Muka-- Tree Hay as an Alternative Livestock Feed

Tree hay and the feeding of trees during the grazing season has been a common practice historically. In recent decades it has more commonly been a practice in times of drought. To help with the cost of keeping livestock in the winter, a method of preserving and storing relatively large amounts of tree hay is needed. Because tree hay is bulky and does not readily lend itself to ordinary haying equipment (baling), this project involved processing small branches, twigs, and leaves with a wood chipper and drying the product with a modified grain dryer.

The project was funded by NESARE.

This project tested the palatability of two tree species-- poplar and black spruce.
This project had some extremely interesting results. First we learned that an invasion of caterpillars can have a significant effect on the amount of leaves in the woods. A severe infestation meant we had to delay harvesting poplar or go to a more distant part of the woods to harvest tree hay.

Secondly we found that the grain dryer was unnecessary. The tree hay dried quite quickly and we never had to utilize the grain dryer. If anything, it dried more quickly than grass hay.
Thirdly we found that the animals fed the black spruce/hay ration found that ration somewhat less palatable than the other groups and gained less. The other groups were all roughly the same.

This project sought to develop an efficient way to dry and store relatively large amounts of tree hay (muka) on farm. This project did the following:

1. Determined the labor and cost required to harvest and store muka using a wood chipper and a modified grain dryer.
2. Evaluated which of three variants of muka are the best supplemental feed for beef cattle. The three variants (poplar, black spruce, 50% poplar/50% black spruce) were tested for nutrition at DairyOne in New York. It was tested for protein, nitrogen, and trace minerals. The muka was fed in the fall and winter of 2024-2025. A control of just hay-- our normal ration-- was fed and compared to the other three feeds.
3. We evaluated palatability of the feed including how much was consumed and how much was wasted.
4. We evaluated cattle for weight gain and body condition while being fed the muka.
5. We determined which of the three feeds is the most appropriate for beef cattle and produce a financial and nutritional analysis of the feed in comparison to other forages.

Cost of production has been on the rise for livestock farmers. All inputs-- including feed, fertilizer, fuel, and labor have gotten increasingly expensive in recent years. In addition, more erratic climate patterns have made livestock farmers more economically vulnerable. In the northeast during drought, many farmers have had to resort to trucking feedstuffs in from distant

places-- an expensive practice that has a significant environmental impact. This project aimed to develop a feed that can be produced cheaply on-farm, in times of drought and at times of the year when other feedstuffs cannot be harvested.

Although currently underutilized, tree hay has been fed to livestock for centuries-- particularly in Russia, where it is known as muka. (Young.) As a feed, it has several advantages. Trees are quite resistant to drought and other weather extremes and can be harvested when other forages do not produce. In the northeast, trees are plentiful. Maine, for example, is the most forested state. Most farmers own or have access to an underutilized woodlot. In addition, tree hay as produced in this project could be produced in coordination with a nearby logging operation, making a useful feed out of the twigs, leaves, and small branches that would otherwise go to waste. A cheap, plentiful, quality feed can only help productivity and economical viability for livestock farmers in the northeast.

Shipping is not going to become cheap. Having hay or other feeds shipped in from the Midwest or from Canada is not a viable financial option in the long term. Also, local feeds reduce the carbon footprint of agriculture. The closer a feed is produced to the farm it is fed on, the less environmental impact that feed has.

Tree hay also improves the economical situation for farmers because it can be produced in coordination with logging. Lumber prices are high-- a farmer could cut some trees, make the twigs, branches, and leaves into feed, and also make a profit from selling the logs or lumber. Tree hay is the ultimate resilient crop. The forests of the northeast fortunately recover from thinning quite quickly. Tree hay can also be produced via pollarding-- cutting off selected branches of the tree while leaving the stem intact. In this way, a woodlot can produce tree hay indefinitely. Also, if a farmer were set up to easily harvest and store tree hay in volume, that farmer could make use of the inevitable blowdowns that regularly occur in any woodlot. Resistant to drought and other extreme weather, regenerative, and readily available, tree hay is bound to increase the resiliency of livestock farms in the northeast.

Another challenge livestock farmers currently face in the northeast is availability of land. Land prices have risen sharply in recent years because of the pandemic and various other reasons. Many people have chosen to move to more rural areas, sometimes changing the status of rented agricultural land. High food prices have also contributed to agricultural land being more in demand and sometimes harder to access. Using trees as feed increases the amount of cropland available to livestock producers.

In addition, tree hay diversifies the nutrition being delivered to the livestock. Several species of trees have been shown to contain minerals and other nutrients not readily available from other sources.

We own 100 acres of mixed woodlot which has had very little logging done on it in the past forty years. It is dominated by spruce and fir with white birch, poplar, yellow birch, brown ash, and white cedar. For this project we focueds on thinning some of the spruce and poplar. I am experienced in sustainable forestry -- I use a team of oxen along with trucks and tractors. The oxen hauled the branches to a landing where the branches were chipped.

The system worked, although it took more time than we had anticipated. We enjoy working with oxen but a more mechanized way of moving the branches may be more efficient for many farmers. Our method of doing it was cheap.

We found that it was relatively easy to get the muka to 15% moisture. The key was to cut in the morning, haul the branches to rows at the landing, and leave them there until day three. The branches continued to transpire and dry. We chipped them on day three. We ended up not using black plastic as planned. We had several large hay tarps from when we used them to cover dry hay. They shed the rain and worked well to store the muka. In the few instances when were experienced unanticipated rain, we used hay tarps to cover the drying tree hay.

We used a three point hitch wood chipper behind a massey ferguson tractor to chip.

The trees ranged in dbh from 10 to 14 inches, with 12 inches being the average for both poplar and black spruce. On average, the poplar yielded 180 pounds of dry muka per tree while the black spruce yielded 150. It took six hours of labor to produce a ton of poplar muka and eight hours of labor to produce a ton of black spruce muka. The difference is accounted for by the growth habit of black spruce-- it often has a long stem with no branches until the very top. Poplar has a much more open and branched form.

We ended up producing 20 tons of muka-- it took longer in hours and also more of the summer than we had anticipated.

We started feeding the muka in October. We had four groups of eight. Feeding the animals went as planned.

We fed a herd of thirty-two beef animals (dexters) born in the spring of 2023. The animals were evaluated for body condition and scored prior to feeding. The animals were also taped to determine weight before feeding starts. Group one was fed 80% hay, 20% poplar muka. Group two was fed 80% hay, 20% black spruce muka. Group three was fed 80% hay, 20% muka which was half poplar and half black spruce. Group four was the control and fed our normal ration-- clover and timothy hay. (Initially, the animals were gradually transitioned from all hay to 20% muka over a two week period so they didn't experience any digestive problems.)

Feeding this ration proceeded for the duration of the winter (roughly 200 days) at which time the animals were evaluated, taped, and scored for body condition again.

Throughout the course of the project we recorded how much of the muka was consumed daily and how much was wasted. Body condition and weight gain was also recorded for each animals each month.

Group One(p)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1.	320	330	355	360	370	385	400	420
2.	300	330	355	360	370	390	420	440
3.	300	335	350	370	385	400	420	440
4.	305	320	345	355	365	380	410	440
5.	320	340	355	375	385	400	420	440
6.	305	325	345	365	380	400	430	450
7.	310	330	350	360	375	390	425	450
8.	290	325	350	360	375	395	420	440
Group Two(bs)								
1.	365	380	400	405	420	425	430	440
2.	350	365	380	390	400	405	410	420
3.	325	345	365	380	390	400	410	420
4.	315	330	355	370	380	385	400	410
5.	340	350	360	370	375	380	385	400
6.	345	360	370	375	375	380	385	395
7.	320	340	355	360	365	380	385	395
8.	345	350	360	365	365	375	380	385
Group three (p/bs)								
1.	295	325	355	370	380	400	420	440
2.	300	330	355	365	375	390	420	450
3.	290	315	330	340	350	370	400	430
4.	290	315	330	345	350	370	375	410
5.	290	310	345	355	360	370	395	410
6.	305	310	335	345	350	375	390	420
7.	310	315	330	345	350	370	390	420
8.	300	320	340	350	355	365	380	410
Group Four(c)								

1.	330	350	370	370	370	375	380	390
2.	315	325	340	345	350	360	375	390
3.	320	340	350	360	365	370	375	390
4.	330	345	355	360	365	370	375	390
5.	315	330	350	350	355	360	370	385
6.	300	325	350	355	355	360	370	385
7.	295	310	330	330	340	350	360	370
8.	330	340	350	355	360	370	385	390

Dexters are small cattle and are relatively slow growing. The winter in northern Maine is harsh. Average weight gain for group one-- fed hay and 20% muka-- was 135lbs. Average gain for group two-- fed hay and 20% black spruce muka-- was 70 lbs. Average gain for group three-- fed hay and 20% poplar/black spruce muka-- was 126 lbs. Average gain for the control group-- fed hay-- was 70lbs.

Waste for groups one, three, and four were minimal-- under 5%. Waste for the black spruce was more-- we estimate that roughly 20% of the black spruce was not consumed. This indicates that there was a palatability issue.

Poplar

272 EAST RD |% Crude Protein | 7.6 | 8.0 |

NEW SWEDEN, ME 04762 |% Available Protein | 7.0 | 7.4 |

|% ADICP | .6 | .6 |

|% Adjusted Crude Protein | 7.6 | 8.0 |

---------- |Soluble Protein % CP | | 36 |

ENERGY TABLE - NRC 2001 |Degradable Protein%CP | | 57 |

---------- |% NDICP | 2.2 | 2.4 |

Mcal/Lb Mcal/Kg |% Acid Detergent Fiber | 36.8 | 39.0 |

------- ------- |% Neutral Detergent Fiber| 59.4 | 62.9 |

DE, 1X 1.16 2.55 |% Lignin | 8.7 | 9.1 |

ME, 1X 0.96 2.12 |% NFC | 21.1 | 22.4 |

NEL, 3X 0.54 1.19 |% Starch | 8.6 | 9.1 |

NEM, 3X 0.56 1.24 |% WSC (Water Sol. Carbs.)| 7.3 | 7.8 |

NEG, 3X 0.30 0.67 |% ESC (Simple Sugars) | .2 | .2 |

---------- |% Crude Fat | 2.7 | 2.8 |
TDN1X, % 58 |% Ash | 5.88 | 6.23 |
---------- |% TDN | 55 | 58 |
NEL, Mcal/Lb	.48	.51
NEM, Mcal/Lb	.50	.53
NEG, Mcal/Lb	.26	.27
Relative Feed Value		87
% Calcium	.41	.43
% Phosphorus	.15	.16
% Magnesium	.16	.17
% Potassium	.86	.91
% Sulfur	.17	.18
% Chloride Ion	.18	.19
% Lysine	.22	.24
% Methionine	.11	.12
Horse DE, Mcal/Lb	.91	.97
Black Spruce

|% Moisture | 6.1 | |
JOHN O MEARA |% Dry Matter | 93.9 | |
182 EAST RD |% Crude Protein | 6.5 | 6.9 |
NEW SWEDEN, ME 04762 |% Available Protein | 5.3 | 5.6 |
|% ADICP | 1.2 | 1.3 |
|% Adjusted Crude Protein | 6.5 | 6.9 |
---------- |Soluble Protein % CP | | 37 |
ENERGY TABLE - NRC 2001 |Degradable Protein%CP | | 68 |
---------- |% NDICP | 2.3 | 2.4 |
Mcal/Lb Mcal/Kg |% Acid Detergent Fiber | 43.5 | 46.4 |
------- ------- |% Neutral Detergent Fiber| 62.4 | 66.4 |
DE, 1X 1.04 2.29 |% Lignin | 10.7 |11.3 |
ME, 1X 0.85 1.87 |% NFC | 20.4 | 21.7 |
NEL, 3X 0.46 1.02 |% Starch | 2.0 | 2.1 |

NEM, 3X 0.47 1.04 |% WSC (Water Sol. Carbs.)| 8.0 | 8.6 |
NEG, 3X 0.22 0.49 |% ESC (Simple Sugars) | 1.8 | 2.0 |
---------- |% Crude Fat | 2.4 | 2.5 |
TDN1X, % 53 |% Ash | 4.57 | 4.87 |
---------- |% TDN | 50 | 53 |
NEL, Mcal/Lb	.41	.44
NEM, Mcal/Lb	.41	.44
NEG, Mcal/Lb	.18	.19
Relative Feed Value		74
% Calcium	.62	.66
% Phosphorus	.18	.19
% Magnesium	.15	.16
% Potassium	1.03	1.10
% Sulfur	.13	.14
% Chloride Ion	.18	.19
% Lysine	.19	.20
% Methionine	.10	.10
Horse DE, Mcal/Lb	.88	.94

Poplar/Black Spruce Mixed
|% Moisture | 4.8 | |
JOHN O MEARA |% Dry Matter | 95.2 | |
272 EAST RD |% Crude Protein | 6.1 | 6.4 |
NEW SWEDEN, ME 04762 |% Available Protein | 5.5 | 5.8 |
|% ADICP | .6 | .6 |
|% Adjusted Crude Protein | 6.1 | 6.4 |
---------- |Soluble Protein % CP | | 37 |
ENERGY TABLE - NRC 2001 |Degradable Protein%CP | | 61 |
---------- |% NDICP | 2.5 | 2.7 |
Mcal/Lb Mcal/Kg |% Acid Detergent Fiber | 38.9 | 40.9 |
------- ------- |% Neutral Detergent Fiber| 62.9 | 66.1 |
DE, 1X 1.14 2.51 |% Lignin | 5.7 | 6.0 |

ME, 1X 0.95 2.08 |% NFC | 21.3 | 22.4 |

NEL, 3X 0.53 1.16 |% Starch | .8 | .9 |

NEM, 3X 0.55 1.21 |% WSC (Water Sol. Carbs.)| 12.4 | 13.1 |

NEG, 3X 0.29 0.64 |% ESC (Simple Sugars) | 1.6 | 1.7 |

---------- |% Crude Fat | 2.3 | 2.5 |

TDN1X, % 58 |% Ash | 5.11 | 5.37 |

---------- |% TDN | 55 | 58 |

|NEL, Mcal/Lb | .46 | .48 |

|NEM, Mcal/Lb | .49 | .52 |

|NEG, Mcal/Lb | .25 | .26 |

|Relative Feed Value | | 80 |

|% Calcium | .34 | .36 |

|% Phosphorus | .13 | .14 |

|% Magnesium | .18 | .19 |

|% Potassium | .77 | .81 |

|% Sulfur | .17 | .18 |

|% Chloride Ion | .15 | .16 |

| | | |

|% Lysine | .18 | .19 |

|% Methionine | .09 | .10 |

| | | |

|Horse DE, Mcal/Lb | .90 | .95 |

The numbers on the nutrient values were better than expected and show that tree hay in general is a viable feed.

Weight gain averages indicate that the poplar and poplar/black spruce feed is a much better choice than just hay and black spruce. Palatability also indicates that the poplar and the mixed muka are a better choice. In addition, the black spruce costs more in labor to produce.

However, the black spruce has the advantage that it can be harvested in winter, when one is not making hay.

Overall, poplar tree hay seems the best of what was tested. Because of the ability to harvest black spruce in winter and mix it with poplar, thereby achieving similar weight gains and palatability, that is also a viable option. The results of this project indicate that feeding black spruce at 20% rate should only be done in a feed emergency. It would be better to just feed hay if hay were available.