SUITABILITY OF ASPEN TREES AS LIVESTOCK FEED

Phase II

Utilization of Aspen Trees

as a

Ruminant Feed Component

THE OLD WEST REGIONAL COMMISSION
May 1977

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Utilization of Aspen Trees
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Ruminant Feed Component**

May 1977

Prepared for the Old West Regional Commission
by
The South Dakota State Division of Forestry
Department of Game, Fish and Parks
Pierre, South Dakota 57501

The Old West Regional Commission is a Federal-State partnership designed to solve regional economic problems and stimulate orderly economic growth in the states of Montana, Nebraska, North Dakota, South Dakota and Wyoming. Established in 1972 under the Public Works and Economic Development Act of 1965, it is one of seven identical Commissions throughout the country engaged in formulating and carrying out coordinated action plans for regional economic development.

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FOREWORD

Building on an earlier demonstration which clearly proved the suitability of ground aspen as a component in livestock feed, this considers the economic factors of harvesting and utilizing the product for a feed component, and its competitive status in relation to traditional feeds. Like Phase I of the project, this portion of the work was conducted by the Animal Science Department of South Dakota State University at Brookings. Principal investigators were Leslie D. Kamstra, L. B. Embry and Mahendra Singh.

Warren C. Wood
Federal Cochairman

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INTRODUCTION

Aspen, (*Populus tremuloides*), which is found growing in relative abundance throughout the region, is not presently being utilized for any purpose other than for occasional use as firewood.

Due to the fact that industrial markets for aspen are virtually non-existent, the periodic harvesting of the stands necessary for their perpetuation does not occur. Consequently, as the individual trees age and eventually mature, they become virtually useless as a source of food and cover for wildlife, and for use in the manufacture of wood products, because of defects caused by excessive rot.

Since extensive harvesting of a timber resource cannot take place without adequate markets, it remained for someone to examine marketing possibilities for the material which could be generated in an aspen harvesting program. Most traditional markets were ruled out because the size and quality of the raw material which would be scheduled for cutting made it generally unsuitable for conversion into useful products by existing manufacturing methods. Consultations with Dr. L.D. Kamstra of the College of Agriculture and Biological Science at South Dakota State University, subsequently revealed that prior research efforts directed at utilization of wood materials for livestock feed indicated that in all likelihood, aspen trees could be converted into a suitable food for livestock. It was felt that if this could be successfully demonstrated, either a new or existing industry could capitalize on the opportunity which would result in benefits to the livestock industry, the rural economy, and the timber

and wildlife resources. A study plan was subsequently formulated and funding approval obtained from the Old West Regional Commission. The following section contains a brief description of the study procedure used.

THE STUDY

Objectives:

1. To determine whether or not aspen trees can be economically reconstituted into a form suitable for use as livestock feed at less cost per unit than traditional feeds presently available.
2. To determine the value of aspen in maintenance rations.
3. To establish the value of treating aspen to increase its utilization in high roughage rations.
4. To determine the nutrient components of aspen by analytical and other laboratory procedures.

Procedures:

A. Harvesting

A cutting site, typifying Black Hills aspen stands, was selected on National Forest lands in Township 5 North, Range 5 East, Section 17, and was sampled for the following factors:

No. of trees per acre -----	470
Avg. Diameter at Breast Height -----	5.53 inches
Stand Age -----	60 years
Site -----	Fair

Harvesting operations began on June 17, 1975, after the trees had broken dormancy and were carried on sporadically until approximately 80,000 lbs. of aspen chips had been manufactured and shipped to Egan, South Dakota for further processing. To obtain this quantity of chips required the removal of all aspen trees from an area approximately 1.3 acres in size. Using the factor of 470 trees/acre, the average tree yielded 131 lbs. of green chips. This is consistent with the results of

an earlier sample obtained from Custer State Park in which the average tree was found to yield 126 lbs. of green chips.

No attempt was made to either define or utilize a "best harvesting method" for use on the project since the primary objectives dealt largely with the feeding aspects of the study. As a result, conventional logging methods were used to harvest the trees, chipping was accomplished by use of a substantially smaller chipper than those used on commercial, whole tree chipping operations, and no financial limitations were imposed on the harvesting operations other than those deemed necessary to stay within the fiscal requirements of the agreement. However, by utilizing grapple skidders and a whole tree chipper on the order of Morbarks "Chip Harvester", the combined cost of harvesting and chipping could be expected to approximate \$21.00 per green ton.

B. Processing

The green chips were trucked to Egan, South Dakota and immediately upon arrival were put thru a dryer to reduce the moisture content, in order to retard spoilage and facilitate grinding. Following drying, they were ground to an average size of approximately 0.16 centimeter. The ground material was then mixed with additional components and pelletized to formulate the rations listed in Table 1.

Table 1
Ration Composition

Ingredients	Ration No.					
	1	2	3	4	5	6
	(Lbs. of Ingredients/100 lbs. of ration)					
Alfalfa	93	73	53	33	13	13
Soybean Oil Meal*	--	8	16	24	32	32
Aspen	--	12	24	36	48	48**
Molasses	5	5	5	5	5	5
Trace Minerals	1	1	1	1	1	1
Dicol	1	1	1	1	1	1
Vitamin A***						

* Ratio of 60-40 aspen-soybean oil mix was held constant for all rations.

** Treated by adding 4% Na OH by weight.

*** 2,000 I.V. of vitamin A added/kg. of ration

After formulation, the various rations were analyzed for their chemical composition. The results are contained in Table 2.

Table 2
Chemical Composition of The Rations

Ration No.	Carotene	Acid Detergent Fiber	Crampton & Maynard Fiber	Crude Protein	Ca	P
	Mg/lb	P E R C E N T				
1 - Control	2.20	42.97	28.90	12.91	1.62	0.32
2 - 12% Aspen	0.98	37.97	29.36	13.62	1.35	0.39
3 - 24% Aspen	1.32	38.73	28.62	15.00	1.38	0.42
4 - 36% Aspen	0.72	35.12	27.91	16.27	1.03	0.34
5 - 48% Aspen	0.62	34.01	27.82	16.27	1.08	0.38
6 - 48% Aspen & Na OH	0.72	34.81	28.54	15.61	0.98	0.35

In addition to analyzing the rations, each truck load of chips was sampled and analyzed for the following factors:

1. Moisture
2. Ash
3. Detergent Lignin
4. Detergent Fiber
5. Crampton & Maynard Cellulose
6. Crude Protein

The resultant data is contained in Table 3.

Table 3
Composition of Aspen Chip Samples

Load No. and Sample Date	Moisture	Ash	Detergent Lignin	Detergent Fiber	Crampton & Maynard Cellulose	Crude Protein
			P E R C E N T			
1 - 7/2	41.5	2.19	8.54	58.84	46.62	1.38
2 - 7/22	43.8	2.78	12.56	60.50	46.42	1.58
3 - 7/25	42.7	4.70	11.46	54.52	37.82	1.44
4 - 8/5	35.8	1.85	13.58	58.20	40.26	1.41
5 - 8/8	38.6	1.77	14.62	59.50	42.89	0.90
6 - 8/13	41.3	1.45	11.40	61.52	43.33	0.72
7 - 8/-	----	1.92	11.98	58.23	40.88	0.96
8 - 8/26	43.3	1.84	11.96	59.49	41.24	0.86

C. Feeding Trials

Sixty Hereford steers weighing approximately 725 pounds each were selected and randomly sorted into 12 lots of five animals each. Feeding commenced on July 15th and continued for a period of 93 days. The animals were cleaned and weighed on the 32nd and 57th days of the trial with the final weigh-in occurring on the 93rd day. Feeding was discontinued for several days in order to obtain the shrunk weight. Data obtained in the feeding trials is contained in Table 4, Feedlot Performance of Six Aspen Rations.

Table 4
Feedlot Performance of Six Aspen Rations

	#1 Control	#2 12% Aspen	Ration #3 24% Aspen	#4 36% Aspen	#5 48% Aspen	#6 48% Aspen +4% NaOH
Number of Animals	10	10	10	10	10	10
Number of Days Fed	93	93	93	93	93	93
Avg. Initial Filled Wt.	728 lbs.	728	723	726	725	726
Avg. Initial Shrunk Wt.	708 lbs.	705	702	702	704	704
Avg. Final Filled Wt.	873 lbs.	934	980	989	978	970
Avg. Final Shrunk Wt.	826 lbs.	893	937	951	930	931
Avg. Daily Ration Consumption (lbs)						
At 32 Days	16.49	19.03	23.75	24.42	23.25	23.71
At 57 Days	21.38	24.46	28.56	29.40	26.14	27.42
At 93 Days	24.68	27.74	30.33	30.86	27.81	29.09
Avg. Daily Gain (lbs)						
At 32 Days	0.94	1.48	3.16	3.56	3.27	3.63
At 57 Days	1.69	2.90	3.52	3.32	3.17	3.16
At 93 Days (Filled)	1.55	2.23	2.77	2.83	2.72	2.62
At 93 Days (Shrunk)	1.26	2.02	2.53	2.68	2.42	2.44
Lbs. of Feed Consumed Per Lb. of Gain						
At 32 Days	20.31	13.54	7.53	6.88	7.12	6.58
At 57 Days	15.63	10.26	8.08	9.04	8.31	9.59
At 93 Days (Filled)	15.93	12.49	10.95	10.95	10.25	11.12
At 93 Days (Shrunk)	19.50	13.80	12.07	11.66	11.56	12.03

CONCLUSIONS

A. Economic Implications

Probably the most logical approach to an examination of the economics of feeding experimental rations is one which compares the cost per pound of gain made by the ration fed livestock with the cost per pound of gain made by the animals utilizing a conventional feed. Table 5, Comparative Cost Data, serves to accomplish this by splitting out the various cost components for viewing and than recombining them into a total cost per ration from which a figure representing cost per pound of gain can be developed for each ration fed. The cost components used include harvesting and chipping, drying, grinding, pelletizing, and bagging. The cost of transporting the aspen chips from the woods to a processing point was not included because it was felt that the extreme variations involved in trucking distances and charges, prohibits developing a truly meaningful average transportation cost figure. With the exception of the harvesting and chipping costs, all other costs used in the analysis are "as experienced" costs and should not be construed to represent the actual costs which would be experienced by a prudent entrepreneur engaged in producing a large volume of feed. Especially might this hold true for the drying and grinding costs which could be expected to be significantly less for a large scale operation.

The harvesting and chipping costs used in the analysis was selected after a search of the literature dealing with whole tree harvesting and chipping. USDA Forest Service Research Paper RM-125 titled "Demonstration

Test of Inwoods Pulp Chip Production in The Four Corners Region" served as the major reference for this purpose, and the cost figure selected for use was purposely inflated in order to retain a somewhat "conservative" approach to the analysis.

Table 5
Comparative Cost Data

Cost Item	Cost/Ton in Dollars	Cost/lb in Cents	Cost Per Ton In Dollars				
			Control	12% level	24%	36%	48%
Harvesting & Chipping	20.50	0.01	0	2.40	4.80	7.20	9.60
Drying	18.60	0.009	0	2.16	4.32	6.48	8.64
Grinding	1.90	0.009	0	0.22	0.44	0.66	0.88
(1) Sub Total = (Cost of aspen portion of the ration)	41.00	0.0205	0	4.78	9.56	14.34	19.12
(2) Pelletizing & Bagging	18.00	0.009	18.00	18.00	18.00	18.00	18.00
(3) Cost of the Additive Portion of Ration			97.75	96.75	89.00	81.70	75.20
Total Ration Cost (Sum of Items 1-3)			115.75	119.53	116.56	114.04	112.32*
Ration Cost/Lb.			.058	.060	.058	.057	.056
Ration Cost/Lb of Gain (Shrunk wt)			1.13	.83	.70	.66	.65

It would appear that all aspen containing rations were significantly superior to the alfalfa control ration in average daily gain, feed requirements per pound of gain, and cost per pound of gain. The addition of Sodium Hydroxide to the rations did not increase animal utilization.

It seems likely that aspen could serve as a major component of maintenance, high roughage rations if its known nutritional deficiencies such as protein and Vitamin A are corrected. It would also appear that aspen has potential value as a component of growing rations.

B. Raw Material Aspects

Aspen grows in abundance in most of the forested states west of the Mississippi, although normally the acreage occupied by the species is quite small in relation to the total forested area.

It (aspen) is classified in most forest inventories as a "non-commercial" species, ie; a species having little or no potential as raw material for conversion into useful products, and as such it tends to be disregarded by most forest managers. This is especially true in the area making up the "old west region" where the aspen stands are generally small sized and are widely interspersed among extensive stands of the various coniferous species native to the area.

Forest inventory data for the Black Hills area of South Dakota, where aspen is typically found growing under the conditions described, can well serve to illustrate the potential of the resource. Although no attempt was made to determine the total quantity of aspen present in the five state area, it is estimated that the volumes set forth in Table 6, Black Hills

Aspen Resource, represents less than one seventh of the total available for use as livestock feed.

Table 6
Black Hills Aspen Resource

Ownership	1/ Dry Tons (-15% M.C.)	2/ Cubic Feet	
U.S. Forest Service	181,426	10,734,400	
Private Lands	48,519	2,870,718	
State Lands	7,049	417,091	
Total	236,994	14,022,209	

1/ Includes the main stem, branches, and leaves of trees 5 inches in diameter or larger at breast height.

2/ Includes the mainstem portion only of trees 5 inches in diameter or larger at breast height.

Based on these and other data, it is estimated that a sustained yield aspen harvesting program in the Black Hills could generate from 15,000 to 20,000 tons of dry chips per year.

A P P E N D I X

Slaughter Data

(Each figure represents an average of four randomly selected animals)

	#1	#2	#3	#4	#5	#6
	Control	12% Aspen	24% Aspen	36% Aspen	48% Aspen	48% Aspen W/Na OH
Hot Carcass Weight	489.0	546.3	561.3	579.0	583.0	548.3
Dressing %	54.2	56.8	56.5	56.9	56.1	55.7
Fed Grade	Standard	Standard Plus	Good	Good	Standard Plus	Standard Plus
Morrell Grade	Good	Good	Good	Good	Good	Good
Marbling Score	2.8	3.0	3.8	3.8	3.3	3.3
Abscessed Livers	1	0	0	0	0	0

Taste Values (10 Member Panel)

Tenderness	3.82	3.48	3.23	4.02	3.03	2.80
Flavor	3.43	3.25	3.13	3.43	3.18	3.00
Juiciness	3.90	3.80	3.53	3.98	3.58	3.10
Confirmation	17.8	19.0	19.3	19.5	19.0	19.3
Maturity	23.0	23.0	23.0	23.0	23.0	23.0
Color	3.5	3.8	5.3	5.0	3.8	4.8
Firmness	5.0	4.8	5.8	5.5	5.3	5.3

O.W.R.C ASPEN FEEDING STUDY
Grant # 10570108
Statement of Expenditures

<u>ITEM</u>	<u>AMOUNT</u>	<u>DATE PAID</u>
1. Contractual Services by SDSU	\$ 5,000.00	June 1975
College of Agriculture	2,650.00	July 1975
and Biological Sciences	6,120.00	Nov. 1975
	1,530.00	Dec. 1975
2. Contract skidding expense	515.00	Aug. 1975
3. Contract labor for cutting	777.00	Sept. 1975
4. Contract chipping expense	797.00	Jan. 1976
5. Wood chip drying costs	743.90	Sept. 1975
6. Wood chip grinding costs	75.70	Sept. 1975
7. Supplies and Materials		
Gas and Oil	418.42	July-Nov. 1975
	431.37	March 1976
8. Miscellaneous		
A. Coons Machine Shop	16.00	Aug. 1975
B. Mon-Dak Stihl	17.25	Aug. 1975
C. Hill City Standard	9.00	Sept. 1975
Grand Total	\$19,100.64

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