What research tells us about forage mixtures for pasture?

Part 2

Carole Lafrenière, Ph.D.

Complex Mixtures:
Production System to Extend the Grazing Season

Research Team:
Forage Production System

- Carole Lafrenière, Project Leader (UQAT)
- Yousef Papadopoulos (AAFC)
- John Duynisveld (AAFC)
- Julie Lajeunesse (AAFC)
- Mathieu Laplante (UQAT graduate student)
- Nicolas St-Pierre (UQAT graduate student)

Complex mixtures: Forage Production System

- Objective:
  - Evaluate the potential of alfalfa-based complex mixtures to stockpile for grazing early fall

Forage Production System:
Complex Mixtures to Stockpile early fall

- 5 forage alfalfa-based complex mixtures
- 3 sites
  - Nappan – simulated grazing
  - Normandin – simulated grazing
  - New Liskeard – simulated grazing
- Seeded in 2014
- Data recorded in the next two years (2015-2016)

Forage Production system trial: Species

Legume

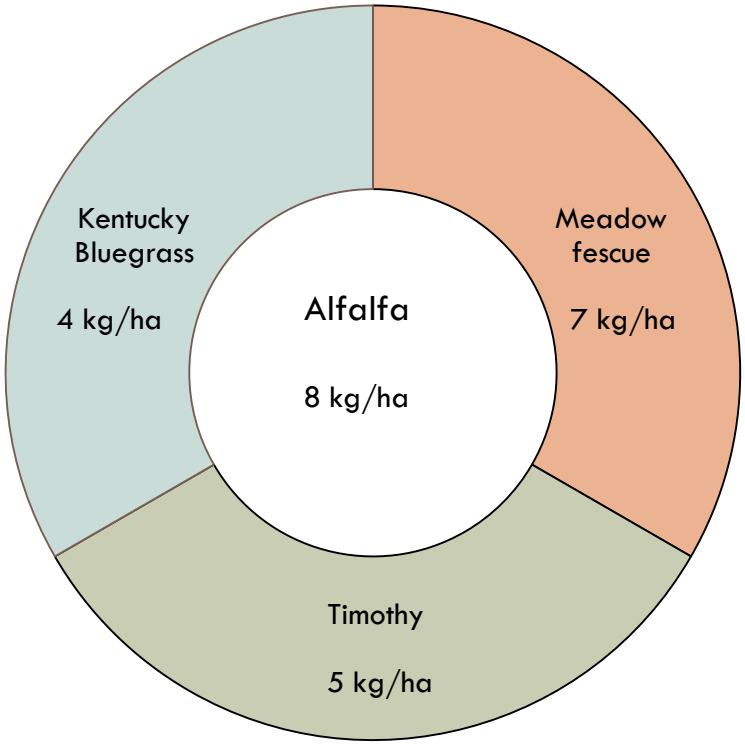
- Alfalfa – CRS1001

Grasses

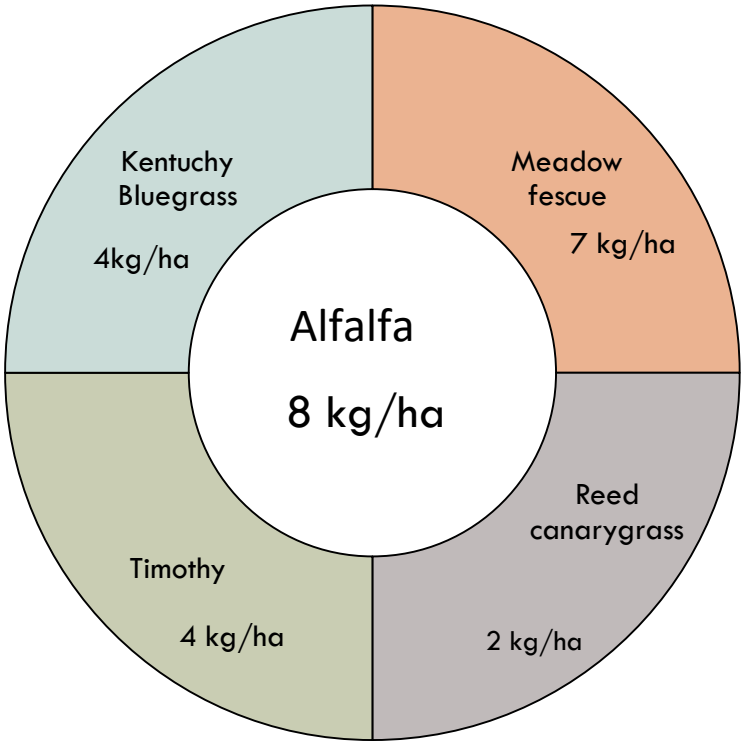
- Timothy - Ovation
- Meadow fescue - Laura
- Tall fescue - Barolex
- Orchardgrass - Bardiana
- Meadow brome - Fleet
- Kentucky bluegrass – Big Blue
- Reed canarygrass – Bellevue
- Red creeping fescue - Boreal

Forage Complex Mixtures and Seeding Rate

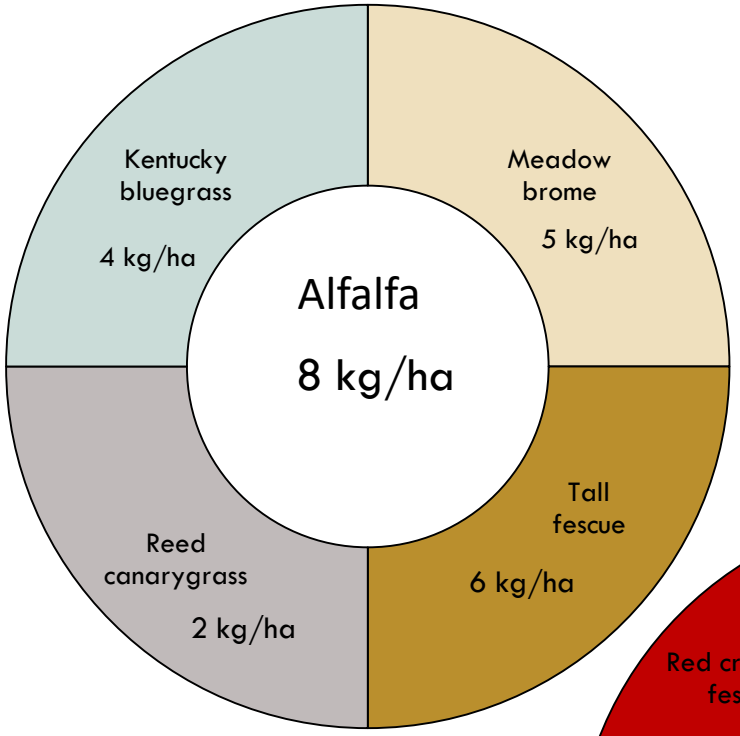
Mixture 1



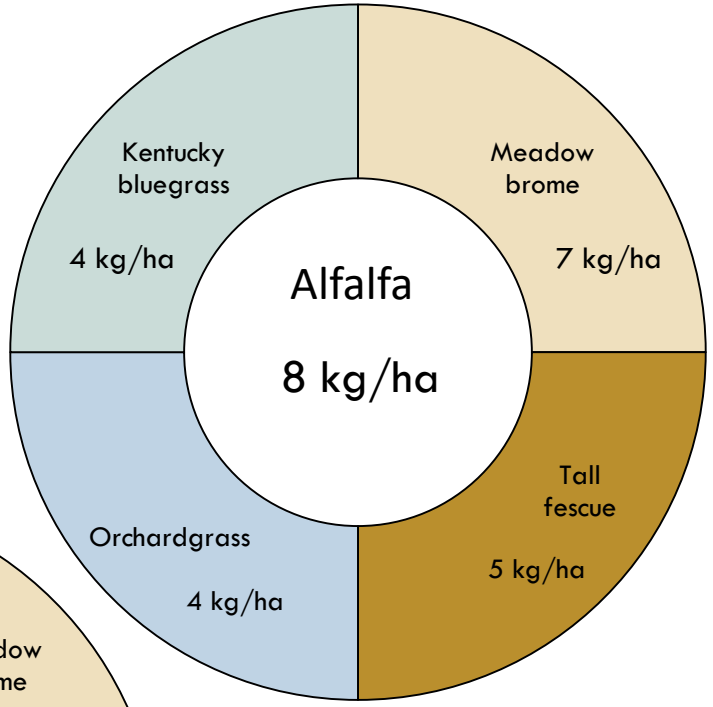
Mixture 2



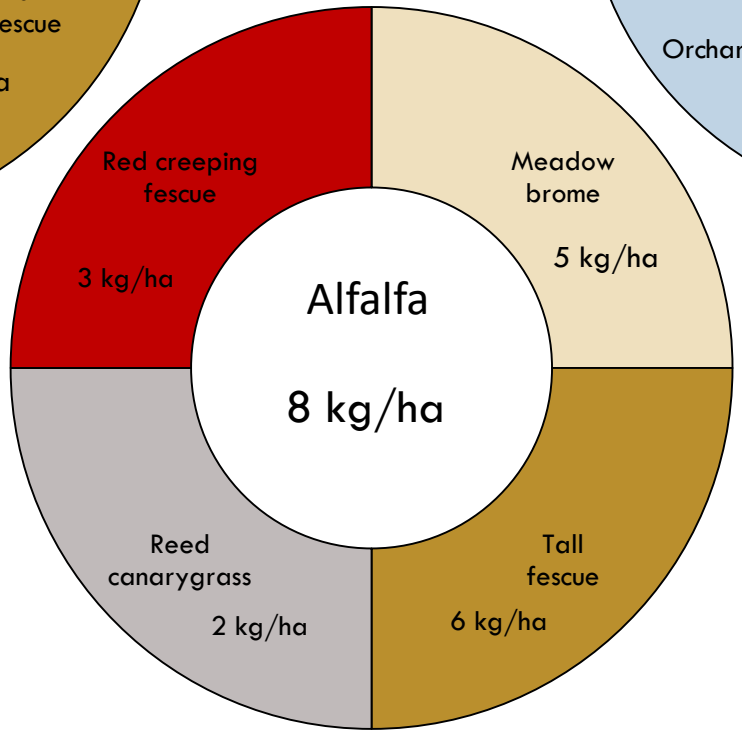
Mixture 3



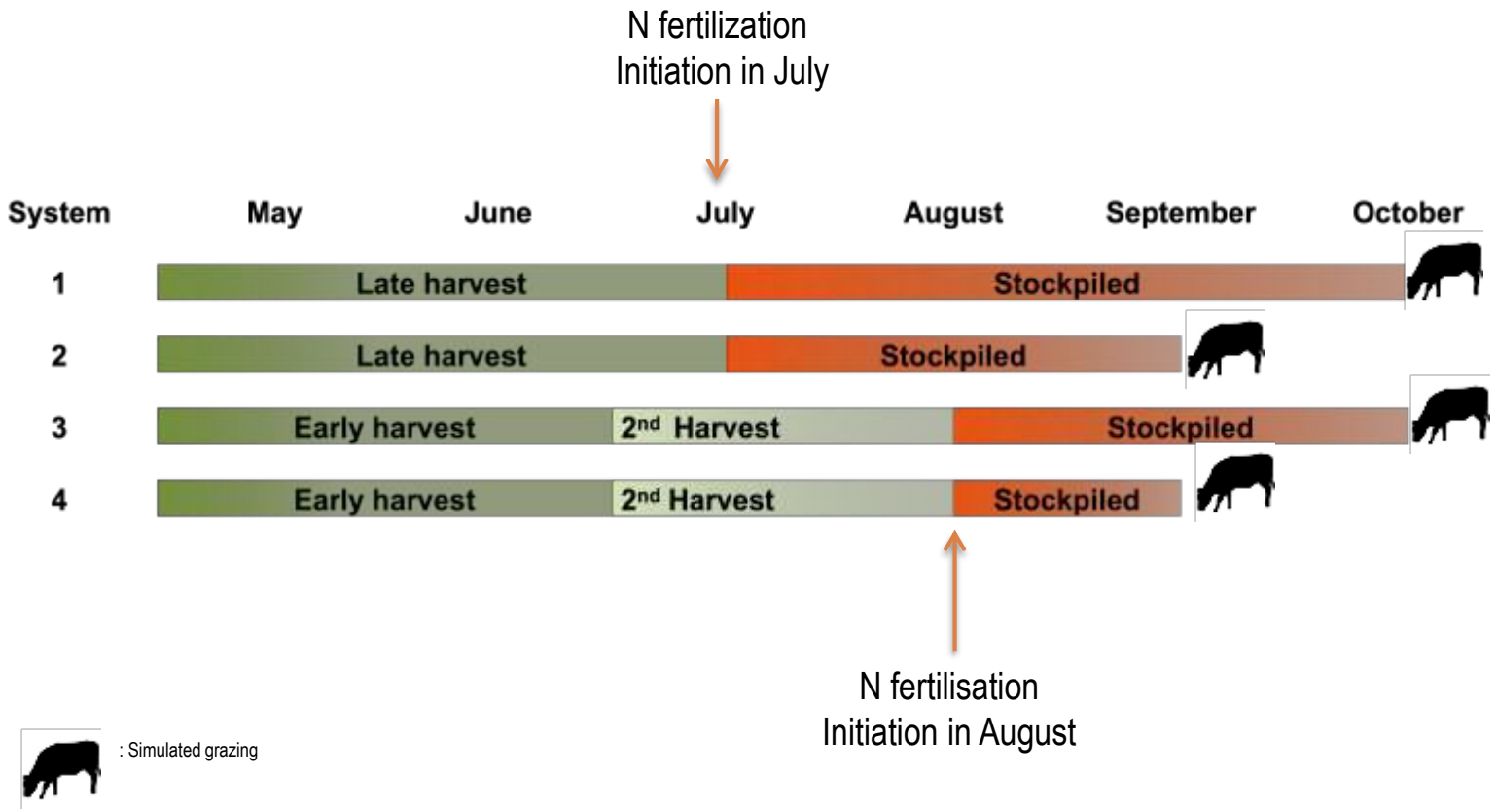
Mixture 4



Mixture 5



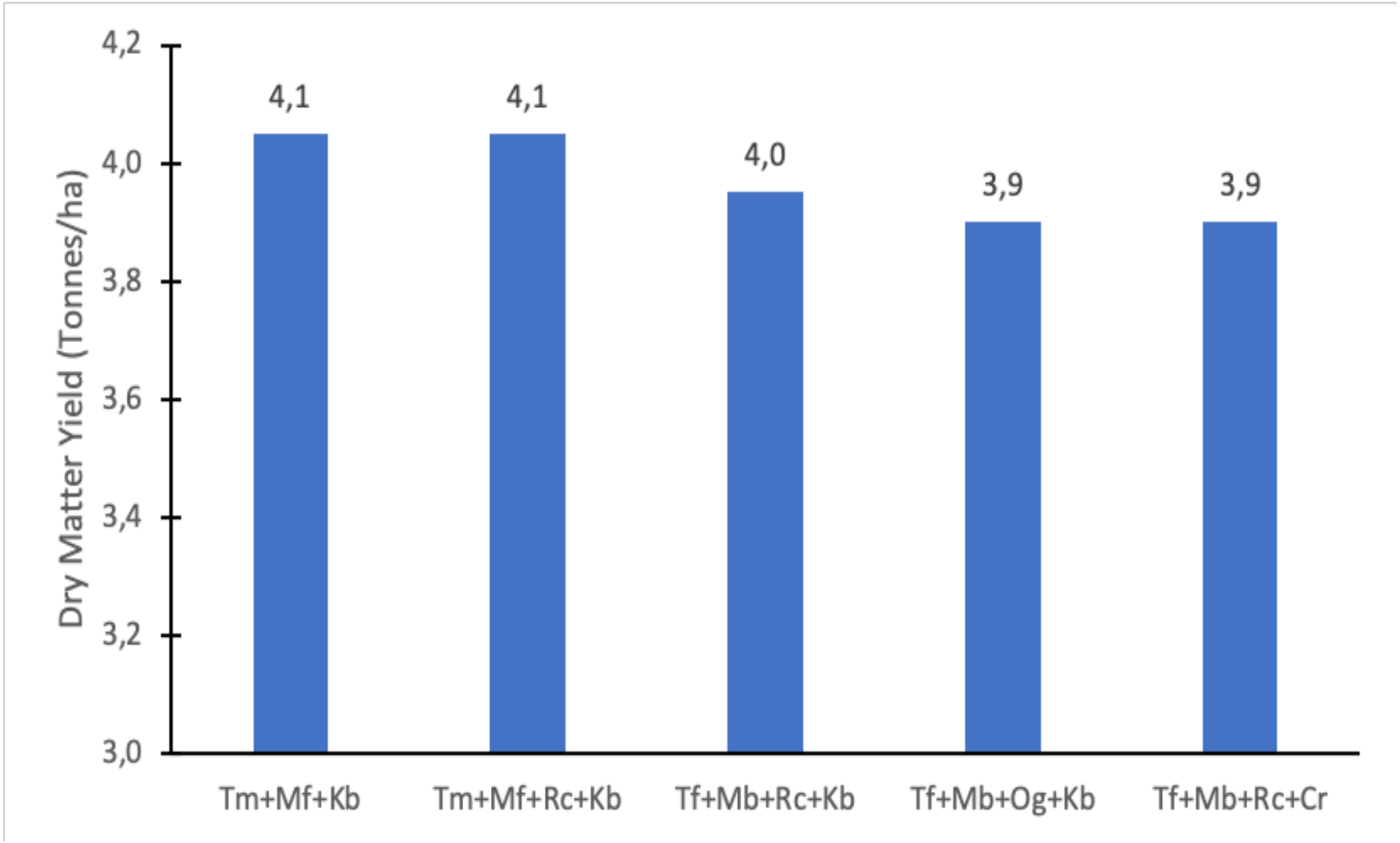
Forage System Trial



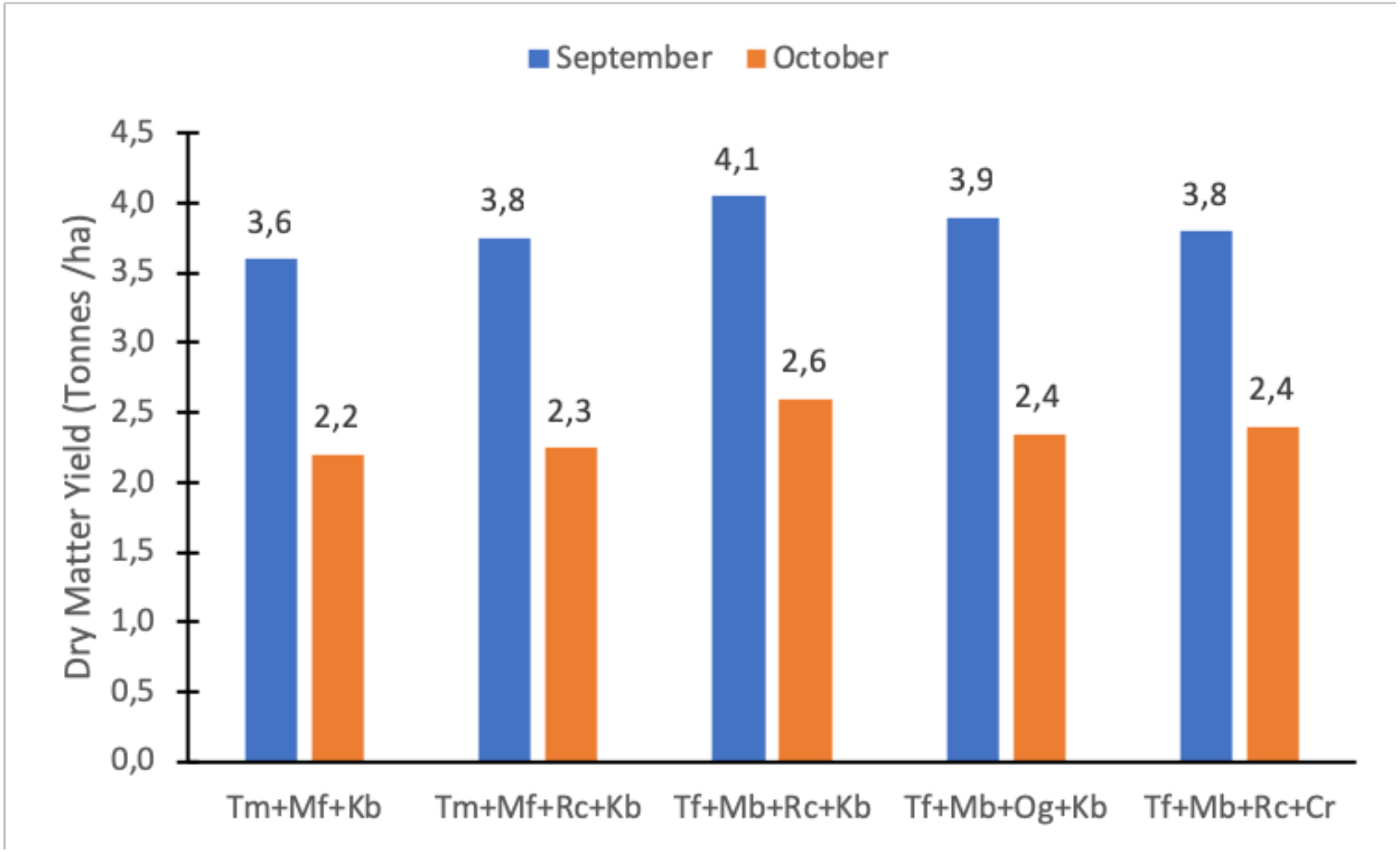
What was Measured ?

- Dry matter yield (DMY)
- Contribution of seeded species to DMY
- Total digestible nutrients content (TDN)
- Minerals (only on forages stockpiled in August)
  - Macronutrients (Ca, P, K, Mg, Na, S)
  - Micronutrients (Fe, Zn, Mn, Cu, Mo, Co, Cr)

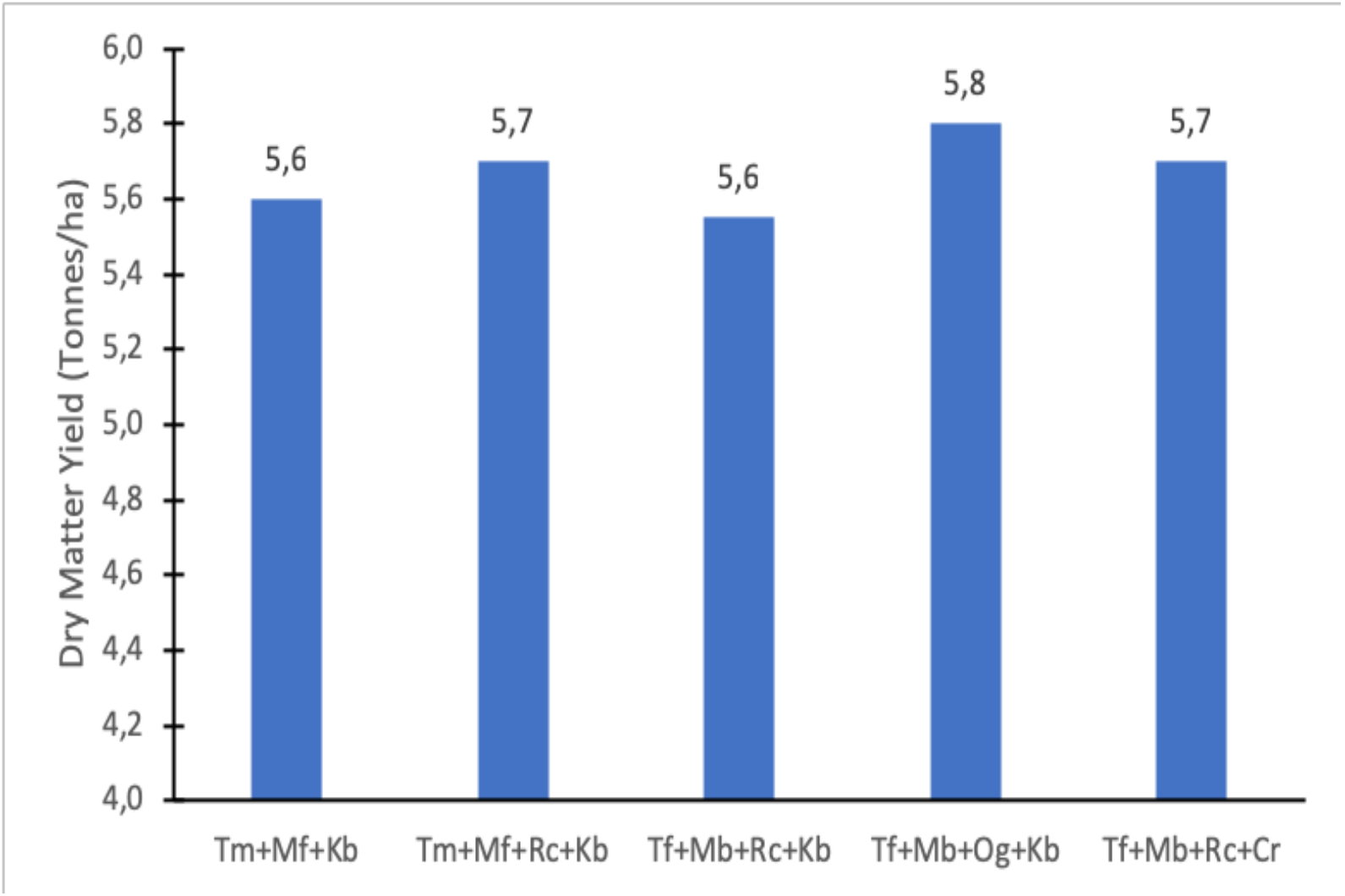
Late Cut – Growing Season
1 Harvest Before Stockpiled



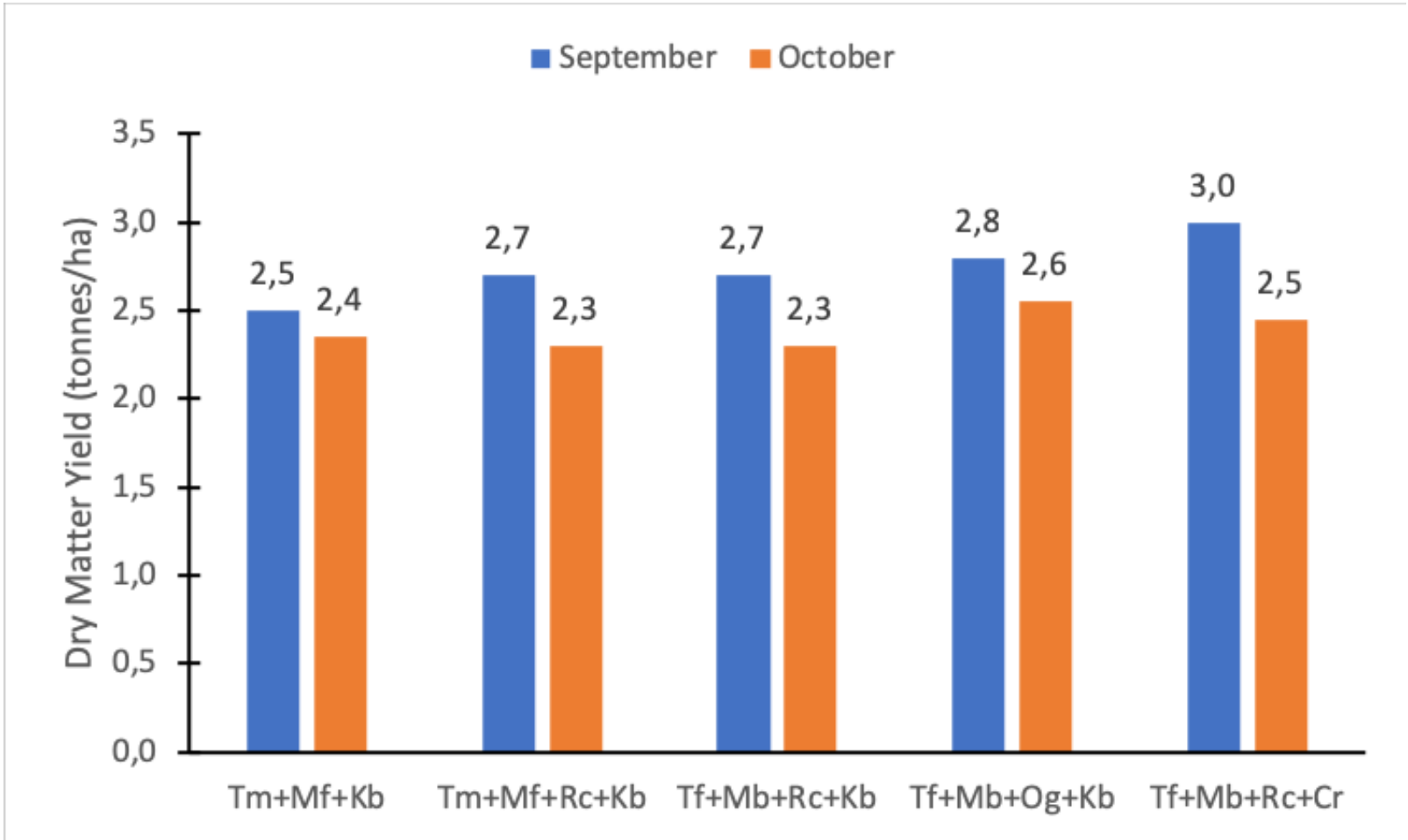
Late Cut – Stockpiled



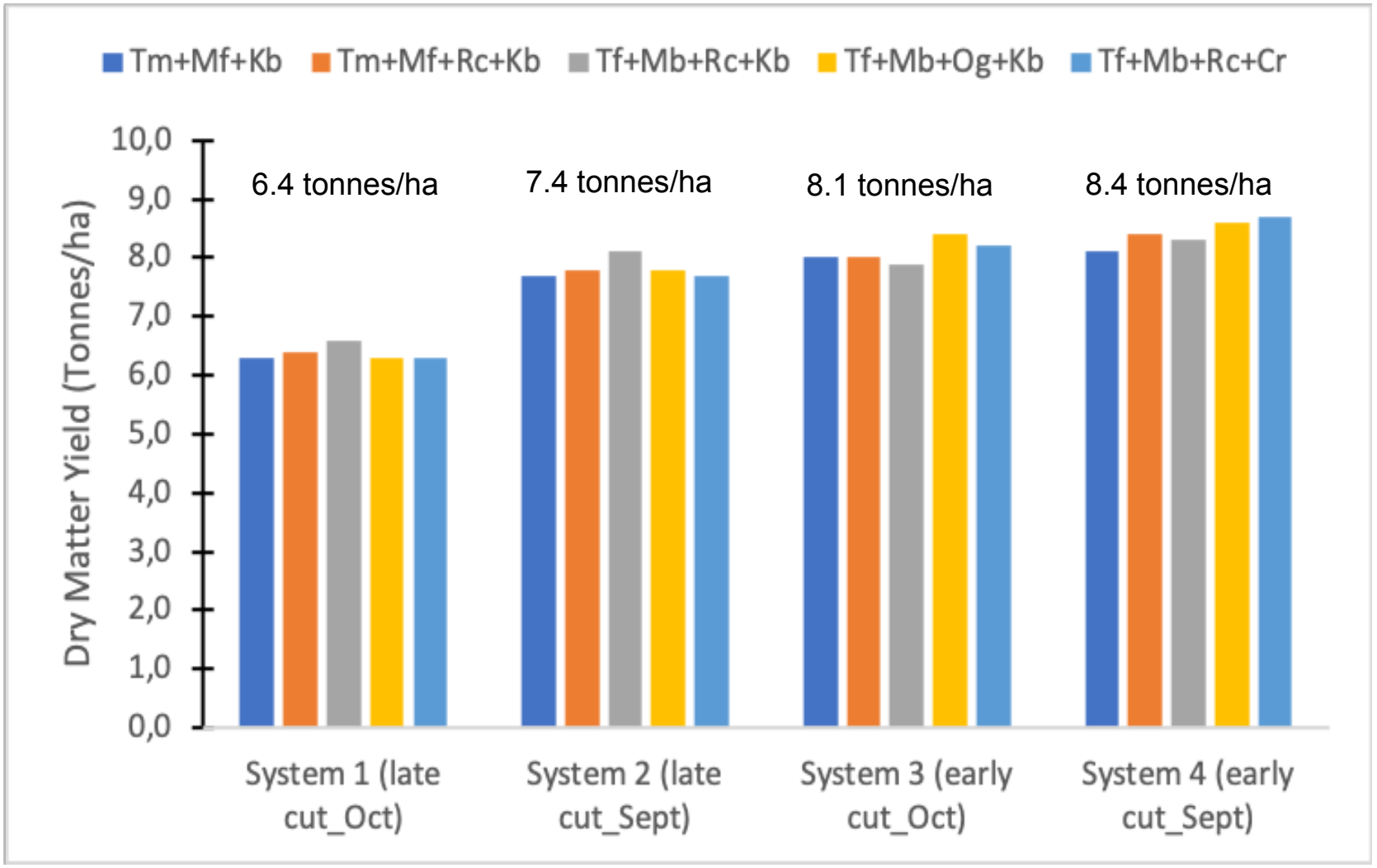
Early Cut – Growing Season
2 Harvests Before Stockpiling



Early Cut – Stockpiled



Forage production system: Harvest + Stockpiled



Nutritive Value:
TDN Content (% of DM)

Table 1. Forage capacity of beef cows[a].

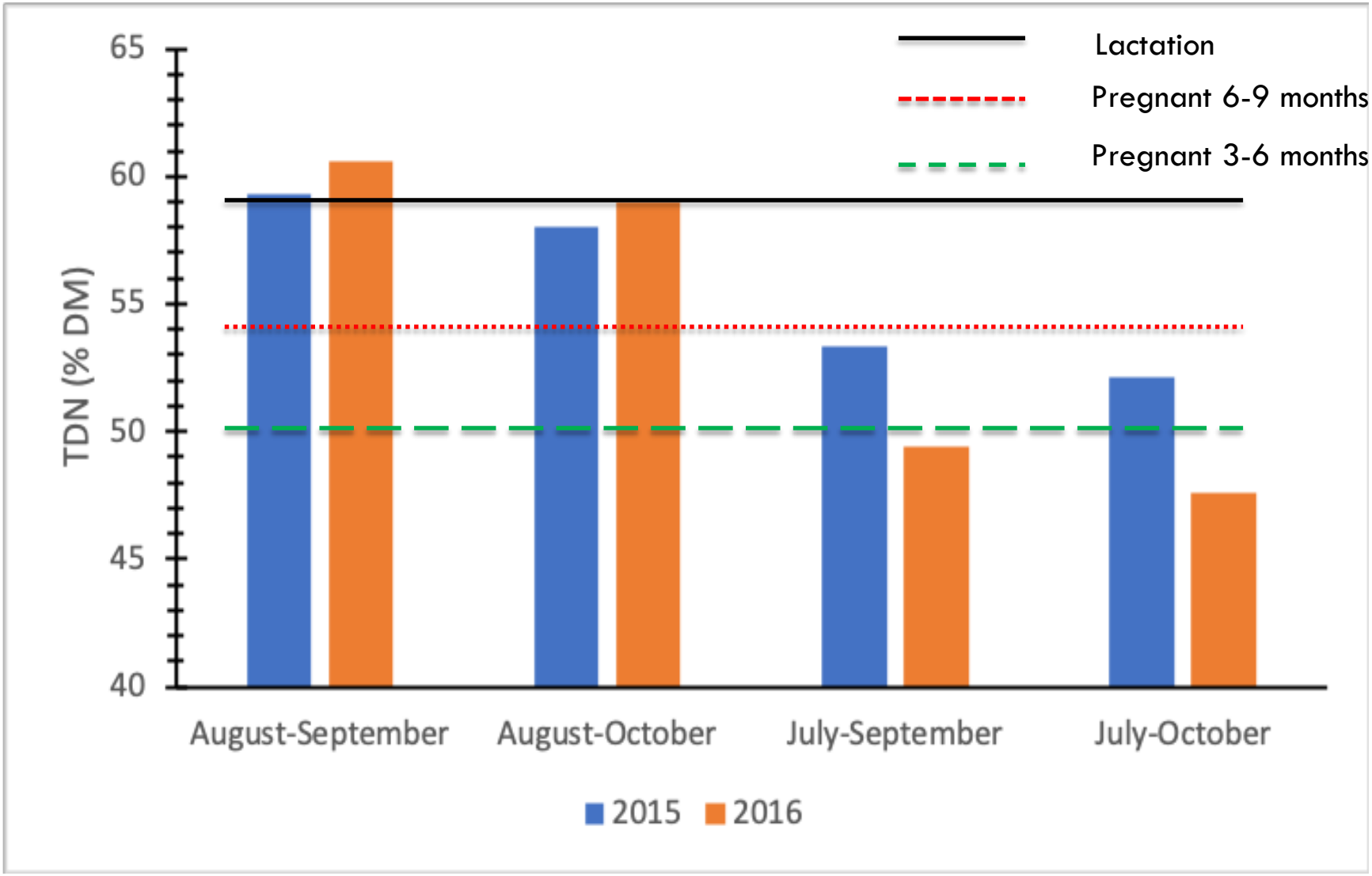
Forage Type and Maturity	*Stage of Production*	*Forage Dry Matter Intake Capacity, % of Body Weight*
Low quality forage (< 52% total digestible nutrients)	Dry	1.8
Dry winter forage, mature legume and grass hay, straw	Lactating	2.2
Average quality forage (52% to 59% total digestible nutrients)		
Dry summer pasture, dry pasture during fall, late-bloom	Dry	2.2
legume hay, boot stage and early-bloom grass hay	Lactating	2.5
High quality forage (> 59% total digestible nutrients)		
Mid-bloom, early-bloom, and prebloom legume hay,	Dry	2.5
preboot stage grass hay	Lactating	2.7
Lush, growing pasture	Dry	2.5
	Lactating	2.7
Silages	Dry	2.5
	Lactating	2.7

[a] Intake estimates assume protein requirements are met by the forage or through supplementation when forage protein is not adequate. When protein requirements are not met, forage intake will be lower than the values shown in the table.
Source: Hibbard and Thrift.

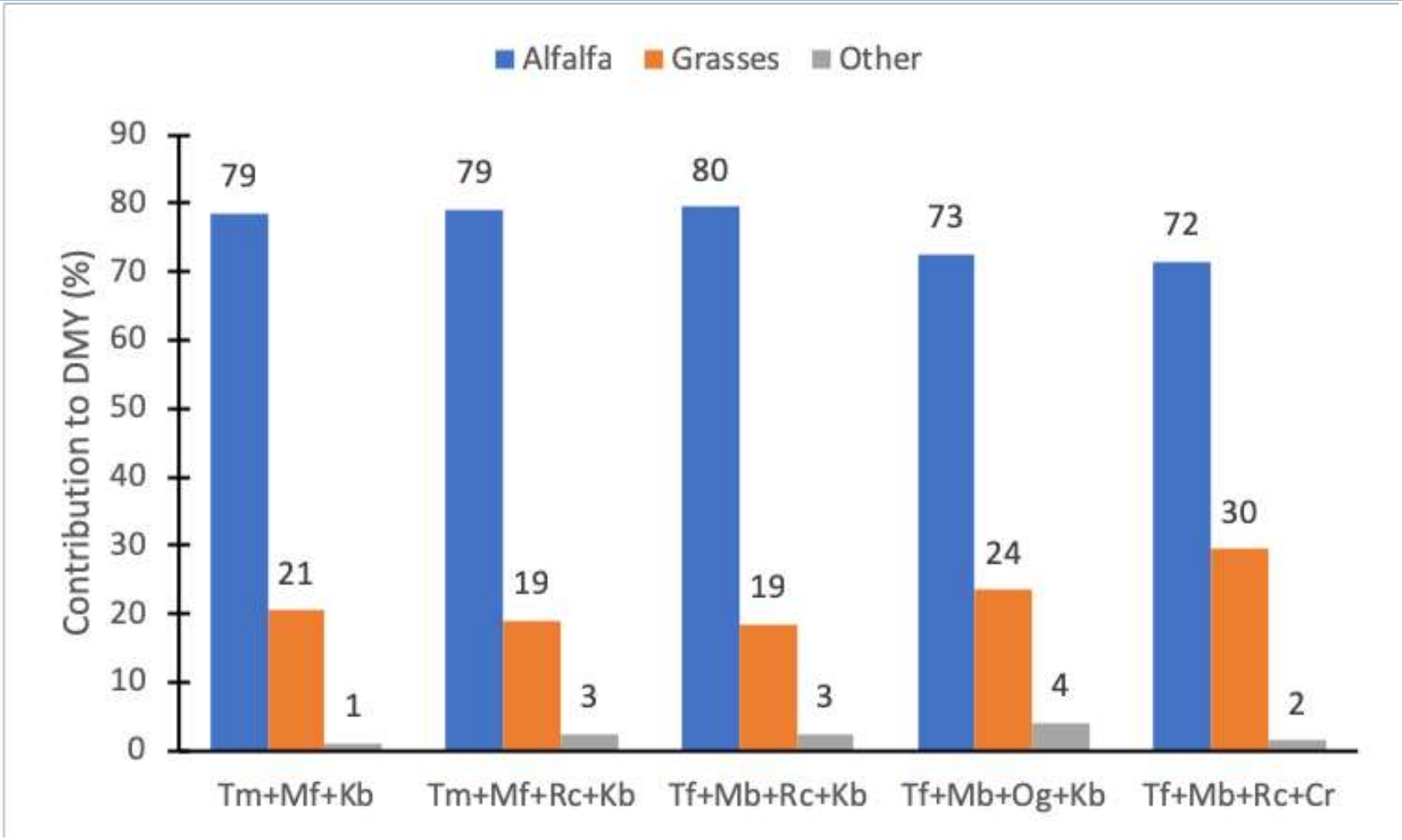
Source : Lalman and Richards, 2004

Weight cow: 545 kg

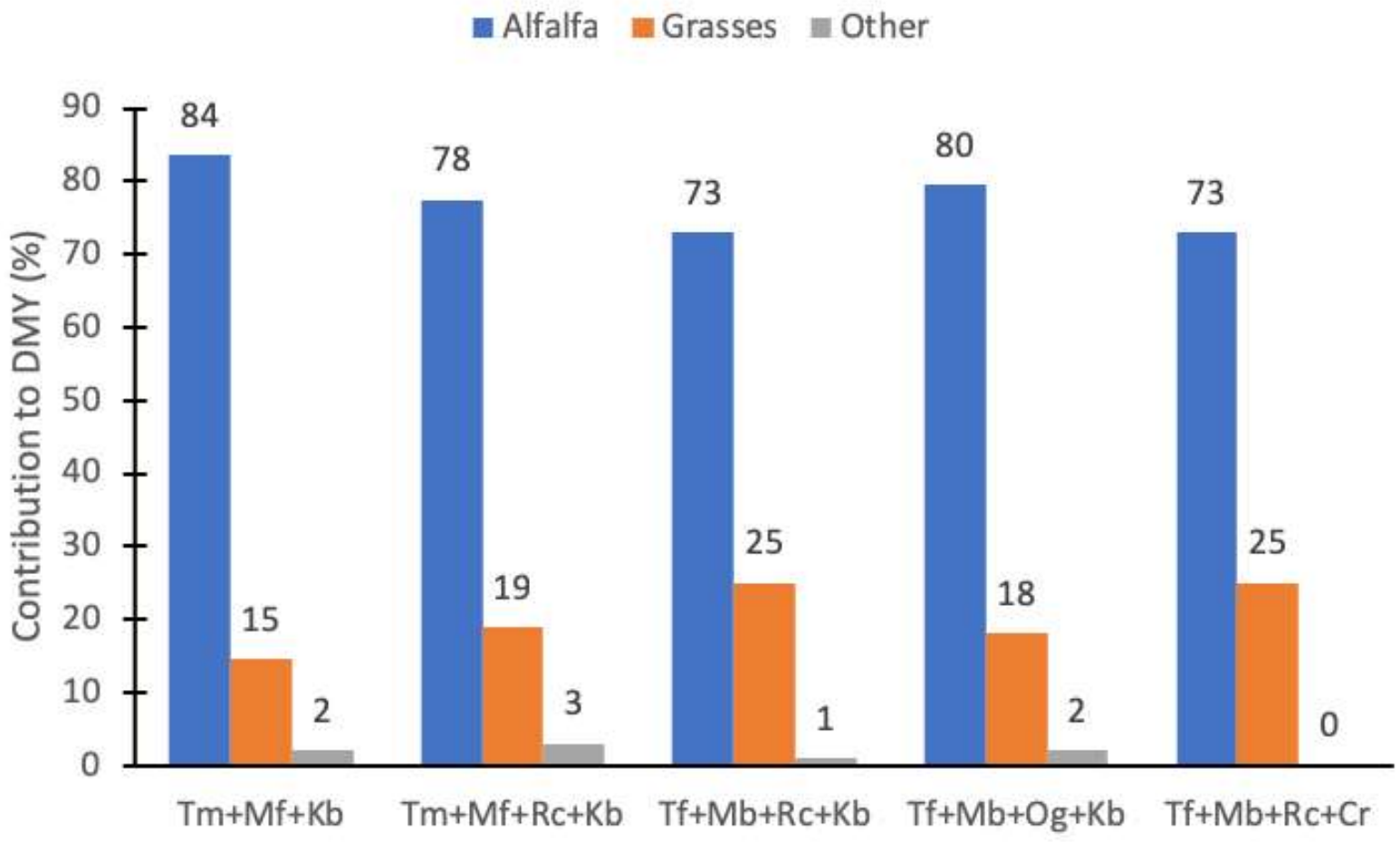
TDN Content: New Liskeard



Contribution to DMY: September



Contribution to DMY: October



Minerals: Macronutrients
Fall Period

	P		K		Ca		Mg		S	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
New Liskeard	---------- % DM ----------									
September	0.29[a]	0.28[a]	2.87[a]	2.69[a]	1.37	2.13[b]	0.24	0.28	0.19[a]	0.28[a]
October	0.26[b]	0.26[b]	2.45[b]	2.30[b]	1.32	2.31[a]	0.21	0.26	0.17[b]	0.25[b]

Minerals: Micronutrients
Fall Period

	Fe		Mn		Mo		Zn	
	2015	2016	2015	2016	2015	2016	2015	2016
New Liskeard	---------- PPM ----------							
September	100,47	488,87	22,93	26,13	1,82	2,12	21,93[a]	23,53[a]
October	79,87	450,00	19,80	27,80	1,89	2,39	18,60[b]	21,73[b]

Cow Needs to Evaluate Forage Complex Mixtures

- Minerals needs were evaluated for a specific cow (NRC 2016)
  - 5 years, 650 kg
  - Breeding: Charolais Angus-Simmental
  - 155 days from calving
  - Weight of calf at birth: 39 kg
  - Pregnant since 95 days
  - Average milk production/day 9 kg
  - Graze at least 15 kg DM/day

Minerals:
To Be Added to the Diet

- Macronutrients: Sodium
- Micronutrients: Manganese, Zinc, Cobalt, Chrome

Take-home Message:

- Forage complex mixtures are productive.
- In the North, forage complex mixtures stockpiled beginning of August have nutritive value varying from average to high quality forage.
- High management might be needed if contribution of alfalfa to DMY is too high.
- Birdsfoot trefoil should be considered to replace alfalfa.
- Forage analysis is highly recommended to evaluate mineral content.

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UQAT
LA FONDATION

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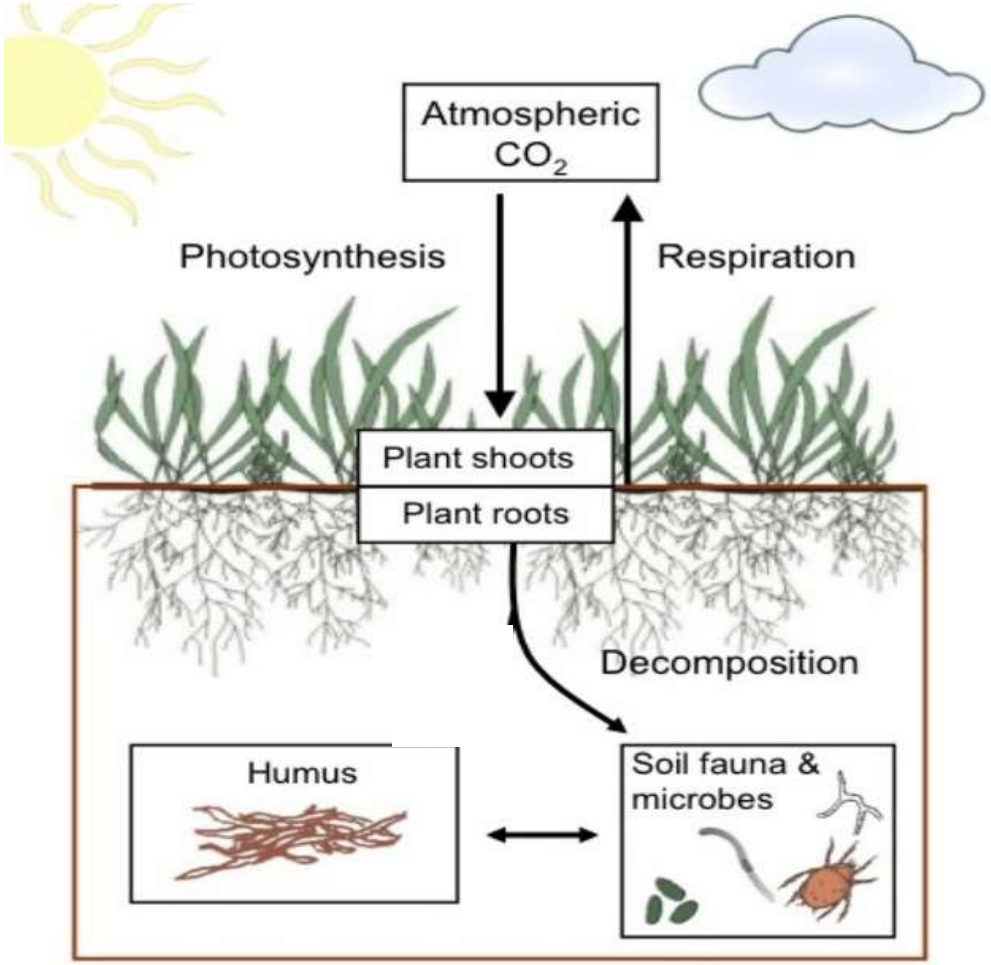
Québec

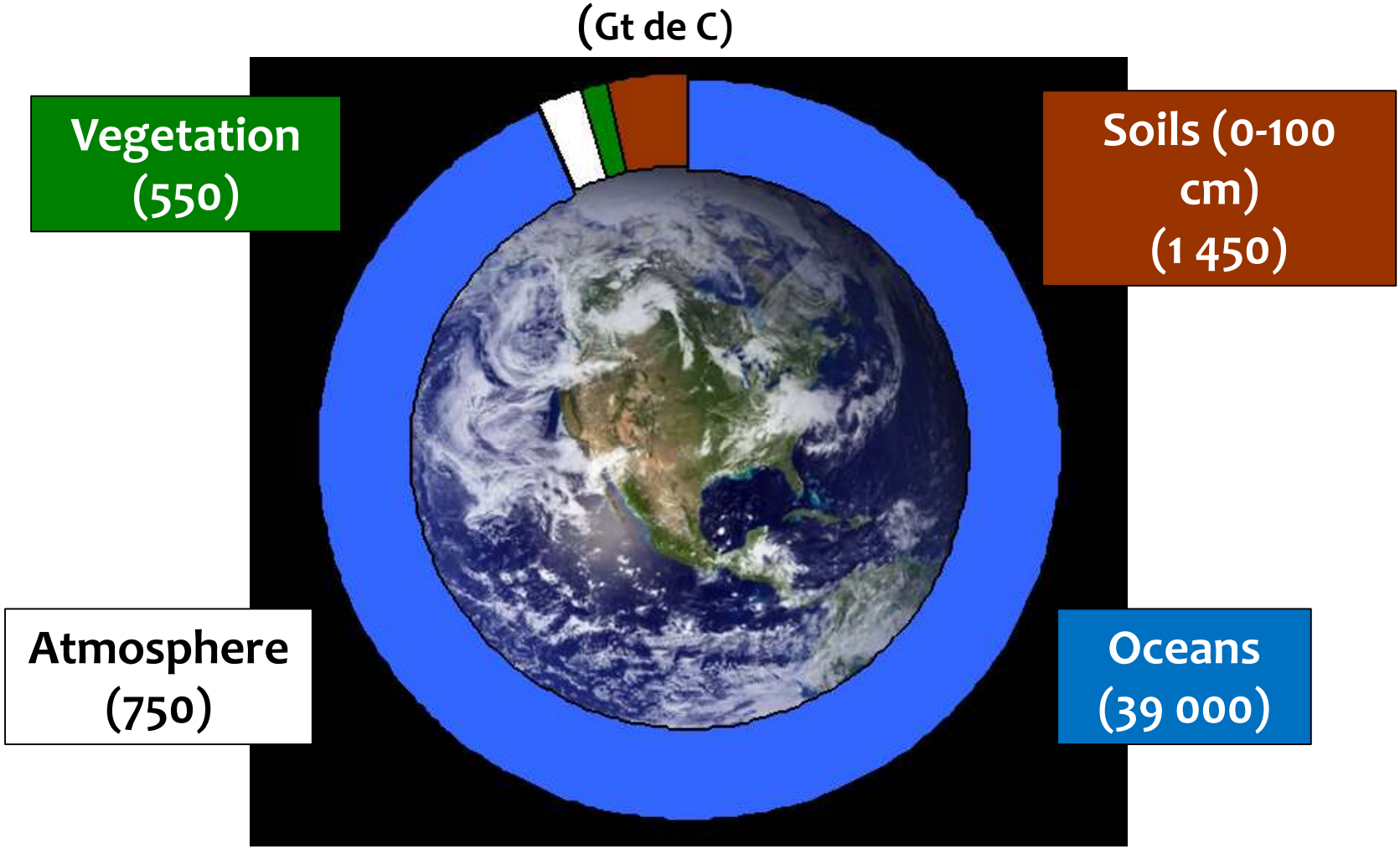
Carbon Sequestration with Complex Mixtures



Carbon Sequestration with Complex Mixtures: Research Team

- Vincent Poirier, Project leader (UQAT)
- Julie Lajeunesse (AAFC)
- Jean Lafond (AAFC)
- Carole Lafrenière (UQAT)
- Hiba Benmohamed (UQAT graduate student)

Soil : 2nd Reservoir of C in the Biosphere



Carbon Sequestration: Objectives

- Compare C-sequestration of 2 stocking methods: continuous vs rotational
- Compare 3 selected mixtures with these 2 stocking methods

Carbon Sequestration: Methodology

- Plots established for the forage system trial were used
- 1 site: Normandin
- Same mixtures as Complex mixtures to stockpile

  Grass mixtures 2, 3, and 4 + Legume = Alfalfa

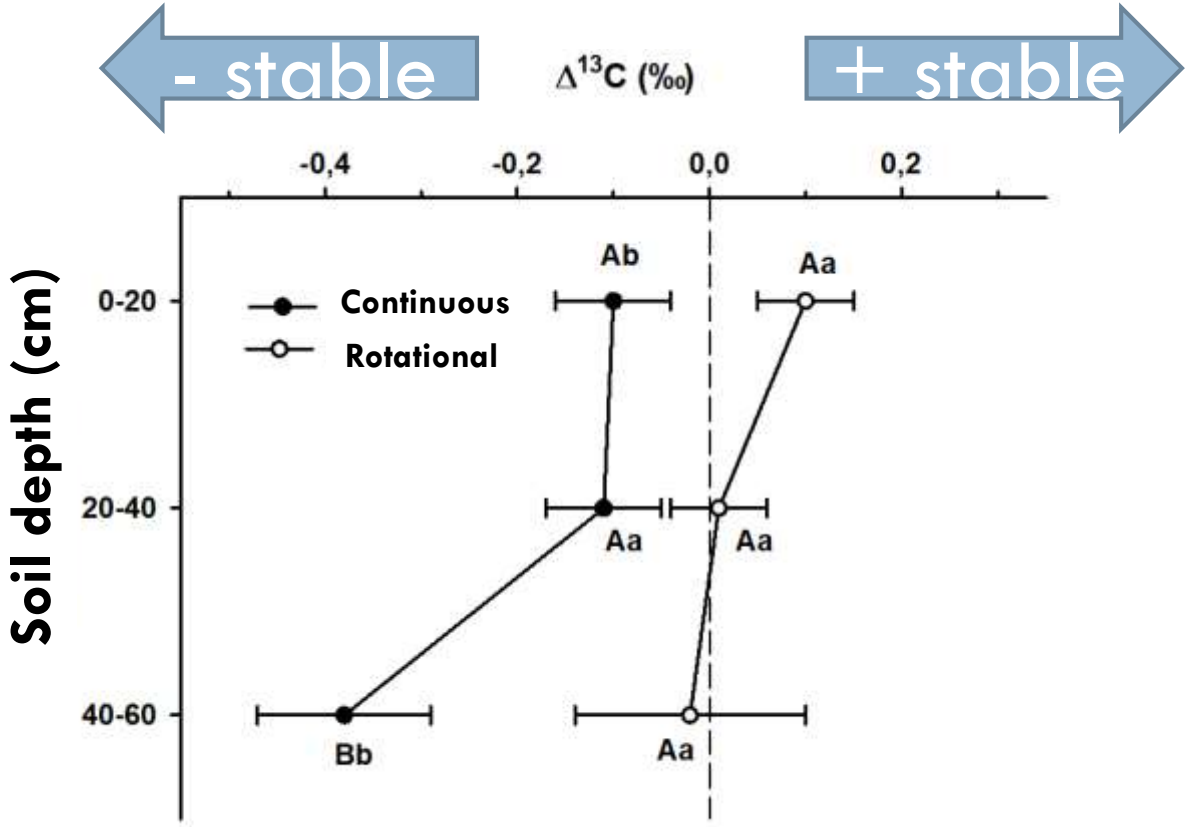
  - *Mixture 2*: **Timothy, Meadow fescue,** Reed canarygrass, Kentucky bluegrass
  - *Mixture 3*: **Tall fescue, Meadow brome,** reed canarygrass, Kentucky bluegrass
  - *Mixture 4*: **Tall fescue, Meadow brome,** Orchardgrass, Kentucky bluegrass

Carbon Sequestration: Methodology

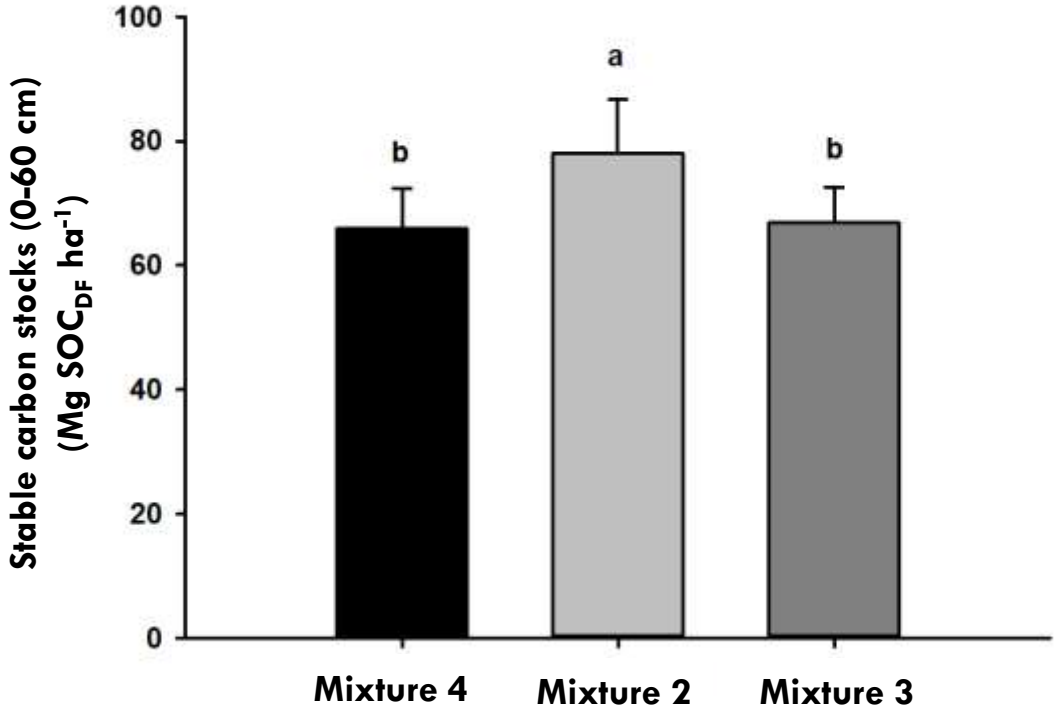
- Grazing approach by simulated grazing
  - Continuous: Cut each time 15 cm is reached
  - Rotational: Cut each time 25 cm is reached

- Soil is sampled in September at 3 depths:
  - 0-20 cm
  - 20-40 cm
  - 40-60 cm

C-Sequestration:
Effect of Stocking Method



C-Sequestration: Effect of Complex Mixtures



Good Pasture
Better Productivity
Better Soils

Thank you for your attention!
Questions?

What research tells us about forage mixtures for pasture?

Part 1

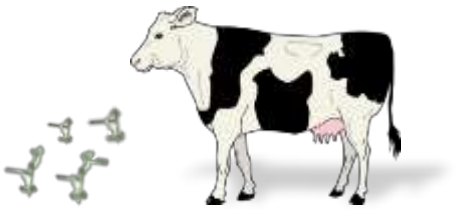
Carole Lafrenière, Ph.D.

Presentation Plan

- Introduction
  - Why using mixtures for grazing?
  - Why complex mixtures?
- Mixtures
  - Methodology approach
  - Binary mixtures
    - Species, dry matter yield, and nutritive value
  - Complex mixtures
    - Species, dry matter yield, and nutritive value,
    - Grazing results (Nappan site)
    - Production system to extend grazing to early fall
    - Carbon sequestration

Forage Mixtures for Grazing

One specie

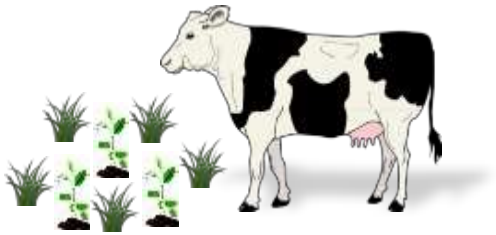


Easier to manage

Mixtures

↑ **Dry matter yield**
(Papadopoulos and al., 2012)

↑ **Yield stability**
(*Deak and al., 2009)*



↓ **Weeds**
(*Finn and al., 2013)*

↑ **Nutritive value**
(*Peyraud and al., 2009)*

↓ **N fertilizer**
(Nyfeler and al., 2011)

More difficult to manage

Approaches for Complex Mixtures

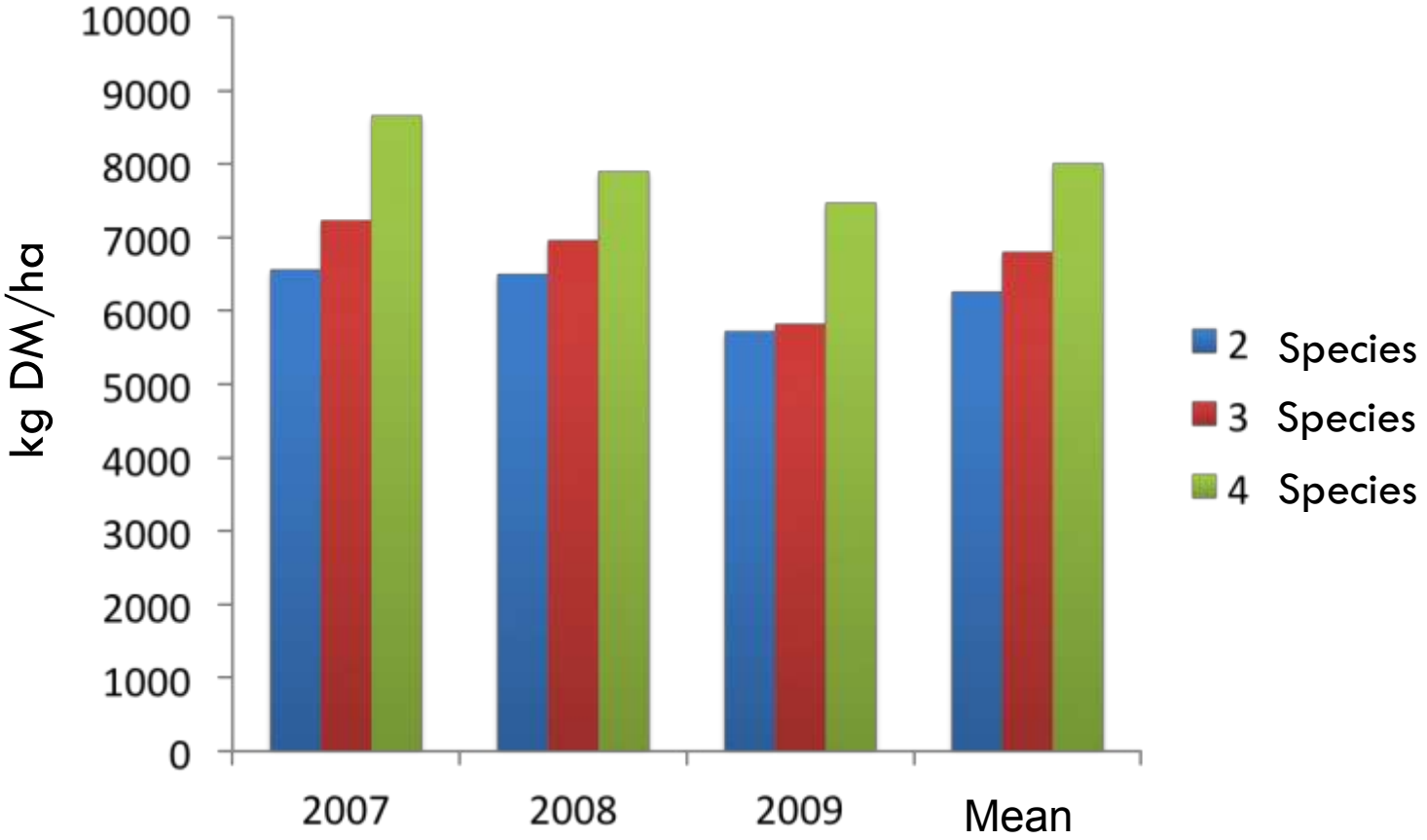
- Two different approaches
  - Ecological approach
    - Based mainly on biodiversity
    - Number of species
  - Agronomic approach
    - Consider biodiversity but also productivity, regrowth during season, and persistance

Complex Mixtures: Trial with White Clover

- Mixtures: White clover with 2, 3 or 4 grasses
- Grasses: Timothy, Kentucky bluegrass, Reed canarygrass, Meadow fescue.
- Rotational grazing from mid-May to mid-October with dairy heifers from 2005 to 2009.

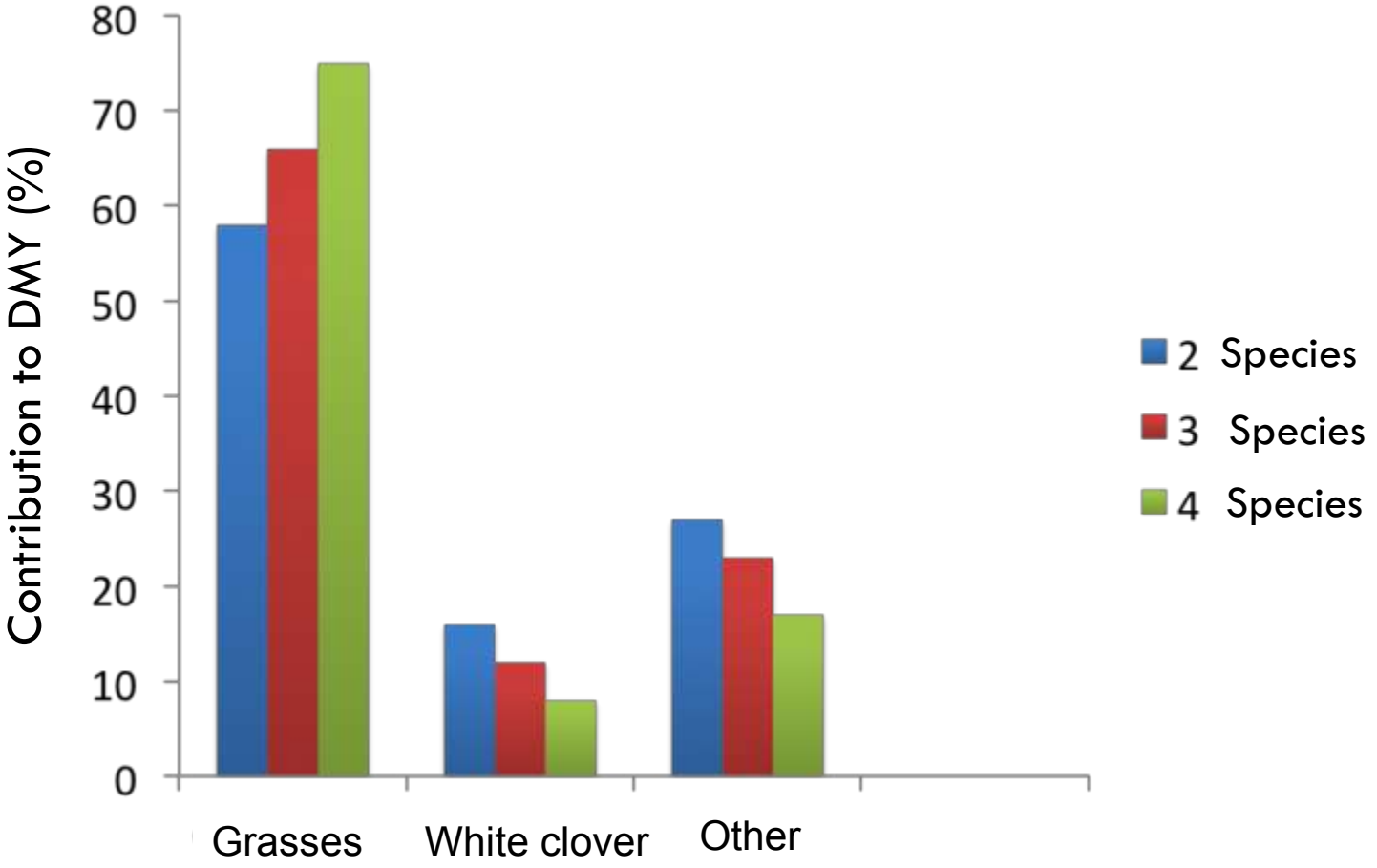
Papadopoulos *and al*. 2012

Dry Matter Yield 2007-2009



Papadopoulos *et al.* 2012

Contribution to DMY



Papadopoulos *et al.* 2012

Main Results from that Trial

- Best productivity with 4 grass species which was the highest number of species tested in that trial
- Complex mixtures: an answer to the climatic variability

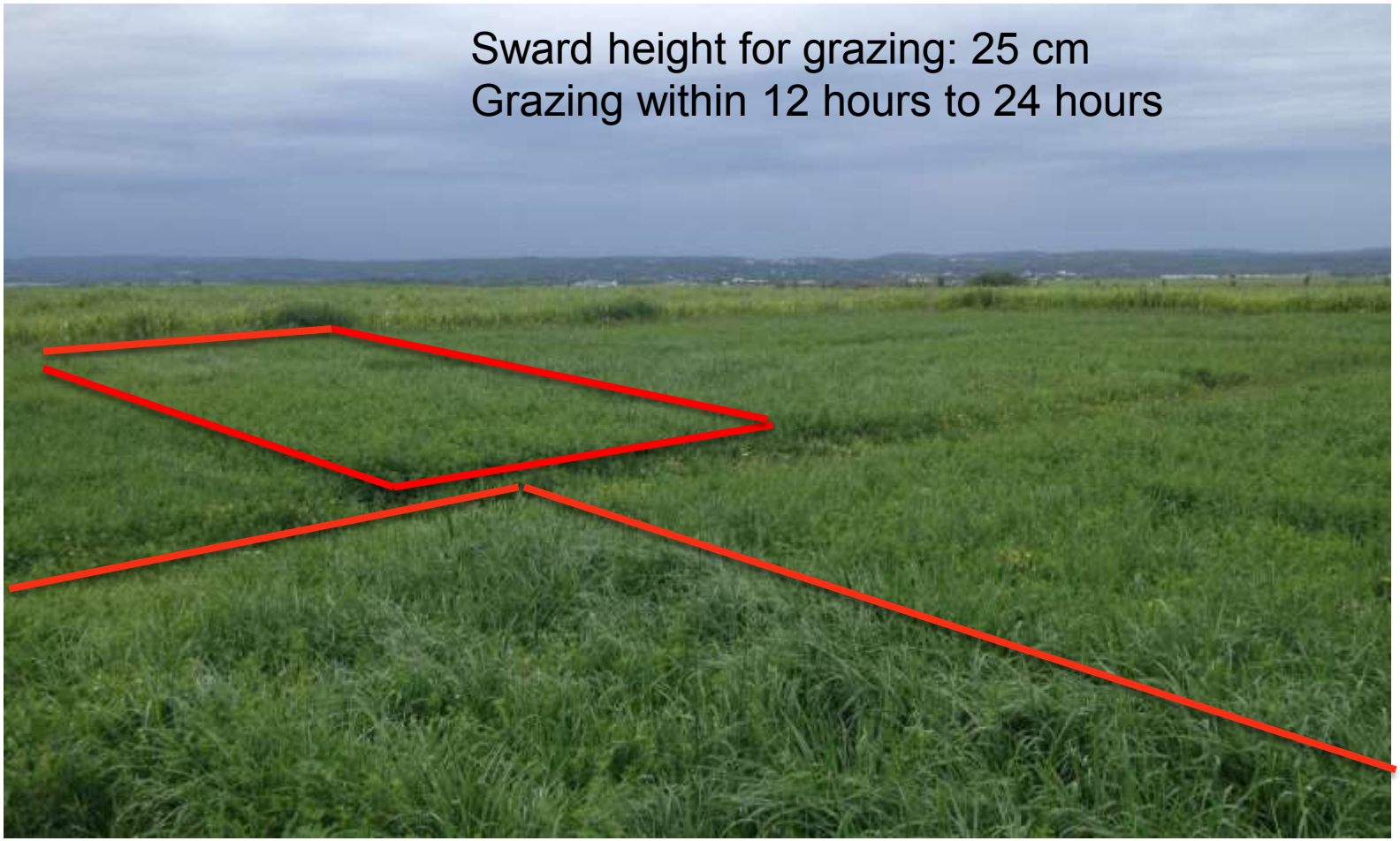
Main Objective: Trial 1 and 2

- Identify the best performing forage mixtures under grazing:
  - Binary mixtures (1 legume + 1 grass)
  - Complex mixtures (1 legume + many grasses)

Methodology to Study Forage Mixtures

- Two major methodologies have been used
  - Plots grazing by animals (mob grazing technic)
  - Simulated grazing (mechanically harvested)

Methodology: Mob Grazing Technic



Methodology: Mob Grazing Technic

Pros:
Plants are trampled by animals.
Prefered species can be identified.

Cons:
Not long enough to determine ADG.

Methodology: Simulated Grazing

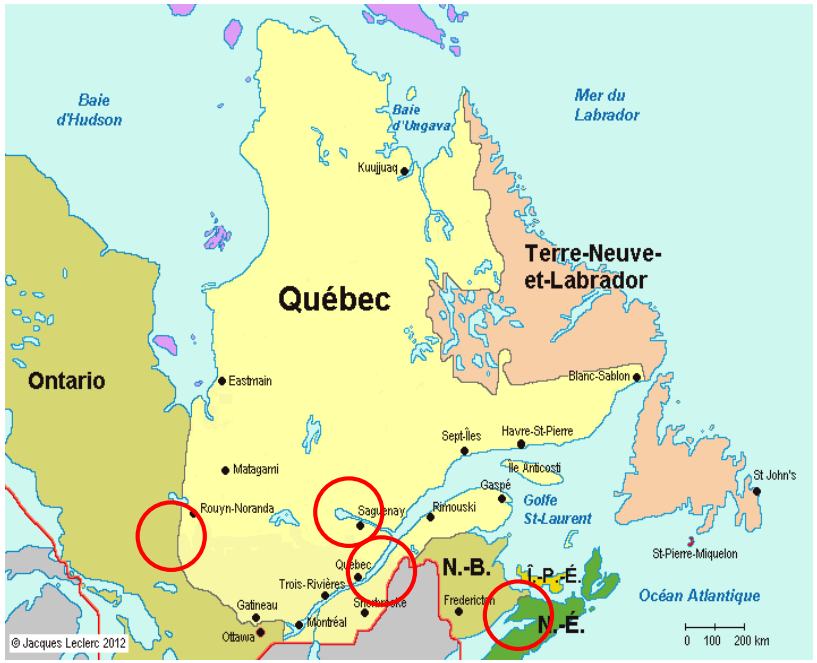
Pros:
Evaluate many different mixtures.

Cons:
No interaction between plant and animal.
Persistance of species may be different from grazing with animals.

Forage Mixtures Under Grazing

- Three trials at different sites since 2010:

- Nappan (NS)
- Lévis (QC)
- Normandin (QC)
- New Liskeard (ON)



Climatic Normals (1980- 2010)

	Nappan (NS)	Lévis (QC)	Normandin (QC)	New Liskeard (ON)
Annual precipitation, mm	1155	1179	709	786
Annual temperature, °C	6.0	4.6	0.8	2.6
GDD (5 °C basis)	1762	1768	1329	1581
Latitude	45° 46' N	46° 48' N	48° 51' N	47° 51' N
Longitude	64° 15' W	71° 23' W	72° 32' W	79° 67' W

http://climate.weather.gc.ca/climate_normals/index_e.html.

Research Team: Binary and Complex Mixtures – Trials 1 and 2

- Yousef Papadopoulos, Project Leader, (AAFC)
- John Duynisveld (AAFC)
- Gilles Bélanger (AAFC)
- Gaëtan Tremblay (AAFC)
- Julie Lajeunesse (AAFC)
- Carole Lafrenière (UQAT)
- Sherry Fillmore (AAFC)

Species in Binary Mixtures: Trial 1

Legumes

- Alfalfa = Af
- Birdsfoot trefoil = Bt
- White clover = Wc

Grasses

- Timothy = Ti
- Meadow fescue = Mf
- Tall fescue = Tf
- Orchardgrass = Og or Or
- Meadow brome = Mb
- Kentucky bluegrass = Kb

Species and Cultivar in Binary Mixtures: Trial 1

Legumes

- Alfalfa – CRS1001
- Birdsfoot trefoil – AC Langille
- White clover - Milkanova

Grasses

- Timothy - Express
- Meadow fescue - Pradel
- Tall fescue - Courtnay
- Orchardgrass - Killarney
- Meadow brome - Fleet
- Kentucky bluegrass - Troy

Seeding Rate in Binary Mixtures: Trial 1

Legumes

- Alfalfa 8 kg/ha
- Birdsfoot trefoil 8 kg/ha
- White clover 8 kg/ha

Grasses

- Timothy 8 kg/ha
- Meadow fescue 15 kg/ha
- Tall fescue 15 kg/ha
- Orchardgrass 12 kg/ha
- Meadow brome 15 kg/ha
- Kentucky bluegrass 22 kg/ha

Trial 1:
Binary Mixtures for Grazing

- 18 binary mixtures (1 legume + 1 grass)
- 3 sites
  - Nappan – Mob grazing with steers (25 cm)
  - Lévis – Simulated grazing (25 cm)
  - Normandin – Simulated grazing (25 cm)
- Seeded in 2010
- Data recorded in the next five years (2011-2015)

What was Measured?

- Dry matter yield (DMY)
- Contribution of seeded species to DMY (June and August)
- Nutritive value
  - TDN (Energy)

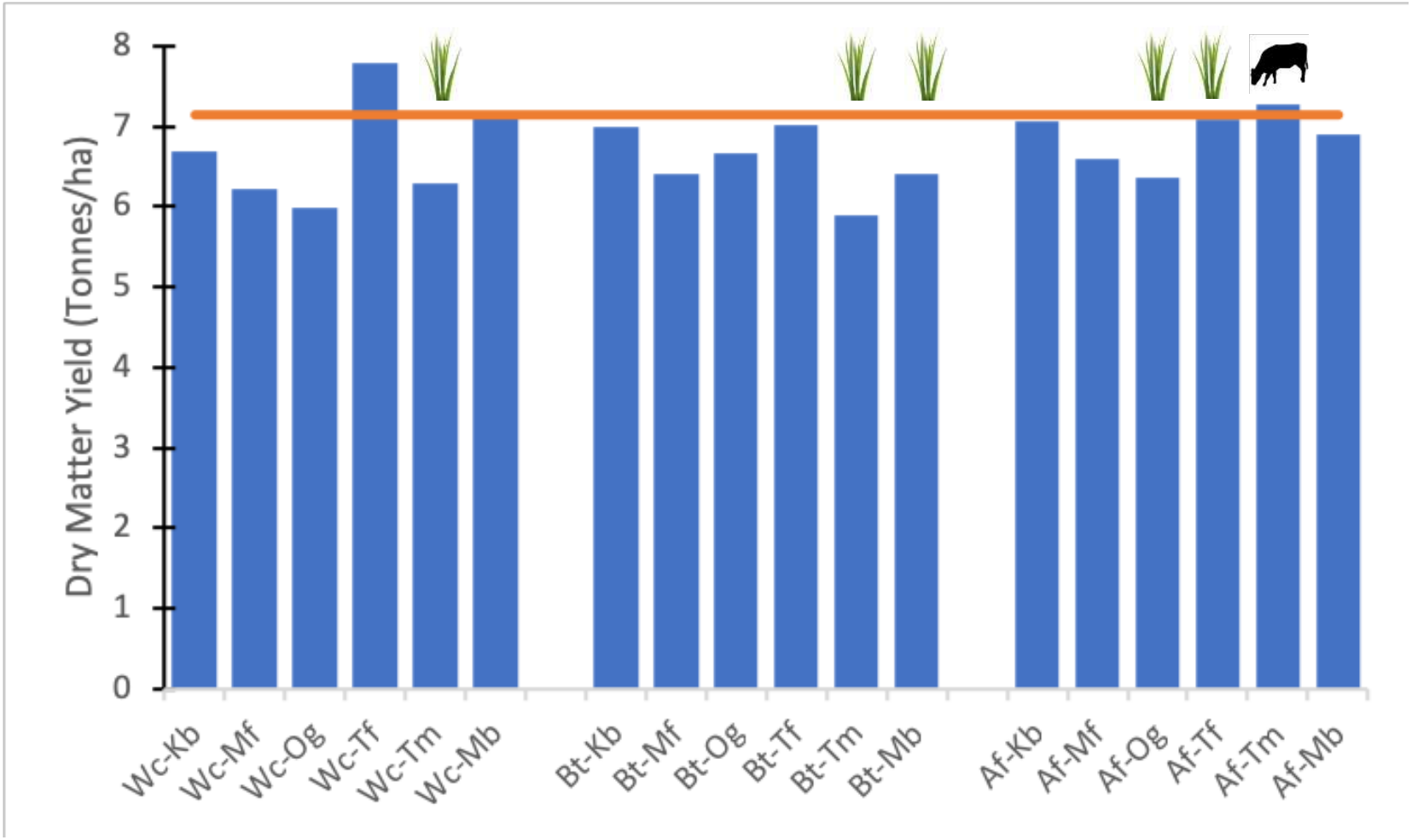
Total Digestible Nutrients (TDN)

Total digestible energy in forages

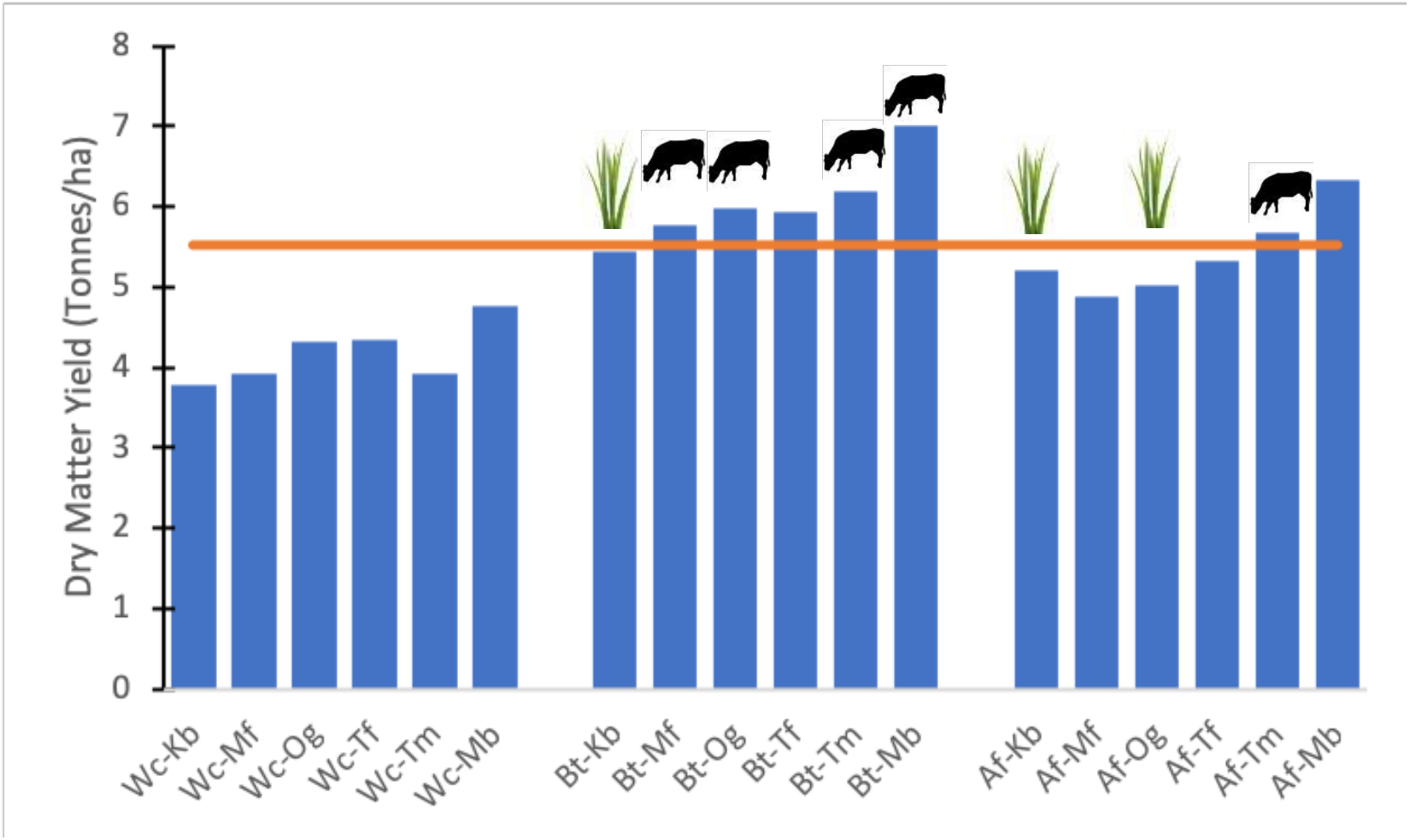
How to Understand Next Three Slides

- Higher DMY: All forage mixtures (blue bar) above the orange line
- Higher DMY and higher TDN: All forages mixtures (blue bar) above the orange line and
- Higher TDN but lower DMY: All forages mixtures (blue bar) below the orange line and

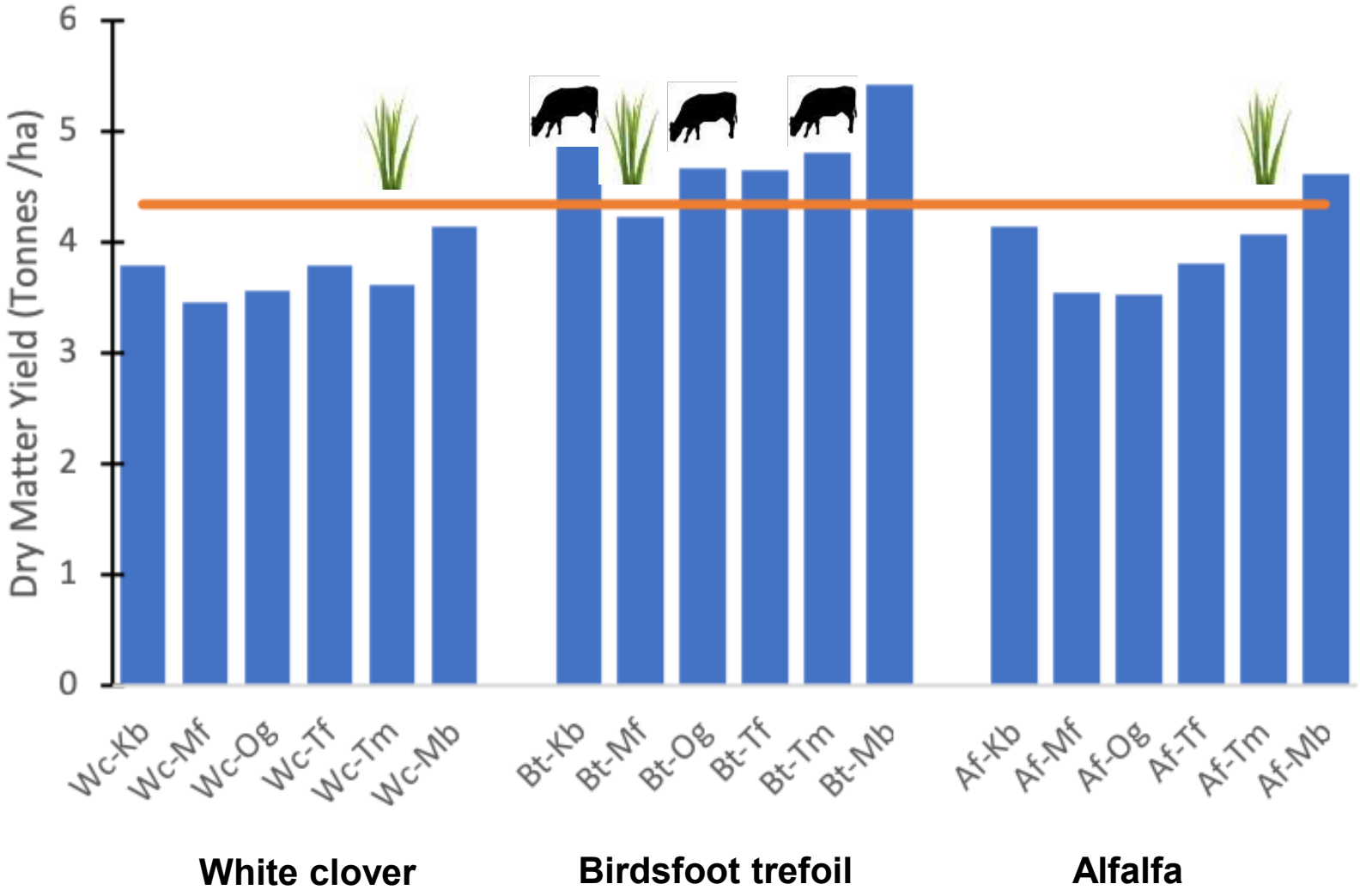
Binary Mixtures: Nappan DMY and TDN: 5 Years Average



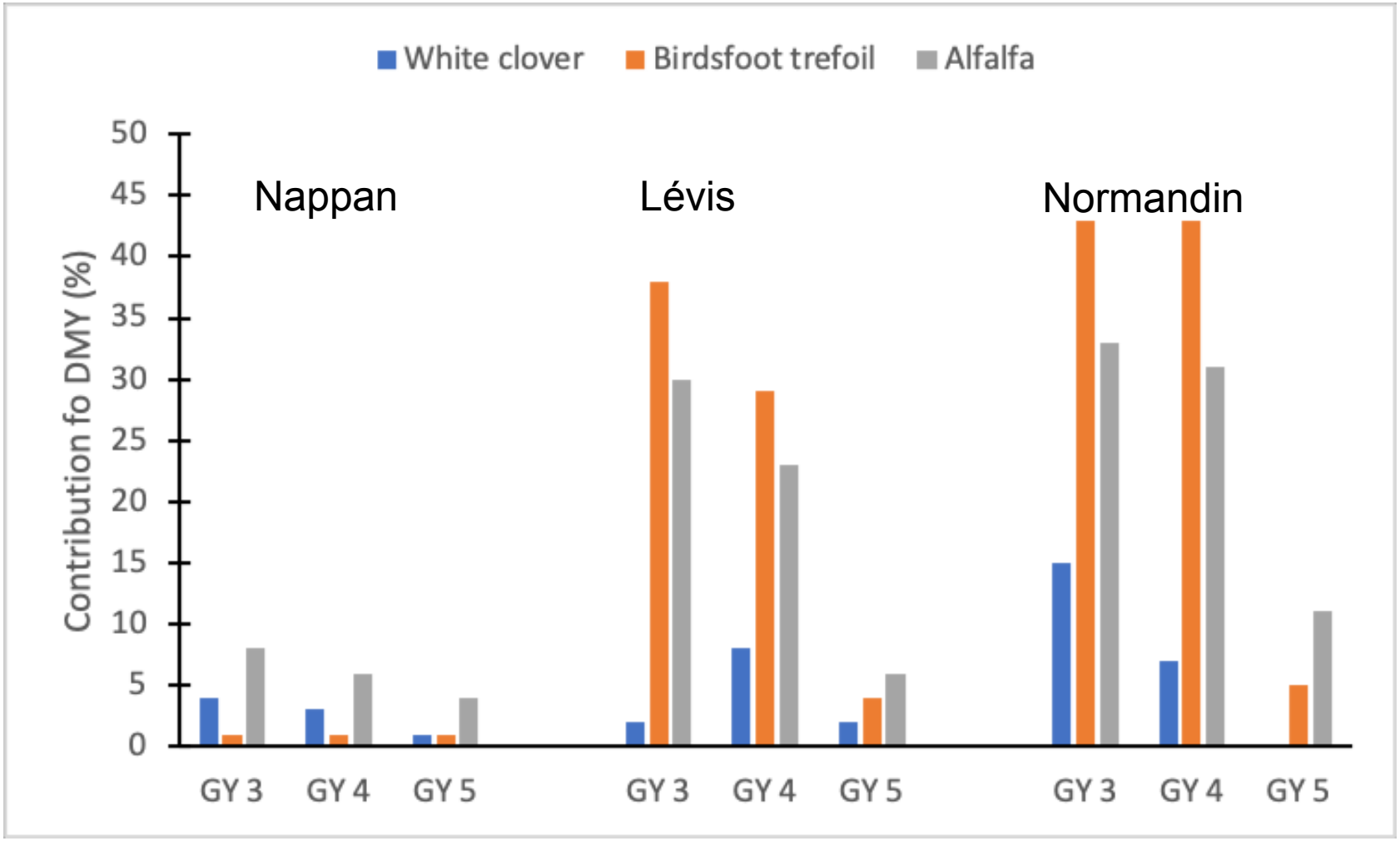
Binary Mixtures: Lévis
DMY and TDN: 5 Years Average



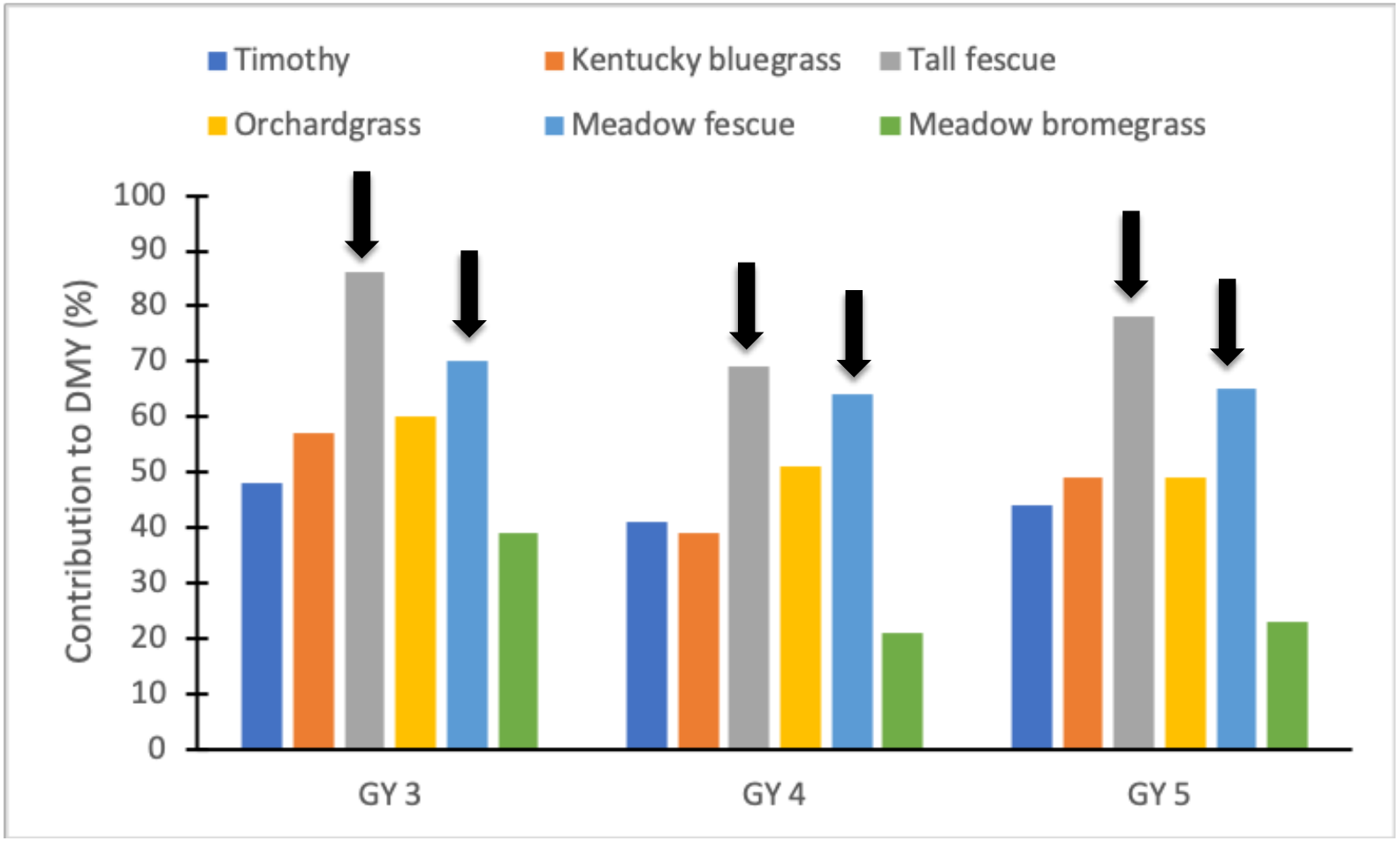
Binary Mixtures: Normandin DMY and TDN: 5 Years Average



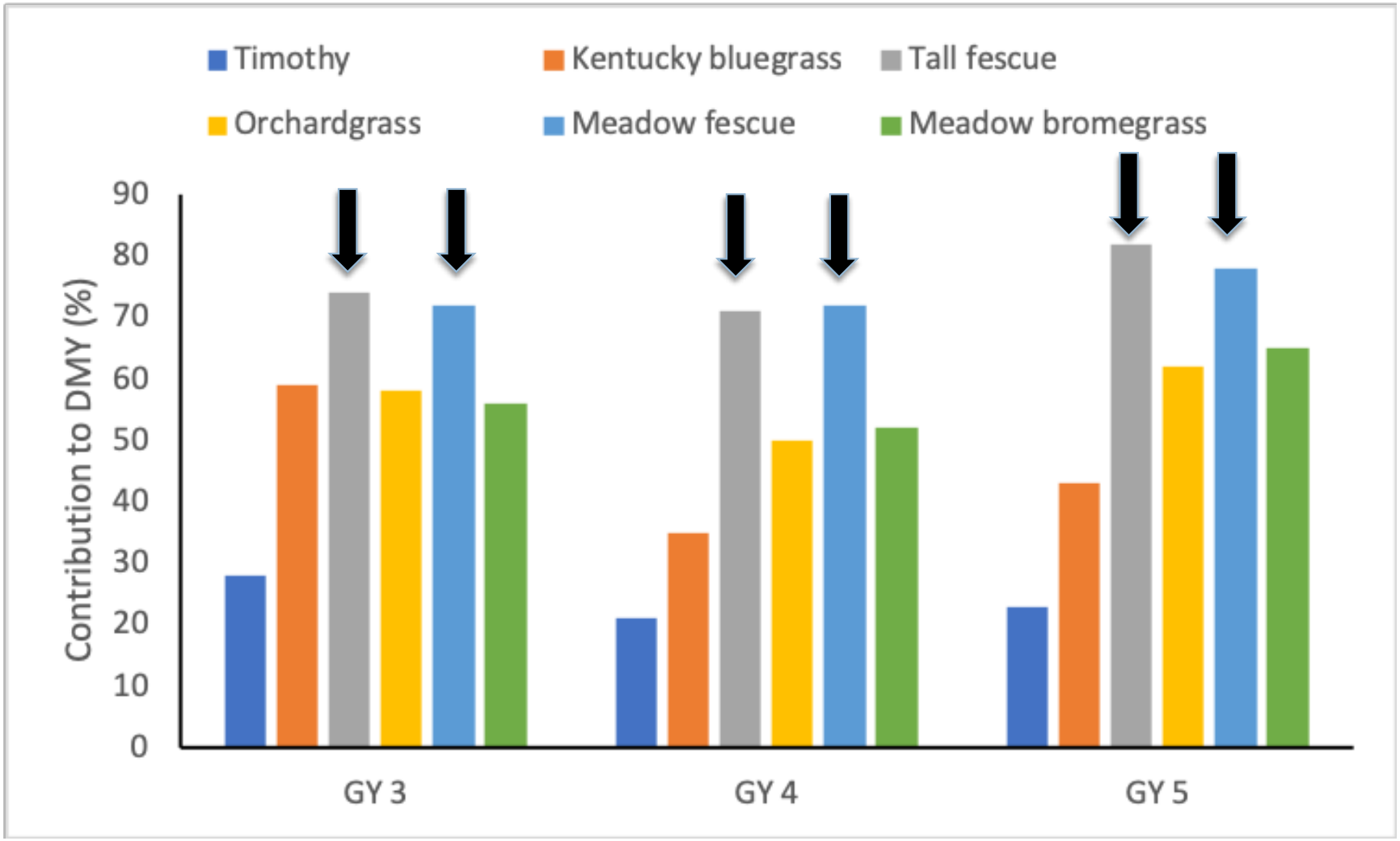
Binary Mixtures: Contribution of Legume to DMY



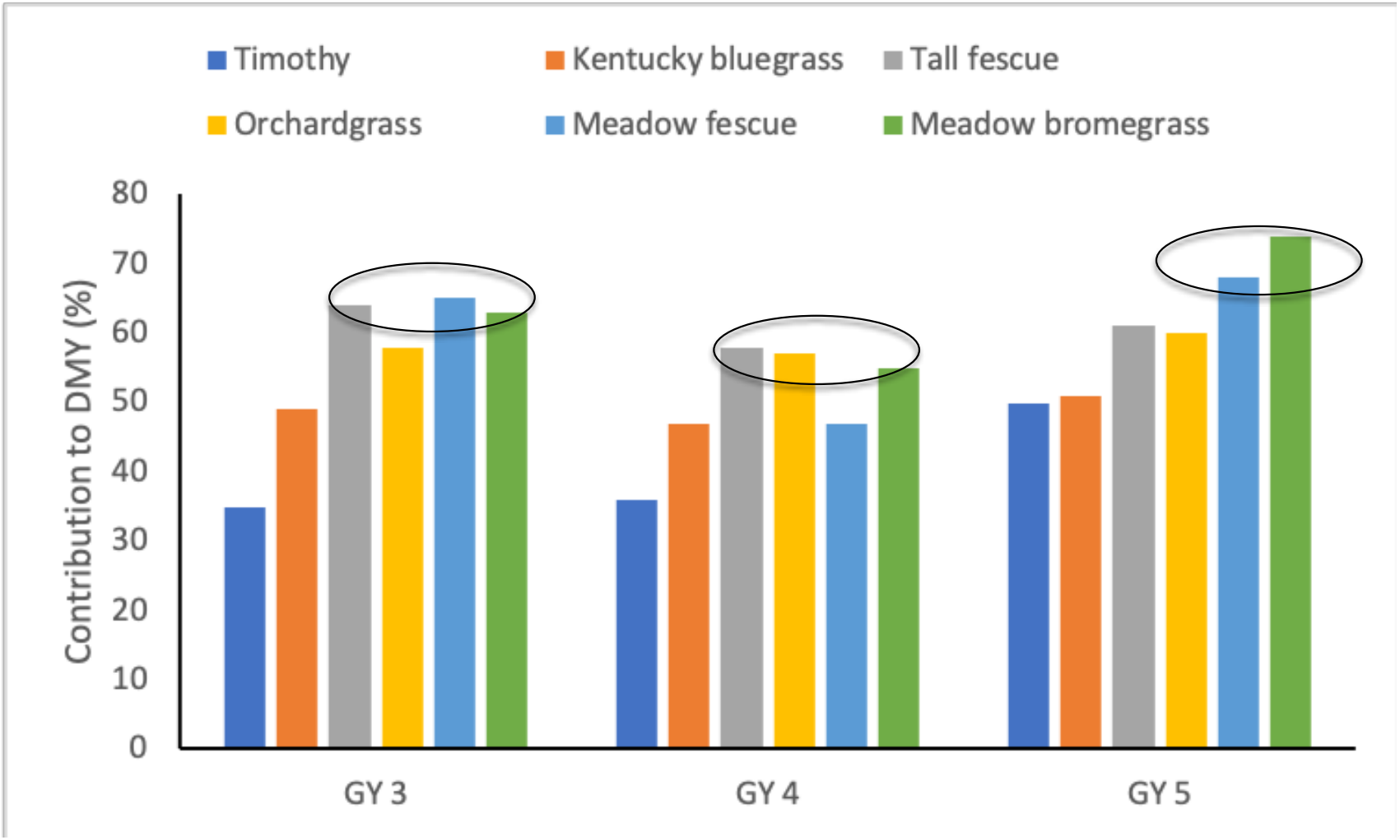
Binary Mixtures: Nappan Contribution of Grasses to DMY



Binary Mixtures: Lévis
Contribution of Grasses to DMY



Binary Mixtures: Normandin Contribution of Grasses to DMY



Take-home Message: Trial 1

- Under grazing (Nappan), productivity of binary mixtures are not very much different.
- Over all, tall fescue and meadow fescue are species that contributed to DMY at high level.
- Legume disapeared rapidly within 2-3 years when grazed with animals

Complex Mixtures: Trial 2

- 8 complex mixtures
- 3 sites
  - Nappan – Grazing with steers (25 cm)
  - Lévis – Simulated grazing (25 cm)
  - Normandin– Simulated grazing (25 cm)
- Seeded in 2010
- Data recorded in the next five years (2011-2015)

Species and Cultivar : Trial 2

Legumes

- Alfalfa – CRS1001
- Birdsfoot trefoil – AC Langille

Grasses

- Timothy - Express
- Meadow fescue - Pradel
- Tall fescue - Courtnay
- Orchardgrass - Killarney
- Meadow brome - Fleet
- Kentucky bluegrass – Troy
- Reed canarygrass - Venture

Grass Mixtures and Seeding Rate: Trial 2

- **Mix 1:** Timothy (4 kg/ha), Meadow fescue (7 kg/ha), Reed Canarygrass (2 kg/ha) Kentucky bluegrass (3 kg/ha)
- **Mix 2:** Tall fescue (6 kg/ha), Meadow brome (7 kg/ha), Orchardgrass (4 kg/ha), Kentucky bluegrass (3 kg/ha)
- **Mix 3:** Timothy (5 kg/ha), Meadow fescue (7 kg/ha), Kentucky bluegrass (3 kg/ha)
- **Mix 4:** Tall fescue (6 kg/ha), Meadow brome (5 kg/ha), Reed canarygrass (2 kg/ha), Kentucky bluegrass (3 kg/ha)

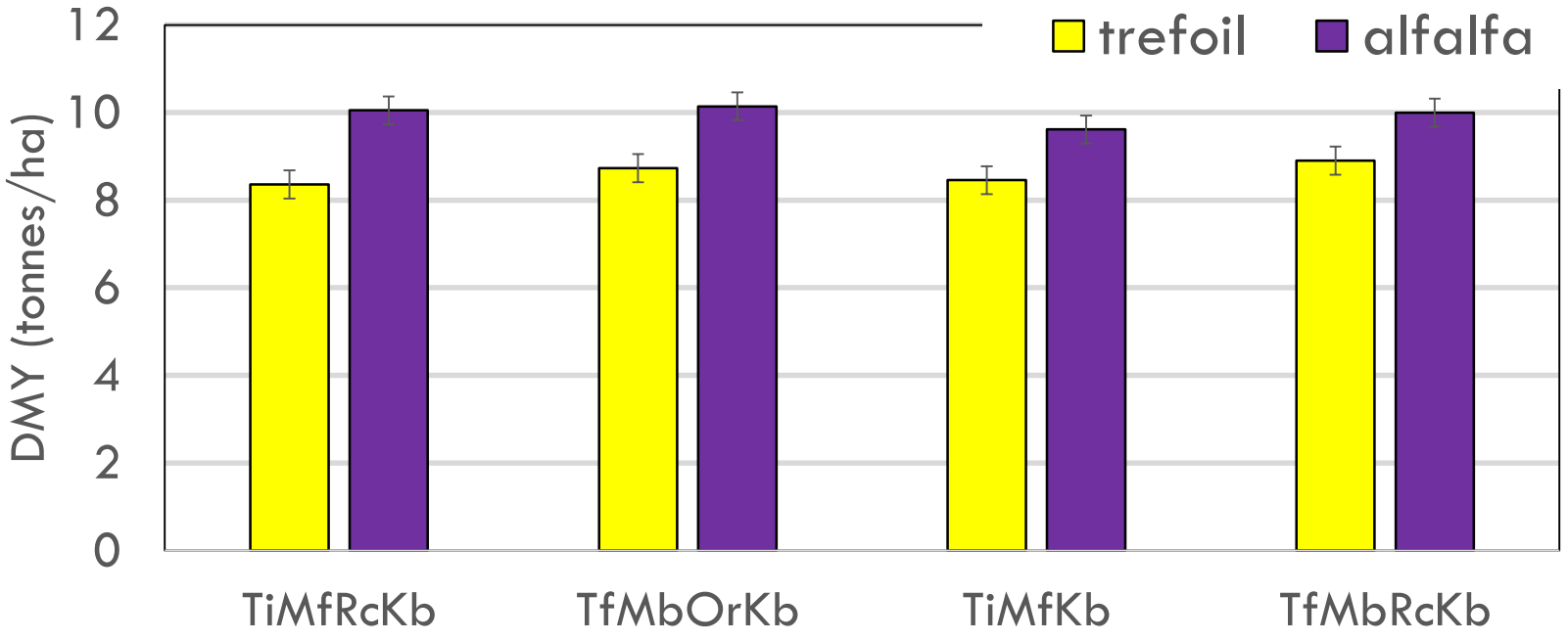
Mixtures and Seeding Rate of Legume species: Trial 2

- **Mix 1:** with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TmMfRcBg Bt + TmMfRcBg
- **Mix 2:** with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TfMbOrKb Bt + TfMbOrKg
- **Mix 3:** with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TmMfKb Bt + TmMfKb
- **Mix 4:** with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TfMbRcKb Bt + TfMbRcKb

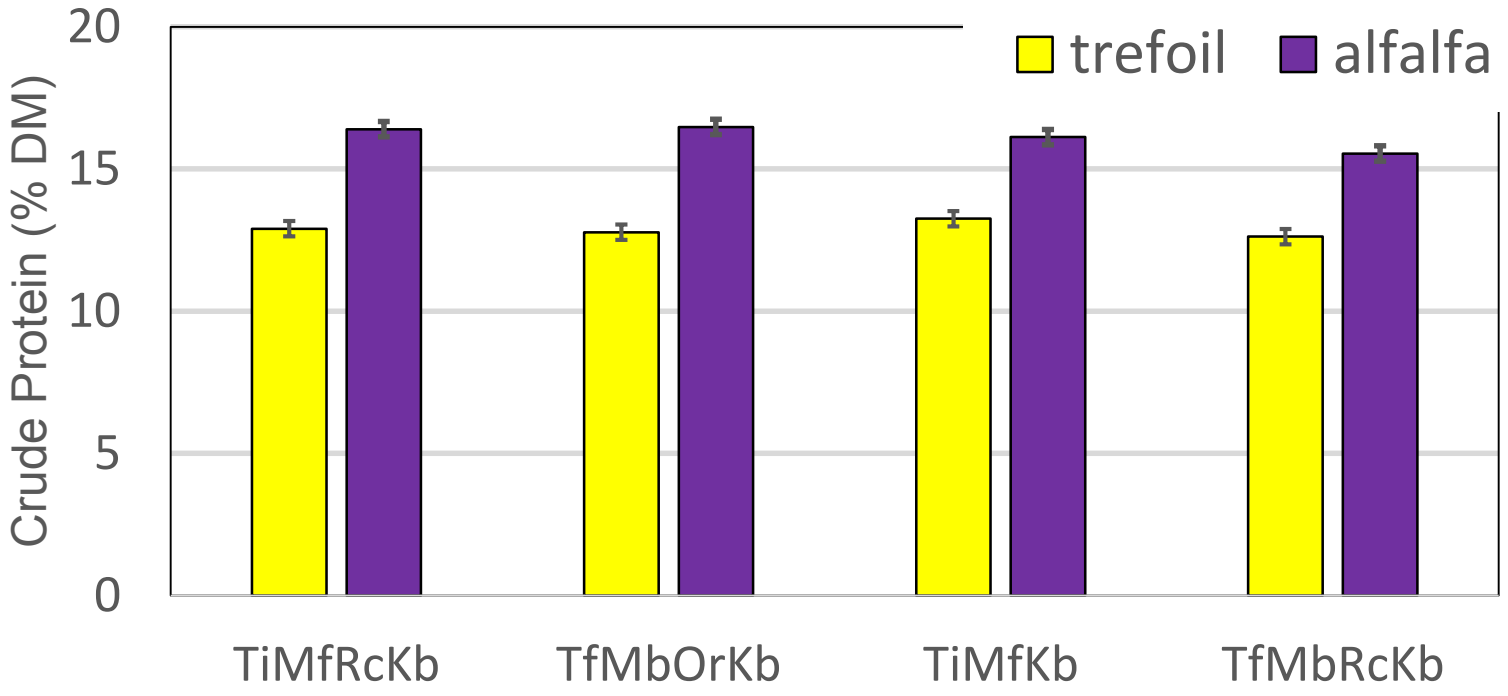
Nappan Site: What was Measured?

- Dry matter yield (DMY)
- Nutritive value
  - TDN (Energy)
  - Crude Protein
  - Average daily gain

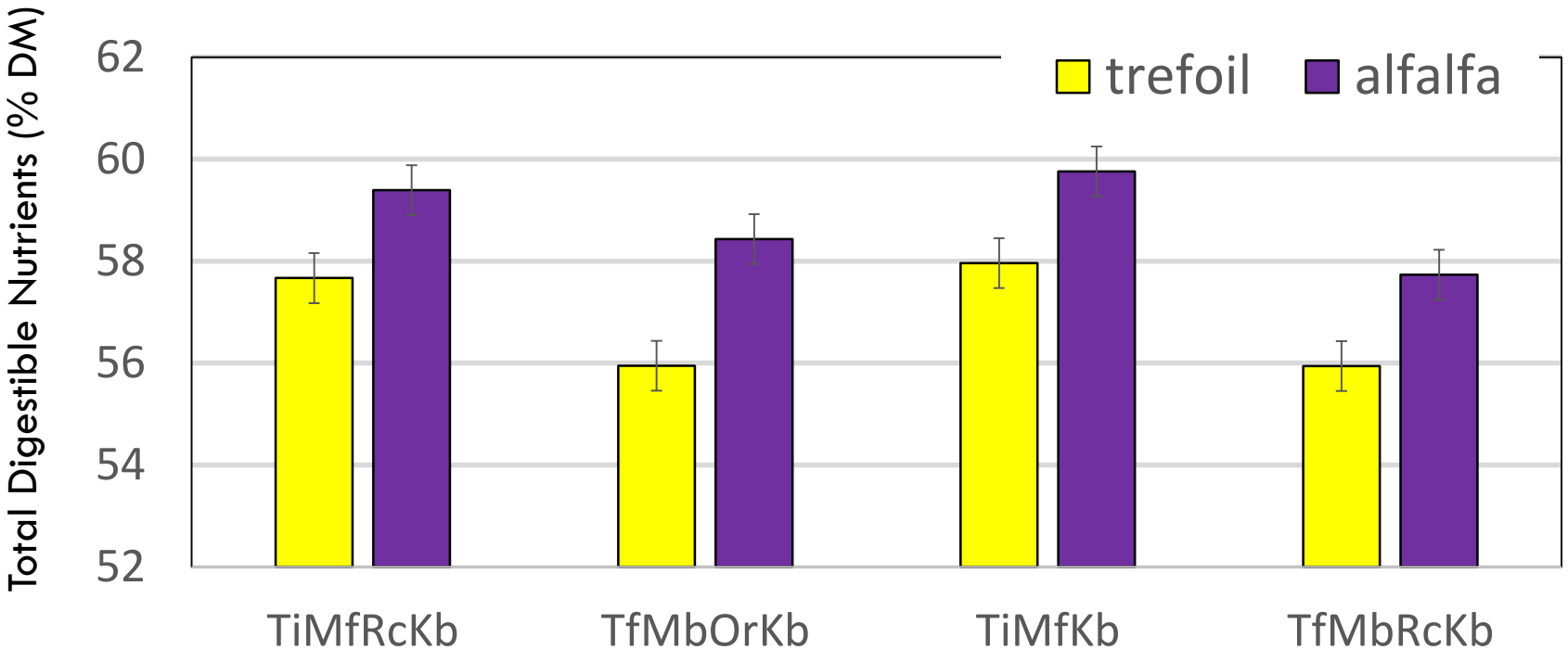
Nappan: Seasonal Dry Matter Yield, 5 Years Average



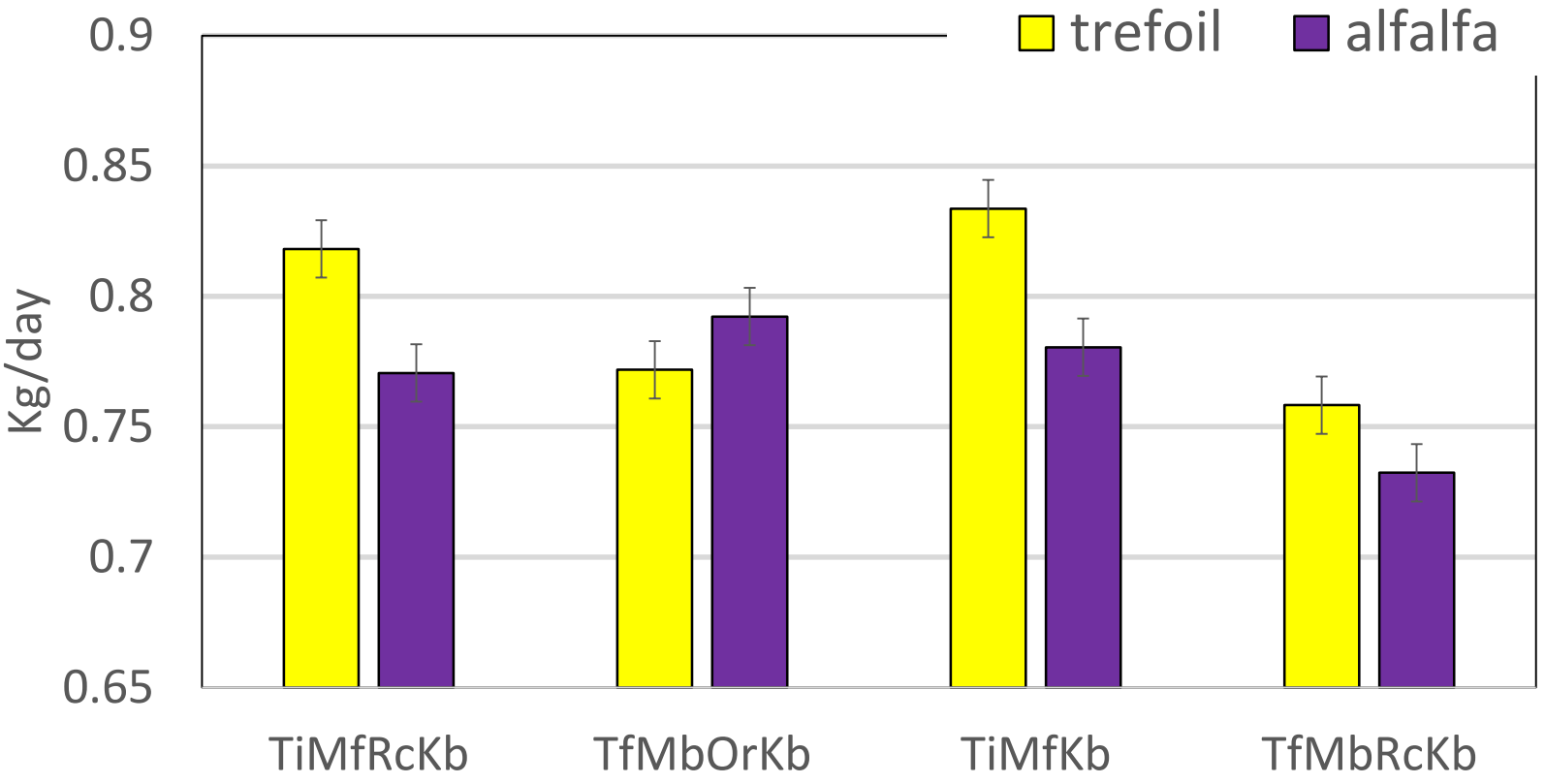
Nappan: Crude Protein Content 5 Years Average



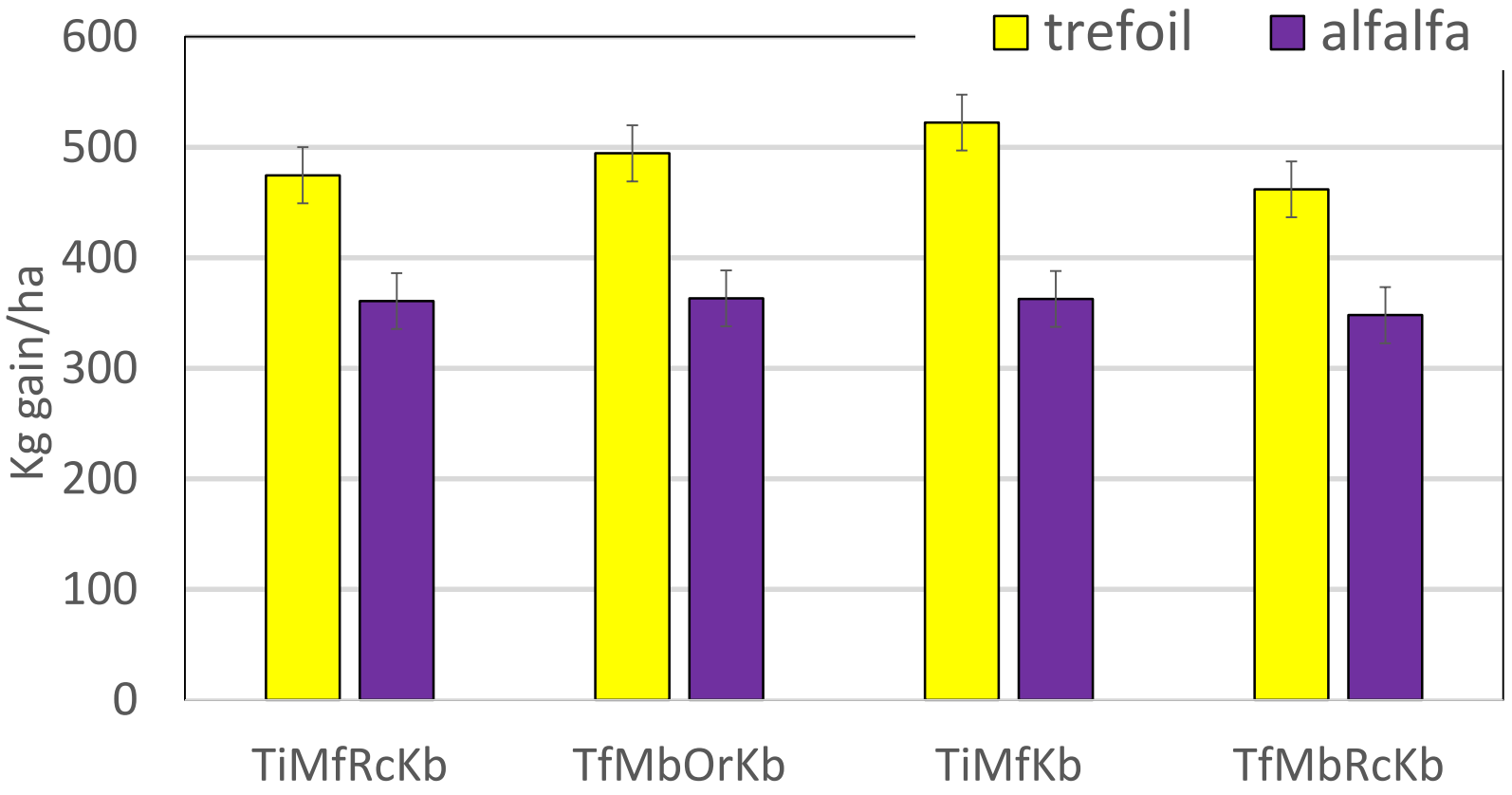
Nappan: TDN Content
5 Years Average



Nappan: Steer Daily Weight Gain 5 Years Average



Nappan: Gain per Unit of Land Area 5 Years Average



Take-home Message: Trial 2

- Mixtures with birdsfoot trefoil had lower DMY than alfalfa but produced more gain per day and per hectare.

Research Team: N- Fertilisation of Complex Mixtures – Trial 3

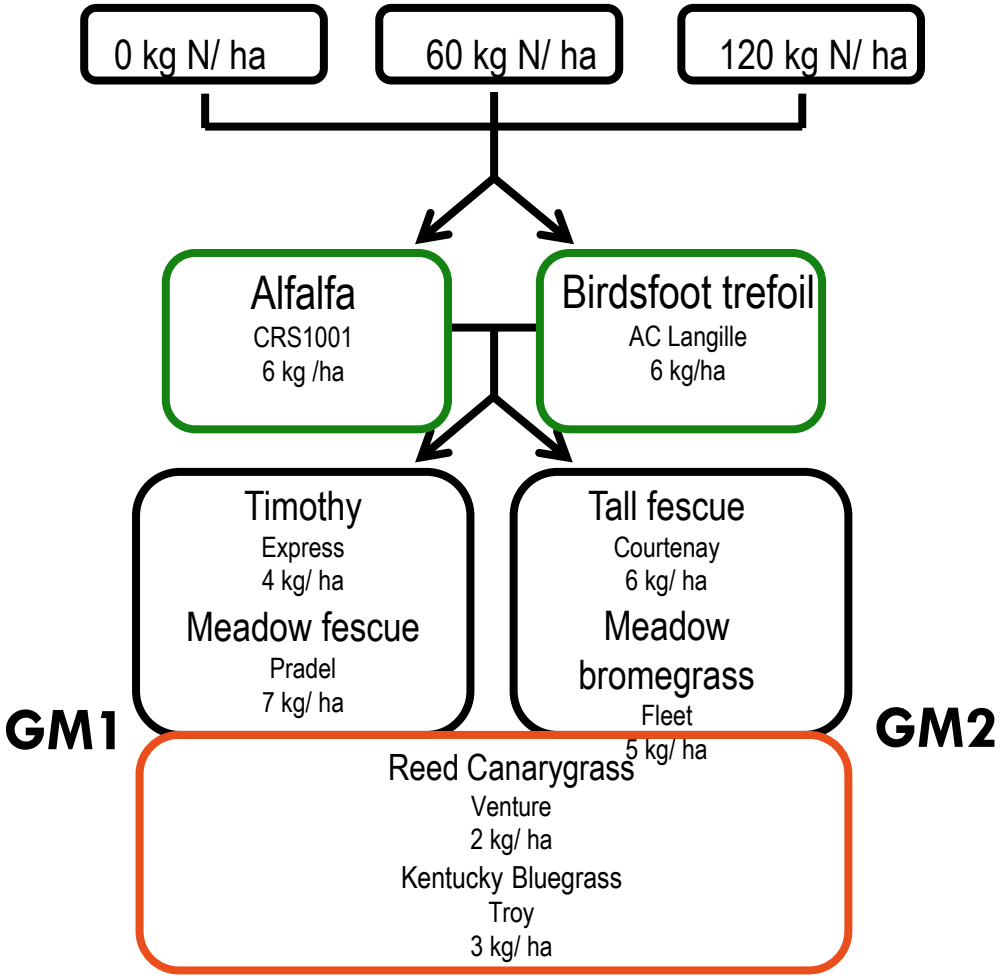
- Yousef Papadopoulos, Project Leader (AAFC)
- John Duynisveld (AAFC)
- Gilles Bélanger (AAFC)
- Gaëtan Tremblay (AAFC)
- Julie Lajeunesse (AAFC)
- Carole Lafrenière (UQAT)
- Sherry Fillmore (AAFC)
- Ira Mandell (UofGuelph)

N - Fertilisation of Complex Mixtures: Trial 3

- 4 complex mixtures
- 3 sites
  - Nappan – Grazing animals (25 cm)
  - Normandin – Grazing animals (25 cm)
  - New Liskeard – Grazing animals (25 cm)
- Seeded in 2013
- Data recorded in the next three years (2014-2016)

Methodology

Complex Mixtures - Nitrogen Fertilisation

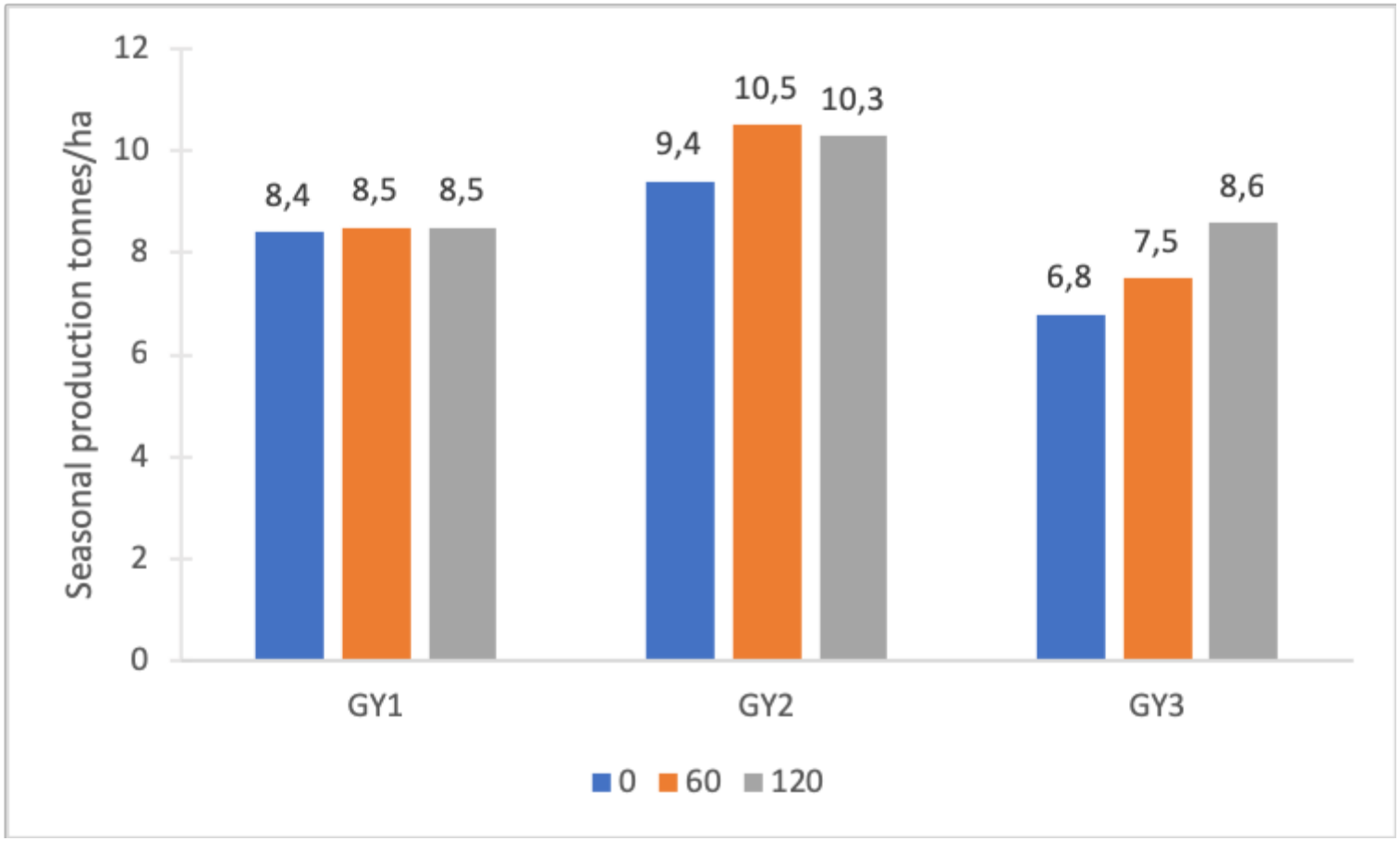


Nitrogen application:

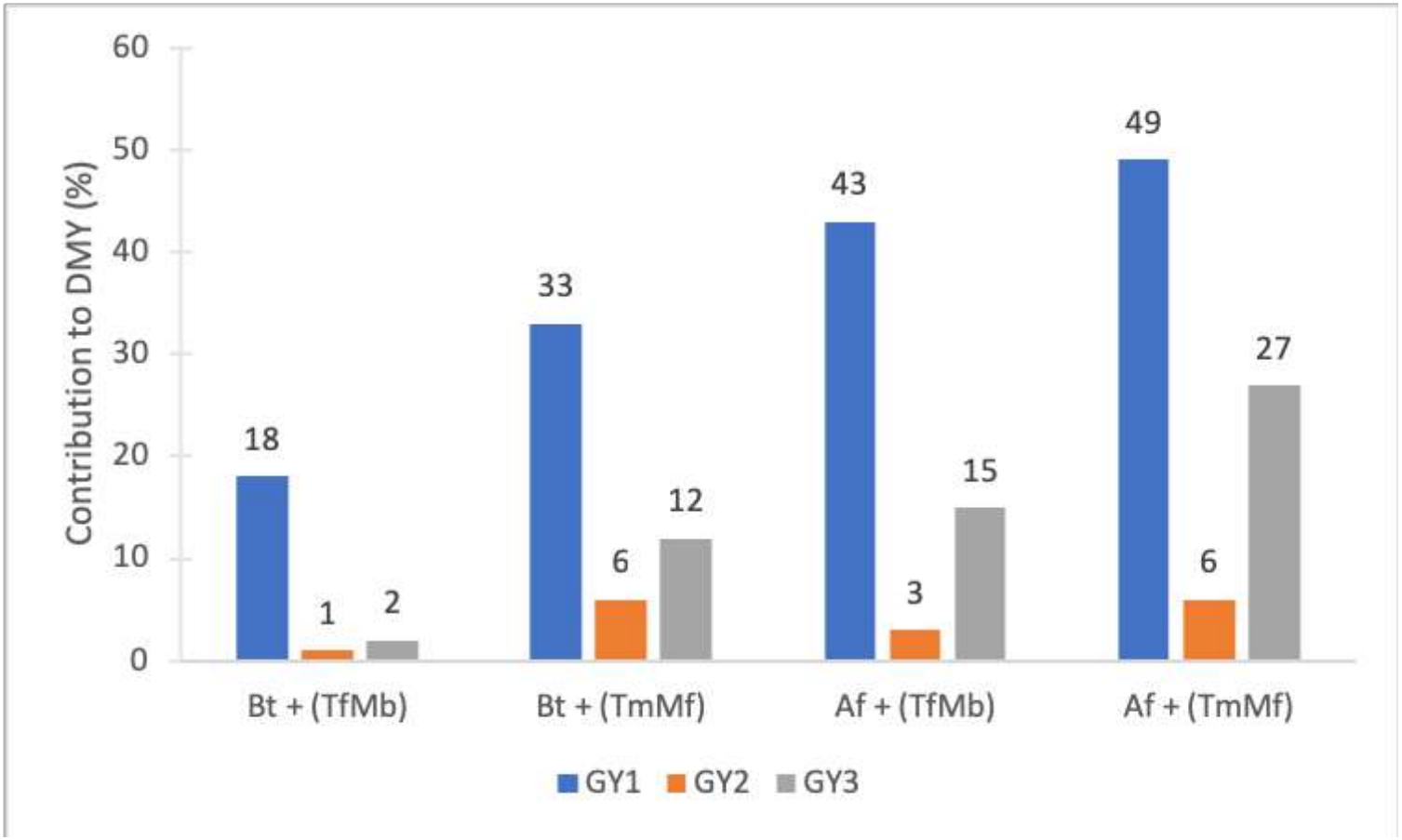
½ after first grazing

½ after second grazing

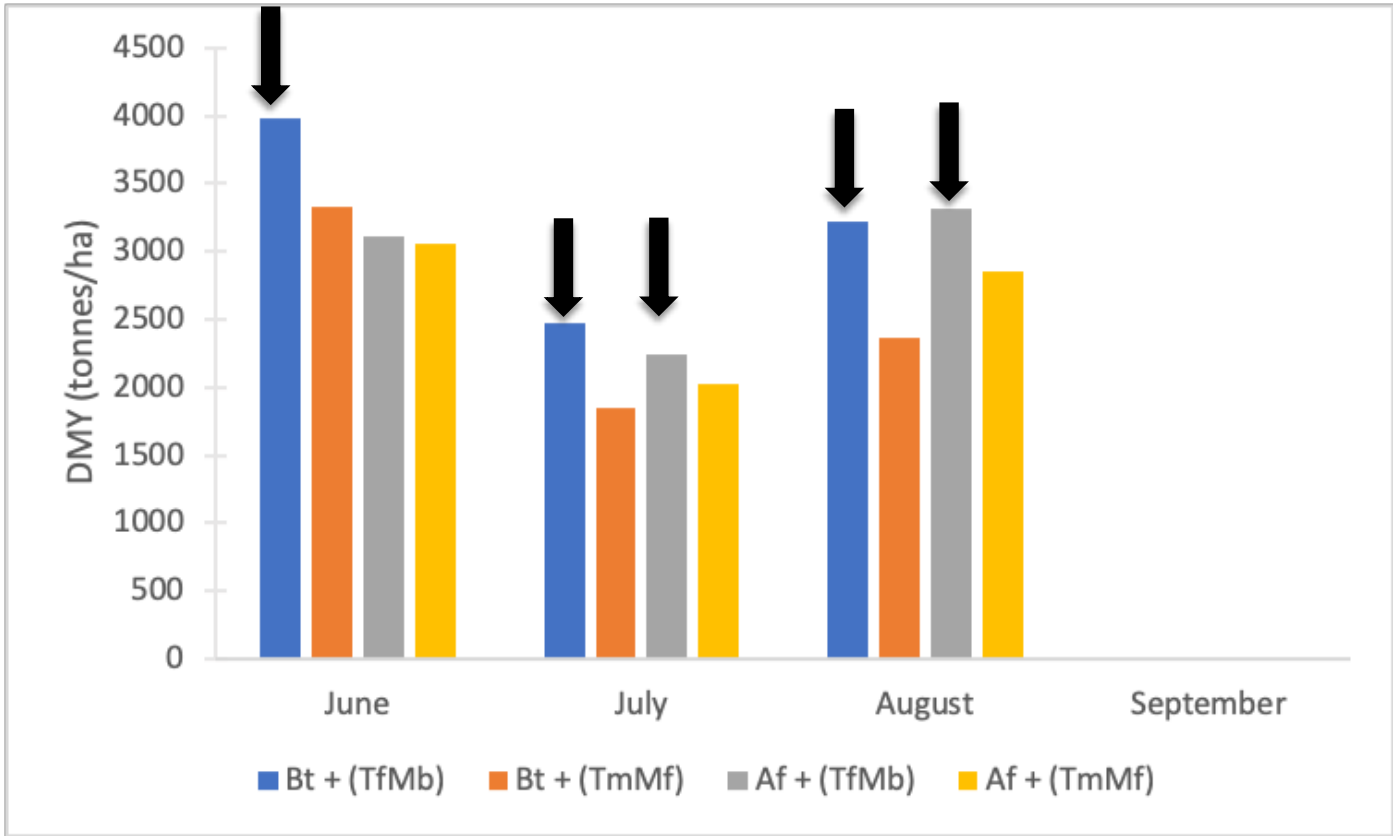
Nitrogen Trial : Seasonal DMY New Liskeard Site



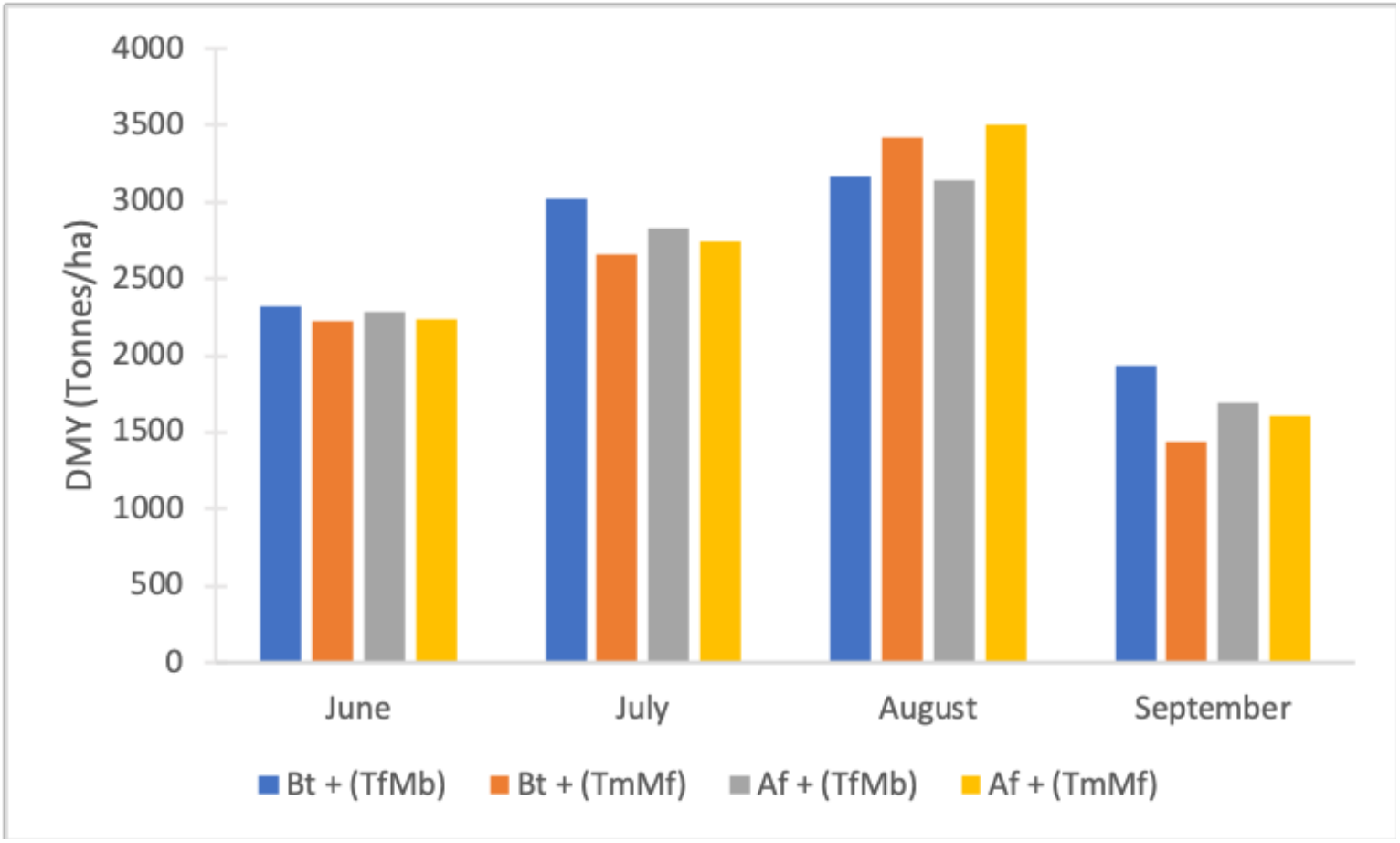
Contribution of Legume Species to DMY New Liskeard Site



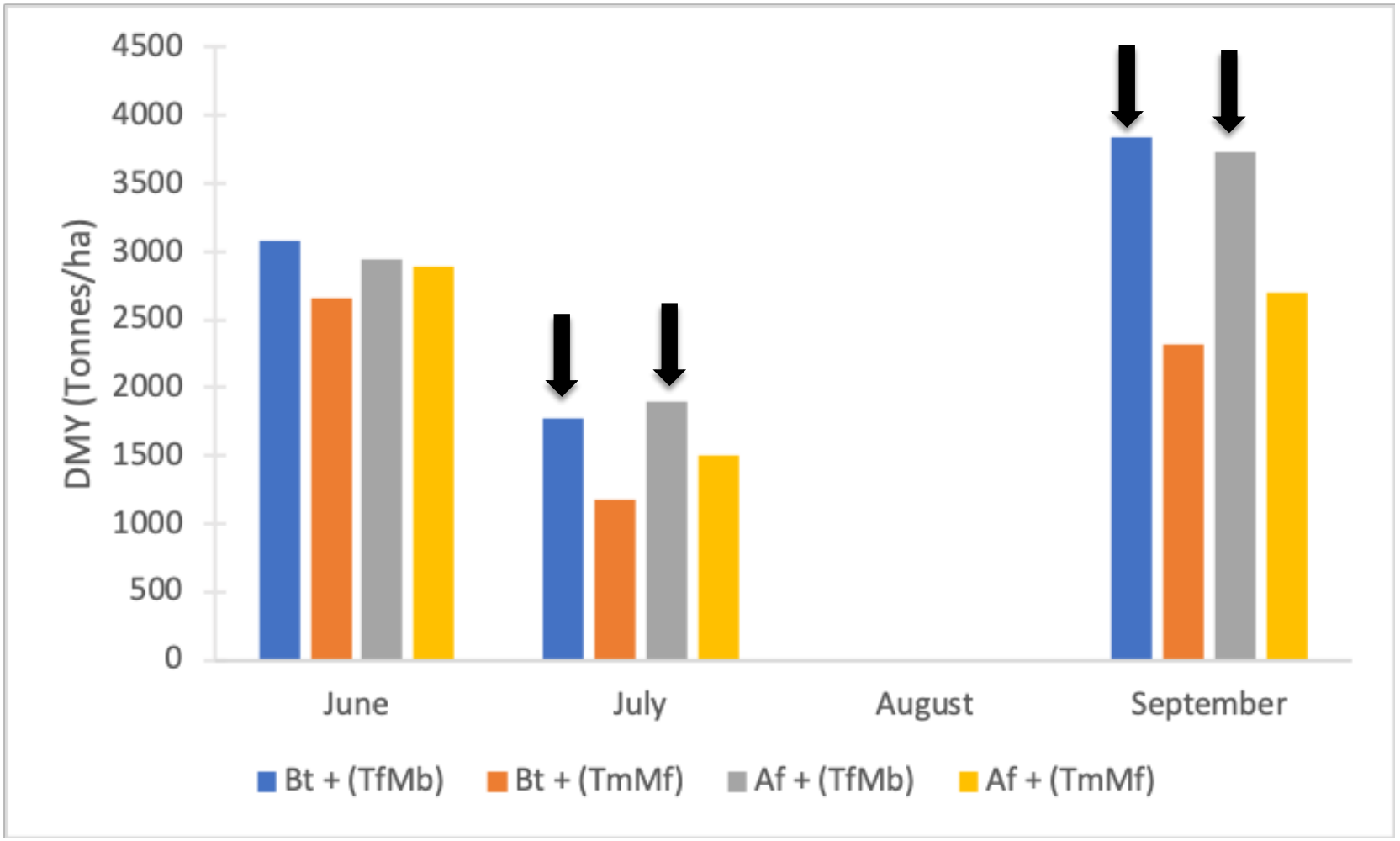
DMY for Each Grazing Cycle 2014: New Liskeard site



DMY for Each Grazing Cycle 2015: New Liskeard Site



DMY for Each Grazing Cycle 2016: New Liskeard Site



Timothy/Meadow Fescue vs Tall Fescue/Meadow brome

Year 2016: Early August vs End-September

Take-home Message:

- Tall fescue can secure forage availability during dry season.
- Maturity of tall fescue is important for grazing.
- Animals must be used to tall fescue.

Acknowledgments:

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- Beef Producers of Ontario and Producteurs de Bovins du Québec also participated in this funding.

BCRC
BEEF CATTLE RESEARCH COUNCIL

Beef Farmers of Ontario

Les Producteurs de bovins du Québec

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- Special thanks to the New Liskeard Research staff that worked on the Nitrogen Forage Mixture trial:

Leo Giesen, Hal Brown, Albert Koekkoek,
John Kobler, Kaley Rodman