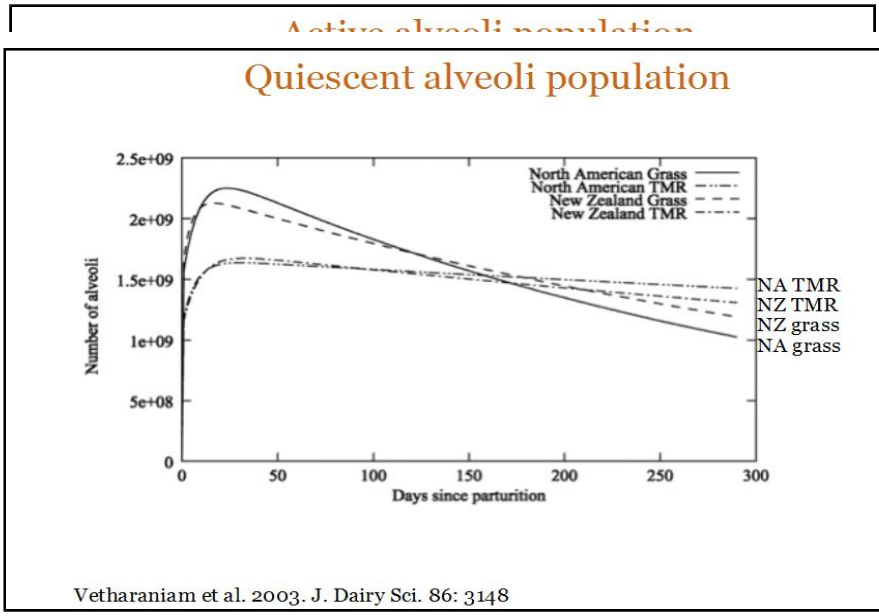
High Forage Diet

At 8:00 AM on Thursday, March 17, Session 6 began on **Transitioning dairy cows to a no grain or high forage diet** with moderator, Dr. Andre Brito, University of New Hampshire hosting it. He introduced the first presenter, Dr. Sabrina Greenwood, Assistant Professor, Department of Animal Science, University of Vermont, Burlington, VT. The title of her presentation was *Milk production and health of grazing dairy cows*. Dr. Greenwood is Canadian born and worked at Lincoln University in New Zealand before coming to the University of Vermont. In New Zealand, dairy farmers are working towards supplementation of milk cows rather than away from it. Many factors contribute to the success of transitioning to no grain or high forage diets with dairy cows: First and foremost is their genetic interaction with nutrition.

Dr. Greenwood displayed two figures from I. Vetharaniam et al., NZ dairy science researchers, to show how NZ dairy cattle Holstein-Fresian genetics differ from US dairy cattle genetics. The two figures show the evolution, over time, of the populations of active and quiescent alveoli for the different genotypes and diets over the lactation cycle. (Editor's note: Alveoli are sack-like structures in the cow's udder where milk is synthesized and secreted. An alveolus is the discrete milk producing unit. It is estimated to hold ~1/5 of a drop of milk.) Alveoli are divided into 3 groups: active (milk secreting), quiescent (not secreting currently), and senescent (dead). Quiescent alveoli can go either way, back to being active or senescing depending on milking regime (times per day cows are milked), days in lactation, and diet. This was shown in a figure from Shorten et al. 2002. Rates of decline of active alveoli were less for cows fed a total mixed ration (TMR) than for cows fed grass, indicating better persistency with the TMR diet , and over the course of a lactation, a larger population of active alveoli. This effect can be linked to differences between diets in the senescene parameter.



More quiescent alveoli early on in lactation cycle for dairy cows on grass versus TMR dampening milk production during early lactation

Looking at persistency of alveoli, the New Zealand genotype performed better than the North American genotype on grass keeping more active alveoli into late lactation, but underperformed the North American (NA) genotype on TMR, reflecting differences in breeding selection criteria in the two regions. Such a difference is probably linked to the genotype × diet effect found in the quiesence parameter. Quiescent alveoli followed opposite trends to active alveoli, with a grass diet resulting in more quiescent alveoli at the expense of active alveoli, for the first part of the lactation. Midway through the lactation, this difference disappeared due to the much greater losses in total alveoli suffered by the cows on a grass diet versus a TMR due to a greater senescence (death) rate of alveoli.

Although the NZ genetics cows do better on grass than NA genetics cows in retaining active alveoli, they still retain more active alveoli when fed a TMR, just not as well as the NA genetics cows. This would explain why NZ dairy farmers are leaning towards supplementation as there is a good response and more milk is produced as a result of feed supplementation to pastured cows. Depending on the price of the supplement being used, it would seem to favor some supplementation to a level where it still provides more income than the expense to buy and feed it. This has to include changes in the price received for the milk produced based on milk components as well as volume. It also tends to stretch the amount of pasture needed to feed the cows adequately to maintain body condition and milk flow.

(Editor's note: It is obvious from this presentation that the NZ Holstein-Friesian genetics has favored cows that do well on pasture as that is the prevalent feed source there, while in NA most dairy farmers have shifted to confinement feeding and thus the genetics have been steered towards cows that do best on a TMR. The fact is that both genetics do best on TMR, but just to different degrees. Pasture is just a cheaper way to feed cows requiring less equipment and feeding facilities, but for dairy cows it must be high quality pasture with high intake potential [plenty of grass on-offer].)

Nutrition – genetic interactions
Animal responses to concentrate

	Levels of concentrates compared			
	Low to Medium		Medium to High	
	Lower genetic merit	Higher genetic merit	Lower genetic merit	Higher genetic merit
Response in milk yield (kg milk per kg concentrates)				
Fulkerson (2000)	1.47	1.75	0.92	1.10
Kennedy *et al.* (2002)	0.65	1.14	0.76	1.07
	NZ strain	OS strain	NZ strain	OS strain
Kolver *et al.* (2005)	0.96	1.24	0.34	0.92
			NZ strain	OS strain
Horan *et al.* (2005)			0.43 *(0.51)**	1.08 *(0.19)**

NZSAP Occasional Publication No. 14

Dr. Greenwood then displayed a figure (above) showing the response to different levels of concentrate feeding by lower genetic merit cows versus higher genetic merit cows. The higher genetic cows always responded with more milk production to concentrate feeding compared to lower genetic merit cows. If concentrates are withheld to higher genetic grazing cows then, they will decline in milk production much more quickly than a lower genetic merit grazing cow. Both will drop in milk production, but the higher genetic cow will drop in milk production more and is more likely to have health problems too. This table also made it apparent that lower levels of concentrate provided the biggest boost to milk production for either lower or higher genetic merit cows with diminishing returns at higher levels.

Diet quality will also make or break the transition to a high forage diet or no grain. Using a series of slides, Dr. Greenwood shows how medium quality pasture, high quality pasture, and a TMR affect milk production and cow health. Medium quality pasture allowed for 33 pounds of dry matter intake (DMI) daily. This produced 40.5 pounds of milk per day. Milk production is held down due the amount of allowable milk metabolizable energy (ME) available in the forage. In metric units, ME allowable milk was 18.4 kg or 40.5 pounds in English units. The metabolizable protein (MP) allowable milk was 23.1 kg or 50.8 pounds of milk, but without an infusion of energy from a supplement the cow on medium quality pasture is only going to produce 40.5 pounds of milk. ME and MP allowable milk should be within 1 kg of each other and should match the observed milk flow before any ration changes are made (Cornell). Clearly there is an excess of MP even on medium quality pasture in relation to ME. Any excess protein is excreted in the urine.

Comparative numbers in milk production

Table 5: Dairy cow intake, production and digestion of contrasting diets offered under normal grazing conditions or as *ad libitum* TMR[1]. Cows weigh 500 kg and are neither gaining nor losing weight. All data on a per day basis unless indicated.

	Medium quality pasture	High quality pasture	TMR
Diet			
Intake kg DM	15 **(33 lbs)**	17.9 **(39 lbs)**	20 **(44 lbs)**
Intake kg WM	75	119	40
DM%	20	15	50
CP%	18	29	17.5
NDF% (effective NDF)	51 (21)	35 (14)	33 (23)
NFC%	20	23	37
Feed ME MJ/kg DM	10.5	12.5	11.4
Production			
Milk kg	18.4 **(40.5 lbs)**	28.0 **(61.6 lbs)**	32.0 **(70.4 lbs)**
Milksolids kg	1.48	2.29	2.53
Limiting nutrients			
ME allowable milk kg	18.4	28.0	32.0
MP allowable milk kg	23.1	36.5	35.4
LYS; MET allowable milk kg	21.6; 22.7	29.7; 30.1	36; 41.2
Digestion			
Rumen fill kg WM (% liveweight)[2]	20	20	14
Apparent DM digestibility%	66	76	71
Apparent N digestibility%	60	81	63
Rumen feed CP degradation (%)	69	79	59

NZSAP Occasional Publication No. 14

On the high quality pasture, milk cow DMI improved to 39 pounds per day and in turn increased milk production to 61.6 pounds per day. This shows that if considering a move to a high forage or no grain diet, a high quality pasture is important, and there must be enough available forage presented to the herd at all times to achieve that level of intake. Even here, ME allowable milk limits milk production since it is 28 kg or 61.6 pounds in the daily diet. There is even a larger amount of excess MP as crude protein is 29% of DM. MP allowable milk is 36.5 kg. This 8.5 kg above ME allowable milk. There will be an energy cost to excrete so much excess protein as uric acid.

The TMR fed cows had a DMI of 44 pounds since it has less fiber in it and combines concentrates with harvested forages. Protein level is near optimum for dairy cows producing 70.4 pounds of milk per day. Non-fibrous carbohydrates (NFC) levels are much higher in the TMR than in the either quality of pasture grass. Therefore, the ME allowable milk is highest in the TMR at 32 kg or 70.4 pounds.

Dry matter intake of dairy cows is limited on pasture due to rumen fill. In the figure below you will note that both the medium and high quality pastures max out at 20 kg of rumen fill. This is generally attributed to the amount of neutral detergent fiber (NDF) present in the cow's diet.

The NDF runs from high of 51% NDF for the medium quality pasture to 35% NDF for the high quality pasture and 33% NDF in the TMR. Thus, the TMR fed cows had less rumen fill. Diets with high NDF content have resulted in more rumen fill and less DMI than lower fiber diets. Note that DMI is only 33 pounds per day on the medium quality pasture. The high quality pasture with a much lower NDF content allows for 39 pounds of DMI per day. Meanwhile, the TMR allows 44 pounds DMI per day since it has the lowest NDF content.

An unbalanced diet increases the risk of metabolic disturbances such as ketosis most commonly. Cows affected with ketosis have been well documented to have reduced milk yield, increased risk for metritis (inflamed uterine wall), and increased risk for displaced abomasum. Healthy, adequately fed cows will also make the transition from dry period to peak more easily. See nutritional disorders table, page 61.

Transition of German Holsteins from TMR (35% corn silage, 35% grass silage, 30% concentrate, DM basis) to pasture (ryegrass-based) resulted in the following over 10 weeks:

- (Temporary 5 kg/d (11 lbs/d) reduction in milk production)
- Lower BCS (0.2 - 0.3 difference using 1-5 scale) up to 48 kg (106 lbs) body weight difference
- Higher serum β-hydroxybutyrate (BHBA) An indicator of subclinical ketosis.
- Higher serum nonesterified fatty acids (NEFA) Elevated NEFA levels indicate that dietary energy intake is insufficient for the cow's needs for milk production or fetal growth and that body fat is being broken down to make up for the energy deficit.

- Lower serum
  - Cholesterol
  - γ-glutamyltransferase (assumed not biologically significant therefore OK for liver cell activity)
- Higher serum
  - Aspartate transaminase (assumed not biologically significant therefore OK for liver cell activity)
  - Red blood cell (physical activity?)
  - Hemoglobin (physical activity?)
  - Hematocrit (physical activity?)
- No change in serum
  - Albumin
  - Total protein
  - Bilirubin
  - Glutamate dehydrogenase
  - White blood cell count
  - Lymphocyte count
  - Monocyte/granulocyte/eosinophil count

Dr. Greenwood went on to say that eliminating supplementation of cows on grass would be similar in response to cattle being supplemented, the results are variable. There can be a good or bad response. She showed a slide showing the response to supplementation. It was all over the board from negative to positive. The average of 33 studies was a positive response of 0.68 kg of milk per day increase in milk production. However, the spread in response was from a loss in milk production of 2.5 kg per day to an increase of 2.3 kg per day. These 33 studies may have had some very dissimilar set of circumstances to be so inconsistent, but this would mimic the differences between dairy farms. Going to no grain supplementation may be good or bad depending on the herd genetics and the quality of the pasture being grazed. There is the possibility of taking a big hit in milk production. If sticking to the all-graze feeding of lactating dairy cows, it will mean culling a lot of cows and keeping the ones that do better (more milk, rebreed on 12 month schedule, and higher BCS) on an all-grass diet.

This led to her next factor affecting the success of transitioning to a no grain diet: type of forage. Typical pasture in New Zealand is a perennial ryegrass-white clover mixture. Kale as a winter forage for dairy cows is promoted and used there. It could help extending the grazing season in the Northeast US. It is rotationally grazed to avoid forage wastage.

In support of the reports by our forage breeding session, Sabrina pointed out from the table Dairy Cow Productivity on Different Forage Types how good the response of eating birdsfoot trefoil (Lotus) was to dairy cows. Where forage was 75% of DMI, trefoil increased DMI by 11% and increased milk solids by 48% over a ryegrass pasture. When the condensed tannins were removed from the trefoil (Lotus) (100% forage diet) DMI increased to 17% but milk solids only increased to 21%. Removing the condensed tannins caused milk solids production to drop. In the meantime, it is interesting to note that if it were a cocksfoot (orchardgrass) pasture on an all-grass diet, DMI would increase 7% but milk solids would decrease 22% compared to ryegrass.

The Potential Plant Toxin Issues table displays the different toxins of plants used as forages or occurring in pastures in NZ and the US. It is of interest, but should not dissuade anyone from pasturing livestock. As the saying goes, everything in moderation. For instance, condensed tannins can be good to bind to plant protein so it passes through the rumen to be digested in the lower digestive tract. However, there is a limit that is reached that makes plants with high levels of condensed tannins unpalatable, such as old varieties of *Sericea lespedeza*. Trefoil could use a little more condensed tannins in it so the trick is to breed it to have more but not too much more. Brassicas, such as kale and rape, make great feed due their high sugar content, but they do have some mildly toxic chemicals and are low in fiber so caution must be used, especially with dairy cows, to slowly get them used to eating it. Kale can depress body condition of cows if overfed or fed too much too quickly. An adaptation period of at least one week is necessary. Slowly ramp up intake of kale. In a study done by Dr. Greenwood, groups of dry Friesian x Jersey cows fed 10 and 14 kg DM per day of kale got sufficient energy (above 115 MJ ME/cow/d) from the two levels to gain 0.5 body condition score over a 6-week winter period. So the final important factor in transitioning cows to a different diet is to give them an adequate length of adaptation to a new feedstuff whether it be to an all-forage diet, a change in green forage radically different in fiber and sugar content, or switching from stored forage to pasture in the spring and back to stored forage later in the fall.

Potential Plant Toxin Issues in US & NZ

Common Name	Poisonous Principle
Cultivated Plants	
Alsike clover	Photosensitising agent-trifolisis
Birdsfoot trefoil	Condensed tannins
Blue lupin	Numerous alkaloids
Borage	Pyrrolizidine alkaloids
Brassica spp.	Glucosinolates, S-methyl cysteine sulphoxide, nitrates, photosensitising agent
Buckwheat	Photosensitising agent
Curbits	Triterpenes
Fodder beets	Nitrates, oxalates
Forage cereals	Nitrates
Japanese millet	Photosensitising agent
Kikuyu	Unknown
Kumara	Ipomeamarone and others
Linseed	Cyanogenic glycosides
Lotus corniculatus	Condensed tannins, cyanogenic glucosides
Lucerne (Alfalfa)	Phyto-oestrogens
Mangels	Nitrates, oxalates
Onion	Allyl polysulphides
Parsnips	Furocoumerins
Phalaris tuberosa	Indolealkyamine alkaloids
Potato (green)	Glycoalkaloids
Radish	Nitrates, glucosinolates, photosensitising agent
Red Clover	Phyto-oestrogens
Rhubarb	Oxalates, possibly glycosides
Ryegrass	Nitrates
Sainfoin	Condensed tannins
Sorghum	Cyanogenic alkaloids, nitrate
Subterranean clover	Phyto-oestrogens
Sugar beet	Nitrates, oxalates
Sulla	Condensed tannins
Vetch	Proanthocyanidins
White clover	Cyanogenic alkaloids
Weeds	
Bittersweet	Glycoalkaloids
Black nightshade	Glycoalkaloids
Broomcorn millet	Photosensitising agent
Bur medick	Phyto-oestrogens
Bushmands poison	Toxins similar to oleander
Buttercups	Glycoside (ranunculin)
Cape tulip	Cardiac glycoside
Cape weed	Nitrates
Cow parsnip	Phototoxins
Couch	Cyanogenic glycosides
Deadly nightshade	Glycoalkaloids
Delphinium	Numerous alkaloids
Fat hen	Nitrates, oxalates
Field horsetail	Thiaminase
Foxglove	Cardiac glycoside
Goats rue	Numerous alkaloids

Common Name	Poisonous Principle
Weeds (continued)	
Groundsel	Pyrrolizidine alkaloids
Hellebores	Glycoside (ranunculin), cardiac glycoside
Hemlock	Piperidine alkaloid
Henbane	Alkaloids
Horsebane	Acethylenic compounds
Indian doab	Cyanogenic alkaloids
Lily of the valley	Cardiac glycosides
Mallow	Unknown toxin causing staggers
Milkweed	Esters of phorbol and ingenol
Oxalis	Oxalates
Patersons curse	Pyrrolizidine alkaloids
Ragwort	Pyrrolizidine alkaloids
Redroot	Nitrates
Reed canary grass	Numerous alkaloids
Scarlet pimpernel	Triterpenoid
Sheep's sorrel	Oxalates
Spearwort	Glycoside (ranunculin),
Spurges	Mono and di-esters
Spurrey (yarr)	Possibly oxalates
St John's wort	Photosensitising agent
Staggerweed	Unknown toxin causing staggers
Storksbill	Photosensitising agent
Sweet clover	Phyto-oestrogens
Variegated thistle	Nitrates
Vipers' bugloss	Pyrrolizidine alkaloids
Willow weed	Photosensitising agent
Wimmera ryegrass	Cornyetoxins
Woody nightshade	Glycoalkaloids
Yew	Dieterpenoid taxanes (taxine)
Trees and shrubs	
Apple of sodum	Glycoalkaloids
Bracken	Thiaminase
Buxus	Steroidal alkaloids
Cherry laurel	Cyanogenic alkaloids
Datura spp.	Tropane alkaloids
Elder	Cyanogenic alkaloids
Karaka	Karakin, cardiac glycosides
Kowhai	Alkaloids (cytisine)
Laburnum	Alkaloids (cytisine)
Larkspur	Many alkaloids
Macrocarpa	Isocupressic acid
Ngaio	Ngaione
Oak	Tannins
Oleander	Cardiac glycosides
Pinus ponderosa	Unknown toxin causing abortion
Poroporo	Glycoalkaloids
Privet	Unknown toxin causing staggers
Rangiora	An unknown hepatotoxin
Robinia	Glycoprotein
Rhododendron	Diterpenes
Wattles	Cyanogenic alkaloids, tannins
Titoki	Cyanolipids
Tutu	Tutin

Adapted from Angus (2000b); Connor (1977); Craw (1995)

NZSAP

Copper (Cu	
Cobalt (Co)	
Iodine defic	s.
Grass tetany	
Milk fever (	
Phosphatic	
Selenium d... disease)	oil levels of
Vitamin A (	
Vitamin D (	ot crops, ... sunlight.
Vitamin E deficiency (white muscle disease)	High intake of unsaturated fats especially in young stock. Forage, such as mature hay, straw, corn silage, root and cereal crops, are low in vitamin E.

Dr. Brito thanked Sabrina for a very in-depth look at the pitfalls that can occur in transitioning cows to an all-forage diet. He then introduced Dr. Jessica Williams, Assistant Professor of Forage Management & Forage Extension Specialist at Penn State University, University Park, PA. Her presentation was entitled *Annual Forage Crops - Overcoming Challenges and Maximizing Opportunities for Improved Productivity*. Dr. Williamson began her presentation by telling the audience that she is from Flintstone, Maryland in the western mountains near the PA border. She displayed the typical cool season grass seasonal distribution chart with the summer slump that occurs typically in July in PA. It also shows that in southern PA, the grass starts growing in mid-March and ends in mid-November. This gives winter annual forage crops value as they can extend the grazing season into winter and perhaps gives some very early season pasture in late winter-early spring before corn planting on cropland. Annual forages can also provide forage for pasture during the summer slump when summer annuals do well. Annual forages are getting a new look for these reasons:

- Additional feed – extension of grazing season
  - ➔ Helps mitigate high stored/harvested feed costs
- Periodic drought alleviation
- Improvement of no-till equipment
- New seed options
  - ➔ Fit more operations
- Better understanding of utilization
- Soil/nutrient management

Matching the forage to the farm is imperative. Benefits of forage should match the farm's needs:

- Alleviate compaction
- Improve soil structure
- Nitrogen fixation
- Nitrogen retention
- Weed suppression
- Lasting surface mulch
- Beneficial insects
- Fall and/or spring forage production

What are the constraints on the farm?

- Planting date - must be cropable land available, such as renovatable pasture or idle cropland.
- Seed and planting costs

Cultivar selection is important. Follow these suggestions:

- Use cultivars with a proven track record in your region
- Adapted to soil conditions on the farm field
  - ✓ Soil type, drainage, pH
- Mixture of species (especially if grazing!)
  - ✓ Stretches supply of high-quality forages over longer period of time
  - ✓ Early-maturing species with late-maturing
  - ✓ Extends grazing time, prolongs pasture productivity
  - ✓ Inclusion of legumes improves forage quality and provides N-fixation

Small Grains for Winter Grazing

Forage	Advantages	Disadvantages
Winter Oats	Early grazing High forage quality (gains) Germinates under limited moisture	Poor cold tolerance Poor disease tolerance in many varieties
Annual Ryegrass	Most popular cool-season grass Can be seeded by surface broadcast Few bloat problems Late Maturing (long spring grazing)	Limited fall grazing Poor winter grazing in cold weather Contamination of fields for other small grains
Rye	Most drought tolerant Most cold tolerant Rapid fall growth	Early maturity (early termination) Unpalatable at boot stage Can become infested with ergot (poisonous)
Winter Wheat	Good Cold tolerance Can be grazed or grained Drought tolerant	Least productive cool-season grass Low disease tolerant Bloat and grass tetany problems

Source: Stichler and Livingston (Texas A&M).

Complimentary maturation of annual forage mixtures in Spring is important. Cereal rye matures too early compared to legumes. Consider triticale or annual ryegrass instead. Triticale also yields better than rye, or wheat.

Greater forage biomass equals greater benefits. All of these benefits are boosted:

- Nitrogen retention
- Nitrogen supply
- Weed suppression
- Erosion control
- Soil organic matter

To increase biomass, select complementary species that can grow together well.

Complementary growth periods for grazing allow for the longest period to be on pasture. Spring wheat would have to be utilized for mid-season grazing in the Northeast if using small grains in table below.

Common Mixtures	Season Available for Grazing
Wheat/annual ryegrass	Mid- and late-season grazing
Rye/annual ryegrass	Early- and late-season grazing
Wheat/rye/annual ryegrass	Early-, Mid-, and Late-season grazing

Nutrient needs for annual forages of the 3 major nutrients: nitrogen (N), phosphorus (P), and potassium (K) should be applied generally in this proportion: N-4, P-1, and K-3. Monitor K soil test levels closely on annual forages. Continuous double cropping will often result in some need for broadcast K where the annual forage crops are planted in rotation with other crops. Alternating double crop fields can slow nutrient drawdown. Applying potash prior to corn planting (or a blend of ammonium sulfate and K) can be one approach where it is double cropped with an annual forage crop. This helps to avoid luxury consumption of K by the annual forage crop. Supplemental N is needed on corn and triticale double crop. Monitor corn N sufficiency to adjust N rates. Plant annual forage after silage corn or interseed in growing corn for best fall growth if planning to graze annual forage crop in late fall.

Nutrient needs for an annual grass pasture program should follow this sequence and rates of application:

1. Seeding: apply nutrients recommended in soil report
2. After emergence (2 to 4 leaf stage): 30-45 lb N/ac
3. After 1st grazing: 45-60 lb N/ac
4. After each subsequent grazing: 30-45 lb N/ac

This stages N application to maximize annual grass growth; otherwise growth rate will slow as N is drawn down.

Nutrient needs for a hay or silage program should follow this sequence and rates of application:

1. Seeding: apply nutrients recommended in soil report
2. After emergence (2 to 4 leaf stage): 30-35 lb N/ac
3. After 1st cutting: 60-75 lb N/ac
4. After 2nd cutting: 45-60 lb N/ac

Harvest stage makes a difference (See Biddle 2014 forage analysis chart), at least as far as crude protein is concerned. Flag leaf stage forage has more crude protein than letting the forage mature to boot stage as seen in the chart below. Fertilizing with N boosts crude protein and marginally improves energy. N also boosts K uptake. However, this not necessarily good especially in lush annual forage as the addition of N and the elevation of K in plant tissues to the level shown in the chart could lead to grass tetany in cattle or milk fever. K levels here are approaching 5% when N fertilizer is applied which could trigger grass tetany if magnesium levels are subpar in the total ration. Cool to cold, wet weather when this forage is being utilized triggers tetany.

Biddle 2014 forage analyses

Type	Crude Protein	ADF	NEL	Potassium
Boot	12.5	42.2	0.61	4.57
Boot no fert	9.7	41.7	0.59	3.02
Flag leaf	17.6	41.7	0.61	4.66
Flag leaf no fert	10.8	37.8	0.59	2.95

eekes growth stages of wheat: stage 8 is emerging flag leaf, stage 9 is ligule on flag leaf visible, and stage 10 is where grain head is in "boot".

Target flag emergence leaf stage (Feekes stage 8) for harvesting annual forages as silage such as wheat. The flag leaf is the fourth leaf to emerge on a wheat tiller. Grazing should occur so that all wheat or other small grain to be grazed completely (not to harvested as grain) is grazed off before boot stage (Feekes stage 10). These stages are shown in the picture above.

Ideally winter annuals should be planted as early as late August to early September for best yields. Planting them as late as October 1 can cause a yield drop of a half ton from a late August seeding.

Penn State Short Lived Forage Trial, 2013

Cereals		Harvest	Yield(t/A)	Stand	CP %	NDF %	NDFd 30	RFV
Huron	Rye	16-May	3.07	95	21.3	44.6	80.6	146.0
Trical 141	Triticale	16-May	2.98	97	14.1	55.7	75.9	104.0
Trical 815	Triticale	16-May	2.90	97	18.0	49.3	79.8	127.0
Trical 336	Triticale	16-May	2.82	96	16.4	53.8	75.4	112.0
Fridge	Triticale	16-May	2.64	94	16.6	51.0	78.8	120.0
Valor	Barley	13-May	2.50	94	17.1	56.6	70.0	105.0
Aroostook	Rye	2-May	2.42	97	22.0	49.7	76.5	124.0
Malabar	Wheat	13-May	2.00	97	14.1	59.0	70.8	97.0
Mean			2.69	96	17.5	52.5	76.0	116.9
LSD (.05)			0.28	5.8				
CV (%)			7.20	4.3				

Triticale cultivars did very well in the 2013 trial (See above chart) only Huron rye did better, marginally. Aroostook rye came off sooner, and although yield was lower, quality was good and if following with corn, a much earlier date to get the corn seed in the ground. Malabar wheat was the poorest performer for several reasons. If taking the last harvest of forage off in mid-May, use a corn variety that is 3-5 days earlier to insure it matures completely before a fall killing frost.

Alternatives, such as grazing or ensiling winter cover crops (cool season annuals), often need **more** not less management. Management issues with grazing winter annuals are:

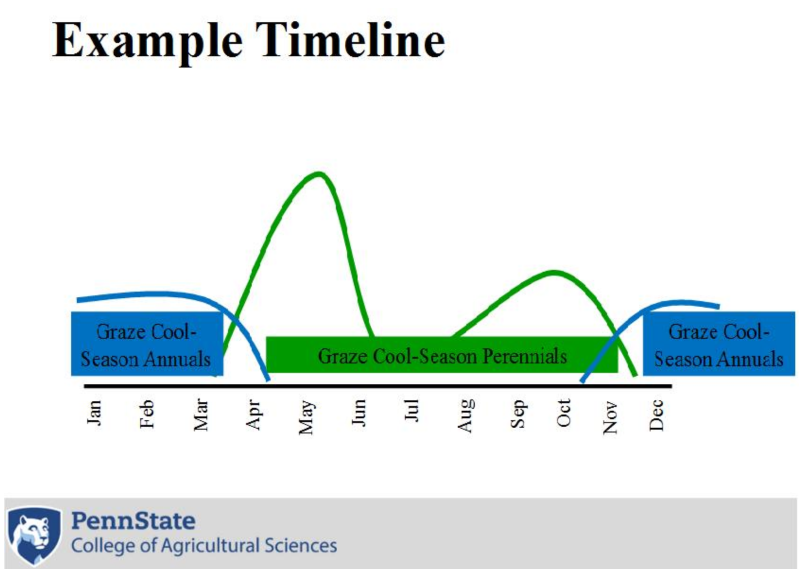
- Timely planting to ensure a good stand and maximize yield
- Timely harvest to get optimum forage quality, good regrowth if possible, and realize yield potential.
- Adequate N and other nutrients, esp. K to optimize forage quality and yield while avoiding issues such as grass tetany and nitrate poisoning.
- Species, variety selection critical to get compatibility in mixtures and best yield performance.

Avoid the "cover crop" plant and forget mentality.

Dr. Williamson explained that the use of winter annual forages extends the grazing season to a full year if done with careful planning and execution, and weather permitting in the Northeast. She used the chart below to show how this is accomplished. Now, we need to take care of the summer slump that occurs over much of the Northeast especially south of the NY/PA and CT/MA border.

Summer annual forages can:

- get you through the "summer slump" and,
- follow winter annuals nicely.

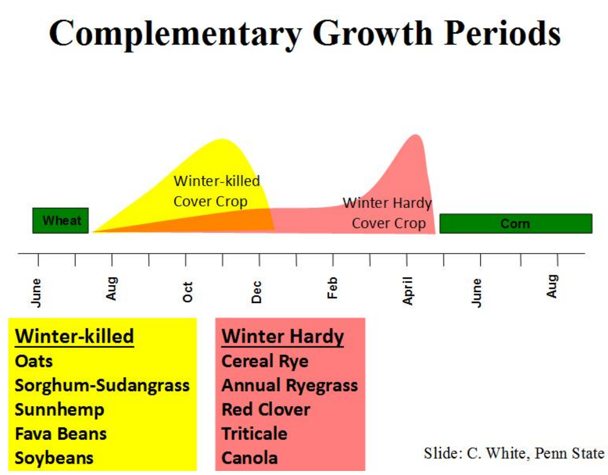


As with winter annuals, harvest (graze) summer annuals at correct maturity since they lose their quality fast. Stagger planting date to rotate animals onto pastures with more vegetative, higher quality forage. They tend to be rapidly-growing so it is important to sow only what can be grazed off quickly enough to not lose quality. Select for species that tolerate grazing and will regrow, for instance, use pearl millet over hay millet.

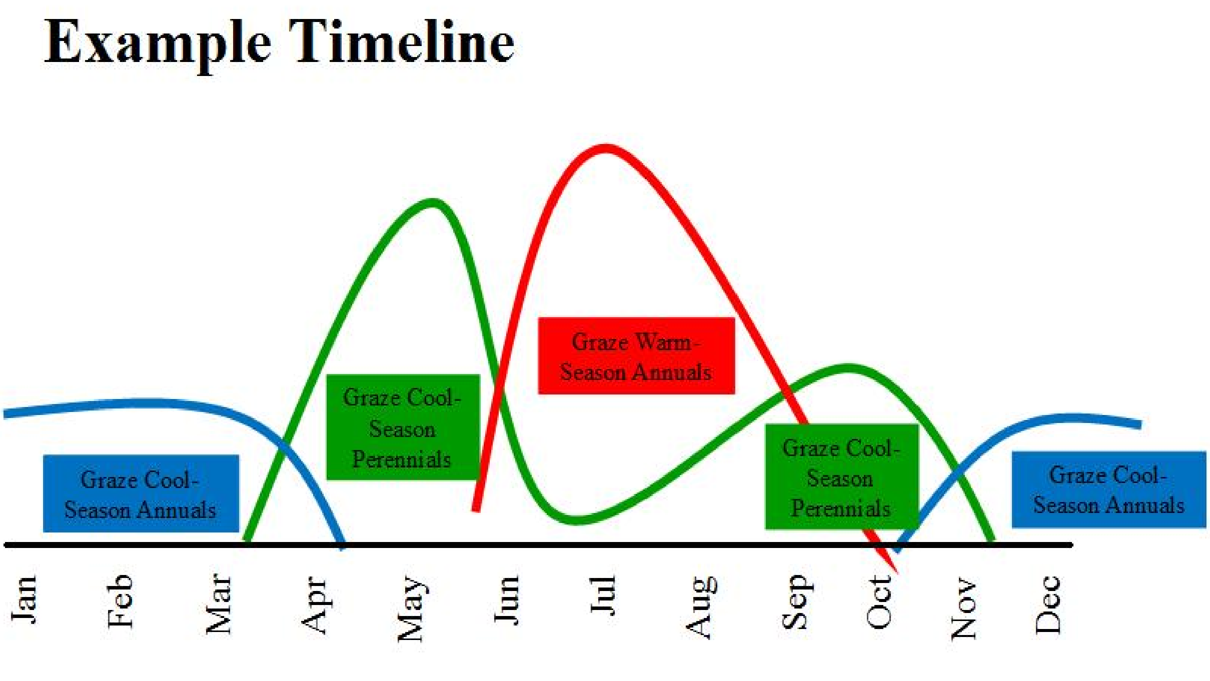
Summer annual management:

- Plant when soil temperatures reach 60-65ºF
- Fertilize (according to soil test recommendations)
- Lime as needed, perform best on soils with >6.0 pH
  - ✓ Pearl millet less sensitive to soil acidity than sorghums/sudangrasses.
- N application
  - ✓ 60-80 lb/ac after 1st and 2nd graze for optimum production

If following a wheat crop where double-crop soybeans for grain is not productive, there is a long period of a cropfield being fallow (idle) so planting cover crops to take up residual N and to maintain ground cover is a good idea, but grazing them will help the bottomline of a livestock farm. The graph below shows how winter-killed cover crops can work in combination with winter-hardy cover crops. The winter-killed plants listed will actually be killed by the first killing frost in the Fall but their residue cover will last probably as shown. They grow fast and a plant like oats may provide a good amount of grazing biomass before it dies from a killing frost. Sorghum-sudangrass would as well, just be wary of grazing it after a killing frost as it can cause prussic acid (cyanide) poisoning. The cover crops that will survive over winter can then be grazed in early to mid-spring. An example of a complementary growth period cover crop planting would be to simultaneously plant sorghum-sudangrass on a portion of the idle acres and plant winter-hardy annual ryegrass and red clover on the rest after wheat harvest.



The graph below shows year-around forage availability for a grazing herd by extending the grazing season to all twelve months and having warm season annuals growing when cool season pastures go dormant or nearly so in mid-summer. This keeps the need for harvested stored forage to a minimum or eliminates it altogether. Growing warm season annuals on cropland on farms with tall or meadow fescue growing on permanent pastures allows the fescue to be stockpiled for early winter use as there is sufficient grazable forage elsewhere and the fescue pasture (all or some of it) can be allowed to grow ungrazed until late fall.



eason distribution of cool & warm season annuals with cool season perennial pastures

Dr. Williamson then talked about complementary growth forms when formulating planting mixtures of annual forages. Two things to consider when formulating mixtures are:

- Mix tall-open species with low-dense species and vining species
- Do not plant any of the species too densely

Sunn hemp was given as an example of a tall open species. Sunn hemp is a relatively new legume crop being introduced more widely into the US. Newer varieties of it are low in alkaloids that ordinarily cause refusal by livestock or poor utilization and health problems. It does not produce seed in the continental US so it is not invasive here as it can be in warmer climates. It actually is more palatable and nutritious than the name hemp implies. It is quite sensitive to frost. It can have an understory plant grown with it if the Sunn hemp is not planted too thick.

Planting sorghum-sudangrass at the rate of 30 pound/acre is too thick to allow another species to survive that would be planted with it.

Non-complementary growth forms lead to competition. Seeding 12 pounds/acre of red clover with 10 pounds per acre of annual ryegrass is likely to produce almost a pure stand of annual ryegrass with a weak stand of clover. A better choice with annual ryegrass might be vining legume like hairy vetch.

A complementary nutrient acquisition strategy can produce forage mixtures which have different species with different rooting depths to extract nutrients at different levels in the soil or include legumes that fix N for the benefit of all plants in the mix. Two examples shown were forage radish-oats-Austrian winter pea and oats with crimson clover.

A diverse mixture can adapt to different soil fertility levels. Soils low in N will require a mixture that has legumes in it that can fix N. Meanwhile, a high N soil will tend to form a monoculture of the species most favored by the large supply of N. For instance, kale with it broad leaves is favored in a high N soil as it will shade out its competition.

Annual forages can be more than biomass for grazing and plowdown. Benefits from specific species:

- Flowering species, such as legumes, for pollinator resources
- Alleviating soil compaction with forage radish roots
- High forage quality from annual ryegrass or triticale

Cover Crop Mixtures: Establishment details are important. Achieving the right seeding depth is critical. There is a wrong way and a right way:

Wrong - Mix the seeds and shoot for the middle - ~0.75 to 1" of seeding depth. Sometimes leads to poor stands especially if small seeded species and large seeded species are mixed. Small seeds will be seeded too deep to emerge easily, if at all. Large seeds may end up too shallow to imbibe enough water to sprout or will sprout but dessicate if rain is lacking for a time.

Right - Separate seeds by size into a drill with two seed boxes, one for large seeds and one for small seeds. Most reliable, need the right equipment. For instance, if planting large, fluffy seeds, a drill with a box with an agitator in it may be necessary to prevent bridging. Another option is to make separate trips with different equipment such as a grain drill for large seeds and then use a broadcast seed spreader and cultipack to plant small seeded forages into a firm seedbed.

<u>Finding the right seeding rates:</u>
Start with an educated guess or Extension seeding rate guide for the species to be sown, plant a small acreage, observe results, adjust as needed. Much of this depends on the equipment used and its delivery accuracy and the seedbed preparation itself. Seedbed must be firm but not compacted.

<u>For a grass-legume mix:</u>
Reduce grass seeding rate to between ½ and ¼ the monoculture rate.
Keep legumes near monoculture rates. Most are small seeds so a small seed box on a drill is needed.

<u>Highly competitive species - low seeding rates required:</u>
Forage radish – 2 to 3 lbs/acre
Canola – 3 to 4 lbs/acre
Sorghum-sudangrass – 15 to 20 lbs/acre
Oats – 20 to 40 lbs/acre

When species share the same growth period, growth form, and nutrient acquisition strategy, divide seeding rate by the number of species in the group.

Preventing seed separating and settling:

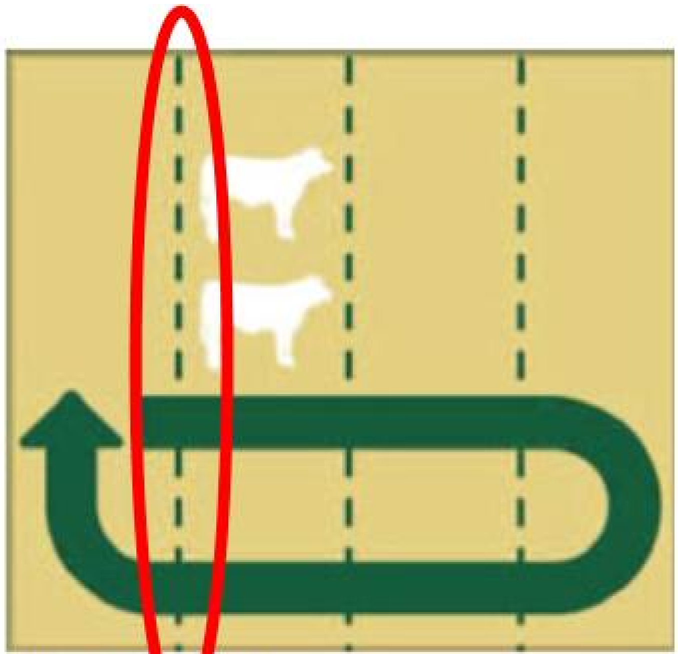
- Rarely a problem
- Worst case is large round and small round seeds - (eg. Austrian winter pea + Canola) - need to be in separate drill boxes for large and small seeds.
- Seeds of different shapes and sizes mixed together create a stable packing arrangement.

Where corn is taken off late in the growing season, interseeding a cover crop into growing corn is a way to get the cover crop started while the corn crop is still growing rather than wait until after silage harvest or after high moisture grain corn harvest. Forget establishing a cover crop after harvest on grain corn allowed to dry on the stalk after several hard freezes. It may not germinate until next year. Interseeding into corn:

- Plant corn as usual.
- Can harvest as grain or silage.
- When corn reaches V4-V7 stage, drill in interseeded forages between the rows of corn.
- Grows slowly under the canopy of the corn.
- When corn is removed, forages "take off" in growth, responding to increased sunlight.

Grazing management of annual crops is similar to that of perennial crops. Consider the plant first to keep it growing well if grazing an annual crop with regrowth potential. Plant leaves capture sunlight and convert it into energy. Without leaves, the plant cannot photosynthesize! In general, the lower the forages are grazed, the more nutrient stores are removed from the roots to jump start regrowth since there is less and less leaf area to feed the plant energy, thus depleting the root nutrient stores. If grazed to low to the ground, it may be one graze and done. Before turning animals onto the field:

- The forage should be:
  - ✓ 6-8" tall– Cool-season annuals
  - ✓ 12" tall– Warm-season annuals
- No sooner than 4 to 6 weeks after emergence
  - ✓ Establish roots (to avoid plants being pulled out by grazing animal) and allow tillering (to get a thicker stand - increased DMI per bite)
- Do not graze under
  - ✓ 3-4" – Cool-season annuals
  - ✓ 5-6" – Warm-season annuals
- Allow forage to regrow to
  - ✓ 6-8" before regrazing– Cool-season annuals
  - ✓ 12" before regrazing– Warm-season annuals



Strip grazing method.

nnual crops lend themselves to be strip grazed with a front and back portable single strand electrified fence for cattle or netting for goats and sheep. Move portable water trough along with herd.

Jessica concluded her presentation with these remarks:

- Farmer innovations in annual forage use will continue to occur, including mixtures
- Researchers are trying to keep up to quantify benefits, provide recommendations
- Three easy steps to success:
  1. Tailor the annual forages to meet farm management objectives
  2. Select complementary species -Growth form / Growth period / Nutrient acquisition
  3. Follow basic management recommendations for establishment, seeding rates, nutrient application and grazing management
- Observe results and make adjustments as necessary

Dr. Brito introduced the last speaker of this session, Sarah Flack, Sarah Flack Consulting, Enosburg, VT. Ms. Flack's presentation was *Zero grain dairy: Lessons learned from farm successes and disasters*. Sarah began her presentation by contrasting dairy farms going to zero grain diets:

- Successful farms are financially sustainable & cows are doing well.
- Some have cash flow problems due to higher forage needs and low milk production.
- Some have poor reproductive performance, low BCS, and other concerns.

Genetics plays a role in whether a farmer is successful or not, but it is not necessarily about dairy breed. She has seen a Jersey dairy farm fail while a Holstein herd looks like it will be successful. Organic farms are the main dairies that are adopting zero grain diets. Early adopters of zero grain began feeding no grain back in the mid 1990's. They had seasonal dairy herds. Seasonal herds do transition better. Cows should be culled more to keep a tight breeding season. This eliminates poor doers under this feeding regimen quicker. Overall herd BCS will be much better with a good culling program. It is an absolute must to have high quality pastures to be successful; otherwise, milk production will be very low and hurt cash flow and profit margin even without the expense of feeding grain, especially organic grain.

Farmer motives for going to zero grain differ:

- Cash flow crisis so they just stopped buying grain.
- Thoughtful, planned decision in order to eliminate the grain bill, be more self-sufficient, lessen carbon footprint, and up CLAs & Omega-3 fatty acid in their milk.
- Pay price premiums or direct market/consumer demand

The keys to success with going to zero grain ration with dairy cows are:

- Maximize dry matter intake of forages.
- Plan for forage demand and acreage required.
- Monitor BCS & reproductive performance.
- Supply minerals as needed to insure there are no deficiencies.
- Do the math – will it cash flow? Organic grain currently costs $650 per ton.

The most common problems with going to zero grain dairy cow diets are:

- Not monitoring days in milk (DIM)/reproduction performance & BCS
- Underestimating the additional forage acreage needs
- Underestimating stored forage needs
- Running out of low NDF forage in February or March
- Declining soil fertility with no imported feedstuffs
- Low milk per cow
- Low summer DMI (heat stress to animals and cool season forages)
- Financial challenges (even with zero grain premiums)

Some of these problems happen immediately, but others do not show up for a year or two.

Strategies for maximizing DMI are offering diverse forage mixtures to stimulate forage DMI and providing easy cow flow with good laneways and managing their environment (shade, sprinklers) to minimize heat stress to encourage DMI. Automatic gate openers and tumble wheel fencing can aid in moving cows to new pasture. Surfaced laneways in shade can provide escape from the sun and provide a place for lounging that avoids creating a bare spot in the pasture. A good mix of annual and perennial forage pastures in summer will provide enough forage on-offer to get through the summer slump of limited cool season grass growth. Sudax (a summer annual forage) is grown in the South. Pearl millet is a better summer annual in the North. Also take into account how much stored forage is being fed during the pasture season from day to day to ensure adequate DMI and be sure mineral supplements are being fed as required.

It can take a 7 to 8 year transition process to produce enough high quality stored forage & pasture to replace the grain in a dairy ration. The forages need to supply as much energy as possible to keep milk production from tanking too much. More interest in birdsfoot trefoil as it improves milk production.

Dairy cows on rotational pasture with a tumble wheel forward fence

If seasonal calving 100% grass-fed, must maintain a 12-month calving interval.

Sarah offered some observations about zero grain dairies:

- Stocking rate changes on 100% forage farms
  - Lower stocking rate on many farms
- Soil fertility
  - Declining fertility on some farms due to less manure per acre (also less imported feedstuffs)
- Variability in use of stocking densities
  - Moving away from very high stock densities (less "mob" grazing)
- Changes in pasture pre-grazing heights
  - Backing off from previously taller pre-grazing height
- Huge variation in milk production and how those numbers are reported.

Sarah, as a dairy consultant, visits many zero grain dairies. This is the range in annual milk production that she has seen in 2014 and 1015:

- 2745 lbs/lactation – many open cows (Anything below 3000 lbs/lactation is a train wreck.)
- 4750 – some calves nursing
- 4880 – seasonal calving with short lactation (< 5000 lbs/lact. caused by poor quality forage.)
- 6180
- 7625 – seasonal calving herd
- 8400 - seasonal calving herd.

Two herds are producing 11,000 and 12,000 lbs./lactation have calving intervals over 12 months long.

ilking Devon Cow

Helping farmers ask the right questions is important before going to zero grain diets. Here is the list:

- Is there enough land?
- Is there enough high quality forage?
- What are the soil fertility needs – current and long term?
- What is the current calving interval/reproductive performance?
- Minerals required?
- Milk production?
- Herd genetics and selection? (Seasonal-calving milking Devons give 8500-9200 lbs./lactation.)
- Do pay price premiums cover loss of milk production and higher land/forage costs?

Advice from dairy farmers practicing zero grain is:

- Takes 7 years or more to transition off of grain. Transitional herds tend to have high milk urea nitrogen (MUN) levels in their milk. Long term no grain, the MUN's are low.
- Invest in improving soil fertility ahead of time (especially lime).
- Make high quality forage. You will need even more than you think!

- Reduce cow stress, eliminate any competition for feed.
- Plan to spend more on purchased forage, or harvesting & land rent on neighboring farms.

Ms. Flack offered these ideas for research opportunities for zero grain dairy cow diets:
- How much forage DM is being consumed/cow?
- Mineral & energy supplementation needs
- Milk production & livestock fertility relationships
- Relationship between stocking rates & soil fertility

She is working on a SARE grant with Dr. Heather Darby of UVM delving into some these questions.

Sarah closed her remarks by saying her website, www.sarahflackconsulting.com, has articles on grazing management. Her email address is: sarahflackconsulting@gmail.com