# Soil & Forage Benchmarking

## 2022 D24

Soil health and forage productivity in Manitoba Beef & Forage Initiatives Operation

| | |
|---|---|
| Project Lead: | **Manitoba Beef & Forage Initiatives** |
| MBFI Location(s): | Brookdale Farm, Johnson Farm, & First Street Pasture |
| Collaborating Partners: | Mae Elsinger, Rangeland Biologist, Agriculture & Agri-Food Canada |
| Start Date: | 2022 Status: In Progress |

**Background**

Soil health is an important consideration for farmers in Canada[1]. Soil Health is the ability of a soil to function, including biological productivity, sustaining environmental quality, and maintaining plant and animal health[2]. Soil has direct economic benefits in terms of food, fibre, and fuel production[3]. Other soil functions, such as water regulation, carbon sequestration, support of biodiversity, and nutrient cycling, have less immediate economic benefit but provide long term stability and resilience to an agroecosystem[3,4].

Five principles of soil health management are: keep soil covered, limit mechanical disturbance, keep living roots, increase plant diversity, incorporate livestock[1]. To determine the health of a soil, various indicators have been studied, covering soil physical properties, chemical characteristics, and biological indicators[4,5]. However, fewer studies examine soil health in the context of the above ground land-use and plant responses.

Plant biomass and nutrient status indicate how well a soil is functioning in providing nutrients and supporting plant growth[4]. A Rangeland or Pasture Health Assessment uses similar principles to those promoted for soil health assessments, using above ground indicators to determine the health of the system[6]. Rangeland functions include productivity, site stability, capture and beneficial release of water, nutrient cycling, and plant species diversity. A key indicator of rangeland or pasture health is litter cover, which also fulfills a soil health principle of keeping soils covered[1,6]. The relation of soil health and pasture health demonstrates the interconnectedness of soil and plant systems.

Noxious weeds can affect biological diversity, and structure, function, and sustainability of the agroecosystem[6]. In Southern Manitoba, over 1.2 million acres are infested with leafy spurge (BU Economic assessment). Leafy spurge competes with other plants for nutrients, and as it is not utilized by cattle, decreases the carrying capacity of the pasture[7].

The establishment of a baseline essential when monitoring soil and vegetation, to examine how management affects various indicators of soil and plant health[4]. Universal indicators of health are not practical to use as soil characteristics and climate influence the capacity of the soil. Benchmarking is a process used to identify standards and provide areas for continuous improvement[8].

Manitoba Beef & Forage Initiatives is a year-round cow/calf operation, with the advantage of extensive record keeping for farm and research. Several sites were chosen to examine soil and plant health indicators, covering different soil types and different land uses. Long-term monitoring of these sites will provide benchmark data for the farm, stratified by soil type and land use.

## Objectives

To monitor changes in soil and plants, across land use types and soil types and through time.

1. Establish reference field points for long-term monitoring
2. Evaluate soil for indicators of soil health, including physical, chemical, and biological indicators.
3. Evaluate above-ground indicators of plant health, including plant yield, nutrient status, stand composition, invasive weed density, and overall pasture health.

## Project Design and Methods

*Establish reference field points*

Manitoba Beef & Forage Initiatives (MBFI) operates on three sites with different land characteristics (Table 1). Cow-calf production is the primary operation of the farm. Land is used for perennial pasture, perennial hay, and annual forage production. All three land uses support the primary cow-calf operation.

Table 1. Land characteristics of the three sites at Manitoba Beef & Forage Initiatives[9]

| Site | Acres | Land Classification | Dominant Soil Type | |
|---|---|---|---|---|
| Brookdale | 640 | Class 2 | Loamy Till | Newdale |
| Johnson | 411 | Class 4 & 5 | Sandy Lacustrian<br>Sand & gravel | Stockton, Hummerston<br>Dorset |
| First Street | 426 | Class 4 & 5 | Sandy Lacustrian<br>Sand & gravel | Stockton, Hummerston<br>Dorset |

To monitor changes across the different land uses and soil types, fields were selected from each land use (Table 2). First Street Pasture was further divided into Upland, Lowland, and Riparian areas. Paddocks with the same name are managed as one pasture (Figures 1 & 2, Appendix).

In each location, monitoring sites were selected and GPS coordinates recorded. These coordinates were used for both soil and forage sampling. Field 6, Field 5 South and Paddock 12 are the exception, as soil sampling locations were fixed in previous years and forage samples were taken from different locations.

Perennial pastures at Brookdale and First Street used the same sampling locations as required in previous years by previous projects and are used for concurrent grazing projects, Impact of Utilization and Impact of Rest and Duration[10,11,12,13]. Treatment averages from a concurrent annual forage project on Field 7 are presented here[14].

Table 2. Pastures and fields selected for benchmarking.

| Farm | Land Use | Current Management | Historical Management | Fields or Paddocks |
|---|---|---|---|---|
| Brookdale | Perennial Pasture | 50% utilization | Planned Grazing | Paddocks A1, B1, E1 |
| | | 50% utilization | Continuous Grazing | Paddocks A2, B2, E2 |
| | | 80% utilization | Planned Grazing | Paddocks A3, B3, E3 |
| | | 80% utilization | Continuous Grazing | Paddocks A4, B4, E4 |
| | | Farm grazing (multi-day rotation) | Planned Grazing | Paddocks C1, D1, F1, G1 |
| | | Farm grazing (multi-day rotation) | Continuous Grazing | Paddocks C2, D2, F2, G2 |
| | Perennial Grass | No grazing (fallow) | No grazing (fallow) | Field 2 |
| | Perennial Hay | Hay + fall grazing | Hay + fall grazing | Field 5 South |
| | | Hay, no grazing | Hay, no grazing | Field 6 |
| | Annual Forage Production | Monocrop | Corn (2018-2021) | Field 7 |
| | | Polycrop | Corn (2018-2021) | Field 7 |
| First Street | Perennial Pasture (Upland) | One-day rotation | Twice-over rotation | Paddocks A, B, C, D |
| | | Multi-day rotation | Twice-over rotation | Paddocks E, F, G, H |
| | | Farm grazing (multi-day rotation) | Twice-over rotation | Paddocks I |
| First Street | Perennial Pasture (Lowland) | One-day rotation | Twice-over rotation | Paddock D |
| | | Multi-day rotation | Twice-over rotation | Paddocks E, F |
| | Perennial Pasture (Riparian) | Farm grazing (multi-day rotation) | Twice-over rotation | Paddocks I, J |
| Johnson | Annual Forage Production | Annual forage production (Green Feed) | Annual forage production | Paddock 12 |

*Evaluate soil health*

Soil health is influenced by physical, chemical, and biological factors[4]. In this benchmarking project, multiple tests are used to evaluate the soil (Table 3). Some tests may provide similar outcomes, such as the standard fertility test and the Haney test. This project uses GPS coordinates to evaluate changes in each test over time.

In 2022, only soil fertility was evaluated due to equipment constraints. Soil samples were collected for the 0-6” and 6-24” depths. Multiple locations were sampled for each paddock or field and these samples were composited into one sample for analysis. Field 7 is the exception, as plots were sampled for a

concurrent project; in this case the treatment average is provided[14]. All soil fertility samples were sent to Agvise Laboratories for analysis to their lab standards.

Table 3. Soil tests for benchmarking

| Soil Test | Frequency | Outcomes |
|---|---|---|
| Soil Fertility | Annual | Organic Matter<br>pH (2 depths)<br>Nitrate (2 depths)<br>Phosphorus<br>Potassium<br>Sulfur (2 depths)<br>Zinc<br>Magnesium<br>Calcium<br>Sodium<br>Salt (2 depths)<br>Cation Exchange Capacity<br>Base Saturation (Ca, Mg, K, Na, H) |
| Haney Test | Annual | 24-hour CO2 respiration<br>Water-extractable organic carbon and nitrogen<br>H3A-extractable phosphorus<br>Potassium<br>Calcium<br>Iron<br>Zinc<br>Aluminum<br>Soil Heath Score |
| Basal respiration | Annual | Actual microbial respiration |
| CO2 burst test | Annual | Max biological activity |
| POX-C | Annual | Active Carbon |
| Water infiltration | Annual | Water infiltration in soil |
| Compaction | Annual | Soil compaction |
| Bulk density | Every 3 years | Soil structure condition |
| Total Carbon | Every 3 years | Total carbon in soil |
| Aggregate stability | Every 3 years | Soil structure |
| Water holding capacity 0.33bar | Every 3 years | Soil moisture content |
| PLFA | Every 3 years | Representation of living soil microbial biomass |

*Evaluate plant and pasture health*

The health of a plant stand, either annual or perennial, can be evaluated using several types of tests (Table 4).

For perennial pasture, concurrent projects provided much of the data for peak yield, forage quality, and pasture health assessments[12,13]. Prior to peak yield sampling, grazing was prevented using grazing cages, a standing frame which prevents livestock from grazing in the intended sample area. Forage biomass

was sampled in July and sorted into functional groups. These functional groups were determined by the overall pasture composition of the site. Forage samples were dried, and dry weight used to determine forage yield. Dried samples were composited and sent to Central Testing Laboratories for wet chemistry forage analysis. At First Street, Pasture Health Assessments were conducted around the grazing cages where forage biomass was collected. At Brookdale, a transect was selected for sampling and GPS coordinates were recorded. Noxious weed assessments were conducted on a GPS coordinate recorded transect near the grazing cages.

Table 4. Forage tests for benchmarking.

| Plant Test | Frequency | Outcome |
|---|---|---|
| Peak Yield | Annual | Total biomass<br>Biomass by functional group |
| Forage quality (peak yield) | Annual | Nutrient status of the forage stand |
| Pasture Health Assessment | Every 3 years | Plant type, function, and cover<br>Litter estimate<br>Soil erosion & bare soil<br>Noxious weeds – cover and density<br>Woody regrowth – cover and density<br>Pasture Health Score |
| Noxious weeds | Annual | Leafy Spurge<br>- Canopy cover<br>- Height<br>- Stem density<br>- Flowering stem density |

*Weather*

Weather data is collected onsite from weather stations run by Manitoba Agriculture[15].

Table 5. Weather Summary 2022.

| | Brookdale Farm | | Johnson Farm | |
|---|---|---|---|---|
| Month | Total Precipitation (mm) | Average Temperature (°C) | Total Precipitation (mm) | Average Temperature (°C) |
| January | 11.3 | -18.1 | 17.4 | -17.7 |
| February | 12.9 | -19.4 | 17.4 | -19.0 |
| March | 5.0 | -7.6 | 6.0 | -7.1 |
| April | 38.7 | -1.6 | 41.5 | -0.7 |
| May | 172.2 | 9.7 | 107.6 | 10.6 |
| June | 136.6 | 15.9 | 85.4 | 16.8 |
| July | 68.1 | 19.0 | 98.2 | 19.6 |
| August | 40.7 | 18.4 | 56.4 | 19.2 |
| September | 41.4 | 13.0 | 24.8 | 13.8 |
| October | 30.0 | 5.1 | 20.2 | 5.6 |
| November | 6.4 | -6.1 | 5.5 | -5.3 |
| December | 15.3 | -15.9 | 11.8 | -15.7 |

**Results**

Table 7. Peak forage yield at perennial sites.

| Site | Type | Treatment | Paddock | Total Yield (lb/ac) | Grass Yield (lb/ac) | Grass Yield % Total | Legume Yield (lb/ac) | Legume Yield % Total |
|---|---|---|---|---|---|---|---|---|
| Brookdale | Pasture | 50% utilization | A1 | 5182 | 2019 | 39.0% | 3095 | 59.7% |
| | | | B1 | 3554 | 2567 | 72.2% | 886 | 24.9% |
| | | | E1 | 4738 | 3173 | 67.0% | 1501 | 31.7% |
| | | 50% utilization | A2 | 2185 | 1552 | 71.0% | 488 | 22.3% |
| | | | B2 | 2405 | 1865 | 77.5% | 397 | 16.5% |
| | | | E2 | 2659 | 1682 | 63.3% | 906 | 34.1% |
| | | 80% utilization | A3 | 5181 | 2440 | 47.1% | 2645 | 51.1% |
| | | | B3 | 4636 | 2575 | 55.5% | 1962 | 42.3% |
| | | | E3 | 6254 | 3391 | 54.2% | 2852 | 45.6% |
| | | 80% utilization | A4 | 2289 | 1431 | 62.5% | 790 | 34.5% |
| | | | B4 | 2002 | 1540 | 76.9% | 423 | 21.1% |
| | | | E4 | 4282 | 2649 | 61.9% | 1546 | 36.1% |
| | | Farm management | C1 | 1986 | 963 | 48.5% | 648 | 32.6% |
| | | | D1 | 2644 | 1685 | 63.7% | 351 | 13.3% |
| | | | F1 | 3073 | 1875 | 61.0% | 847 | 27.6% |
| | | | G1 | 3715 | 1531 | 41.2% | 2136 | 57.5% |
| | | Farm management | C2 | 2449 | 1143 | 46.7% | 821 | 33.5% |
| | | | D2 | 2817 | 2027 | 72.0% | 426 | 15.1% |
| | | | F2 | 2915 | 2076 | 71.2% | 729 | 25.0% |
| | | | G2 | 2150 | 1771 | 82.4% | 176 | 8.2% |
| | | No grazing | Field 2 | 2504 | 1898 | 75.8% | 424 | 16.9% |
| First Street | Pasture Upland | One-day rotation | A | 2040 | 1628 | 79.8% | 24 | 1.2% |
| | | | B | 2147 | 1669 | 77.7% | 1 | 0.03% |
| | | | C | 2735 | 1450 | 53.0% | 799 | 29.2% |
| | | | D | 1850 | 1645 | 88.9% | 99 | 5.4% |
| | | Multi-day rotation | E | 1721 | 1240 | 72.0% | 0 | 0.0% |
| | | | F | 1622 | 1407 | 86.7% | 83 | 5.1% |
| | | | G | 2343 | 1457 | 62.2% | 0 | 0.0% |
| | | | H | 1550 | 927 | 59.8% | 0 | 0.0% |
| | | Farm management | I | 1663 | 1429 | 85.9% | 43 | 2.6% |
| | Pasture Lowland | Multi-day rotation | D | 2961 | 2321 | 78.4% | 490 | 16.6% |
| | | | E | 2753 | 2639 | 95.8% | 4 | 0.2% |
| | | | F | 3744 | 1809 | 48.3% | 53 | 1.4% |
| | Riparian Pasture | Farm Management | I | 6398 | 6271 | 98.0% | 27 | 0.4% |
| | | | J | 4167 | 1797 | 43.1% | 0 | 0.0% |
| Brookdale | Hay | Hay + fall grazing | Field 5 South | 5770 | 2783 | 48.2% | 2987 | 51.8% |
| | | Hay, no grazing | Field 6 | 3568 | 1258 | 35.3% | 2309 | 64.7% |

Table 6. Soil fertility in 2022.

| Site | Field | Land Use | Organic Matter (%) | pH | Soluble Salts (mmho/cm) | | Cation Exchange Capacity (meq) | Nitrate (lb/ac) | | Phosphorus (ppm) | Potassium (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0-6” | 0-6” | 6-24” | | 0-6” | 6-24” | | |
| Brookdale | Field 2 | No grazing | 6.7 | 7.9 | 0.31 | 0.62 | 29.9 | 1 | 3 | 4 | 389 |
| | E1 | 50% utilization | 7.9 | 7.8 | 0.39 | 0.36 | 34.8 | 4 | 3 | 3 | 310 |
| | E2 | 50% utilization | 5.4 | 7.7 | 2.88 | 2.50 | 45.0 | 1 | 3 | 6 | 293 |
| | E3 | 80% utilization | 7.2 | 7.3 | 0.34 | 0.33 | 27.4 | 6 | 3 | 6 | 274 |
| | E4 | 80% utilization | 5.5 | 7.8 | 0.36 | 0.72 | 29.8 | 2 | 3 | 5 | 262 |
| | Field 5 South | Hay + fall grazing | 5.9 | 7.7 | 0.33 | 0.32 | 28.9 | 7 | 3 | 4 | 206 |
| | Field 6 | Hay, no grazing | 6.7 | 7.7 | 0.33 | 0.82 | 30.8 | 10 | 3 | 4 | 219 |
| | Field 7 | Barley Monocrop | 5.5 | 7.8 | 0.47 | 0.58 | 30.0 | 9 | 6 | 10 | 261 |
| | Field 7 | Barley Polycrop | 5.7 | 7.8 | 0.46 | 0.68 | 31.2 | 10 | 7 | 11 | 243 |
| First Street | D | One-day rotation | 3.7 | 7.7 | 0.15 | 0.16 | 16.4 | 3 | 6 | 3 | 170 |
| | E | Multi-day rotation | 4.9 | 7.7 | 0.19 | 0.15 | 18.4 | 4 | 6 | 4 | 186 |
| Johnson | Paddock 12 | Oat monocrop | 2.9 | 6.4 | 0.13 | 0.16 | 13.7 | 16 | 9 | 18 | 97 |

**Soil Health**

Samples take in 2022 will provide the baseline measurement for this project (Table 6). Some patterns have emerged based on site and previous management. The Johnson Farm and First Street sampling locations have lower organic matter than the Brookdale Farm sites. Perennial sites generally have higher soil organic matter than annual sites (exception is E2 & E4, which were previously under continuous grazing management).

**Forage Yield**

Perennial forage yield varies depending on site and management (Table 7). Grass yield and legume yield are compared to give an overview of the perennial stand. The Brookdale Farm pasture sites have a higher proportion of legumes than the First Street pasture sites. These pastures have been seeded more recently and are on higher quality soil types.

Weeds such as leafy spurge, shrubs, and non-leguminous forbs are included under Total Yield in Table 7.

Following a similar pattern to the perennial forage, the Brookdale Farm produces more total yield for annual forages compared to the Johnson Farm (Table 8).

Table 8. Forage yield of annual sites

| Site | Field | Crop | Total Yield (lb/ac) |
|---|---|---|---|
| Brookdale | Field 7 | Barley monocrop | 5695 |
| | | Barley intercrop | 6204 |
| Johnson | Paddock 12 | Oat monocrop | 4646 |

**Forage Quality**

Similar to forage yield, the perennial pastures at Brookdale are generally higher in macro- and micronutrients compared to the First Street perennial pastures (Table 9). Higher legume content in the Brookdale pastures contributes to higher crude protein.

Table 10. Forage quality of annual sites.

| Site | Field | Crop | CP (%) | TDN (%) | ADF (%) | NDF (%) | Ca (%) | P (%) | Mg (%) | K (%) | Na (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Brookdale | Field 7 | Barley Monocrop | 9.32 | 57.52 | 37.06 | 58.77 | 0.39 | 0.30 | 0.20 | 2.06 | 0.07 |
| | | Barley Intercrop | 12.35 | 58.14 | 40.91 | 55.21 | 0.64 | 0.29 | 0.30 | 2.51 | 0.12 |
| Johnson | Paddock 12 | Oat Monocrop | 7.01 | 57.96 | 38.07 | 63.11 | 0.20 | 0.29 | 0.12 | 1.85 | 0.02 |

Annual fields show higher macro- and micro- nutrients at the Brookdale site. A more detailed review of the treatments from Field 7 can be found in the report Annual Forage Intercrop to Build Soil Health[13].

Table 9. Forage quality of perennial sites

| Site | Type | Treatment | Paddock | CP (%) | TDN (%) | ADF (%) | NDF (%) | Ca (%) | P (%) | Mg (%) | K (%) | Na (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brookdale | Pasture | 50% utilization | A1 | 12.74 | 55.24 | 40.62 | 52.25 | 0.75 | 0.14 | 0.23 | 3.50 | 0.01 |
| | | | B1 | 10.27 | 54.49 | 41.32 | 57.97 | 0.60 | 0.18 | 0.19 | 2.23 | 0.01 |
| | | | E1 | 10.51 | 54.30 | 41.50 | 58.77 | 0.63 | 0.14 | 0.18 | 2.45 | 0.01 |
| | | 50% utilization | A2 | 9.94 | 56.07 | 39.84 | 56.18 | 0.47 | 0.20 | 0.14 | 2.16 | 0.01 |
| | | | B2 | 10.12 | 54.67 | 41.15 | 60.18 | 0.55 | 0.19 | 0.17 | 2.22 | 0.02 |
| | | | E2 | 9.99 | 51.22 | 44.38 | 62.32 | 0.65 | 0.16 | 0.19 | 2.31 | 0.03 |
| | | 80% utilization | A3 | 13.29 | 53.18 | 42.55 | 56.70 | 0.96 | 0.15 | 0.23 | 2.23 | 0.02 |
| | | | B3 | 11.16 | 54.19 | 41.60 | 53.52 | 0.75 | 0.16 | 0.22 | 2.52 | 0.01 |
| | | | E3 | 12.28 | 54.22 | 41.57 | 55.52 | 0.61 | 0.15 | 0.20 | 2.51 | 0.01 |
| | | 80% utilization | A4 | 9.98 | 55.12 | 40.73 | 56.10 | 0.57 | 0.13 | 0.18 | 2.55 | 0.01 |
| | | | B4 | 9.45 | 52.84 | 42.87 | 62.55 | 0.49 | 0.14 | 0.17 | 2.35 | 0.03 |
| | | | E4 | 10.68 | 55.28 | 40.58 | 55.80 | 0.65 | 0.18 | 0.21 | 2.53 | 0.01 |
| | | Farm management | C1 | 11.65 | 56.50 | 39.44 | 55.65 | 0.73 | 0.18 | 0.17 | 1.92 | 0.04 |
| | | | D1 | 10.02 | 57.13 | 38.85 | 55.02 | 0.61 | 0.22 | 0.20 | 2.37 | 0.01 |
| | | | F1 | 11.36 | 59.52 | 36.61 | 54.16 | 0.63 | 0.10 | 0.19 | 2.25 | 0.01 |
| | | | G1 | 12.92 | 56.70 | 39.25 | 54.77 | 0.62 | 0.13 | 0.20 | 2.60 | 0.02 |
| | | Farm management | C2 | 10.78 | 57.37 | 38.63 | 57.17 | 0.73 | 0.23 | 0.17 | 2.34 | 0.03 |
| | | | D2 | 9.96 | 56.03 | 39.88 | 57.53 | 0.44 | 0.21 | 0.22 | 2.01 | 0.04 |
| | | | F2 | 10.32 | 56.45 | 39.49 | 60.39 | 0.46 | 0.15 | 0.15 | 2.27 | 0.03 |
| | | | G2 | 12.01 | 58.47 | 37.60 | 60.27 | 0.37 | 0.15 | 0.16 | 1.82 | 0.03 |
| | | No grazing | Field 2 | 8.57 | 56.99 | 38.98 | 61.31 | 0.42 | 0.11 | 0.10 | 1.71 | 0.01 |
| First Street | Pasture Upland | One-day rotation | A | 8.50 | 56.34 | 39.59 | 58.98 | 0.43 | 0.23 | 0.11 | 1.40 | 0.01 |
| | | | B | 8.36 | 53.55 | 42.20 | 64.69 | 0.43 | 0.18 | 0.12 | 1.56 | 0.01 |
| | | | C | 9.09 | 54.72 | 41.11 | 58.83 | 0.78 | 0.13 | 0.14 | 1.29 | 0.01 |
| | | | D | 7.77 | 55.42 | 40.45 | 63.36 | 0.36 | 0.12 | 0.11 | 1.30 | 0.01 |
| | | Multi-day rotation | E | 10.68 | 56.55 | 39.39 | 57.41 | 0.50 | 0.13 | 0.13 | 1.43 | 0.00 |
| | | | F | 10.34 | 60.20 | 35.98 | 59.03 | 0.45 | 0.17 | 0.12 | 1.49 | 0.01 |
| | | | G | 9.23 | 54.55 | 41.27 | 58.20 | 0.57 | 0.27 | 0.13 | 1.65 | 0.01 |
| | | | H | 9.98 | 54.17 | 41.62 | 58.39 | 0.61 | 0.27 | 0.13 | 1.60 | 0.01 |
| | Pasture Lowland | Multi-day rotation | E | 8.78 | 55.94 | 39.96 | 65.29 | 0.27 | 0.18 | 0.09 | 1.40 | 0.01 |
| | Riparian Pasture | Farm Management | J | 8.47 | 58.29 | 37.77 | 67.07 | 0.26 | 0.15 | 0.19 | 1.43 | 0.02 |
| Brookdale | Hay | Hay + fall grazing | Field 5 South | 13.22 | 51.13 | 44.47 | 59.44 | 0.73 | 0.14 | 0.25 | 2.20 | 0.02 |
| | | Hay, no grazing | Field 6 | 14.45 | 51.63 | 44.00 | 55.80 | 0.94 | 0.15 | 0.33 | 2.31 | 0.03 |

**Invasive Weeds**

Leafy Spurge is monitored at the First Street Pastures. Spurge is denser in the south pastures A, B, and G (Table 11). Pastures with more leafy spurge tend to have correspondingly taller spurge stems and more flowering stems. The exception is on Paddock C. In this paddock, spurge is very tall, likely due to increased nutrients from the higher alfalfa content of the paddock.

Table 11. Leafy spurge canopy cover, height, and density.

| | Average (*Range*) | | | |
|---|---|---|---|---|
| Paddock | Spurge Canopy (%) | Height (cm) | Spurge Stem Density (#/m2) | Spurge Flowering Stem Density (#/m2) |
| A | 50.0 (*10.0 – 90.0*) | 34.5 (*22.9 – 43.2*) | 73.6 (*20.0 – 120.0*) | 19.6 (*4.0 – 52.0*) |
| B | 45.5 (*20.0 – 75.0*) | 34.2 (*19.1 – 52.1*) | 85.2 (*40.0 – 148.0*) | 23.6 (*0.0 – 44.0*) |
| C | 19.5 (*0.0 – 35.0*) | 51.7 (*29.2 – 77.5*) | 29.6 (*0.0 – 60.0*) | 21.6 (*0.0 – 48.0*) |
| D | 6.6 (*1.0 – 15.0*) | 25.5 (*5.1-43.2*) | 16.4 (*4.0 – 40.0*) | 5.6 (*0.0 – 16.0*) |
| E | 32.5 (*10.0 – 75.0*) | 34.1 (*19.7 – 54.6*) | 64.0 (*24.0 – 116.0*) | 18.0 (*0.0 – 52.0*) |
| F | 26.0 (*5.0 – 70.0*) | 22.0 (*15.2 – 31.1*) | 49.2 (*12.0 – 92.0*) | 4.0 (*0.0 – 24.0*) |
| G | 79.0 (*50.0 – 100.0*) | 34.5 (*22.2 – 48.3*) | 110.8 (*60.0 – 232.0*) | 44.0 (*16.0 – 92.0*) |
| I | 45.5 (*15.0 – 95.0*) | 30.2 (*15.9 – 48.9*) | 62.8 (*16.0 – 136.0*) | 20.8 (*0.0 – 48.0*) |

**Pasture Health**

Pasture Health Assessments were conducted at multiple locations on both farms (Table 12). At Brookdale Farm, most pastures were given a Healthy rating. The main reasons these pastures lost points was for species composition shift away from desirable plants. Some paddocks had weeds such as Canada Thistle, which lost points in the exotic component.

At First Street, only two sites were rated Healthy. The low overall biomass and plant diversity limited litter accumulation and increased soil erosion. All areas assessed for pasture health are affected by leafy spurge and therefore scored low in the exotic component. Interestingly, on Paddock G, there was such a high amount of leafy spurge that it had appeared to limit cattle grazing. This increased litter and decreased erosion, which increased the overall score of the site above initial expectations.

Table 12. Summary of pasture health assessments

| Site | Paddock | Pasture Type | Species component | Litter component | Soil component | Exotic component | Woody component | Final Health Score | Health Rating |
|---|---|---|---|---|---|---|---|---|---|
| | ***Total Possible Score*** | | ***40*** | ***25*** | ***15*** | ***10*** | ***10*** | | |
| Brookdale | C1 | Modified Tame | 30 | 25 | 15 | 2 | 5 | 77% | Healthy |
| | C2 | Modified Tame | 23 | 0 | 7 | 4 | 8 | 42% | Unhealthy |
| | D1 | Tame | 30 | 25 | 15 | 6 | 8 | 84% | Healthy |
| | D2 | Modified Tame | 0 | 16 | 11 | 6 | 10 | 43% | Unhealthy |
| | E1 | Tame | 40 | 25 | 15 | 6 | 10 | 96% | Healthy |
| | E2 | Tame | 40 | 8 | 7 | 2 | 10 | 67% | Health with Problems |
| | E3 | Tame | 40 | 16 | 13 | 6 | 10 | 85% | Healthy |
| | E4 | Tame | 37 | 8 | 7 | 1 | 10 | 63% | Healthy with Problems |
| | F1 | Tame | 26 | 25 | 7 | 0 | 10 | 68% | Healthy with Problems |
| | F2 | Tame | 40 | 16 | 13 | 1 | 10 | 80% | Healthy |
| | G1 | Tame | 40 | 25 | 12 | 4 | 10 | 91% | Healthy |
| | G2 | Tame | 30 | 16 | 12 | 2 | 10 | 70% | Healthy with Problems |
| First Street | A | Tame | 26 | 16 | 10 | 0 | 10 | 62% | Healthy with Problems |
| | B | Tame | 19 | 0 | 7 | 0 | 10 | 36% | Unhealthy |
| | C | Tame | 30 | 8 | 8 | 0 | 10 | 56% | Healthy with Problems |
| | D Upland | Tame | 30 | 0 | 8 | 1 | 10 | 49% | Unhealthy |
| | D Lowland | Tame | 33 | 16 | 15 | 2 | 10 | 76% | Healthy |
| | E Upland | Tame | 19 | 16 | 15 | 1 | 10 | 61% | Healthy with Problems |
| | E Lowland | Tame | 23 | 25 | 15 | 1 | 10 | 74% | Healthy with Problems |
| | F Upland | Tame | 19 | 8 | 7 | 0 | 10 | 44% | Unhealthy |
| | F Lowland | Modified Tame | 5 | 25 | 15 | 1 | 10 | 56% | Healthy with Problems |
| | G | Modified Tame | 14 | 16 | 10 | 0 | 10 | 50% | Healthy with Problems |
| | H | Modified Tame | 14 | 0 | 8 | 0 | 10 | 32% | Unhealthy |
| | I Upland | Modified Tame | 14 | 16 | 15 | 0 | 10 | 55% | Healthy with Problems |
| | I Lowland | Tame | 26 | 25 | 10 | 5 | 10 | 76% | Healthy |

## Project Findings

The first year of sampling has demonstrated the differences in soil and forage between the farms at Manitoba Beef & Forage Initiatives. Sampling in future years will explore soil and forage indicators as they relate to land use and management.


## Acknowledgements

Manitoba Beef & Forage Initiatives acknowledges Canadian Agricultural Partnership strategic grant funding in the undertaking of the study.

Thank you to Mae Elsinger for her advice and expertise in Pasture Health Assessments as well as her input on concurrent project, First Street Grazing: Impact of Rest. Thank you to Pam Iwanchysko for leading concurrent project Brookdale Grazing: Impact of Utilization.


## References


1 – What Makes Soil Healthy? Calgary AB: Beef Cattle Research Council; c2020 [updated 2020 Jul 28; accessed 2023 Jan 05]. https://www.beefresearch.ca/blog/what-makes-soil-healthy/

2 – Van Eerd LL, Congreves KA, Arcand M, Lawley Y, Halde C. Soil health and management. In: Krzic M, Walley FL, Diochon A, Paré MC, Farrell RE, editors. Digging into Canadian soils: An introduction to soil science. Pinawa (MB): Canadian Society of Soil Science, 2021. p. 463-517. https://openpress.usask.ca/soilscience/chapter/soil-health-and-management/

3 – Schulte RPO, Creamer RE, Donnellan T, Farrelly N, Fealy R, O'Donoghue C, O'hUallachain D. Functional land management: A framework for managing soil-based ecosystem services for the sustainable intensification of agriculture. Environmental Scient & Policy. 2014 Apr 1;38:45-58. DOI: 10.1016/j.envsci.2013.10.002

4 – Bünemann EK, Bongiorno G, Bai Z, Creamer RE, De Deyn G, de Goede R, Fleskens L, Geissen V, Kuyper TW, Mäder P, Pulleman M. Soil quality–A critical review. Soil Biology and Biochemistry. 2018 May 1;120:105-25. DOI: 10.1016/j.soilbio.2018.01.030

5 – Stewart RD, Jian J, Gyawali AJ, Thomason WE, Badgley BD, Reiter MS, Strickland MS. What we talk about when we talk about soil health. Agricultural & Environmental Letters. 2018;3(1):180033. DOI: 10.2134/ael2018.06.0033

6 – Adams BW, Ehlert G, Stone C, Alexander M, Lawrence D, Willoughby M, Moisey D, Hincz C, Burkinshaw A, Richman J, France K. Rangeland Health Assessment for Grassland, Forest and Tame Pasture. 4th ed. Edmonton (AB): Public Lands and Forests Division, Alberta Sustainable Resource Development. Pub. No. T/044.

7 – Rempel, K. 2010. Economic Impact Assessment of Leafy Spurge in Southern Manitoba – Final Report. Rural Development Institute, Brandon University, Brandon, Manitoba. https://www.brandonu.ca/rdi/files/2011/03/EconomicImpactAssessment2010.pdf

8 – Manglai. Examining record keeping and benchmarking effects on the production and performance of cow-calf farms in Canada [thesis]. Saskatoon (SK): University of Saskatchewan; 2016.

9 – Manitoba Agriculture and Rural Development. Agrimaps. [accessed 2022 Dec 01]. https://agrimaps.gov.mb.ca/agrimaps/

10 – Iwanchysko P. Measuring the impact of planned grazing on forage, soil, and livestock productivity. 2021. Brandon (MB): Manitoba Beef & Forage Initiatives Inc. Available from: https://www.mbfi.ca/planned-grazing

11 – Thornton J, Elsinger M. Improving marginal pastures through rotational grazing compared to mob grazing. 2020. Brandon (MB): Manitoba Beef & Forage Initiatives Inc. Available from: https://www.mbfi.ca/marginal-pasture-grazing

12 – Iwanchysko P. Brookdale grazing: Impact of utilization. 2022. Brandon (MB): Manitoba Beef & Forage Initiatives Inc.

13 – Elsinger M. First Street grazing: Impact of rest and duration. 2022. Brandon (MB): Manitoba Beef & Forage Initiatives Inc.

14 – Manitoba Beef & Forage Initiatives. Annual forage intercrop to build soil health. 2022. Brandon (MB): Manitoba Beef & Forage Initiatives Inc.

15 – Current Ag Weather Conditions. Winnipeg (MB): Manitoba Agriculture. https://www.gov.mb.ca/agriculture/weather/current-ag-weather-conditions.html

**Figures**


*Figure 1. First Street Pasture (left) and Johnson Farm (Right) pastures and fields used for benchmarking.*


*Figure 2. Brookdale Farm map of pastures and fields used for benchmarking.*

Table 13a. Soil fertility in 2022

| Site | Field | Landuse | Organic Matter (%) | pH | | Soluble Salts (mmho/cm) | | Cation Exchange Capacity (meq) | Base Saturation (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0-6” | 6-24” | 0-6” | 6-24” | | Ca | Mg | K | Na | H |
| Brookdale | Field 2 | No grazing | 6.7 | 7.9 | 8.3 | 0.31 | 0.62 | 29.9 | 83.1 | 13.4 | 3.3 | 0.2 | 0.0 |
| | E1 | 50% utilization | 7.9 | 7.8 | 8.3 | 0.39 | 0.36 | 34.8 | 82.4 | 15.1 | 2.3 | 0.2 | 0.0 |
| | E2 | 50% utilization | 5.4 | 7.7 | 8.1 | 2.88 | 2.50 | 45.0 | 68.1 | 28.0 | 1.7 | 2.2 | 0.0 |
| | E3 | 80% utilization | 7.2 | 7.3 | 8.1 | 0.34 | 0.33 | 27.4 | 77.8 | 19.4 | 2.6 | 0.2 | 0.0 |
| | E4 | 80% utilization | 5.5 | 7.8 | 8.2 | 0.36 | 0.72 | 29.8 | 76.2 | 21.2 | 2.3 | 0.3 | 0.0 |
| | Field 5 South | Hay + fall grazing | 5.9 | 7.7 | 8.4 | 0.33 | 0.32 | 28.9 | 78.7 | 19.3 | 1.8 | 0.3 | 0.0 |
| | Field 6 | Hay, no grazing | 6.7 | 7.7 | 8.1 | 0.33 | 0.82 | 30.8 | 77.0 | 20.9 | 1.8 | 0.3 | 0.0 |
| | Field 7 | Barley Monocrop | 5.5 | 7.8 | 8.3 | 0.47 | 0.58 | 30.0 | 78.3 | 19.1 | 2.2 | 0.3 | 0.0 |
| | Field 7 | Barley Polycrop | 5.7 | 7.8 | 8.4 | 0.46 | 0.68 | 31.2 | 78.3 | 19.3 | 2.0 | 0.3 | 0.0 |
| First Street | D | One-day rotation | 3.7 | 7.7 | 8.1 | 0.15 | 0.16 | 16.4 | 80.8 | 16.3 | 2.7 | 0.2 | 0.0 |
| | E | Multi-day rotation | 4.9 | 7.7 | 8.1 | 0.19 | 0.15 | 18.4 | 75.5 | 21.6 | 2.6 | 0.3 | 0.0 |
| Johnson | Paddock 12 | Oat monocrop | 2.9 | 6.4 | 8.1 | 0.13 | 0.16 | 13.7 | 72.1 | 15.6 | 1.8 | 0.5 | 10.0 |

Table 13b. Soil fertility in 2022.

| Site | Field | Land Use | Nitrate (lb/ac) 0-6” | Nitrate (lb/ac) 6-24” | Phosphorus (ppm) | Potassium (ppm) | Sulfur (lb/ac 0-6” | Sulfur (lb/ac 6-24” | Calcium (ppm) | Magnesium (ppm) | Zinc (ppm) | Sodium (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brookdale | Field 2 | No grazing | 1 | 3 | 4 | 389 | 18 | 360+ | 4969 | 480 | 0.84 | 11 |
| | E1 | 50% utilization | 4 | 3 | 3 | 310 | 24 | 36 | 5741 | 633 | 0.79 | 16 |
| | E2 | 50% utilization | 1 | 3 | 6 | 293 | 120+ | 360+ | 6124 | 1514 | 0.69 | 231 |
| | E3 | 80% utilization | 6 | 3 | 6 | 274 | 20 | 30 | 4267 | 637 | 1.07 | 15 |
| | E4 | 80% utilization | 2 | 3 | 5 | 262 | 28 | 360+ | 4543 | 760 | 0.59 | 22 |
| | Field 5 South | Hay + fall grazing | 7 | 3 | 4 | 206 | 14 | 24 | 4539 | 667 | 0.72 | 17 |
| | Field 6 | Hay, no grazing | 10 | 3 | 4 | 219 | 12 | 360+ | 4737 | 772 | 0.84 | 22 |
| | Field 7 | Barley Monocrop | 9 | 6 | 10 | 261 | 37 | 148 | 4717 | 684 | 0.79 | 24 |
| | Field 7 | Barley Polycrop | 10 | 7 | 11 | 243 | 57 | 199 | 4896 | 720 | 0.83 | 23 |
| First Street | D | One-day rotation | 3 | 6 | 3 | 170 | 10 | 12 | 2652 | 332 | 0.84 | 8 |
| | E | Multi-day rotation | 4 | 6 | 4 | 186 | 22 | 18 | 2772 | 476 | 1.46 | 11 |
| Johnson | Paddock 12 | Oat monocrop | 16 | 9 | 18 | 97 | 8 | 18 | 1970 | 255 | 0.97 | 16 |